ABSTRACT BOOK

The Association of European Operational Research Societies

Institute for Operations Research and the Management Sciences

Turkish Operational Research Society

Boğaziçi University

"New Opportunities for Operations Research"

istanbul ←2003→

JULY 06-10

EURO / INFORMS

JOINT INTERNATIONAL MEETING

www.istanbul2003.org

5th EURO/INFORMS Joint International Meeting

July 6 - 10, 2003

İstanbul, TURKEY

"New Opportunities for Operations Research"

ABSTRACT BOOK

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Message from EURO President

It is a pleasure to welcome you to the 5th edition of the joint EURO/ INFORMS Conference. The first joint conference was held in Lausanne in 1982, other meetings were held in Paris, Helsinki and the last one was held in Barcelona in 1997. I wish you a pleasant stay enjoying both İstanbul as a wonderful historic city and the scientific sessions with about 1500 contributions distributed in 90 topic areas, being the İstanbul meeting the biggest one that we have had as a joint meeting as well as an EURO Conference.

As President of EURO I would like to use this opportunity to briefly mention what is EURO and its organization. EURO is The Association of European Operational Research Societies within IFORS. Now it has 28 National OR Societies and during these days the Council of Representatives will vote on the membership of LITORS, the Lithuanian OR Society once it is a member of IFORS. The Executive Committee elected by the Council of Representatives handles the EURO day-by-day business. The mission of EURO is to promote OR in our society. For doing so EURO has given itself several instruments. The three most important instruments are the European Journal of Operational Research (EJOR), its first issue is from 1977, the Working Groups, currently there are 25, and the k-Conferences (İstanbul Conference is our k=XIX Conference, Rhodes Conference will be the XX Conference next year). EURO has other important instruments such as the mini-Conferences, the EURO Summer/Winter Institutes and the recently launched OR Peripatetic Post-Graduate Program (ORP3).

EURO prizes are the EURO Gold Medal to be awarded at each k-Conference as the highest distinction to be awarded to a person or an institution for his scientific contribution and promotion of OR, particularly in Europe, the EURO Excellence in Practice Award, the EURO MSSIP (Management Science Strategic Innovation Prize), currently sponsored by SAP and the new award the EURO DDA (Doctoral Dissertation Award). For more information, you can visit the EURO page at http: //www.euro-online.org.

I would like to mention the efforts and dedication of the Executive Committee to strengthen our relationship with the private sector and the European Commission, particularly with the Research and Development branch to help OR to become a priority research in the next R&D framework program.

I would not like to finish my welcome message without mentioning our special relationships not only with IFORS (a vice-president is VP EURO) and INFORMS but also with ALIO (Asociación Latina de Investigación de Operaciones).

I think it is worthy to mention that in cooperation with IFORS, EURO is conducting an African project to support the creation of National and transactional OR Societies and international meetings in Africa.

Again, I wish all of you a pleasant stay in İstanbul and an enjoyable meeting.

Laureano F. Escudero
EURO President

Message from INFORMS President

Welcome to İstanbul and the Joint Meeting of EURO and INFORMS. We hope you enjoy the rich heritage of this exciting city and the very special conference you have come to attend.

İstanbul is a fitting location for this international meeting. It traditionally represents the meeting place of East and West, Europe and Asia, a variety of cultures, religions, and nations. It is a place of ancient history and the most up-to-date innovation.

This is the first EURO/INFORMS meeting of the new millennium, and it promises an excellent array of presentations about advances in operations research. The most exciting people in the academic and practice halves of our field are addressing this conference. And we will recognize the excellent among us with awards to their fine work.

We are at a crossroads for our field, a time when we must actively acquaint business, government, and academia with the great role that we have the potential to play. Fittingly, the theme of the conference, **"New Opportunities for Operations Research,"** addresses this special moment. You will hear speakers highlight research directions to manage increasing complexity, dynamic behavior and uncertainty. You will receive guidance making our field more accessible to a broad spectrum from students to leaders of organizations. I think this is a meeting you will remember well.

On behalf of INFORMS, I thank all the organizers for their hard work. And I thank you for joining us at this special conference. I'm sure it will provide all of us with the tools to go forth and help our field, our students, our clients, and, indeed, the world.

Thomas Cook
INFORMS President

Message from the Organization Committee Chair

On behalf of the organization committee, let me welcome you to the EURO/INFORMS Joint International Conference in İstanbul during July 6-10, 2003. Boğaziçi University and the Turkish Operational Research Society are proud to host this meeting that will provide a unique opportunity of intellectual excitement and social reunion for renowned scholars and practitioners at the city where East meets West.

We have been motivated by the interest of the members of our professional societies. The total number of registrations now exceeds 1500 which is far above our initial expectations. A total of 912 papers are scheduled in invited sessions and 592 in contributed sessions, and the registered participants come from 64 different countries from all over the globe.

Over the course of millennia, İstanbul was the seat of three great empires - Roman, Byzantine and Ottoman - and a meeting place of peoples of many religions and cultures who came together and learned to live in peace and harmony. We believe that you will discover the same sense of scientific fusion in this meeting by interacting and exchanging innovative ideas with your colleagues in the context of "New Opportunities for Operations Research".

We hope you will also have some time to experience the splendors of the Roman, Byzantine and Ottoman past in this thriving metropolis, discover the traditional Turkish hospitality and make this Conference a treasured and lasting memory in your life.

Gülay Barbarosoğlu
Organization Committee Chair

Message from the Programme Committee Co-Chairs

Murat Tarımcılar

Gerhard Wäscher

Welcome to the beautiful and legendary city of İstanbul. As she has offered endless opportunities and memories to many civilizations through the ages, İstanbul is now ready to serve the OR/MS community of the World for the next few days. We hope you all have a productive and an enjoyable conference.

During the last decade, Operations Research/Management Science has evolved into many new exciting areas such as Financial Engineering, Reverse Logistics, Telecommunications, Health Care and many others. Under the conference theme, "New Opportunities for Operations Research", we would like to capture these developments and make them accessible to a wider audience. Almost 1,500 papers (invited and contributed) will be presented in parallel sessions, along with 4 plenary, 9 semi-plenary and 28 tutorial sessions, and an Industry Panel. We believe all these activities will develop a more complete view of Operations Research and its state-of-the-art.

Our sincere thanks go to all those who supported us in setting up this conference program. We are grateful to the members of the Program Committee and the Cluster Chairs who managed to attract so many researchers and practitioners to participate in the Conference. We have been enormously lucky to work with an impressive Local Organization Committee. We are indebted to them for their support and co-operation which they offered in a friendly, trusting, and accommodating atmosphere.

Despite a number of adverse developments in the region and globally, as a team, we managed to put together an impressive academic and social venue. We hope you take advantage of all the new ideas, all memorable moments and all personal friendships.

Murat Tarımcılar
PC Co-Chair (INFORMS)

Gerhard Wäscher
PC Co-Chair (EURO)

Committees

PROGRAMME COMMITTEE

Murat Tarımcılar
Co-Chair (INFORMS)
George Washington University
muratt@gwu.edu

Gerhard Wäscher
Co-Chair (EURO)
Otto-von-Guericke-Universität Magdeburg
gerhard.waescher@ww.uni-magdeburg.de

Michael O. Ball
University of Maryland
mball@rhsmith.umd.edu

Eberhard E. Bischoff
European Business Management School
e.lydiard@swansea.ac.uk

Raymond Bisdorff
Centre Universitaire de Luxembourg
bisdorff@cu.lu

Nesim Erkip
METU
erkipn@ie.metu.edu.tr

Erhan Erkut
University of Alberta
erhan.erkut@ualberta.ca

José Soeiro Ferreira
Universidade do Porto
jsf@fe.up.pt

Karla Hoffmann
George Mason University
khoffmann@gmu.edu

Jakop Krarup
University of Copenhagen
krarup@diku.dk

Silvano Martello
University of Bologna
smartello@deis.unibo.it

Süleyman Özekici
Koç University
sozekici@ku.edu.tr

Gary R. Waissi
University of Michigan
gwaissi@umd.umich.edu

INTERNATIONAL ORGANIZATION COMMITTEE

Gülay Barbarosoğlu
Chair
Boğaziçi University
barbaros@boun.edu.tr

Thomas Gulledge
George Mason University
gulledge@gmu.edu

Paul Jensen
University of Texas
pjensen@mail.utexas.edu

Jo van Nunen
Erasmus University Rotterdam
j.nunen@fbk.eur.nl

Zilla Sinuany-Stern
Ben-Gurion University of the Negev
zilla@bgumail.bgu.ac.il

Murat Tarımcılar
George Washington University
muratt@gwu.edu

Gerhard Wäscher
Otto-von-Guericke-Universität Magdeburg
gerhard.waescher@ww.uni-magdeburg.de

LOCAL ORGANIZATION COMMITTEE

Gülay Barbarosoğlu
Chair
Boğaziçi University
barbaros@boun.edu.tr

Kuban Altınel
Boğaziçi University
altinel@boun.edu.tr

Ümit Bilge
Boğaziçi University
bilge@boun.edu.tr

Taner Bilgiç
Boğaziçi University
taner@boun.edu.tr

Esra Çınar
Boğaziçi University
cinare@boun.edu.tr

Gökçe Esenduran
Boğaziçi University
esendura@boun.edu.tr

Eylem Koca
Boğaziçi University
kocaeyle@boun.edu.tr

İlhan Or
Boğaziçi University
or@boun.edu.tr

Kerem Özkısacık
Boğaziçi University
keremo@boun.edu.tr

Süleyman Özekici
Koç University
sozekici@ku.edu.tr

CONFERENCE THEME: "NEW OPPORTUNITIES FOR OPERATIONS RESEARCH"

Today operations research faces significant theoretical and practical challenges posed for the sustainable development of a united world. The theme of the Conference "New Opportunities for Operations Research" will highlight potential research directions for managing increasing complexity, dynamic behavior and uncertainty with a special focus on newly emerging areas.

INFORMATION FOR SPEAKERS & SESSION CHAIRS

Guidelines for Speakers

The room and the location of your session are listed in the Parallel Sessions section and in the Master Track Schedule. Please be on time for your session and check in with the session chair 15 minutes before your session starts.

The total time allocated to each speaker in a parallel session is 22 minutes. Time your presentation to fit within your designated time span and leave an opportunity for questions and audience participation.

We do not produce proceedings with complete papers. To obtain complete copies of any papers abstracted in the program, please contact the authors directly at the addresses supplied with each abstract.

Guidelines for Session Chairs

The role of the chair is to coordinate the smooth running of the session. The Chair:

- Begins and ends each session on time. Each session lasts 90 minutes and the time per presentation is 22 minutes. Equal time should be given to each paper.
- Introduces each presentation (just the title of the paper and the name of the presenting author). Lets speakers know when time is running short.
- Ensures that presentations are made in the order shown in the program. This allows for "session jumping". If a speaker cancels or does not attend, the original time schedule should be adhered to rather than sliding every succeeding talk forward.
- In case the assigned session chair is absent, the speaker of the last paper in the session, and if he is also absent then the speaker of the first paper in the session will act as the session chair.

Audio/Visual Equipment

Every room is equipped with a data projector and an overhead projector. Please follow these guidelines to ensure a successful presentation using the data projector:

- Bring your laptop PC to your session in İstanbul. We supply the projector, but we do not supply the computer.
- Arrive at your session at least 15 minutes before it begins. All presenters in a session should set up and test the connection to the projector before the session begins.
- Produce and bring overhead transparencies as a backup.

Quick instructions and technical assistance for any problems will be provided at each session room.

İSTANBUL WELCOMES YOU

İstanbul is the only city in the world built on two continents, one arm reaching out to Asia, the other to Europe. Through the city's heart, the Bosphorus strait, courses the waters of the Black Sea, the Sea of Marmara and the Golden Horn. The former capital of three successive empires - Roman, Byzantine and Ottoman - today İstanbul honors and preserves the legacy of its past while looking forward to its modern future.

General Information

REGISTRATION

Registration will take place in the Ballroom Foyer Area (R Level). Registration hours:

Sunday	July 6	1:00pm - 10:00pm
Monday	July 7	7:30am - 5:30pm
Tuesday	July 8	8:30am - 5:30pm
Wednesday	July 9	8:30am - 5:30pm
Thursday	July 8	8:30am - 5:30pm

On registering you will receive your conference bag and materials, including the name badge, which must be worn to all conference events. All tickets, which will have to be shown for the Get-Together Party, Dinner Reception and the lunches, will be provided at registration.

REGISTRATION FEE

The registration fee includes lunches, coffee breaks, the Get-Together Party, the Dinner Reception at Boğaziçi University and participation in the sessions and tutorials. For the accompanying persons, the registration fee covers the Get-Together Party and the Dinner Reception at Boğaziçi University. The registered accompanying guests will also receive a name badge that must be worn for admittance to these events and attendance to plenary sessions; however guests are not eligible to attend the parallel sessions.

CONFERENCE INFORMATION DESK

Located in the Ballroom Foyer Area, R Level, next to the Registration Area, it will provide information about all aspects of the Conference. It will be open from Monday, July 7, to Thursday, July 10, between 8:30am-5:30pm.

- All messages will be posted on a message board and participants wishing to exchange personal messages should use this message board. Please note that neither participants nor exhibitors can be contacted by telephone directly.
- An updated daily program will be available on the message board. Please check the board to track program changes.

BUSINESS CENTER

Located near the Junior Ballroom Foyer Area, L Level, it will provide information on all social and business aspects of the Conference. It will be open on Sunday, July 6, between 1:00pm-9:00pm and from Monday, July 7, to Thursday, July 10, between 8:30am-5:30pm. Otari Tours will be available in the Center to provide the following services:

- All travel and accommodation arrangements.
- Daily half-day and full-day tours of İstanbul, pre- and post-conference tours to various locations in Turkey.
- Additional tickets for the Banquet at Dolmabahçe Palace, the Dinner Reception at Boğaziçi University, Bosphorus Cruise and lunches at the Conrad Hotel.
- Sending fax messages, making photocopies and buying telephone cards.

E-MAIL CENTER

Computers are available at the E-mail Center, located in the Hospitality Center, R Level. However, you can also use your laptop PC's to access your e-mail and the Web. Name badges must be worn for admittance. The center will be open during the following hours:

Sunday	July 6	1:00pm - 8:00pm
Monday	July 7	8:30am - 6:00pm
Tuesday	July 8	8:30am - 6:00pm
Wednesday	July 9	8:30am - 6:00pm
Thursday	July 10	8:30am - 6:00pm

EXHIBIT HALL

Located in the Lounge Area, R Level, it will be open during the following hours:

Sunday	July 6	12:00pm - 5:00pm
Monday	July 7	8:30am - 6:30pm
Tuesday	July 8	8:30am - 6:30pm
Wednesday	July 9	8:30am - 6:30pm
Thursday	July 10	8:30am - 6:30pm

LIST OF EXHIBITORS

ILOG, Inc.

www.ilog.com

ILOG is the leading developer and supplier of mathematical programming and constraint programming optimization technology. ILOG was recently chosen as one of the top 12 influential IT companies by IE magazine. With a commitment to premiere R&D, expert technical support, hands-on product training and superior customer service, ILOG is focused on producing the most powerful, intuitive, stable large-scale LP, MIP, QP and CP modeling tools and solving engines. As the world's largest software component vendor, ILOG also develops Java and C++ visualization, database connectivity and business rule engine technology that can be used to produce complete decision-support systems. Join the many companies who have chosen ILOG to power their critical applications such as BEA, i2 Technologies, Oracle, Siebel, SAP, Sabre, American Express, POSCO, Chase Manhattan Bank and DaimlerChrysler.

ILOG WORKSHOP

Sunday, July 6 **1:00pm - 6:00pm**

Conrad Hotel, M Level, M32

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Springer-Verlag

www.springer.de

Springer publications cover all relevant areas for Operations Research, from Business Administration, Production, Simulation to Applied Computer Science and Applied Mathematics: books, journals, electronic media.

Cluster Chairs

- **Airline Applications**
  Christine Strauss
  University of Vienna
- **Analytic Hierarchy Process**
  Ernest Forman
  George Washington University
- **Artificial Intelligence, ES and Neural Networks**
  Gary Koehler
  University of Florida at Gainerville
- **Bayesian Statistics**
  Refik Soyer
  George Washington University
- **Bioinformatics**
  Metin Türkay
  Koç University
- **Capacity Planning**
  Alf Kimms
  Technical University Freiberg
- **Cross-Entropy**
  Reuven Y. Rubinstein
  Technion
- **Cutting and Packing**
  Andrea Lodi
  University of Bologna
  Jose Fernando Oliveira
  FEUP/INESC
- **Data Envelopment Analysis**
  Emmanuel Thanassoulis
  Aston University
- **Data Mining and Data Base Modeling**
  Özgür Türetken
  Temple University
- **Decision Theory and Analysis**
  Ben Lev
  University of Michigan at Dearborn
- **Disaster and Crisis Management**
  Gülay Barbarosoğlu
  Boğaziçi University
- **E-Commerce**
  Kemal Altınkemer
  Purdue University
- **Economic Modeling**
  Hayri Önal
  University of Illinois at UC
- **Education and Distance Learning**
  Armann Ingolfsson
  University of Alberta
- **Energy Policy and Planning**
  İlhan Or
  Boğaziçi University
- **Entrepreneurship**
  Moren Levesque
  Case Western Reserve University
- **Environmental Management**
  H. D. Haasis
  University of Bremen
- **Financial Engineering**
  Hercules Vladimirou
  University of Cyprus
- **Flexible Manufacturing Systems**
  Kathryn E. Stecke
  University of Texas at Dallas
- **Forestry Management**
  Peter Lohmander
  SUAS
  Lluís M. Pla
  University of Lleida
- **Fuzzy Sets and Systems**
  Marc Roubens
  University of Liege
- **Game Theory**
  Murat Sertel
  Koç University
- **Graphs and Networks**
  Stefano Pallottino
  University of Pisa
- **Group Decision Making and Negotiation**
  Melvin Shakun
  New York University
  Marc Kilgour
  Wilfrid Laurier University
- **Health Care**
  Yaşar A. Özcan
  Virginia Commonwealth University
- **Innovation**
  Maria Romanova
  George Washington University
- **Knowledge Management**
  Michael Stankosky
  George Washington University
- **Large Scale Optimization**
  Vardan Petrosyan
  Yerevan State University
  Özlem Ergün
  Georgia Institute of Technology
- **Location**
  Vedat Verter
  McGill University
- **Management Information Systems**
  Kemal Altınkemer
  Purdue University
- **Marketing**
  Tülin Erdem
  University of California at Berkeley
- **Mathematical Programming**
  Alper Atamtürk
  University of California at Berkeley
- **Medical Applications**
  Horst Hamacher
  University of Kaiserslautern
- **Metaheuristics**
  Ibrahim Osman
  American University of Beirut
- **Military Operations Research**
  Gülay Barbarosoğlu
  Boğaziçi University
- **Multi-Criteria Decision Aids**
  Raymond Bisdorff
  University of Luxembourg
- **Multi-Objective Decision Making**
  Murat Köksalan
  METU
- **Natural Resources**
  Hayri Önal
  University of Illinois at UC
- **Network Design**
  Mustafa Pınar
  Bilkent University
- **Optimization, Combinatorial**
  Peter Hammer
  Rutgers University
  Bo Chen
  Stanford University
- **OR Applications in South Pacific**
  Erhan Kozan
  Queensland University of Technology
- **OR in Development**
  Hans W. Ittmann
  CSIR
- **Parallel Algorithms and Implementation**
  İlkay Boduroğlu
  Boğaziçi University

Cluster Chairs

- **Production and Inventory Systems**
  Fikri Karaesmen
  Koç University
- **Programming, Dynamic**
  Moshe Sniedovich
  University of Melbourne
- **Programming, Integer**
  Giuvanni Rinaldi
  IASI - CNR
- **Programming, Linear**
  Enriqueta Vercher
  University of Valencia
- **Programming, Nonlinear**
  Mustafa Pınar
  Bilkent University
- **Project Management and Scheduling**
  Rainer Kolisch
  Technical University of Munich
- **Queuing Systems**
  Erol Gelenbe
  University of Central Florida
- **Reliability**
  Süleyman Özekici
  Koç University
- **Revenue Management and Pricing**
  Itır Karaesmen
  University of Maryland
- **Reverse Logistics/ Remanufacturing**
  Elif Akçalı
  Univesity of Florida
  Luk Van-Wassenhove
  INSEAD
- **Risk Analysis and Management**
  Spiros Martzoukos
  University of Cyprus
  Rita D'Ecclesia
  University of Roma La Sapienza
- **Robust Optimization**
  John-Paul Clarke
  Massachusetts Institute of Technology
- **Routing**
  Paolo Toth
  University of Bologna
- **Scheduling**
  Ceyda Oğuz
  Hong Kong Polytechnic University
  Christopher Potts
  University of Southampton
- **Search Algorithms**
  Shmeul Gal
  University of Haifa
- **Service Operations**
  Zeynep Akşin Karaesmen
  Koç University
- **Simulation**
  Jack Kleijnen
  Tilburg University
- **Stochastic Models**
  Suresh Sethi
  University of Texas at Dallas
  Metin Çakanyıldırım
  University of Texas at Dallas
- **Strategic Planning and Management**
  Maureen Meadows
  University of Warwick
- **Supply Chain Management**
  Yasemin Aksoy
  Tulane University
- **System Dynamics and Theory**
  Yaman Barlas
  Boğaziçi University
- **Telecommunications**
  Kemal Altınkemer
  Purdue University
- **Timetabling**
  Jonathan Thompson
  Cardiff University
- **Transportation and Logistics**
  Mauriziu Bielli
  IASI - CNR
  Erhan Erkut
  University of Alberta
- **Warehouse Design, Planning, and Control**
  Rene de Koster
  Erasmus University Rotterdam
- **Work Flow Management Systems**
  Gabriele Kotsis
  University of Linz
- **EWG MCAD Multicriteria Aid for Decision**
  Raymond Bisdorff
  University of Luxembourg
- **EWG ESIGMA Special Interest Group on Multicriteria Analysis**
  Theodor Stewart
  University of Cape Town
- **EWG Transportation**
  Maurizio Bielli
  IASI - CNR
- **EWG EU/ME European Chapter on Metaheuristics**
  Ibrahim Osman
  American University of Beirut
- **EWG LA Locational Analysis**
  Frank Plastria
  Vrije University
- **EWG EUROFUSE Fuzzy Sets**
  Janos Fodor
  Szent Istvan University
- **Financial Modelling**
  Jaap Spronk
  Erasmus University Rotterdam
- **EWG ECCO European Chapter on Combinatorial Optimization**
  Silvano Martello
  University of Bologna
- **EWG WATT Working Group on Automated Time Tabling**
  Jonathan Thompson
  Cardiff University
- **EWG DEAPM Data Envelopment Analysis and Performance Measurement**
  Mikko Syrjänen
  Helsinki School of Economics
- **EWG Methodology for Complex Societal Problems**
  Dorien J. DeTombe
  University of Amsterdam
- **OR in Sports**
  John Norman
  University of Sheffield
- **Semi-Plenary Sessions**
  Erhan Erkut
  University of Alberta
- **EURO Excellence in Practice Award (EPA)**
  Michael Pidd
  Lancaster University
- **EURO Management Science Strategic Innovation Prize (MSSIP)**
  Christof Weinhardt
  University of Karlsruhe

Program at a Glance

From	To	MONDAY July 7, 2003	TUESDAY July 8, 2003	WEDNESDAY July 9, 2003	THURSDAY July 10, 2003
08:30am	10:00am	MA Tutorials/ Parallel Sessions	TA Tutorials/ Parallel Sessions	WA Tutorials/ Parallel Sessions	RA Tutorials/ Parallel Sessions
10:00am	10:15am		Coffee Break		
10:15am	10:30am	Opening Session			
10:30am	10:45am		TB Plenary	WB Plenary	RB Semi-Plenaries
10:45am	11:00am	MB Plenary			
11:00am	11:15am				
11:15am	11:30am				
11:30am	11:45am		Lunch Break starting at 11:30am		
11:45am	12:00pm				
12:00pm	1:30pm	MC Parallel Sessions	TC Parallel Sessions	WC Parallel Sessions	RC Parallel Sessions
1:30pm	2:00pm		Lunch Break ending at 2:00pm		
2:00pm	3:30pm	MD Tutorials/ Parallel Sessions	TD Tutorials/ Parallel Sessions	WD Semi-Plenaries/ Parallel Sessions	RD Tutorials/ Parallel Sessions
3:30pm	4:00pm		Coffee Break		
4:00pm	5:00pm	ME Tutorials/ Parallel Sessions	TE Tutorials/ Parallel Sessions	WE Tutorials/ Parallel Sessions	RE Plenary
5:00pm	5:30pm				Closing Session

OPENING SESSION MB 10:15am-10:45am

Chair: Gülay Barbarosoğlu, Boğaziçi University

Welcome

- Gülay Barbarosoğlu, OC Chair
- Nesim Erkip, President, OR Society of Turkey
- Laureano F. Escudero, President, EURO
- Michael Trick, Immediate Past President, INFORMS

CLOSING SESSION RD 5:00pm-5:30pm

Closing Remarks

- Gerhard Wäscher, PC Co-Chair (EURO)
- Murat Tarımcılar, PC Co-Chair (INFORMS)

Next Conferences

- EURO Conference 2004, Rhodos
  Yannis Siskos, OC Chair
- INFORMS Meeting 2003, Atlanta
  Donna Llewellyn, General Chair
- IFORS Triennial 2005, Honolulu
  Paolo Toth, President IFORS
- CORS/INFORMS Int. Meeting 2004, Banff
  Erhan Erkut, General Chair

EURO/INFORMS İSTANBUL 2003 QUICK REFERENCE

Among your conference materials you will find a separate flier including the Master Track Schedule and floor plans, providing a quick, portable summary of the meeting. Make sure that you get one with your registration package.

INDUSTRY DAY

Wednesday, July 9 is designated as "Industry Day" to place more emphasis on OR/MS applications in industry. August-Wilhelm Scheer of IDS Scheer and Universität des Saarlandes will give a talk on "Business Process Management - from Vision to Execution". The Industry Day will be highlighted by a panel discussion on bridging the gap between theory and practice.

SUNDAY, JULY 6

1:00pm	-	10:00pm	Registration

MONDAY, JULY 7

7:30am	-	5:30pm	Registration
8:30am	-	10:00am	Tutorials/Parallel Sessions
10:00am	-	10:15am	Coffee Break
10:15am	-	10:45am	Opening Session
10:45am	-	11:45am	Plenary - EURO Gold Medalist
11:45am	-	2:00pm	Lunch Break
12:00pm	-	1:30pm	Parallel Sessions
2:00pm	-	3:30pm	Tutorials/Parallel Sessions
3:30pm	-	4:00pm	Coffee Break
4:00pm	-	5:30pm	Tutorials/Parallel Sessions

TUESDAY, JULY 8

8:30am	-	10:00am	Tutorials/Parallel Sessions
10:00am	-	10:30am	Coffee Break
10:30am	-	11:30am	Plenary - Omega Rho Distinguished Lecturer
11:30am	-	2:00pm	Lunch Break
12:00pm	-	1:30pm	Parallel Sessions
2:00pm	-	3:30pm	Tutorials/Parallel Sessions
3:30pm	-	4:00pm	Coffee Break
4:00pm	-	5:30pm	Tutorials/Parallel Sessions

WEDNESDAY, JULY 9

8:30am	-	10:00am	Tutorials/Parallel Sessions
10:00am	-	10:30am	Coffee Break
10:30am	-	11:30am	Plenary - Industry Day Speaker
11:30am	-	2:00pm	Lunch Break
12:00pm	-	1:30pm	Parallel Sessions
2:00pm	-	3:30pm	Semi-Plenary Sessions/Parallel Sessions
3:30pm	-	4:00pm	Coffee Break
4:00pm	-	5:30pm	Tutorials/Parallel Sessions

THURSDAY, JULY 10

8:30am	-	10:00am	Tutorials/Parallel Sessions
10:00am	-	10:30am	Coffee Break
10:30am	-	11:30am	Semi-Plenary Sessions
11:30am	-	2:00pm	Lunch Break
12:00pm	-	1:30pm	Parallel Sessions
2:00pm	-	3:30pm	Tutorials/Parallel Sessions
3:30pm	-	4:00pm	Coffee Break
4:00pm	-	5:00pm	Plenary - IFORS Distinguished Lecturer
5:00pm	-	5:30pm	Closing Session

BOĞAZİÇİ UNIVERSITY

Formally established on September 10, 1971, Boğaziçi University has in fact taken over a peerless heirloom from the Robert College, which was the first American College to be established outside the boundaries of the United States in 1863. With its excellent facilities and distinguished academic tradition, Boğaziçi University has an exceptional place among Turkish universities.

Special Journal Issues

EUROPEAN JOURNAL OF OPERATIONAL RESEARCH (EJOR) SPECIAL ISSUE

A special issue of EJOR will be published in 2004. The theme of the special issue is **"New Opportunities for Operations Research"**. Conference participants who are interested in having their paper published in this special issue should submit four (hard) copies to

Prof. Gerhard Wäscher
Otto-von-Guericke-Universität Magdeburg
Betriebswirtschaftslehre - Management Science
P.O.Box 4120
D-39016 Magdeburg
Germany

no later than September 30, 2003. Papers are particularly invited from areas such as Financial Engineering, Health Care & Medical Applications, Reverse Logistics, Marketing, Telecommunications, Revenue Management, E-Commerce, Bioinformatics etc. Papers should be prepared according to the "Instructions for Authors" which can be found at the end of each volume of EJOR. All papers will be refereed according to EJOR standards.

HEALTH CARE MANAGEMENT SCIENCE (HCMS) SPECIAL ISSUE

A special issue of HCMS will be published in 2004. The theme of the special issue is **"Contemporary Health Care Applications in OR/MS"**. Conference participants whose presentations related to Health Care topics and who are interested in having their paper published in this special issue should submit four (hard) copies to

Prof. Yaşar A. Özcan
Editor-in-Chief
Health Care Management Science
Department of Health Administration
Virginia Commonwealth University
P.O. Box 9802031008 East Clay Street, Room 213
Richmond, VA 23298-0203
USA

no later than June 1, 2003. Papers should be prepared according to the "Instructions for Authors", which can be found at http://www.wkap.nl/journalhome.htm/1386-9620. All papers will be refereed according to HCMS standards.

OMEGA SPECIAL ISSUE

A special issue of OMEGA Journal will be published in 2004. The theme of the special issue is **"New Approaches in Management and Management Science"**. Conference participants whose presentations are related to management and management science topics and who are interested in having their paper published in this special issue should submit four (hard) copies to

Prof. Gülay Barbarosoğlu
Guest Co-Editor
Omega Journal
Boğaziçi University
80815 Bebek İstanbul
Turkey

Prof. Murat Tarımcılar
Guest Co-Editor
Omega Journal
George Washington University
Washington, D.C. 20052
USA

no later than November 1, 2003. Papers should be prepared according to the "Instructions for Authors", which can be found at http://www.omegajournal.org. All papers will be refereed according to OMEGA Journal standards.

Schedule of Networking Events

SOCIAL EVENTS

SUNDAY, JULY 6

• **Get-Together Party**	7:00pm - 10:00pm	The Get-Together Party will take place at the Conrad Hotel. Food and beverages will be served. No extra fees. Badges and tickets are required.

MONDAY, JULY 7

• **Dinner Reception**	7:00pm - 10:00pm	The Dinner Reception will be held at the Boğaziçi University South Campus. Buses will depart from all Conference hotels at 6:30pm. Open buffet. No extra fees. Badges and tickets are required.

TUESDAY, JULY 8

• **Bosphorus Cruise**	7:00pm - 11:00pm	Buses will depart from all Conference hotels at 6:30pm. Dinner will be served on board. An additional fee will be charged.
• **5K Race**	6:45pm - 9:00pm	Buses will leave at 5:45pm only from the Conrad Hotel. The race will take place at Belgrade forest running trail and will begin at 6:45pm. Tickets are required to attend the race. All İstanbul 2003 meeting registrants and their guests who are 18 year of age or older may participate in the race. Seasonal fruits and beverages will be available. Prizes will be awarded at the end of the race.

WEDNESDAY, JULY 9

• **Banquet**	7:00pm - 11:00pm	The Banquet will be held at the Dolmabahçe Palace. Buses will depart from all Conference Hotels at 6:30pm. Cocktails will be served between 7:00pm and 8:00pm, followed by a sit-down dinner after 8:00pm. An additional fee will be charged.

BUSINESS MEETINGS

EURO

SATURDAY, JULY 5

• Dinner	7:30pm - 8:30pm	Conrad Hotel, Prego Restaurant

SUNDAY, JULY 6

• EURO Council 1	8:00am - 10:30am	Conrad Hotel, M Level, M37
• Extended Council	10:30am - 12:00am	Conrad Hotel, M Level, M30
• Lunch	12:00pm - 2:00pm	Conrad Hotel, Prego Restaurant
• Extended Council	2:00pm - 4:00pm	Conrad Hotel, M Level, M30

MONDAY, JULY 7

• PC Meeting of EURO 2004 Conference	3:30pm - 5:30pm	Conrad Hotel, Bosphorus Suite, No 225

TUESDAY, JULY 8

• Lunch	12:00pm - 1:00pm	Conrad Hotel, Prego Restaurant
• EJOR Editorial Lunch	12:30pm - 1:30pm	Conrad Hotel, Monet Restaurant

WEDNESDAY, JULY 9

• Board Meeting	8:30am - 9:30am	Conrad Hotel, Bosphorus Suite, No 225
• EURO Council 2	9:30am - 11:00am	Conrad Hotel, Bosphorus Suite, No 225
• Lunch	12:00pm - 1:00pm	Conrad Hotel, Prego Restaurant

IFORS

SUNDAY, JULY 6

• IFORS Administrative Committee	9:00am - 5:00pm	Conrad Hotel, M Level, M31

TUESDAY, JULY 8

• IFORS Administrative Committee Lunch	12:00pm - 3:00pm	Conrad Hotel, Bosphorus Suite, No 325

INFORMS SECTION ON GDN

WEDNESDAY, JULY 9

• GDN Business Meeting	5:30pm - 7:00pm	Conrad Hotel, M Level, M32

OMEGA

TUESDAY, JULY 8

• OMEGA Editorial Board Meeting	11:30am - 1:00pm	Conrad Hotel, L Level, L18

EURO GOLD MEDAL PLENARY

Monday, July 7
MB: 10:45am-11:45am Room: MB

Moderator: Paolo Toth
University of Bologna

The EURO Gold Medal is the highest distinction within OR in Europe. It is conferred to a prominent person or institution, for an outstanding contribution to the Operational Research science.

The Award, which officially is bestowed in conjunction with a EURO Conference, is not only a significant honour for the Laureate personally, but also important for the general promotion of OR as leading scholars and their contributions are made better known via the Medal. Laureates of the EURO Gold Medal are invited to all future EURO Conferences without payment of the registration fees.

Nominations of candidates are solicited from the national societies in the year prior to each EURO Conference. To emphasize the European flavour of the award, all societies are strongly urged not to propose a candidate from their own country. Moreover, no currently active officer of EURO (Executive Committee Member, EURO Gold Medal jury member, Organising and Programme Committees Chairmen of the conference where the EURO Gold Medal will be awarded) is eligible. The societies are responsible for providing a recent and detailed CV of their nominee, as well as a written motivation stating the reasons why their nominee deserves the EURO Gold Medal.

The jury evaluates the proposed candidates essentially on basis of their scientific activities (papers in excellent journals, editorials, positions held, number of PHD students...). The proposed laureate should also have contributed to the promotion of OR, in particular in Europe.

OMEGA RHO PLENARY

Tuesday, July 8
TB: 10:30am-11:30am Room: MB

Moderator: Graham K. Rand
Lancaster University

Operations Research and Financial Engineering

Erhan Çınlar
Department of Operations Research and Financial Engineering
Princeton University

Financial services form a powerful and expanding industry. It is heavily computerized, has good data sets, and has become very sophisticated in combining such resources with the methods and mathematics of operations research. Moreover, the field has many problems that suggest fresh research topics in operations research, especially in statistics, stochastics, simulation, and large-scale optimization. The marriage between operations research and financial engineering promises to be exciting and fruitful.

Erhan Çınlar

Erhan Çınlar is the chair of the Department of Operations Research and Financial Engineering at Princeton University. Previously, he taught at Northwestern and held visiting positions at the universities of Stanford, Rennes, Rome, and the Institute of Advanced Study. He is a fellow of the Institute of Mathematical Statistics, an elected member of the International Statistical Institute, and was awarded the science prize of Tübitak, Turkish Council for Scientific and Technological Research. He has served on the editorial boards of numerous journals including the editorship of Mathematics of Operations Research. He is the author of Introduction to Stochastic Processes and is best known for his work on reliability and queuing theory and his extensive research in semimartingales, Markov processes, and Markov renewal theory.

OMEGA RHO

Omega Rho, the official Honor Society of INFORMS, was founded in 1976 to recognize superior scholarship and encourage leadership in operations research, management science and related disciplines.

The society has 35 active collegiate chapters and more than 4,950 student and faculty members. It is a member of the Association of College Honor Societies. In addition to sponsoring Omega Rho Distinguished Lectures at INFORMS annual and international meetings, Omega Rho provides financial support to the annual INFORMS Doctoral Colloquium and to its local chapters.

Honorary Membership in Omega Rho is bestowed upon individuals who provide leadership and extraordinary support for the encouragement of operations research and management science through their professional activities.

INDUSTRY PLENARY

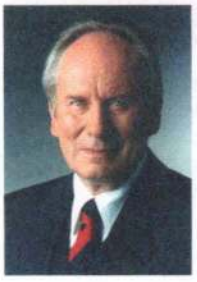
Wednesday, July 9
WB: 10:30am-11:30am Room: MB

Moderator: Christoph Schneeweiss
University of Mannheim

Business Process Management - from Vision to Execution

August-Wilhelm Scheer
Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI)
Universität des Saarlandes

At the beginning of the 1990s, the concept of a global, process-oriented view on information systems emerged from the notion of a company-wide data model. From today's point of view business processes have been established as objects of the organizational design. As component architecture and web services progressively transform software architectures, the importance of business process modelling with direct connectivity to the software configuration is growing steadily. Moreover, comprehensive business processes require the specification of responsibilities dealing with reciprocal material and financial relationships, quality standards and time constraints. To achieve this, the relevant business processes have to be well-documented. Thus, know-how in the field of developing and using the relevant methods of business process management will further affect business and research in the future.



August-Wilhelm Scheer

Prof. Dr. Dr. h.c. mult. August-Wilhelm Scheer is the director of the Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI). His research focuses on information and process management in industry, services and administration. Prof. Scheer has received many awards ("Medal of National Education" in Warsaw, the "TMBE'96 Award for Achievement and Contribution to the Industry", "IT-Precursor Award" by the computer magazine IT.Services," Philip Morris Research Award 2003", and the Distinguished Service Medal of the Saarland) and honorary doctorates (from the University of Pilsen and the University of Hohenheim) for his scientific achievements in the development of methods for the configuration of information systems and for the analysis of business processes.

Prof. Scheer was a member of Germany's "Federal Council for Research, Technology and Innovation" and of the "Expert Board for Research and Technology in the Saarland." He is representative for innovation, technology and research of the Prime Minister of the Saarland, and a member of the initiative "IT-research 2006" by the Federal Minister for Education and Research. Prof. Scheer is the founder of the August-Wilhelm-Scheer Foundation for Science and Art, the founder and chairman of the supervisory board of IDS Scheer AG as well as of imc, information multimedia communication AG, based in Saarbrücken. Furthermore, he is a member of the supervisory board of SAP AG, based in Walldorf, as well as of abaXX Technology AG in Stuttgart. Prof. Scheer is the editor of various serial books and journals and organizes the conference "Saarbrücker Arbeitstagung" once a year. He has written more than 300 essays and more than 10 books, the standards Business Process Engineering, ARIS: Business Process Frameworks and ARIS: Business Process Modeling among them. These books have been translated into English, French, Japanese, Chinese, Russian, Czech and Polish.

IFORS PLENARY

Thursday, July 10
RE: 4:00pm-5:00pm Room: MB

Moderator: Michel Gendreau
Université de Montréal

A Sampling of Optimization Models for Making Hard Decisions

Richard E. Rosenthal
Department of Operations Research
Naval Postgraduate School

This talk will present examples of important decision problems that are addressed with optimization models. Because of the large scale and complexity of the real situations upon which these models are based, these efforts often provide challenges to the computational state of the art. Even as computers get faster and algorithms get smarter, our clientele's thirst for solving larger and larger problems is very difficult to quench. The key for operations researchers to keep pace is better and better modeling.

Richard E. Rosenthal

Rick Rosenthal is a professor in the Operations Research Department at the Naval Postgraduate School in Monterey, California. He has been on the NPS faculty since 1984 and has served as chairman of the OR Department. He served for 15 years as the Editor-in-Chief of Naval Research Logistics. Rick has a passionate interest in the application of optimization. His research projects for the US military have touched all branches and include studies of transportation, logistics, manpower and operations. He has also worked on civilian applications, most recently as a Visiting Senior Scientist at Hewlett-Packard Labs. He is a winner of the INFORMS Award for the Teaching of Operations Research Practice and several research awards. He earned a B.A. in mathematical sciences from Johns Hopkins University in 1972 and a Ph.D. in OR from Georgia Institute of Technology in 1975.

Semi-Plenary Sessions

SEMI-PLENARY

Wednesday, July 9
WD: 2:00pm-3:30pm Room: MB II

Chair: Ali Rıza Kaylan
Boğaziçi University

Engineering Exuberance

Thomas L. Magnanti Massachusetts Institute of Technology

In the last hundred years, engineers conceived, designed, and implemented major scientific and technological developments that have transformed our lives. And, they will do so again in the next hundred years. But the context of engineering differs today from the past with innovations flourishing in such fields as bioengineering, engineering systems, tiny technologies, information, computation and communications, and new educational technologies. It is an exciting time for engineering, with almost unprecedented opportunities. This talk will summarize some emerging themes and ways the modern research university will remain at the forefront of engineering education, research, and practice.

Thomas L. Magnanti

Thomas L. Magnanti currently serves as Dean of Engineering and as one of fourteen Institute Professors at MIT, where he has been a faculty member since 1971. He has devoted much of his professional career to education that combines engineering and management and to teaching and research in applied and theoretical aspects of large-scale optimization. Professor Magnanti is the co-author or editor of four books and numerous research publications on such topics as production planning and scheduling, transportation planning, facility location, logistics, and communication systems design. He was a founding co-director of MIT's Leaders for Manufacturing and the System Design and Management Programs. He has previously served as co-director of MIT's interdepartmental Operations Research Center and as head of the Management Science Area of the Sloan School. He is a past President of both the ORSA and the INFORMS and has been Editor-in-Chief of Operations Research. Professor Magnanti has received ORSA's Lanchester Prize for best publication and ORSA's Kimball Medal and the MIT Billard Award for distinguished service as well as the Irwin Sizer Award for significant innovations in MIT education.

SEMI-PLENARY

Wednesday, July 9
WD: 2:00pm-3:30pm Room: MB III

Panel on University - Industry Relations in the Context of OR/MS

Moderator: Gündüz Ulusoy
Sabancı University

Panelists

August-Wilhelm Scheer
Universität des Saarlandes

Larry J. LeBlanc
Vanderbilt University

Andrés P. Weintraub
Universidad de Chile

İbrahim Kavrakoğlu
Kavrakoğlu Consulting

Thursday, July 10
RB: 10:30am-11:30am Room: MB I

Chair: Silvano Martello
University of Bologna

Half a Century of Combinatorial Optimization

Jan Karel Lenstra
Georgia Institute of Technology

In the past fifty years combinatorial optimization has grown to become one of the strongest branches of operations research. In this presentation I will discuss some of the highlights of its development. I will focus on the progress that has been made in our understanding of the complexity of combinatorial optimization problems and in our ability to solve them exactly or to a reasonable degree of approximation. As a vehicle I will use two hard problem instances, a routing problem and a scheduling problem, that served as a contest among high school students in the Netherlands.

Jan Karel Lenstra

Jan Karel Lenstra was researcher at CWI in Amsterdam from 1969 until 1989. In 1989 he became Professor of Optimization at the Technische Universiteit Eindhoven, where he served as Dean of Mathematics and Computer Science from 1999 until 2002. In the fall of 2002 he joined the faculty of the Georgia Institute of Technology in Atlanta. He has spent sabbatical leaves at the University of California in Berkeley, Cornell University, MIT, and Rice University. His research interests are in combinatorial optimization, in particular complexity theory, approximation algorithms, local search, routing, and scheduling. He wrote about 80 papers and was co-editor of 15 books, including The Traveling Salesman Problem, History of Mathematical Programming, and Local Search in Combinatorial Optimization. He has been Chair of the Mathematical Programming Society and of the Wiskundig Genootschap (the Dutch Math Society), and Editor-in-Chief of Mathematics of Operations Research. He is presently area editor of the INFORMS Journal on Computing and Editor-in-Chief of Operations Research Letters.

SEMI-PLENARY

Thursday, July 10
RB: 10:30am-11:30am Room: MB II

Chair: Erhan Erkut
University of Alberta

OR Education: Spreadsheets as a Powerful Platform for OR/MS Education

Armann Ingolfsson
University of Alberta

Thomas Grossman
University of Calgary

Teaching of OR/MS has changed dramatically at many universities during the last decade, driven by three forces: 1) powerful new spreadsheet add-in software for OR/MS, 2) threats of elimination of management science from business school curricula, and 3) a growing awareness of the importance of educating business students to be effective end-user modelers. We discuss the surprising benefits of using spreadsheets for OR/MS, as well as their limitations. To fully harness the benefits of spreadsheets it is important to align course content with the aptitudes and interests of the students, and teach foundation modeling and analytical skills. We provide a guide to resources for OR/MS educators with pointers to teaching materials such as textbooks, cases and teaching notes, software suitable for education, new ideas, and discussion.

Armann Ingolfsson

Armann Ingolfsson is an Assistant Professor of Management Science at the University of Alberta School of Business, Edmonton, Canada. He received a Ph.D.

SEMI-PLENARY

in operations research from the Massachusetts Institute of Technology in 1994. He has taught courses in operations management and quantitative modeling to undergraduate, M.B.A., and Ph.D. students and has received awards for teaching both at the undergraduate and graduate levels. A former VP-Publications of the INFORMS Education Forum and editor of OR/MS Today's "Issues in Education" column, he is currently an associate editor of INFORMS Transactions on Education. He has given presentations at international conferences on various topics related to the teaching of management science. His research interests focus on operations management in the service sector, including workforce management and emergency service operations.

Thomas Grossman

Thomas Grossman is an Associate Professor at the Haskayne School of Business at the University of Calgary in Canada. An award-winning teacher, he holds a PhD from the Department of Management Science and Engineering at Stanford University. His consulting experience includes designing, developing and deploying software systems for revenue management and airline schedule optimization, pricing technology in the semi-conductor industry, and patent litigation. His current research interests are business analytics, spreadsheet engineering, and call center operations. He is president of the Spreadsheet Productivity Research Interest Group, and is Past-President of the INFORMS Education Forum.

Thursday, July 10
RB: 10:30am-11:30am Room: MB III

Chair: Murat Tarımcılar
George Washington University

Disruption Management: Airline and Other Applications

Gang Yu
The University of Texas at Austin

The September 11th terrorist attack has drastically changed the world. It also pushed the disruption management to the front stage of the operations research/management arena. In fact, the disruption management concept has been successfully applied in the airline industry. This is exemplified by our Franz

SEMI-PLENARY

Edelman Prize-winning application, Crew Recovery System, at Continental Airlines. It has brought significant benefit and impact to the airline operations including the remarkable recovery from the 9-11 event. In Year 2001, the system has saved Continental a total of over $60 million. In this talk, I will present a general framework, optimization models, and solution techniques for disruption management with emphasis on airline applications. I will also illustrate the methodologies via applications in other areas including supply chain management and scheduling; drawing parallels with airline operations recovery.

Gang Yu

Gang Yu received M.S. from Cornell University and Ph.D. from the Wharton School, University of Pennsylvania. He is currently the Jack G. Taylor Regents Professor in Business at McCombs School of Business at The University of Texas at Austin. He is the author of over 50 journal articles and 4 books, and he serves on five editorial boards. He consulted for over a dozen Fortune 500 companies including IBM, United Airlines, EDS, Tracor Applied Sciences, and Continental Airlines. He is the Founder and former Chairman/CEO of CALEB Technologies Corp. The real-time operations control systems he led to develop are currently deployed at Continental Airlines, Northwest Airlines, and Southwest Airlines. In Year 2001, one of the disruption recovery systems saved Continental Airlines over $60 million. He recently won the Franz Edelman Award for Management Science Achievement.

Thursday, July 10
RB: 10:30am-11:30am Room: JB A

Chair: Gerhard Wäscher
Otto-von-Guericke-Universität

Closed-Loop Supply Chains and a Simple Method for Balancing Supply and Demand

V. Daniel R. Guide, Jr.
The Pennsylvania State University

Luk N. Van Wassenhove
INSEAD

There are common processes required by a closed-loop supply chain for reverse supply chain activities: product acquisition, reverse logistics, inspection, testing and disposition, remanufacturing, and selling and distribution. However, the management activities and focus in these common processes are not the same among all closed-loop supply chains. We document a number of diverse products that are presently being remanufactured and describe their supply chains. After each case, we summarize and discuss the distinguishing features of the supply chains. We discuss the crucial differences in the management of each of the different supply chain systems and research needs. A framework for analyzing the profitability of reuse activities is developed, and we show how the management of product returns influences operational requirements. We show that the acquisition of used products may be used as the control lever for the management and profitability of reuse activities. Finally, a simple model is developed for determining the optimal prices to stimulate product returns, and determining the corresponding overall profitability.

V. Daniel R. Guide, Jr.

V. Daniel R. Guide, Jr. is presently on the faculty at the Smeal College of Business Administration at The Pennsylvania State University, USA. He has also been a visiting research fellow at INSEAD (2001-2003). Dan's research is focused on the development and control of closed-loop supply chains, time-based models for commercial product returns, and remanufacturing. His research has appeared in numerous academic and managerial journals. He also regularly works and consults with global organizations (including the US Navy, US Air Force, Hewlett-Packard, Bosch, and Lucent) on a variety of closed-loop supply chain problems.

Luk N. Van Wassenhove

Luk N. Van Wassenhove is the Henry Ford Chaired Professor of Manufacturing at INSEAD, France. Luk's current research focuses on supply chain management (including closed-loop supply chains) and excellence in operations (including software production). His work has appeared in numerous academic as well as managerial journals. Luk is also known for his earlier work on production planning and combinatorial optimization (scheduling, lot-sizing and routing).

Special Awards

EURO MANAGEMENT SCIENCE STRATEGIC INNOVATION PRIZE (MSSIP 2003)

Wednesday, July 9
WD: 2:00pm-3:30pm Room: JB A

Chair: Christof Weinhardt, University of Karlsruhe.

The European Association of Operational Research Societies (EURO) is offering the Management Science Strategic Innovation Prize (MSSIP) to foster specific areas of application of Operational Research in management. The prize is intended to award outstanding contributions in theory or in practice to a well-chosen scientific area encouraging innovative researchers and possibly entire research groups to focus their work on a domain of particular strategic interest. The prize is conferred at each EURO-k conference and is sponsored by SAP AG, Germany.

The MSSIP is awarded the first time at EURO 2003 in İstanbul for an innovative contribution in the area of "Market Co-ordination in Supply Chain Management". The winning paper will be presented on Wednesday, July 9, between 2:00pm-3:30pm (session WD). The prize will be awarded to the winner at the Banquet on Wednesday, July 9.

EURO EXCELLENCE IN PRACTICE AWARD (EPA 2003)

Wednesday, July 9
WD: 2:00pm-3:30pm Room: MB I

Chair: Michael Pidd, Lancaster University.

EURO Excellence in Practice Award 2003 is awarded for an outstanding application of Operations Research in practice. The contestants for the EURO Excellence in Practice Award will make presentations on Wednesday, July 9, between 2:00pm-3:30pm (session WD) . This award is for papers that describe OR work of high quality that has a definite practical impact. The award will be presented to the winner at the Banquet on Wednesday, July 9.

ARMS: An Automated Resource Management System for British Telecommunications plc

Christos Voudouris
Gilbert Owusu
Raphael Dorne
Cedric Ladde
Botond Virginas

British Telecommunications plc

Accurate demand forecasting combined with resource planning is critical to a company's performance and profitability. This paper describes ARMS (Automated Resource Management System), an integrated system developed for the customer service operations of British Telecommunications plc to help with the operational planning and deployment of the company's 20,000-strong field engineer workforce. ARMS integrates a forecasting tool with a resource planning tool providing an end-to-end automated resource management solution for the organisation. OR techniques including ARIMA for forecasting, Constraint Satisfaction for problem modelling, Heuristic Search for problem solving are used throughout the system.

Broadcast Scheduling for Mobile Advertising

Bert De Reyck
Zeger Degraeve

London Business School

We developed a broadcast scheduling system for a firm specialized in location-sensitive permission-based mobile advertising using SMS text messaging. Text messages containing advertisements and promotional offers were sent to customers when shopping in shopping centres in London. The company's problem was deciding which ads to send out to which customers at what particular time, given a limited capacity of broadcast timeslots, while maximizing customer response and revenues from retailers. We solved the problem using integer programming with an interface in Microsoft Excel. The system significantly reduced the scheduling time, and resulted both in increased customer response and revenues.

Laps Care - An Operational System for Staff Planning in Home Care

Mikael Rönnqvist
Patrik Eveborn
Patrik Flisberg

Linköping University

The health care system in many other countries is facing increasing costs. We focus on a staff planning problem arising in Sweden where people receive home care from the local authorities. The planning is to find work routes to visit caretakers and at the same time consider a number of restrictions and soft objectives. We describe a decision support system Laps Care to aid the planners. It consists of several components including optimization routines. The system is currently in operation at a number of home care organizations. The savings are considerably in terms of saved planning time and quality.

From	To	MONDAY July 7, 2003	TUESDAY July 8, 2003	WEDNESDAY July 9, 2003	THURSDAY July 10, 2003
08:30am	10:00am	**MA** • Paolo Toth • Richard Francis/ Timothy Lowe	**TA** • Rolf H. Möhring • Rakesh K. Sarin • Salih N. Neftçi	**WA** • Matthias F. W. Kirchmer/ Savaş Özatalay • Grace Lin • Peter Bell	**RA** • David Chadwick/ Grenville Croll • Bezalel Gavish • Dimitri P. Bertsekas
10:00am	10:15am		Coffee Break		
10:15am	10:30am	Opening Session			
10:30am	10:45am		**TB**	**WB**	**RB**
10:45am	11:00am	**MB**			
11:00am	11:15am				
11:15am	11:30am				
11:30am	11:45am		Lunch Break starting at 11:30am		
11:45am	12:00pm				
12:00pm	1:30pm	**MC**	**TC**	**WC**	**RC**
1:30pm	2:00pm	Lunch Break ending at 2:00pm			
2:00pm	3:30pm	**MD** • Raphael Amit • Cynthia Barnhart • Murat Köksalan	**TD** • Colin Reeves • Daron Acemoğlu • Stavros A. Zenios	**WD**	**RD** • Robert G. Sargent • Hervé Thiriez
3:30pm	4:00pm	Coffee Break			
4:00pm	5:00pm	**ME** • Marielle Christiansen • Yaşar A. Özcan • Hartmut Stadler	**TE** • Andrés P. Weintraub • Horst W. Hamacher • H. Mete Soner	**WE** • Jan A. Van Mieghem • Gary L. Lilien • Gilbert Laporte	**RE**
5:00pm	5:30pm				Closing Session

COFFEE BREAKS

Light refreshments, coffee, tea and cookies will be available at the Coffee Break Areas located at the R Level, M Level and L Level during the following hours:

Monday, July 7
10:00am-10:15am
3:30pm-4:00pm

Tuesday - Thursday, July 8 - 10
10:00am-10:30am
3:30pm-4:00pm

LUNCH BREAKS

Note: Lunch will be served continuously at the Manzara Restaurant and at the Conrad Hotel Garden between the following hours:

Monday, July 7
11:45am-2:00pm

Tuesday - Thursday, July 8 - 10
11:30am-2:00pm

Tutorials

MONDAY, JULY 7

MA: 8:30am-10:00am **Room: MB III**

Optimization Problems in Railway Applications

Paolo Toth
University of Bologna

The rail transportation industry is very rich in terms of problems that can be modeled and solved using mathematical optimization and operations research techniques. In the last twenty years we have witnessed a gradual transition from simulation-based methods, used to analyze various scenarios, to optimization methods capable of determining optimal or near-optimal solutions to complex problems in a reasonable amount of computing time. Some recent contributions dealing with two important problems arising in railway management, i.e., the "Train Timetabling Problem" and the "Crew Planning Problem," will be considered in the following. These problems account for a large portion of the management activities performed by most railways. Graph Theory and Integer Programming models are presented, and heuristic algorithms, based on Lagrangian relaxation, are proposed. Extensive computational results on large-size real-world instances are reported.

MA: 8:30am-10:00am **Room: M32**

Demand Aggregation in Facility Location Models

Richard Francis
University of Florida

Timothy Lowe
University of Iowa

Most facility location problems involve facilities providing services to customers, with distances between the two being of interest. When the customers are at the household level, aggregation of their locations may be necessary to obtain a tractable model. A common approach is aggregating every customer location in a postal code area into the centroid of the area. This aggregation introduces error. We survey methods developed in the last decade, based on viewing the aggregation as a second-order location problem, and using error bounds, to do aggregation in such a way as to keep the error small.

MD: 2:00pm-3:30pm **Room: MB I**

Applications of Quantitative Methods in Entrepreneurship Research

Raphael Amit
University of Pennsylvania

This highly interactive active learning workshop will review a range of key issues in entrepreneurship research and offer insights into the use of a variety of analytical, statistical, econometric, and optimization techniques in entrepreneurship research. Workshop participants will work in groups and will be expected to actively contribute their ideas to enhance their learning experience.

MD: 2:00pm-3:30pm **Room: MB II**

Multiple Criteria Decision Making

Murat Köksalan
METU

The area of Multiple Criteria Decision Making (MCDM) has seen major developments during the last 40 years. In this tutorial, we discuss these developments and describe some of them in detail. We consider the problems where the solution space is defined as a set of alternatives as well as the problems where the solution space is continuous. We summarize a variety of approaches developed for each case and cover some of them in detail. In addition to the problem of selecting the best solution, we also discuss subset selection and classification problems under multiple criteria. Many researchers have been working on developing heuristic approaches for combinatorial multiple criteria problems in recent years. We briefly discuss some of these developments as well.

MD: 2:00pm-3:30pm **Room: MB III**

Aircraft and Crew Scheduling

Cynthia Barnhart
Massachusetts Institute of Technology

In this tutorial, we survey the state-of-the-art in aircraft and crew scheduling, problems rich in complexity, with significant associated costs and revenues. We present selected fleeting, routing and crew scheduling optimization models and algorithms, and describe their impact in practice. We also survey the status of efforts to integrate these models and enhance them to achieve operational robustness. We examine trends in airline passenger delays and explore the effects of various scheduling and recovery strategies on passengers. Finally, we describe remaining challenges and research opportunities in aircraft and crew scheduling.

ME: 4:00pm-5:30pm **Room: MB I**

OR Applications in Maritime Transportation

Marielle Christiansen
Norwegian University of Science and Technology

In this tutorial, we will give an overview of some planning problems within maritime transportation at the various planning levels. We start at the strategic fleet planning level and discuss the design of fleets and sea transport systems. We continue with the tactical and operational fleet planning level and consider problems that comprise various ship routing and scheduling aspects. Here we discuss the different modes of operations separately, namely industrial, tramp and liner shipping. Examples of real cases, elements of models and solution methods will be given. A commercial decision support system used for ship routing and scheduling will be presented, and some experiences with the system will be given. Finally, we present some trends regarding future developments and use of optimization-based decision support systems for ship routing and scheduling. Several of the trends indicate both accelerating needs for and benefits from such systems.

ME: 4:00pm-5:30pm **Room: MB II**

OR/MS in Health Care: Contemporary Issues and Solutions

Yaşar A. Özcan
Virginia Commonwealth University

Problems in the health care industry present a unique platform for operations research and management science professionals. This session will identify past, current and potential future research questions concerned with operations research and health care applications. The session will disseminate solutions to the above questions, and explore the application of OR/MS methods to health care. While finances in health care is a force which drives policy decisions from

cost/reimbursement perspectives, on the other hand OR/MS methods that can enhance efficiency and quality play a more integral part in hospital and clinic management. More specifically, benchmarking the health services practice became one of the contemporary issues. This session will present OR/MS tools and applications for benchmarking in health services.

ME: 4:00pm-5:30pm Room: MB III

Supply Chain Management and Advanced Planning

Hartmut Stadtler
Technische Universität Darmstadt

More and more companies collaborate with their suppliers and customers in order to better serve the ultimate customer and to gain competitive advantage. The design, planning and control of these - so called supply chains - is the task of Supply Chain Management (SCM). We will start the tutorial by outlining the building blocks of SCM which we feel constitute some degree of novelty of this management paradigm. One of the building blocks - Advanced Planning - will be discussed in greater detail based on the standard architecture underlying Advanced Planning Systems today - like those from i2 technologies, JD Edwards or SAP AG. By means of a hypothetical example we will illustrate the models used and their interactions to support the different planning tasks facing an intra-organisational Supply Chain (SC). Finally we will consider inter-organisational SCs, especially the issue of collaborative planning.

TUESDAY, JULY 8

TA: 8:30am-10:00am Room: MB I

Routing in Telecommunication and Traffic Networks

Rolf H. Möhring
Technische Universität Berlin

Networks, such as telephone networks, the Internet, airline, railway and bus networks are omnipresent and play a fundamental role for communication and mobility in our society. We almost take their permanent availability, reliability, and quality at low cost for granted. However, traffic jams, ill-designed train schedules, canceled flights, break-downs of telephone and computing networks, and slow Internet access are reminders that networks are not automatically good networks. In fact, designing and operating communication and traffic networks are extremely complex tasks that involve many OR-type problems. The increasing use of existing networks and the resulting capacity problems have led to the development of new methods for "optimizing" network usage. This lecture will give an overview on such network optimization methods in telecommunication (reliable networks) and traffic (route assignment under rush hour conditions). The common methodological themes in these applications are complex multicommodity flows and dynamic flows.

TA: 8:30am-10:00am Room: MB II

Group Decisions and Intergenerational Equity

Rakesh K. Sarin
The Anderson School at UCLA

In this presentation, we focus on group decisions where a group of individuals or a committee collectively shares the responsibility for choosing among alternative proposals for action. Individuals or committee members may have different views on the relative merit of each proposal. Therefore, the problem boils down to how one should aggregate the preferences of the committee members to arrive at a preferred decision. We propose an approach and hint at possible applications. In the second part of the presentation, we focus on those decisions where equity and fairness are paramount in the group's choice of a preferred decision. Some suggestions for incorporating equity and fairness in-group decisions are offered. Some issues with decisions that involve consequences deep into the future are highlighted.

TA: 8:30am-10:00am Room: MB III

Financial Engineering

Salih N. Neftçi
City University of New York and
University of Reading

Financial engineering is the application of synthetic asset creation or, of replicating portfolios to solving real world problems. These problems fall into several categories and the methods to be applied follow some clear principles. In this tutorial we present a general overview of these methods and provide the minimum formal modeling that one needs as a common ground to solving these problems.

TD: 2:00pm-3:30pm Room: MB I

Landscapes of Modern Heuristic Search

Colin Reeves
Coventry University

Important steps have been made in the last two decades in developing heuristic search algorithms for hard combinatorial optimization problems. Heuristics may be classified into several broad categories, but much of the impetus for recent developments has come from the application of general heuristic paradigms based on the simple idea of local search methods such as simulated annealing, tabu search and genetic algorithms. These modern approaches (sometimes referred to as 'metaheuristics') have much to offer in terms of generality and flexibility. Perhaps the best way to view the variety of approaches is by making use of the general concept of a landscape in order to obtain a unified treatment. In this talk, I shall discuss the idea of a landscape and show how modern heuristic methods fit into this framework.

TD: 2:00pm-3:30pm Room: MB II

A New Approach to Search Theory

Daron Acemoğlu
Massachusetts Institute of Technology

Search theory analyzes a class of problems where individuals are imperfectly informed about prices and engage in costly sampling. The standard approach considers a decision problem where an individual sequentially takes random draws from a known or unknown distribution, F(p), and decides when to stop and accept one of the draws. The trade-off is between costly delay and the expectation of obtaining more favorable draws in the future. This talk will survey new research on "directed search models" where individuals are allowed to direct their search towards one of several conditional distributions, F(p|x) for some observable characteristic x. In addition, these models incorporate the possibility that the relative number of sellers with

characteristic x vs. buyers sampling from the conditional distribution F(p|x) affects the probability of transaction. An example would be whether to search in different areas with different distribution of prices, while taking into account the possibility of stock-outs as a function of the number of stores in a given area relative to buyers visiting that area. In these models, the key trade-off is between the expectation of better offers and "expected queue lengths". More attractive conditional distributions will attract more buyers, leading to greater expected queue lengths and making stock-out more likely. Therefore, the search strategy of each individual has to be determined as a best-response to the search strategies of other individuals. This approach to search theory requires a different type of modeling strategy, has a variety of applications, and leads to different implications than the random/undirected search approach.

TD: 2:00pm-3:30pm Room: MB III

Advances in Financial Modelling and Portfolio Optimization

Stavros A. Zenios
University of Cyprus

Quantitative methods have been gaining increasing importance in finance over the last decades. Not only the celebrated models for options pricing have evolved to unprecedented levels and are used routinely in industry, but policymakers have also come to rely on quantitative models for risk management and control. Within the framework of enterprise-wide risk management methods and techniques drawn from operations research play today an important role. This talk will survey the current state-of-affairs. For related material visit www.hermes.ucy.ac.cy/zenios/

TE: 4:00-5:30pm Room: MB I

Modeling and Algorithmic Challenges in Forestry: Twenty Open Problems

Andrés P. Weintraub
Universidad de Chile

Operations Research has had a very significant role in forestry, both in methodological proposals, and in real use. Decisions supported by OR techniques include long range strategic planning, tactical decisions of sequencing of areas to harvest and road building, scheduling short term harvesting, machine location and transportation. A major source of problems relates to environmental issues such as the protection of wildlife, soil and water quality, sustainability, and diversity. Main algorithmic approaches include LP, Nonlinear Programming, Mixed Integer LP, Heuristics, and Metaheuristics, in particular Tabu search and simulated annealing, Simulation, Dynamic and Stochastic programming. An issue of importance is the integration of models to information technologies, data and communication. The talk will concentrate in state of the art results obtained so far, and in particular in open problems, that have not been resolved as yet and are in the frontier of research. This includes so far intractable combinatorial problems, finding adequate representations and models of complex real problems, dealing with soft data, as well as incorporating uncertainty and multiple attribute issues into actual decision making.

TE: 4:00-5:30pm Room: MB II

Operations Research and Planning of Radiation Therapy

Horst W. Hamacher
University of Kaiserslautern

In fighting cancer, finding good, patient-specific radiation plans is extremely important for the success of radiation therapy. In addition to its practical importance, this problem very interesting is from an Operation Research point of view. In order to design good radiation plans, various decisions have to be made, which can be tackled by OR methods. For example, one can use global optimization to find promising radiation angles. The problem is to decide where to stop with the radiation gantry in order to send off radiation. In the past equidistant angles have been used as rules of thumb, but these can be improved. Another interesting problem deals with multicriteria optimization to balance radiation dosage. In order to kill all cancerous cells, one would want to send as much radiation as possible. But this imposes significant risks of destroying one or more of the healthy organs. The idea is to produce a well-chosen set of Pareto solutions which correspond to high quality radiation plans, from which the doctors can choose the ultimate plan. A third example deals with integer programming and network optimization to implement a radiation plan. Here we concentrate on devices used to shape the radiation field. In this talk we will report on research performed at research groups in Kaiserslautern in cooperation with the German Cancer Research Center, MRC Systems, and Harvard Medical School/Mass General Hospital.

TE: 4:00-5:30pm Room: MB III

Option Pricing with Constraints

H. Mete Soner
Koç University

This tutorial surveys several methods for pricing in markets with constraints. In the classical Black-Scholes model, the financial market consists of two instruments: money market with a deterministic return and a risky asset called stock. Stock dynamics is assumed to be a geometric Brownian motion. Under the assumptions that there are no constraints and transaction costs, it is known that any contingent claim or equivalently any instrument designed by using the two underlying assets can be replicated by the underlyings. Hence, any pricing approach to this claim gives the same answer, namely the Black-Scholes price. However, in the presence of constraints, transaction costs or any other market imperfection, there is no unique arbitrage price but rather there is a no-arbitrage interval: If the initial price of the claim is in this interval there is no sure way of arbitrage. Hence, any pricing approach yields prices in this interval and the characterization of this interval of is important. Convex duality and partial differential equations techniques used to study this interval will be outlined in this tutorial. A stochastic representation for geometric flows is also obtained as a corollary.

WEDNESDAY, JULY 9

WA: 8:30am-10:00am Room: MB I

Enabling Value Chain for E-Business

Mathias F. W. Kirchmer
IDS Scheer

Savaş Özatalay
Widener University

This presentation will discuss the process of enabling the value-chain for e-Business in three stages. The first stage will examine the components, the structure, and the data requirements of an integrated value-chain. The second stage will show how the implementation of Enterprise Resource Planning (ERP) systems and Advanced Optimization and Planning (APO) tools will help to increase the efficiency of the value-chain. In the final stage, the process of moving the ERP and APO enhanced value-chain into an e-Business platform will be discussed. The presentation will conclude with the discussion of how the Business Process Improvement Tools, by using IDS Scheer's ARIS as an example, can help to expedite and improve this transformation process.

WA: 8:30am-10:00am Room: MB II

Adaptive Value Chain Optimization

Grace Lin
IBM TJ Watson Research and
IBM Academy of Technology

As companies look for ways to improve operation efficiency and customer values in the dynamic and challenging business environment, a new supply chain focus, models and technologies are emerging to create a competitive edge. In the last few years, Supply Chain Management (SCM) has evolved its focus from Enterprise Resource Planning (ERP) to Advanced Planning Systems (APS) to Collaborative Planning, Forecasting, and Replenishment (CPFR). Companies are starting to share risks and values to optimize their value chains. Additional capabilities such as dynamic pricing, e-auctions, and risk management are being developed and deployed to multiply the impact, efficiency and value of the supply chain process. In order to utilize these capabilities effectively, many companies are starting to shift from the rigid command and control business models to more adaptive models. In this talk, the pros and cons of the traditional Command and Control and a Sense and Respond business models will be examined and a new adaptive business model that dynamically exploits various business analytics will be presented. The criticality of business process management and the adaptive technologies required to support the adaptive business will also be discussed, as will a framework for adaptive value chain optimization to support adaptive business and cross-enterprise optimization.

WA: 8:30am-10:00am Room: MB III

Revenue Management

Peter Bell
The University of Western Ontario

This tutorial will present revenue management (also known as "yield management") and the basic tools used by the revenue manager: optimum dynamic pricing, overselling, trading-up, discount allocation, and re-planing. The business rationale and the underlying OR models that guide decision-making for each will be discussed. Emphasis will be placed on research opportunities in this fast growing and important application area for OR.

WE: 4:00pm-5:30pm Room: MB I

Capacity Portfolio Investment and Hedging: Review and New Directions

Jan A. Van Mieghem
Northwestern University

This special session surveys the literature on stochastic capacity investment and presents new work on hedging the risk of the investment by purposely unbalancing the capacity portfolio. Capacity relates to upper bounds on the sustainable production quantities of a firm resulting from limitations in its processing network. While many factors can limit production quantities, the discussion here will focus on the prime economic factors of production: capital and labor resources. Investment is the change of the stock of capital and labor and includes expansion and contraction. A general stochastic capacity investment model and its major properties are reviewed together with a discussion of important issues in the formulation of capacity problems. Recent directions in stochastic capacity investment are discussed: investment in multiple resources, investment by multiple agents, and investment that incorporates risk considerations. We focus on optimal investment in a portfolio of capacity types or "real assets" and discuss and contrast hedging strategies involving financial versus operational means. We show that, in contrast to single resource capacity problems, the portfolio capacity problem cannot be transformed into an equivalent deterministic problem, which has repercussions on capacity planning in practice. New results on the efficient risk-return frontier and the optimal risk-hedging capacity adjustment path are presented. This suggests a measure for the value of operational hedging by purposely deviating from a balanced capacity configuration (or from the risk-neutral optimal configuration as prescribed by a newsvendor network solution).

WE: 4:00pm-5:30pm Room: MB II

Marketing Engineering: Marketing Decision Models for the Digital, Networked Economy

Gary L. Lilien
The Pennsylvania State University

The digital networked economy is inducing significant structural changes in (a) how marketing models are developed and deployed, (b) who uses marketing models, and (c) what types of models are developed. In the first phase of our Marketing Engineering program (marketing decision support with OR inside) we developed over two dozen tools in an integrated, user-friendly environment, making those tools accessible to students and to practitioners. In the second stage of development, we are making the most widely used of these tools available in an application service provider (ASP) basis, requiring little or no software on the client computer. We will illustrate our ideas with implementations of leading edge marketing models, including perceptual mapping, conjoint analysis, choice models and cluster analysis, operating over the internet. We will show what the impact of these developments have been for teaching and implementing marketing models in practice and will provide a perspective on the future developments of OR in marketing.

WE: 4:00pm-5:30pm Room: MB III

Vehicle Routing

Gilbert Laporte
HEC Montréal

Vehicle routing problems lie at the heart of distribution management. These problems are NP-hard and, to this day, exact algorithm can only solve relatively small instances. In practice heuristics are the only sensible solution methodology. Over the past forty years several heuristic principles have been put forward and the best available methods are highly performing. Still, practitioners often use packages based on rather unsophisticated heuristics, dating sometimes from the 1960s. There can be several reasons for this state of affairs, but one of them is that most of the available methods simply lack the necessary attributes to make them appealing to practitioners. We argue that a good vehicle routing heuristic should be accurate, fast, simple and flexible. We examine several classical heuristics and some of the better performing metaheuristics proposed in recent years and we assess them with respect to these criteria.

THURSDAY, JULY 10

RA: 8:30am-10:00am Room: MB I

The Subversive Spreadsheet

David Chadwick
University of Greenwich

Grenville Croll
Arthur Andersen

This talk will be in two phases: phase one will give an overview of the problem of spreadsheet errors, phase two will look at a detailed approach to spreadsheet audit. Phase one will cover common the problem of spreadsheet errors - what they are, how they are caused, the risks they pose and what can be done about them. A taxonomy of errors will be discussed and examples of common errors shown. The aspects of causation such as human error and non-awareness will be covered in overview with suggestions on how to prevent or minimise. Audit aspects such as audit tools, methods and strategies will be briefly covered. Phase two will be looking at a tried and tested audit methodology composed of ten steps. Each of the steps incorporates a number of checking and risk management procedures resulting in an assessment of a level of confidence that may be placed in the integrity of the reviewed spreadsheet model.

RA: 8:30am-10:00am Room: MB II

Modelling of Telecommunications and Electronic Commerce

Bezalel Gavish
Southern Methodist University

Telecommunication systems, the Internet and Electronic commerce are having an enormous impact on industrial organizations, economic activities of nations, governmental activities and services offered and executed by individuals. The tutorial will present some of the innovative applications and services that stem from the widespread availability of the Internet, the opportunities and limitations of growth imposed on them by economic and physical considerations. The tutorial will also present some new problems in this area and will develop mathematical and economic models; they will be used as a basis for developing solution procedures. Their use will be demonstrated through numerical examples.

RA: 8:30am-10:00am Room: MB III

A New Look at Convexity, Duality, and Optimization

Dimitri P. Bertsekas
Massachusetts Institute of Technology

We provide a unified framework for minimax theory and constrained optimization duality as special cases of duality between two simple geometrical problems. Within this framework, the fundamental constraint qualifications needed for strong duality and existence of saddle points are quite apparent, and admit straightforward proofs. Some new tools from convex analysis, needed to fully exploit this framework, will be discussed. This analysis is central to the new textbook Convex Analysis and Optimization by D. Bertsekas, A. Nedic, and A. Özdağlar.

RD: 2:00pm-3:30pm Room: MB I

Verification and Validation of Computer-based Models

Robert G. Sargent
Syracuse University

In this presentation we discuss the verification and validation of computer-based models. The different approaches to deciding model validity are presented; how model verification and validation relate to the model development process are discussed with the use of pictorial diagrams to show different relationships; various validation techniques are defined; conceptual model validation, model verification, operational validity, and data validity are described; ways to document results are given; and a recommended procedure is presented.

RD: 2:00pm-3:30pm Room: MB II

Creative Operations Research Modeling using Excel and Add-ins

Hervé Thiriez
Groupe HEC

In this session, many examples will be shown of professional models developed with Excel and, in some cases, an Excel add-in. In the first part of this session, we will see an expert system for the diagnosis of pipes in a nuclear plant, a general-purpose toll booth simulation model, a traffic simulation model for the simulation of car traffic around an airport zone (between the highways and the protected airport area), a model for the optimization of satellite launches, a model for supervising the operations in a steel factory. Each of these models was developed much faster and cheaper with Excel than what competitive bids offered. In the second part of this session, we will see what techniques (known only by very few Excel users) were used in order to develop models which most people are totally convinced are far above Excel's capabilities. Some examples: graphs with pull-down menus, graphs with adaptive titles, flexible graphs, even movies. There is a major interest in developing OR models with a spreadsheet: not only do you save significant amounts of time and money, but you also benefit from an interactivity which most large dedicated modelling packages simply cannot offer.

These institutions have made valuable contributions to the success of the EURO/INFORMS Joint International Meeting 2003. We gratefully acknowledge their sponsorship.

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Personal Planner

MONDAY	TUESDAY	WEDNESDAY	THURSDAY
MA - 08:30am-09:30am	TA - 08:30am-09:30am	WA - 08:30am-09:30am	RA - 08:30am-09:30am
MB - 10:15am-11:45am	TB - 10:15am-11:45am	WB - 10:15am-11:45am	RB - 10:15am-11:45am
MC - 12:00pm-1:30pm	TC - 12:00pm-1:30pm	WC - 12:00pm-1:30pm	RC - 12:00pm-1:30pm
MD - 2:00pm-3:30pm	TD - 2:00pm-3:30pm	WD - 2:00pm-3:30pm	RD - 2:00pm-3:30pm
ME - 4:00pm-5:30pm	TE - 4:00pm-5:30pm	WE - 4:00pm-5:30pm	RE - 4:00pm-5:30pm

How to Navigate the Parallel Sessions

The following are intended to help you to navigate and understand the EURO/INFORMS İstanbul 2003 Parallel Sessions:

- The parallel session listing (pages 29-228), is presented chronologically by day/time, showing each session and the papers/abstracts/authors within each session.
- The "Master Track Schedule", which can be found in the EURO/INFORMS İstanbul 2003 Quick Reference, is an overview of the tracks and when/where they are scheduled.

The Session Codes

M A 01

The day of the week

Time Block: Matches the time blocks shown in the Master Track Schedule.

Track Number: Coordinates with the room locations shown in the Master Track Schedule. Room locations are also indicated in the listing for each session.

Week Days

M (Monday), T (Tuesday), W (Wednesday), or R (Thursday).

Time Blocks

A - 8:30am-10:00am
B - 10:30am-11:30am
C - 12:00pm-1:30pm
D - 2:00pm-3:30pm
E - 4:00pm-5:30pm

Room Locations

The level (L, M, or R) or the initials of the meeting room (JB: Junior Ballroom, MB: Main Ballroom), and the room number (10-39, I-III, or A-B).

: MA03 Optimization Problems in Railway Applications

Tutorial Room: MB III

Optimization Problems in Railway Applications. Paolo Toth, University of Bologna.

The rail transportation industry is very rich in terms of problems that can be modeled and solved using mathematical optimization and operations research techniques. In the last twenty years we have witnessed a gradual transition from simulation-based methods, used to analyze various scenarios, to optimization methods capable of determining optimal or near-optimal solutions to complex problems in a reasonable amount of computing time. Some recent contributions dealing with two important problems arising in railway management, i.e., the "Train Timetabling Problem" and the "Crew Planning Problem," will be considered in the following. These problems account for a large portion of the management activities performed by most railways. Graph Theory and Integer Programming models are presented, and heuristic algorithms, based on Lagrangian relaxation, are proposed. Extensive computational results on large-size real-world instances are reported.

: MA04 Tutorial on Logical Analysis of Data

Invited Session Room: JB A

Chair: Peter Hammer
Rutgers University

1 : Introduction to LAD. Peter Hammer, Rutgers University.

We shall define the basic concepts of LAD: support sets, binarization, patterns, theories, models and discriminants, stressing their intuitive meaning, giving the mathematical formulations of the problems and emphasizing the status of the related computational problems.

2 : Mathematical Issues in LAD. Endre Boros, Rutgers University.

Logical Analysis of Data is a logic and optimization based approach to data analysis, and consists as main phases support set generation, pattern generation, and theory formation. Each of these phases involve mathematical optimization, involving several modeling and algorithmic problems. In this talk we discuss some of the related mathematical issues, and open problems.

3 : Open Questions in LAD. Peter Hammer, Rutgers University; Boros, Endre.

Presentation and discussion of open questions posed by participants and/or speakers.

: MA05 Queueing Models and Traffic Control

Invited Session Room: JB B

Chair: Bernhard Friedrich
University of Hannover

1 : Queueing Models for Online Traffic Monitoring and Control Purposes. Bernhard Friedrich, University of Hannover; Matschke, Irina.

In urban road networks the traffic situation and thus the service quality is particularly determined by the performance of signal controlled intersections. This performance is subject to the interdependence of the variable traffic demand and the respective control actions. In consequence, the better the interdependence is modelled the better the control will perform. This paper gives an overview on queueing models that are suitable for online signal control and monitoring purposes. The most relevant models are analysed using real traffic data. An evaluation of the models due to different criteria completes the paper.

2 : Estimation of Traffic Behaviour in Networks of Signalized Intersections Modelled via Timed Petri Nets. Angela Di Febbraro, Politecnico di Torino; Giglio, Davide; Sacco, Nicola.

Petri nets provide a modelling formalism suitable to represent significant classes of transportation systems. In this paper, Petri nets are applied to give a modular control-oriented representation of urban traffic systems regulated by signalized intersections. Such systems are considered to be composed of elementary structural components, namely, intersections and road stretches. A procedure to evaluate the traffic behaviour by means of the firing sequences of the transitions of the Petri net representing a traffic system is described. The effectiveness of the proposed method is shown through real case studies relevant to the Italian city of Turin.

3 : Pricing of Access to Congested Airports. Amedeo Odoni, Massachusetts Institute of Technology.

Queueing theory can be helpful in applying economic principles to the pricing of access to congested airports. New results will be described based on joint work with T. P. Fan. Applications, however, must also take into consideration several technical and public policy constraints. Examples from a number of North American and European airports illustrate the wide variety of local conditions that must be addressed.

4 : Trends in Intelligent Signal Traffic Control. Maurizio Bielli, Institute of Systems Analysis and Informatics; Felici, Giovanni; Sforza, Antonio; Rinaldi, Giovanni.

Signal traffic control represents a relevant topic both for the OR community interested in developing new methods, models and algorithms and for the practitioners involved in the systems implementation and improvement. Current political issues focused on sustainable mobility and Intelligent Transportation Systems require the investigation of more efficient and integrated systems, by exploiting telematic technologies. Several approaches have been proposed and developed with the application of autonomous agents, artificial intelligence and fuzzy logic techniques. These trends are illustrated and discussed, and a new signal traffic control model based on logic programming is outlined and the experimental results presented.

: MA06 Scheduling in Computer Systems

Invited Session Room: M30

Chair: Maciej Drozdowski
Poznan University of Technology

1 : Exact Algorithms for Scheduling Malleable Tasks. Jacek Blazewicz, Poznan University of Technology; Kovalyov, Mikhail;

Machowiak, Maciej; Denis, Trystram; Weglarz, Jan.

The problem to be cosidered is one of scheduling malleable tasks on a set of m parallel identical processors. Tasks are independent and each of them may be processed on any number of processors not greater than m. Processing times of tasks are expressed in a form of non-decreasing discrete functions relating these times to a number of processors allocated. The objective is to minimize schedule length. In the talk a polynomial algoritm is given for a number of tasks not exceeding m and concave discrete functions.

2 : A New Algorithm for Stochastic Multiprocessor Task Scheduling. Antonio Iovanella, Università degli Studi di Roma "Tor Vergata"; Paolo, Dell'Olmo; Lulli, Guglielmo.

Many applications, such as Multicast networks and Grid computing, deal with tasks which request a number of parallel processors in order to be accomplished. The main issue is to design and analyse algorithms in order to reduce the completion time. In this talk we consider that each task comes with a stochastic ready time, modelled as a random variable, and unitary task processing times. We propose an algorithmic approach to solve the described problem combining both well-known techniques of the off-line multiprocessor task scheduling and stochastic features of the problem.

3 : Influence of Starting Solutions on the Stabilisation of Scheduling Algorithms. Mahjoub Amine, Laboratoire GILCO; Christophe, Rapine; Denis, Trystram.

In the literature about scheduling for parallel processing, most of the works consider that data are perfectly known. In practice, as uncertainty affects the data, it should be considered as part of the decision environment. There exist classical approaches for dealing with uncertainty, such as sensitivity analysis which studies the relationship between the degree of changes in parameters of the model and those in the optimal objective value. Stabilisation is an approach which starts with initial static schedules calculated with estimated data. In this work we are interested to study the influence of the initial schedule on the stabilisation process.

4 : Optimum Divisible Load Scheduling on Heterogeneous Stars with Limited Memory. Maciej Drozdowski, Poznan University of Technology; Wolniewicz, Pawel.

A problem of scheduling divisible application on a set of heterogeneous processors with limited memory sizes is analyzed. Divisible loads are computations which allow for dividing computations into several parts of arbitrary sizes, and the parts can be processed independently in parallel. A star communication network is assumed. Processing elements of the network are characterized by the processing speed, memory size, speed and startup time of the communication link. The problem is established to be computationally hard. Therefore, two types of algorithms are proposed, and evaluated: an exact algorithm with the worst case exponential execution time, and polynomial-time heuristics.

: MA07 **Supply Chain Design and Management**

Invited Session Room: M31

Chair: Erdem Eskigun
General Motors R&D

1 : Examining the Downstream Impact of Component Standardization Decisions in Supply Chains. Kamalini Ramdas, University of Virginia; Randall, Taylor.

For assembled products, component standardization decisions made in the product design phase can have serious consequences in manufacturing and further downstream in the supply chain, in product quality and after-sales costs incurred by the OEM. We examine the downstream impact of component standardization, using data on automotive braking systems.

2 : Optimal and Near-Optimal Component Replenishment Policies for Assemble-to-Order Systems. Jing-Sheng Song, University of California at Irvine; Zheng, Shaohui; Zipkin, Paul.

We examine an assemble-to-order (ATO) inventory system, in which we replenish the stocks for the components from outside suppliers, but final products are assembled only when customer orders occur. The focus is the structure of optimal and near-optimal component inventory control policies.

3 : Controlling Inventories in Divergent Supply Chains with Advance-Order Information. Johan Marklund, University of Colorado.

The presence of advance-order information raises important questions regarding how to use this information to improve the replenishment and allocation of inventories throughout the supply chain. Focusing on a one-warehouse multiple-retailer system operating in a continuous review environment, we present methods for exact and approximate cost evaluation for three warehouse allocation policies when all installations use order-base-stock policies to replenish their inventories. A numerical study illustrates the performance of the proposed policies and heuristics and provides insights as to the value of carefully using advance-order information in supply chain inventory control.

4 : Service Parts Distribution Network Design. Erdem Eskigun, General Motors R&D; Nicholas, Dennis; Tew, Jeffrey.

A network design model is developed to redesign service parts distribution system of a division of General Motors. The design model explicitly considers piece-wise LTL transportation rates for stock order shipments and fixed-charged air transportation rates for emergency order shipments. A Lagrangian heuristic is developed to obtain near optimal results in short computing time. The comparison of the new network design with benchmark network structures reveals significant cost savings. The scenario analyses also allow finding the best stock replenishment lead-time and the frequency of emergency order shipments.

: MA08 **Demand Aggregation in Facility Location Models**

Tutorial Room: M32

Demand Aggregation in Facility Location Models. Richard Francis, University of Florida; Lowe, Timothy.

Most facility location problems involve facilities providing services to customers, with distances between the two being of interest. When the customers are at the household level, aggre-

gation of their locations may be necessary to obtain a tractable model. A common approach is aggregating every customer location in a postal code area into the centroid of the area. This aggregation introduces error. We survey methods developed in the last decade, based on viewing the aggregation as a second-order location problem, and using error bounds, to do aggregation in such a way as to keep the error small.

: MA09 Management of Innovation and New Products

Invited Session Room: L15

Chair: Shantanu Dutta
London Business School

1 : Does Distance Still Matter? The Role of Geographic Proximity on New Product Development. Aric Rindfleisch, University of Wisconsin-Madison.

Many firms rely on outside organizations for knowledge inputs for developing new products. Cluster theorists suggest this knowledge is best obtained from organizations located in close geographic proximity. Close proximity is theorized to foster face-to-face communication,strong ties, knowledge acquisition, and new product outcomes. In order to assess these assumed benefits of proximity, we surveyed 155 firms in the U.S. optics industry. We find that firms located in close proximity do engage in increased face-to-face communication, but this has little effect on knowledge acquisition or new product development. Thus, the assumed benefits of proximity appear to be over-rated.

2 : Conversion Ability. Rajesh Chandy, University of Minnesota; Hopstaken, Brigitte; Narasimhan, Om; Prabhu, Jaideep.

The ability to convert ideas to finished outputs is a critical determinant of success in many fields of endeavor. This research studies firms' ability to convert ideas into launched products, i.e., their conversion ability. Specifically we ask: Why are some firms better at conversion than others? The literature on product development, though vast, has rarely addressed the conversion ability of firms. However, researchers have frequently highlighted the virtues of increased speed and increased idea generation. We propose that a strong focus on speed and on generating many ideas may actually hurt firms, by lowering their conversion ability.

3 : The International Takeoff of New Products: The Role of Economics, Culture and Country Innovativeness. Gerard Tellis, University of Southern California; Stremersch, Stefan.

Prior research on takeoff covers only the US. The present study addresses takeoff in Europe, more specifically: (1) Do different categories and countries have consistently different times-to-takeoff? (2) What factors explain the inter-country differences? (3) Should managers use a sprinkler or waterfall strategy for the introduction of new products across countries? From data on 137 new products (10 categories; 16 countries), we find that (1) the time-to-takeoff varies substantially across countries and categories; (2) while culture partially explains inter-country differences in time-to-takeoff, economic factors are neither strong nor robust explanatory factors; (3) there are distinct advantages to a waterfall strategy.

4 : The Role of Agreement Portfolios in Technology-Intensive Markets - Implications for Innovation and Profitability. Stefan Wuyts, Erasmus University Rotterdam; Dutta, Shantanu; Stremersch, Stefan.

In technology-intensive markets, firms enter into inter-firm R&D agreements to gain access to knowledge bases that reside with other firms. Recent marketing studies show that such agreements aid in new product development projects. While these studies invariably focus on isolated agreements, a firm's portfolio of agreements determines its overall access to knowledge bases. We define several agreement portfolio descriptors that are expected to affect a firm's knowledge in-flow, and we study their effect on radical innovation, incremental innovation, and profitability. We test our model in the pharmaceutical industry, using a unique database of approximately 1000 R&D agreements.

: MA10 Environmental Aspects of Closed-Loop Supply Chains

Invited Session Room: L19

Chair: Costas P. Pappis
University of Piraeus

1 : Scheduling a Single Fire Fighting Resource with Sequence Dependent Setup Times. Nikos P. Rachaniotis, University of Piraeus; Pappis, Costas P.

In fire fighting, time and effort required to control a fire increase if the beginning of the fire containment effort is delayed. The problem of scheduling a single fire fighting resource when there are n fires (igniting simultaneously) to be controlled may be tackled using the concept of deteriorating jobs for the time needed for fire suppression. This paper considers the problem in the case where sequence dependent set-up times are incorporated. An algorithm based on the travelling salesman problem is presented.

2 : Environmental Analysis of SLI Batteries: Life Cycle Interpretation. Giannis Tsoulfas, University of Piraeus; Daniel, Stavros; Pappis, Costas P.

Although a framework for Interpretation, that is the final phase in Life Cycle Analysis, is still being elaborated, several steps have been made towards tracing the techniques that can assist this LCA phase, based on ISO recommendations. In this paper, several proposed techniques are applied in the results of the comparative environmental analysis of the reverse supply chain and the disposal chain of lead-acid batteries. Some relevant tools and concepts that may assist Interpretation are presented and discussed.

3 : Analytical Solutions for Scheduling Deteriorating Jobs in a Rework Environment. Theodore Voutsinas, University of Piraeus; Pappis, Costas P.; Janiak, Adam.

The problem of scheduling deteriorating jobs appears to have a special interest in rework environments. In this paper we study a single machine scheduling problem, where the jobs rework times have the same convex and growing deteriorating function (linear, exponential, polynomial etc.). The problem is solved analytically and it is proved that there is a sequence policy

that optimizes the objective function. Some special cases are experimentally tested.

4 : Evaluating Component Recycling Strategies. Baptiste Lebreton, Universität Augsburg; Tuma, Axel.

The European environmental legislation aims at inciting manufacturers closing their supply chain by explicitly encouraging the reintegration of used components. Though this approach seems to be "ecologically correct", the reluctance of several OEMs and the seldom diffusion of remanufacturing activities indicate that component recycling does not always economically make sense. The purpose of this paper is twofold: identify critical factors for the success of recovery operations and hereby explaining OEMs' behaviour concerning component recycling strategies. In this context an optimization model is discussed taking into account parameters such as life cycle duration, reverse flow distribution, technical compatibility and customer expectations.

: MA11 Applications in the Utilities Sector - I

Invited Session Room: R20

Chair: Ender Gurgen
Rensselaer Polytechnic Institute

1 : The Effects of Regulatory Intervention on Efficiency and Productivity of Electric Power Companies. Ender Gurgen, Rensselaer Polytechnic Institute; Norsworthy, John R.

Energy is a critical input in the production and service industries. Federal and state legislators have altered the structure of the electric utility industry by regulation and deregulation. This paper analyzes how deregulation and restructuring affect the efficiency of U.S. power companies in a panel of 74 large electric utility companies, 1997-2001. Regulatory practices intervene between efficiency and profitability, thus it is important to analyze physical efficiency measured by DEA, and "economic" efficiency or TFP. The RED (Retail Energy Deregulation) index by CAEM applies 22 attributes describing restructuring. We will use them to address efficiency and productivity differences among companies.

2 : An Application of DEA to the Air Traffic Industry. Marta Omero, University of Trieste; Castelli, Lorenzo; Pesenti, Raffaele; Ukovich, Walter.

The European air traffic managing is a complex and relevant issue. The gap between airspace capacity and demand for air navigation services (ANS) is widening, yielding an increase in delay and congestion on the entire net. Consequently, the quality of service provided by Air Control Centres (ACCs) to airlines and passengers is a very critical issue. Accordingly, it is important to analyse the supply of ANS and to understand how the customer needs could be better satisfied. The ACCs activity is assessed by means of DEA; hypotheses and motivations on the variables considered and on the results are made.

: MA12 Communications and Transportation Network

Invited Session Room: M39

Chair: Antonio Sforza
Università di Napoli "Federico II"

1 : The Multisource Quickest Path Problem. Giuseppe Bruno, Università di Napoli "Federico II"; Bellavista, Tiziana; Improta, Gennaro.

The shortest path problem is probably the most important problem in the field of network optimization. Various variants of the problem have been proposed in literature which can have several practical applications. In particular the single pair quickest path problem consists of finding the quickest path in a network from one source to one destination to send a given amount of demand (data, people or commodities) with minimal time, assuming a capacity constraint for each link. In this paper a version of this model is presented which aims to solve the problem in presence of many source nodes.

2 : A Dual Ascent Technique for a Location Problem Arising in Communication Networks. Paola Festa, Università di Napoli "Federico II"; Cerulli, Raffaele.

Facility location models have been intensively investigated in recent years and have stimulated the development of a number of sophisticated ad hoc techniques of pure or mixed integer programming. In this paper we describe a dual descent method for a pure 0-1 location problem known in the literature as the NP-hard capacitated concentrator location problem. The multiplier adjustment technique presented in this work is aimed to find an upper bound in a Lagrangean relaxation context permitting both to decrease and to increase multipliers in the course of the search in contrast with methods where that ones are monotonically updated.

3 : A Multicommodity Flow Model for QoS Management on IP Networks. Simon Pietro Romano, Università di Napoli "Federico II"; Avella, Pasquale; Boccia, Maurizio; Sforza, Antonio; Ventre, Giorgio.

The performance optimization of large scale IP networks has become an important problem. Enhancing the performance of an operational network, at both the traffic and resource levels, are major objectives of Internet traffic engineering. Traffic engineering deals essentially with the selection of optimal paths that different flows should follow in order to optimize resource utilization and satisfy each flow's requirements. A mixed-integer multicommodity flow model is proposed for QoS Management on IP network with some service levels. An algorithmic approach is proposed and experimental results are described.

4 : A Cache Location Model for Virtual Private Network. Antonio Sforza, Università di Napoli "Federico II"; Avella, Pasquale; Boccia, Maurizio; Canonico, Roberto; Ventre, Giorgio.

Content Distribution Networks replicate Web content to reduce client access latency. This replication can also reduce network overhead. Moreover the efficacy of content distribution depends on the placement of these replicas, and on the relative location of the client population. We study the problem of content distribution in the context of Virtual Private Networks, to find how to optimally locate a pre-defined number of web caches in the VPN vertices and how the cache location affects the network design problem. A two stage optimisation approach will be proposed, together with the results of experimentation on test and real networks.

: MA13 OR in Agriculture and Forestry Management

Invited Session Room: R21

Chair: Lluis M. Pla
University of Lleida

1 : Dynamic Programming and Simulation in Farm Management. Lluis M. Pla, University of Lleida; Pomar, Jesus.

Dynamic programming is widely used in farm management. Practical models are formulated in a deterministic way to avoid difficulties that stochastic models can show. We propose the combined use of a deterministic and stochastic models. The former, to get insight into the problem to be analysed and the last to get the variability of outputs. As example, a sow herd DSS is presented based on a semi-Markov model. Inputs include technical and economic parameters which can be fixed as constants or assigned to specific distributions. The DSS outputs include technical and economic indexes and sensitivity analysis of some parameters.

2 : Minimising the Transportation Cost of Sugar Cane. Silvia Miquel, University of Lleida; Lopez, Esteban; Pla, Lluis M.

In this work an approximation to the problem of cost minimization of sugar cane removal from the fields to the sugar mill, is demonstrated. It is solved by mixed linear programming. The complexity of the problem is basically determined by the system approach used. It results in the generation of a great number of variables and constraints that refer to the necessity of continue supply to the sugar mill, cutting means used in the cane harvesting, transportation vehicles and providing routes. The routes are characterized by the existence of storage places at the beginning of the railroad routes.

3 : A New Support System for Tactical Transportation Planning. Mikael Rönnqvist, Linköping University; Forsberg, Mattias.

We describe a new platform for decision support systems for logistic problems in forestry. There are many problems arising in the wood chain. One important is tactical transportation planning. The problem is to satisfy an industrial demand with a given supply at harvest areas and terminals using a number of assortments. The platform developed focuses on integrated wood chains or supply chains where co-ordination between companies and/or organisations and back haulage planning can provide substantial cost reductions. Furthermore, it supports strategic planning where integration/co-ordination of train transportation, terminals and truck transportation is used. Results from case studies are presented.

4 : Optimization of Production and Logistical Processes in the Flower Industry. Jesús Velásquez, Universidad de la Sabana; Perez, Ignacio; Valero, Camilo; Saldaña, Carolina; Joya, Tatiana.

This paper describes a linear programming model of the flower industry supply chain, since it receives the agricultural raw materials until the flowers are sold to the final customers. This is done by the adequate assignation of resources, answering to market requirements and minimizing production costs. The mathematical model underlines the seasonality presented on the life cycle of the product as well as the seasonality in the consuming process, providing flower growers with a formal tool for decision making processes that improve the general management of resources and all activities of the industry.

: MA14 Queueing Applications in Telecommunications

Invited Session Room: R22

Chair: Mine Çağlar
Koç University

1 : Rare Event Simulation of Highly Reliable Markovian Systems. Ad Ridder, Vrije Universiteit Amsterdam; Cheung, Sing Kong.

In this paper we are interested in the probability that a complex part in a telecommunication system breaks down due to system failure. Under exponentiality assumptions the system can be modeled as a reliability system in which the total system breakdown is a rare event. When one would estimate this probability by simulations one needs a variance reduction technique such as importance sampling. Recently an adaptive importance sampling scheme--called cross entropy--has been developed for rare event simulation in queues. In our study we analyse its performance in reliability problems.

2 : Stochastic Discretization for the Long-Run Average Reward in Fluid Models. Jacques Resing, Eindhoven University of Technology; Adan, Ivo; Kulkarni, Vidyadhar.

Stochastic discretization is a technique of representing a continuous random variable as random sum of iid exponential random variables. In this talk we apply this technique to study the limiting behaviour of a stochastic fluid model. More specifically, we consider an infinite capacity buffer, where the net input of fluid is regulated by a finite-state irreducible continuous time Markov chain. Most long-run performance characteristics for such a fluid system can be expressed as long-run average reward for a suitably chosen reward structure. We use stochastic discretization of the fluid content process to efficiently determine the long-run average reward.

3 : Analysis of GI/M/s/c Queues via Markov Regenerative Processes and Uniformization. António Pacheco, Instituto Superior Técnico; Ferreira, Fátima.

We combine embedding and uniformization to analyze GI/M/s/c queues, using their Markov regenerative structure, by computing: the stationary distribution of the number of customers in the system immediately before arrival epochs; the conditional expected sojourn times of the number of customers in each state in-between two consecutive customer arrivals; and, the stationary distribution of the number of customers in the system using the Markov regenerative structure of the process. We illustrate the use of the approach by computing performance measures for various types of GI/M/s/c queues, including Pareto/M/s/c queues, using stable recursions for the mixed-Poisson probabilities and expected sojourn times.

4 : Assessing the Effects of Short and Long Dependences in Network Performance using Stable FARIMA Models. Fotios Harmantzis, Stevens Institute of Technology.

FARIMA(p,d,q) processes with Stable Paretian innovations can accurately model the marginal distribution of network traffic, while accounting for both the long- and short-range depen-

dence. Traditional queueing theory methods are not applicable in the case of self-similar and non-Gaussian input traffic. In this paper, we engineer the loss curve of a single server queue with Stable FARIMA input. We are valuing performance, focusing on the effects and relevance of the long- and short-range characteristics in the queue behavior.

: MA15 **SADERYL: A Decision Support System for Vehicle Routing and Facility Location Problems**

Invited Session Room: R23

Chair: Angel Corberan
Universitat de Valencia

1 : A Decision Support System for Location and Routing Problems. Jaume Barcelo, Technical University of Catalonia; Fernandez, Elena.

Location and Routing models formalize problems solved in the daily practice of distribution and other transportation companies. The underlying support for these problems is geographic. Depots and customers are located at specific geographic points, the real graph represents a physical road network. GIS are the platforms to represent and visualize these problems. In practice the decision maker needs a friendly GUI to define data, select the model, apply an algorithm, and visualize the solution. This paper presents the architecture of a decision support system developed in the project SADERYL integrating in an ad hoc GIS location and vehicle routing models.

2 : On Determining Enrouting Protocols in a Telecommunications Network Under Uncertainty. Laureano Fernando Escudero, Universidad Miguel Hernandez; Marc, Almiñana; Marhuenda, Marco; Monge, Juan Francisco; Sánchez-Soriano, Joaquin.

A telecommunication network with terminal and router nodes and a stochastic origin-destination flow matrix for each instant along a given time horizon is considered. A routing protocol can be defined as the requirement for the information flow routings with identical destination terminal nodes to share the same arcs from common transhipment nodes. Capacities in the arcs, the node buffers and the node processing are considered. A two-stage stochastic mixed 0-1 model with full recourse, as well as a hybrid column generation-genetic approach for problem solving are presented. Some computational experience is reported.

3 : A Branch-and-Cut Algorithm for the Plant-Cycle Location Problem. Juan José Salazar González, Universidad de La Laguna (Tenerife); Rodríguez Martín, Inmaculada; Labbé, Martine.

The PlantCycleLocationProblem is defined on a graph where nodes represent customers and plants. Each customer must be served by one plant, and the plant must be opened to serve customers. The number of customers that a plant can serve is limited. There is a cost of opening a plant and of serving a customer. Customers served by a plant are in a cycle visiting the plant and there is a cost associated to the cycle. The problem consists of determining the plants to open, the assignment of customers to plants, and the cycles in order to minimize the total cost.

4 : Approaching Transhipment Point Problems by Polyhedral Studies. Mercedes Landete, University Miguel Hernández of Elche; Marín, Alfredo; Canovas, Lazaro.

The problem of locating transhipment points arise in telecommunication and transportation systems where several locations send and receive products. We introduce some formulations using some packing constraints for the problem and we study its polyhedral structure. Valid inequalities and facets of the feasible polyhedron are obtained so that stronger formulations are obtained. Time needed to solve the problem decreases when using these stronger formulations.

: MA16 **Integer Programming - I**

Invited Session Room: R27

Chair: Robert Weismantel
Otto-von-Guericke-University of Magdeburg

1 : Fast Integer Programming in Fixed Dimension. Friedrich Eisenbrand, Max-Planck-Institute fuer Informatik.

It is shown that the optimum of an integer program in fixed dimension with a fixed number of constraints can be computed with O(s) basic arithmetic operations, where s is the binary encoding length of the input. This improves on the quadratic running time of previous algorithms, which are based on Lenstra's algorithm and binary search. It follows that an integer program in fixed dimension, which is defined by m constraints, each of binary encoding length at most s, can be solved with an expected number of O(m + log(m) s) arithmetic operations using Clarkson's random sampling algorithm.

2 : An Augmentation Framework for Integer Programming. Utz-Uwe Haus, Otto-von-Guericke-University of Magdeburg; Weismantel, Robert.

A number of practical algorithmic building blocks that combine into an augmentation framework for solving general integer programs are presented. The main ingredients are the generation of augmentation vectors using Lovász's lattice reduction and the Integral Basis Method, which are used to find an initial feasible solution, augment to an optimal point, and prove optimality. Other techniques can be integrated seamlessly at any point, if additional information (e.g. combinatorial structure) for the problem is available. Computational experience on problems from the MIPLIB library is reported upon.

3 : A Primal Approach to the Solution of the Stable Set Problem. Claudio Gentile, IASI-CNR; Haus, Utz-Uwe; Koeppe, Matthias; Rinaldi, Giovanni; Weismantel, Robert.

In this paper some operations are described that transform every graph into a perfect graph by replacing nodes with sets of new nodes. Every stable set in the transformed graph corresponds to a stable set in the original graph. These operations can be used in an augmentation procedure, based on the primal simplex method, for finding a maximum weighted stable set in a graph. At each simplex iteration, nonbasic columns that would lead to pivoting into nonintegral basic feasible solutions are replaced by new columns until a either new integer solution is found, or optimality is proved.

: MA17 Simulation and Logistics

Invited Session Room: R24

Chair: Yuri Merkuryev
Riga Technical University

1 : Robust Solutions for Supply Chain Management: Simulation, Optimization, and Risk Analysis. Fredrik Persson, Linkoping Institute of Technology; Kleijnen, Jack.

A robust solution aims at finding appropriate values for factors that decision-makers can control, while accounting for the randomness of the uncontrollable environmental factors. We demonstrate the robustness issue through a case study, namely a supply chain for Ericsson in Sweden. We derive a solution inspired by Taguchi's approach for designing robust products. We start with the derivation of a shortlist with the most important factors. We investigate the controllable factors through an adapted CCD; from the environmental factors we form random scenarios through LHS. We estimate the controllable factor values that minimize the output's expected value and variance respectively.

2 : Simulation-based Analysis of the Bullwhip Effect in Supply Chains. Yuri Merkuryev, Riga Technical University; Petuhova, Julija; Buikis, Maris.

The paper proposes a methodology of simulation-based analysis and evaluation of the bullwhip effect in supply chains. A mathematical background of the main causes of this phenomenon is discussed, that is aimed to better understanding of the bullwhip effect counteraction possibilities. Results of simulation studies to analyse the impact of lead times, forecasting techniques, and information sharing strategies are presented. The role of the above mentioned causes and strategies in reducing the demand distortion is considered. An approach to measuring the bullwhip effect for the entire supply chain is proposed and practically applied for comparison of different supply chain's configurations.

3 : Automated Generation of Simulation Models of Complex Supply Chains. Carmen-Veronica Bobeanu, Ghent University; Van Landeghem, Rik.

This paper addresses the authors' current results to generate customized tools supporting the construction of simulation models of complex supply chains. The concepts proposed in the authors' previous developments addressing the modular synthesis of Petri nets-based simulation models of complex discrete event systems are implemented in AToM3, A Tool for Multi-formalism, Meta-Modelling. The ultimate goal of the research considered in this presentation is to provide a natural, simple and powerful method for describing and analysing the flow of information and material in supply chains not far from the industrial engineers' habitual notions of system design and operation.

: MA18 Facility Location and the Environment

Invited Session Room: R25

Chair: Antonio Antunes
University of Coimbra

1 : An Optimization Model for the Location of Water Intakes: An Application in Goa, India. Maria Cunha, University of Coimbra; Lobo-Ferreira, João.

This paper presents the optimization model used to analyze several scenarios regarding the location and capacity of water intakes along the coastal area of Bardez, in the State of Goa, India. The location and capacity of water intakes was decided taking into account safe extraction rates to avoid salt-water intrusion into the two aquifers from where the water was to be pumped off. The model was developed within the EU-sponsored INCO-DEV research project COASTIN - Measuring, Monitoring and Managing Sustainability: The Coastal Dimension.

2 : Optimum Location of Environmental Monitoring Stations. Luís Nunes, Universidade do Algarve; Cunha, Maria; Ribeiro, Luís.

This paper addresses the problem of determining the best location for the stations of an environmental monitoring network. The problem is solved through an optimization model aimed at maximizing spatial accuracy and minimizing temporal redundancy regarding the environmental variable being monitored. The model is solved through a simulated annealing algorithm. The application of the model is illustrated for a groundwater monitoring network.

3 : Are Location-Allocation Results Sensitive to Negative Externalities? Dominique Peeters, Catholic University of Louvain; Thomas, Isabelle; Laurent, Marie.

This paper aims at measuring the sensitivity of a simple location-allocation model (extension of the SPLP problem) to the introduction of negative externalities in the case of semi-obnoxious facilities. The analyses are conducted on squared and hexagonal toy-networks, with externalities of various intensities, spatial extensions and shapes of propagation. Special attention is given to the effects provoked by the facilities on neighbouring regions.

4 : Redeployment of a Regional Solid Waste Management System in Portugal. Antonio Antunes, University of Coimbra; Teixeira, João.

The capacity of the three sanitary landfills where the waste produced in the Centro Litoral region of Portugal is disposed of at present will be exhausted within the next three years. For the future, given the difficulty of finding new sites for setting up landfills, the company responsible for the operation of the system decided to adopt incineration. This paper describes the decision process carried out to identify both the location of the incineration plant and the location and capacity of the new transfer stations needed to ensure a proper operation of the system.

: MA19 Measurement and Evaluation Models in Health Care

Invited Session Room: R26

Chair: Yasar Ozcan
Virginia Commonwealth University

1 : The Use of a Coronary Heart Disease Simulation to Assess the Value of Improving Service Response Time. Keith Cooper, University of Southampton; Davies, Ruth.

A simulation of the progress of coronary heart disease patients from diagnosis to death, or to age 85, has been used to assess both the value of improving the response of ambulances to patients suffering a heart attack and the impact of changing the time taken to give thrombolysis to eligible patients. Shorter response times, in both cases, were associated with reduced risks of dying. The benefits from these changes, measured as life years saved, took more than 15 years to reach a steady state. The feasibility and costs of the necessary changes varied between districts and hospital trusts.

2 : Pinpointed Measurement in Health Care Management. Lucas Delesie, Katholieke Universiteit Leuven.

Health care management depends on the measurement of non-physical properties. Examples are patient preferences, intensity of care, staff performance, patient satisfaction, etc. Traditional measurement theory relies on voluminous questionnaires (50 items plus) for large populations (hundreds), sophisticated statistical models (IRT models) and inference for large groups (more than 30). This is all right for research purposes but unsufficient for management purposes of small and divergent customer segments (5 patients, 2 nurses, 1 physician...) on a continuous business basis (maximum 10 items). This contribution illustrates an approach and gives results for the management of care for the aged.

3 : Critical Analysis of Health Status in Kazakhstan. Maksut Kulzhanov, Kazakhstan School of Public Health; Kozhabekova, Saule; Medetbaeva, Gulnar; Kissikova, Saule; Kulzhanova, Aijan; Zakharov, Igor.

This paper reports critical analysis and results of the World Health Survey (WHS) conducted by World Health Organization contracted to Kazakhstan School of Public Health. WHS was conducted during December 2002 - February 2003 in 16 regions of Kazakhstan. Total of 4,500 respondents were interviewed. These surveys included household plus individual questionnaires and contained group of questions on family structure, income, expenditures, health insurance, health related employment and training, social demographic characteristics, health status indicators including mobility, pain, discomfort, risk factors such as tobacco and alcohol consumption, nutrition, and contacts with health system etc.

: MA20 **Non-Smooth and Non-Convex Programming**

Invited Session Room: M35

Chair: Mirjam Duer
Technische Universität Darmstadt

1 : Constraint Qualifications in Nonsmooth Optimization. Oliver Stein, Aachen University.

We introduce extensions of the Mangasarian-Fromovitz and the Abadie constraint qualifications to non-smooth optimization problems. We do not assume directional differentiability but only semi-continuity of the defining functions. By reviewing primal first order optimality conditions for non-smooth problems we motivate the formulations of the constraint qualifications, we study their interrelation, and we give results on their relation to Slater's condition for non-smooth convex problems, to non-smooth reverse-convex problems, and to the stability of parametric feasible set mappings.

2 : A Decomposition-based Outer Approximation Algorithm for Solving Nonconvex MINLPs. Ivo Nowak, Humboldt-Universität zu Berlin.

We propose a cutting-plane method for computing polyhedral relaxations and solution candidates of general sparse nonconvex MINLPs. The algorithm starts with generating a block-separable reformulation of the given problem. Based on this formulation several types of cuts are added subsequently to an initial linear relaxation. During the iteration an upper bound of the optimal value is improved via a relaxation-based rounding heuristic. Moreover, box-reduction techniques are applied to improve the linear relaxation. The algorithm is implemented as part of the MINLP solver LaGO. Numerical results on instances from the MINLPLib will be presented.

3 : Probabilistic Subset Selection in Branch-and-Bound Algorithms. Mirjam Duer, Technische Universität Darmstadt; Stix, Volker.

We investigate the Branch-and-Bound method for solving nonconvex optimization problems. Traditionally, much effort has been invested in improving the quality of the bounds and in the development of branching strategies, whereas little is known about good selection rules. After summarizing several known selection methods, we propose to introduce a probabilistic element into the selection process. We describe conditions which guarantee that a Branch-and-Bound algorithm using our probabilistic selection rule converges with probability 1. Furthermore, we show how information on the quality of the upper and lower bounds influences the choice of the selection rule. We conclude reporting numerical experiments.

: MA21 **Scalable Enterprise Systems**

Invited Session Room: M36

Chair: Pakize Pulat
University of Oklahoma

1 : Real-Time Order Promising. Scott Moses, University of Oklahoma; Grant, Hank; Gruenwald, Le; Pulat, Pakize.

Meeting due dates is an important scheduling objective, but little prior research has considered how to actually assign due dates. In this talk we present a scalable computational approach for dynamic real-time promising by discrete build-to-order environments. We focus on techniques for rapidly assessing time-phased resource availability.

2 : Embedding Optimization-based Available to Promise within Enterprise Systems. Michael Ball, University of Maryland; Zhao, Zhenying.

The Available to Promise (ATP) business function is the set of capabilities that support responding to customer order requests. Traditionally ATP refers to a simple database lookup into the Master Production Schedule. In assembly-to-order and configure-to-order production environments, ATP functionality requires much more complex model and IT support. In this talk, we present mixed integer programming models to support ATP. We also analyze several issues related to embedding ATP optimization models within enterprise systems. Practical experience

with implementation for discrete electronics parts manufacturing is discussed.

: MA22 **2D Rectangular C&P**

Invited Session Room: M37

Chair: Ramon Alvarez-Valdes
University of Valencia

1 : Mixed-Integer Programming Models for Nesting. Matteo Fischetti, University of Padova.

Many industrial problems involve placing objects into containers so hat no two objects overlap. When the 2-dimensional objects to be packed are non-rectangular the problem is called "nesting". In this talk we first outline a basic Mixed-Integer Programming (MIP) model for nesting , based on a early proposal by Daniels, Li, and Milenkovic. We then present a new approximate MIP model for the multiple containment problem, where "small pieces" have to be inserted in the holes left by the placement of "big pieces". Computational results for real-world instances from the textile industry are presented. (joint work with Ivan Luzzi)

2 : An And-Or/Graph Approach for Constrained Guillotine Cutting Problems: Revisited. Reinaldo Morabito, Federal University of São Carlos; Vianna, Andrea; Arenales, Marcos.

In this paper an and/or-graph approach for constrained guillotine cutting problems is revisited. We discuss details of its implementation and how to extend it to deal with different constraints, such as limitations on the maximum number of item types in the cutting pattern. Computational results are presented to illustrate its performance in comparison with other methods of the literature.

3 : Improved Local Search Algorithms for the Rectangle Packing Problem with General Spatial Costs. Shinji Imahori, Kyoto University; Yagiura, Mutsunori; Ibaraki, Toshihide.

The rectangle packing problem with general spatial costs is to pack given rectangles without overlap in the plane so that the maximum cost of the rectangles is minimized. This problem is very general, and various types of packing problems and scheduling problems can be formulated in this form. For this problem, we had proposed local search algorithms which used a pair of permutations of rectangles to represent a solution. In this paper, we propose new speed-up techniques to evaluate solutions in various neighborhoods, and report computational results for area minimization, strip packing and a real-world scheduling problem.

4 : A New Exact Algorithm for the Pallet Loading Problem. Ramon Alvarez-Valdes, University of Valencia; Tamarit, Jose; Parreno, Francisco.

The Pallet Loading Problem consists of maximizing the number of boxes of equal size which can be packed in a pallet. We present a Branch & Cut algorithm with some new features. First, we have improved the classical integer linear programming formulation with new constraints. Second, we take advantage of the relationship of this problem with the maximum independent set problem to use the partial linear description of its associated polyhedron. Finally, we exploit the specific structure of our problem to develop efficient separation procedures. We present computational results for the whole Cover I and Cover II problem classes.

: MA23 **Opportunities and Wealth Creation**

Invited Session Room: M38

Chair: Maria Minniti
Babson College

1 : Business Model Design and the Performance of Entrepreneurial Firms. Raffi Amit, The University of Pennsylvania; Zott, Christoph.

We address both theoretically and empirically one of the main challenges of entrepreneurs' search for wealth creation, namely, the design of their business model, which depicts the ways in which the venture will transact with, interact, and relate to its external stakeholders. Anchored in transaction costs theory and in Schumpeter's theory of innovation, we developand test hypotheses regarding the impact of various business models design themes on the financial performance of the focal firm. We find empirical support for our theory that both efficiency-centered and novelty-centered business model designs are positively related to firm performance.

2 : Opportunity Recognition: An Experiential Learning Model of Transforming Discrepant Experience into Cognitive Possibility. Dimo Dimov, London Business School; Mullins, John.

This paper presents a model of opportunity recognition that addresses the current lack of systematic conceptualisation of both opportunity and prior experience (human capital). It views opportunity as a transformation of individual experience into cognition, wherein the possibility of economic gain becomes apparent. It examines this transformation process from an experiential learning perspective. Prior experience provides a template - a possibility processing structure (learning style) - for dealing with new experience. The main theoretical proposition is that the interaction between specific dimensions of human capital and the four basic styles of learning determines distinct opportunity types.

3 : Risk Takers and Safety Nets. Maria Minniti, Babson College; Levesque, Moren.

Many individuals start new businesses while still holding on to their jobs. This empirical observation is inconsistent with much literature on employment status choice, in which individuals' decisions about self-employment and dependent labor are modeled as being alternative and incompatible. We present a model in which the optimal employment status decision consists, possibly, of a combination of both self-employment and dependent labor. Also, in our model potential entrepreneurs are not committed to one choice permanently and, depending on the expected returns at any point in time, switching is possible.

: MA24 **EWG MCAD - I**

Invited Session Room: L17

Chair: Ayca Tuzmen
University of Sydney

1 : A Distributed Process Management Environment for Collaborative Building Design. Ayca Tuzmen, University of Sydney.

Collaborative building design relies on people working coordinately to accomplish the requirements of a design project. However, not all design teams in current practice are well informed about where the project stands. This paper introduces a process management system that facilitates collaborative design process. The system enables (a) description of the design process, (b) the enactment of the process according to its definition, (c) the management of the resources required for the enactment of the process. The paper also presents the findings of a validation and verification (V&V) study that is conducted to evaluate the effectiveness of the proposed system.

2 : Multicriteria Decision-Analysis for an Electricity Retailer using Cross-Confidence Factors. Risto Lahdelma, University of Turku; Salminen, Pekka; Makkonen, Simo.

Liberation of the European energy market is changing the business environment of energy companies. We consider an electricity retailer's strategic decision support system based on simulation, optimisation and stochastic multicriteria acceptability analysis (SMAA). The continuous decision problem produces a large number of discrete alternatives. Many of the alternatives may be efficient and thus difficult to discriminate using the standard SMAA method. Therefore, we extend SMAA with cross confidence factors based on computing confidence factors for alternatives using each other's central weight vectors. The cross confidence strengthen the discriminative power of the analysis and narrow the set of potentially acceptable alternatives.

3 : A Metaheuristic Approach Dedicated to Multicriteria Knapsack Problems. José Figueira, University of Coimbra; Silva, Carlos; Clímaco, João.

In this paper it is presented a metaheuristic approach, related to tabu search, dedicated to multicriteria knapsack problems, and intending to approximate the nondominated solutions set. Experimental results and the comparison with other metaheuristics are also discussed. Furthermore, some indices are proposed in order to evaluate the quality of the results. For instances of moderate size, comparisons with the exact nondominated solutions set are carried out. Finally, it is outlined the possible use of this type of procedures as part of interactive approaches especially useful to deal with large size instances.

4 : Bipolar Sugeno and Choquet Integrals. Salvatore Greco, Università degli Studi di Catania; Matarazzo, Benedetto; Slowinski, Roman.

We introduce the bipolar Sugeno and Choquet integrals. They are generalizations of the Sugeno and Choquet integrals based on a bipolar capacity which permits to take into consideration positive and negative parts of the values to be aggregated in a very general way. We also investigate axiomatic foundations of bipolar Sugeno and Choquet integrals. Moreover, we prove that the bipolar Sugeno integral is equivalent to a set of "if..., then..." decision rules having a specific syntax. Finally, we show that bipolar Choquet integral can be used to generalize Cumulative Prospect Theory.

: MA25 **System Dynamics and Theory**

Invited Session Room: M34

Chair: Yaman Barlas
Boğaziçi University

1 : Estimating IT System Benefits Early in the Life Cycle: A Process Oriented Approach. Amitava Dutta, George Mason University; Roy, Rahul.

A central problem in justifying IT projects consists of linking them to business performance. This is particularly difficult in the early stages of a project life cycle, when its business case is being analyzed. We argue that in today's integrated value chains, the way to link IT projects to business performance is through the end-to-end business process within which they are embedded. We show how the systems dynamics methodology can be used to assess potential business benefits of IT investments early in the life cycle, and help to analyze their business case with some rigor.

2 : A Simulation Study of the Marketplace for Mobile Data Applications. Oleg Pavlov, Worcester Polytechnic Institute.

Success of the future wireless data services will depend on the ability of mobile networks to support high bandwidth traffic. Current depression in the telecom sector and diseconomies of scale may prevent cellular operators from building reliable individual networks. A multi-operator environment of hybrid technologies with decoupled services and transport provisioning has been suggested as an affordable alternative to capacity buildup. We use system dynamics methodology to evaluate proposed service delivery schemes and to review market outcomes in a competitive setting. The computer model includes elements of the classical quality-differentiation microeconomic theory and the behavioral theory of the firm.

3 : Effects of Instability on IT System Development. Peter Otto, Dowling College; Belardo, Salvatore.

Developing and implementing an information system is a difficult task. All too often these system development and implementation efforts are failures. In all too many cases, IT systems are prone to cost overruns, are not ready on time, or are cancelled before completion. To make matters worse, unstable conditions caused by external and internal disturbances can have severe implications for systems development efforts. This paper is aimed at providing an effective tool for a systemic as well as dynamic approach to systems development projects.

4 : A Model for Duopoly Competition in the Durable Household Goods Market. Gülay Arzu İnal, Sabancı University; Ulusoy, Gündüz.

A duopoly competition environment, where each industrial firm produces virtually identical durable household goods, is modeled using system dynamics approach. Diffusion process consists of innovative and imitative demand based on standard Bass model. Advertising effect, which includes diminishing returns, and accumulated effects builds up the innovative demand. The imitative demand coefficients are the same for each firm, since firms launch identical products. Total number of potential customers is treated as a function of price. The model allows for different market entry times and new product launching opportunities, which are important policy instruments affecting the

nature of competition.

: MA26 **OR Applications in South Pacific - I**

Invited Session Room: L10

Chair: Andrew Higgins
CSIRO

1 : Dynamic Assignment of Containers to Wagons in an Intermodal Terminal. Paul Corry, Queensland University of Technology; Kozan, Erhan.

Dynamic assignment of containers to wagons in an intermodal terminal is investigated in this paper. The problem originates from the Pacific National terminal in Acacia Ridge Australia. Several factors make the system difficult to analyse, such as simultaneous loading, unloading and shunting of trains and many different container sizes. A mixed integer programming model is formulated but cannot be solved quickly enough to be used in a real time system. Several heuristics are proposed to produce acceptable wagon allocations fast enough for a real time system to be viable.

2 : Opportunities for Optimising a Sugarcane Harvesting and Transport Value Chain Within the Australian Sugar Industry. Andrew Higgins, CSIRO; Antony, George; Prestwidge, Di.

Increased cost/price pressures from the international market have forced the Australian sugar industry to look at innovative approaches to increasing profitability and remaining internationally competitive. One avenue is to achieve better integration across the privately owned sectors within the value chain, and to optimise key decisions within the system, leading to reduced costs of production and increased profitability. We focus on how the scientific researchers engaged in participatory research with the industry and simultaneously applied operations research techniques to address some of the opportunities, particularly in harvesting and transport.

3 : Canadian Foreign Bank Branch Productivity. Necmi Avkiran, The University of Queensland.

There is little empirical research on Canadian bank productivity and none that specifically focuses on foreign banks. Data envelopment analysis is used to analyze the productivity of foreign bank branches in a cross-sectional study. Initially, slacks-based measure of efficiency is taken, which is later decomposed into pure technical, scale, and mix efficiencies. Nature of returns to scale and potential improvements are also investigated. Main findings indicate a purely technically efficient but mix and scale inefficient sample. Majority of branches are operating at decreasing returns to scale. There is considerable potential to raise outputs while maintaining input levels.

4 : Productivity and Technical Change in Malaysian Banking: 1989-1998. Ergün Doğan, Yeditepe University; Fausten, Dietrich.

We examine the impact of deregulation and technological change on the productivity of Malaysian banks during 1989-1998. Malmquist indices constructed with nonparametric DEA techniques are decomposed into their pure efficiency, scale efficiency, and technological change components. Our findings indicate an erosion of banking productivity that masks divergent tendencies among its component elements. These are dominated by adverse effects of technological change, which are associated with a reduction in the labor intensity of banking activity. Consistent with the mixed findings reported in the literature, the present investigation suggests that regulatory reform and liberalization are not sufficient conditions for productivity improvement.

: MA27 **Contemporary Issues in Option Pricing**

Invited Session Room: L11

Chair: Spiros Martzoukos
University of Cyprus

1 : Capital Investment Decision Networks with Partial Reversibility and Stochastic Switching Costs. Spiros Martzoukos, University of Cyprus; Pospori, Nayia; Trigeorgis, Lenos.

We study dynamic investment strategy in a network of sequential and partially reversible decisions . We allow time intensive decisions, operating conbstraints (e.g., exhaustible resources), and path-dependent abandonment and switching costs. The framework enables the study of optimal investment choice, optimal scale, optimal sequence of expansion, contraction and mothballing strategies, etc. Our results are intuitive but sometimes non-conventional, e.g., in the presence of flexibility, an increase in uncertainty (or decrease in dividend yield) can often lead to investing earlier instead of waiting. Such non-conventional results are restricted in the presence of factors that limit flexibility (like operating constraints).

2 : Option Pricing Methods with Artificial Neural Networks and Implied Parameters. Spiros Martzoukos, University of Cyprus; Charalambous, Christakis; Andreou, Panayiotis.

In this paper we compare the predictive ability of Black-Scholes (BS) and Artificial Neural Networks for the S&P500 call options using historical and implied volatility measures. The backpropagation training algorithm is replaced with a modified Levenberg-Marquardt. Our results are significant and differ from previous literature. We show that artificial neural networks often outperform BS even if BS utilizes implied volatility forecasts. The method is extended to capture distributions with skewness and kurtosis using the Corrado-Su and jump-diffusion models with implied parameters. Using trading strategies without/with transaction costs we verify the existence of market inefficiencies and profit opportunities.

3 : Variance Reduction for Option Pricing in Stochastic Volatility Models. Maria Letizia Guerra, University of Urbino; Sorini, Laerte.

Methods for variance reduction arise often in finance, especially when the price of a European call option has to be computed via Monte Carlo simulation, because of the absence of a closed formula. We consider options with stochastic volatility as in Hobson and Rogers and a variance reduction technique developed by Newton called importance sampling. Preliminary results show that variance reduction is relevant in simulating prices in the sense of a smaller error and, in addition, it influences greatly the good performances of an option pricing model in capturing market prices.

4 : Option Pricing: Impacts of Portfolio Holdings. Robert Tompkins, Vienna University of Technology; D'Ecclesia, Rita.

We show that different agents will have different shadow prices for adding a position to their portfolio. In a discrete time framework agents are not necessarily willing to trade at the BS price. After developing a theory of bid/offer spreads, given a portfolio of options we examine trading dynamics in presence of random shocks. Using a simulation framework we assess the portfolio rebalancing after a shock occurs. New portfolio holdings are estimated solving an optimization problem aimed at maximizing the excess return subject to a pre-specified level of risk measured by the CVaR of the portfolio.

: MA28 **Meta-Heuristics Directions**

Invited Session Room: L12

Chair: Ibrahim Osman
American University of Beirut

1 : A DSS for Solving Real-Life Vehicle Routing Problems using an Adaptive Memory Programming Method. Chris Kiranoudis, National Technical University of Athens; Tarantilis, Christos.

This paper presents a Decision Support System (DSS) employing an adaptive memory programming metaheuristic, for solving real-life vehicle routing problems on the detailed road network of Athens. Technical and managerial issues aroused from the ad hoc connections between the Geographical Information System (GIS), the routing technique used for calculating shortest paths and the metaheuristic method for finding the best sequence of customers, were faced successfully.

2 : A Hybrid Genetic Algorithm for the Optimal Tree Problem. Mohamed Haouari, Ecole Polytechnique de Tunisie; Chaouachi, Jouhaina.

We introduce a new network design problem which is referred to as the optimal tree problem (OTP). The importance of this model stems from the fact that it encompasses as special cases several well-known tree problems including the Steiner tree problem (STP), the prize collecting Steiner tree problem (PC-STP), the generalized minimum spanning tree problem (GMST). We present an effective hybrid genetic algorithm for the OTP as well as a Lagrangian-based lower bounding strategy. We show through extensive computational experiments that the quality of solutions is promising and the execution times reasonable for large graphs.

3 : Metaheuristics: Models and Analysis. Ibrahim Osman, American University of Beirut.

Metaheuristics are composed of components with several attributes. Each combination of them leads a meta-heuristic implementation with a new name. In this paper, we argue that all meta-heuristics share one basic unified model and differ in the choice of components/attributes. By analogy, human attributes include languages, colors, cultures, and ethics that define them. But, are we different being Arab, European, and Chinese etc.? Meta-heuristics are the same. We invite investigations into more hybridization to generate possibly new better breeds. Last, a new way to compare meta-heuristics is also introduced that takes into account both CPU requirements and quality of solutions

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: MA29 **Airline Applications - I**

Invited Session Room: L13

Chair: Christine Strauss
University of Vienna

1 : Operational Daily Airline Scheduling Model: Yugoslav Airlines Example. Milica Kalic, University of Belgrade; Pavkovic, Goran.

A new daily airline schedule design is necessary for solving the problem of perturbations like cancelled or delayed flights. Cancelled or delayed flights can be caused by meteorological reasons, technical reasons, late or absent crew members, etc. A heuristic algorithm is developed to solve this problem and tested on real numerical examples (Yugoslav Airlines schedule). This paper also presents a decision support software package.

2 : Scheduling Aircraft Landings with Ant Colony Optimization Metaheuristic. Sezgin Kılıç, Aeronautics and Space Technologies Institute; Kaylan, Ali.

Scheduling Aircraft Landings is a major problem in Air Traffic Control field. It is viewed as a machine scheduling problem with sequence-dependent processing times. Penalties are incurred for tardy jobs. Each landing plane has an allowable time window. The objective is to optimally land a set of planes on one or several runways. Using Ant Colony Optimization metaheuristic, we present a generic decision support tool that can be used both for the single and multiple runway landings and takeoffs. Computational results are presented and compared for the standard test problems and show that Ant System solutions can be promising.

3 : Aircraft Routing and Scheduling on the Airport Ground. Ángel Marín, Universidad Politécnica de Madrid; Salmerón, Javier.

In the paper the management of the flights on the airports is studied. A binaary multicommodity flown network model is defined to represent the flight movements from the stand to the taxiway and viceversa. The flow capacity is used to represent the conflicts and competence between airplanes using the airport capacity. The used methodology to solve the model have been the Branch and Bound , and the Fix and Relax. The test network has been the Madrid-Barajas airport, the data are from the airport traffic, the computational experience used Cplex from the Gams platform.

4 : Dynamically Assigning Aircrafts to Gates at an Airport. Ahmet Bolat, King Saud University; Al-Khalifah, Hisham.

The demand for air transportation grows exponentially during summer and holiday seasons, causing long airborne delays, and congestion in taxiways and near terminals before parking aircraft at a gate. Two interrelated decisions, scheduling aircraft landings and assigning gates must be taken in a dynamic fashion as time passes and operational environment changes. Since the 1950's researchers have considered these problems separately and most of the time with "static" case assumptions. A mathematical model is developed for dynamically assigning gates to the aircrafts after landing times are scheduled. The optimiza-

tion procedures are evaluated by comparing with the existing algorithms in literature.

: MA30 **Teaching Revenue Management**

Invited Session Room: L14

Chair: Peter Bell
The University of Western Ontario

1 : Teaching Pricing and Revenue Optimization. Robert Phillips, Manugistics.

I will present some of the lessons learned from teaching Revenue Management at the PhD level and Pricing and Revenue Optimization at the MBA level. I will also present my thoughts on how to improve the teaching of these topics in the future.

2 : Teaching Yield Management to MBAs. Robert Shumsky, University of Rochester.

This talk describes how the theory and application of yield management can be incorporated into a first-year MBA course. We will see how the theory is linked to the standard first-year MBA curriculum and how simple case studies can be used to demonstrate the challenges of real-world application.

3 : Teaching Dynamic Pricing and Revenue Management. Ioana Popescu, INSEAD.

Why and how does a Revenue Management course fit in an MBA curriculum? In this presentation I will share some of my experiences in designing, positioning and delivering a first time ever full MBA course on revenue management. I will provide a roadmap of the evolution of the course over four years, success dynamics and directions for improvement.

4 : Delivering RM to MBA and EMBA students. Peter Bell, The University of Western Ontario.

What should every MBA or EMBA student know about RM? This presentation will suggest a topics list and discuss the classroom delivery of these topics using cases, games, and www-based materials.

: MA31 **AHP - C1**

Contributed Session Room: M33

Chair: Ali Fuat Güneri
Yıldız Technical University

1 : Interactive Fuzzy Programming for Decentralized Two-Level Linear Fractional Programming Problem. Mehmet Ahlatçıoğlu, Yıldız Technical University; Tiryaki, Fatma.

This paper presents interactive fuzzy programming for a decentralized two-level linear fractional programming problem with a single decision maker (DM0) at the upper level and multiple DMs at the lower level. In our interactive method, DM0 decreases his own satisfactory level in favour of objectives at the lower level. Using AHP, DM0 assigns weights to objectives at the lower level. Our model establishes equivalent satisfactory levels for objectives with unequal goals at the lower level and, uses these weights as the weights of the satisfactory levels belonging to objectives at the lower level. Consequently, a satisfactory solution is found efficiently.

2 : A Multi-Criteria and Fuzzy Logic based Methodology for the Relative Ranking of the Fire Hazard of Chemical Substances. Apostolos Paralikas, National Technical University of Athens; Lygeros, Argyrios.

No single property can be used for assessing the fire hazards of chemical substances and materials; different methods use different fire hazard properties in their assessment. In this paper, a new approach for the rapid assessment and relative ranking of the fire hazards of chemical substances is presented. The development of the proposed methodology - the Substance Fire Hazard Index, (SFHI), which is focused on the major accident-hazards of the substances - is based on the Analytic Hierarchy Process and fuzzy logic. The challenges and limitations of using the multi-criteria approach for the development of such an index are discussed.

3 : An Application of the Analytic Hierarchy Process to Location Selection. Ali Fuat Güneri, Yıldız Technical University; Tiryaki, Fatma; Akkaya, Gökay.

Location selection plays a very prominent role in retailing due to its high and long-term investments. The conventional approaches to location selection can only provide a set of systematic steps for problem-solving without considering the relationships between the decision factors globally. Therefore, this paper discusses the location selection, the applicability of Analytic Hierarchy Process (AHP) in problem solving, and how AHP can be applied to the selection of location. The AHP not only helps the analysts to arrive at the best decision, but also provides a clear rationale for the choices made.

4 : BS 7799 (ISO/IEC 17799) Deployment using Analytic Hierarchy Process Models. Tomas Feglar, Academy of Sciences of the Czech Republic.

The original British Standard BS 7799 (ISO/IEC 17799) offers guidelines for information security management. An appropriate deployment strategy for particular organization is highly required because this standard is not intended to give definite details 'how to do it". The paper describes new approach to the deployment based on a new ISO/IEC 17799 Decision Making Model. This model combines "static" criteria that relate to BS 7799 and "dynamic" criteria that are synthesized on the base of risk analysis. This model is used as a basement for development of a set of AHP models in accordance with ISO/IEC 17799 security categories.

: MC01 **Knowledge Leveraging**

Invited Session Room: MB I

Chair: İbrahim Kavrakoğlu
Kavrakoğlu Consulting

Knowledge Leveraging: Postmodern OR. İbrahim Kavrakoğlu, Kavrakoğlu Consulting.

The latter part of the 20th century witnessed the emergence of 'knowledge creating' corporations which were able to generate enormous amounts of wealth. But even more significant are the achievements of certain corporations which also generate great

amounts of value - and wealth. They do so not by creating, but by leveraging knowledge. Given the huge amount of data and information made available by the advent of the Internet, organisations and individuals who can usefully exploit these resources stand to increase their competitiveness. In other words, we are moving ahead from the 'data economy' to an embrace of the true 'knowledge economy'. This knowledge economy has arrived and OR is the discipline best suited to take a leading role in spearheading this transformation.

: MC02 **Disaster Management - I**

Invited Session Room: MB II

Chair: Louise Comfort
University of Pittsburgh

Interactive, Intelligent, Spatial Information System (IISIS): A Community Model for Crisis Management. Louise Comfort, University of Pittsburgh.

: MC03 **MODM - I (DEA)**

Invited Session Room: MB III

Chair: Pekka Korhonen
Helsinki School of Economics

Why Don't MCDM- and DEA-People Discuss More with Each Other? Pekka Korhonen, Helsinki School of Economics.

DEA and MOLP research still go different ways, even though research areas have a lot in common. The concept of efficiency plays an important role in both research fields. Efficient frontier is characterized and an inefficient unit is projected onto the efficient frontier in the same way. Terminology is different. Being seen as competitors is harmful to both research areas. Incorporating preference information into a DEA-analysis is a key issue in MCDM. We discuss the similarities between those research areas, and try to show that they could cross-fertilize each other.

: MC04 **Data Mining**

Invited Session Room: JB A

Chair: Endre Boros
Rutgers University

1 : Decomposition Techniques in Data Mining and KDD. Jan Corstiaan Bioch, Erasmus University Rotterdam.

Data sets with a large number of attributes (or variables) are getting more and more prevalent in data mining. Therefore, structuring the attributes also gains importance especially in the case of predicting an outcome variable. In this paper we focus on learning conceptual hierarchies based on functional decomposition. The method searches for a hierarchy of attributes in an automated fashion. Since the method of concept hierarchies is in its beginning stage, much of the method is not clear yet,. We will discuss for example, how to handle ordinal data and how to select a proper portioning of the input variables.

2 : Consensus Algorithms for the Generation of All Maximal Bicliques. Yves Crama, University of Liège; Alexe, Gabriela; Alexe, Sorin; Foldes, Stephane; Hammer, Peter; Simeone, Bruno.

We describe a new algorithm for generating all maximal bicliques (i.e. complete bipartite) of a graph. The algorithm is inspired by, and is quite similar to, the consensus method used in propositional logic. We show that some variants of the algorithm are totally polynomial, and even incrementally polynomial. The total complexity of the most efficient variant of the algorithms presented here is polynomial in the input size, and only linear in the output size. Computational experiments demonstrate its high efficiency on randomly generated graphs.

3 : On the Complexity of Generation. Vladimir Gurvich, Rutgers University.

Given a hypergraph, generate all (i) minimal vertex sets which contain at least t edges; (ii) minimal edge-sets whose union contains at least t vertices; Given a system of linear inequalities $Ax > b$ where matrix A is non-negative, generate all (iii) minimal feasible integer vectors; (iv) maximal infeasible integer vectors. We show that problems (i) and (iv) are intractable in contrast to problems (ii) and (iii) for which we suggest efficient algorithms. We discuss a general theory of the complexity of generation.

: MC05 **Traffic Assignment**

Invited Session Room: JB B

Chair: Giuseppe Bellei
Università degli Studi di Roma "La Sapienza"

1 : An Analytical Dynamic Traffic Model for Demand-Supply Equilibrium. Fabien Leurent, SETRA.

After a synthetic review of dynamic assignment models, a common analysis framework is presented for assignment models, which consists in four basic problems: (i) the formation of transport services; (ii) users' choices; (iii) volume loading; (iv) traffic flowing. The framework is used to formulate a realistic, yet simple, analytical dynamic traffic assignment model, endowed with straightforward equations and efficient algorithms. This allows solving the demand-supply equilibrium.

2 : Within-day Dynamic Traffic Assignment to Large Scale Road Networks. Guido Gentile, Università degli Studi di Roma "La Sapienza"; Meschini, Lorenzo.

The aim of this work is to present and test a Within-Day Dynamic Traffic Assignment model, allowing for an efficient solving method, and applicable to large-scale road networks. The WD-DTA is regarded as a Dynamic User Equilibrium and formulated as a fixed point problem. The arc performance function is based on link-based macroscopic models. The demand function is specified both through a deterministic and stochastic (Probit) implicit path choice model. Numerical experiments are carried out on the road network of the city of Rome addressing both the deterministic and Probit case. Results are investigated in terms of effectiveness and efficiency.

3 : Road Traffic Equilibrium with Random Supply and Adaptive Behaviour. Giuseppe Bellei, Università degli Studi di Roma "La Sapienza"; Gentile, Guido.

The assignment problem on transit networks has been formulated on the basis of the concept of oriented hyper-graph introducing in quite a natural way the hyperpath as the alternative chosen when travelling on the transit network. More recently the hyperpath approach has been extended to road traffic, with reference to capacitated networks. The aim of this work is to extend the hyper path approach to represent road traffic adaptive behaviour, but deriving the reason for adaptive choice representation from road traffic randomness, while utilizing, as long as possible, usual supply functions and avoiding the formulation of explicit capacity constraints.

4 : OR Techniques for Planning Railway Maintenance. Gabriella Budai, Erasmus University Rotterdam; Dekker, Rommert.

Demand for railway transport has increased considerably in the last years. In order to satisfy the demand, there is need for high quality and modern railway infrastructure, reliable service, more trains per hour, for railway safety and improved punctuality. Increasing the number of trains leads to an increase of deterioration of infrastructure and hence more intensive maintenance is needed. The infrastructure possession time for these maintenance and renewals will increase as well. This paper provides useful methods for finding optimal track possession intervals for carrying out maintenance and renewal works such that the inconvenience for the train operators is minimised.

: MC06 **Meta-Heuristics for Flow-Shop Scheduling**

Invited Session Room: M30

Chair: Ruben Ruiz
Universidad Politecnica de Valencia

1 : A New Genetic Algorithm for the Permutation Flowshop Scheduling Problem. Ruben Ruiz, Universidad Politecnica de Valencia; Maroto, Concepcion.

In this work a new Genetic Algorithm for the known Flowshop Scheduling Problem is proposed. The optimization criterion is makespan minimization. This new algorithm incorporates advanced techniques like hybridization by means of local search, population restart, an special generational scheme and population initialization by using efficient known heuristics. A Design of Experiments (DOE) approach is used in the evaluation of all parameters and operators of the Genetic Algorithm. The proposed algorithm is evaluated against other genetic algorithms, tabu search, simulated annealing and other advanced recent methods using the well known flowshop instances of Taillard. The proposed algorithm shows superior performance.

2 : A Comparison and Evaluation of Heuristics and Metaheuristics for the Flowshop Scheduling Problem. Eva Vallada, Universidad Politécnica de Valencia; Ruiz, Ruben; Maroto, Concepcion.

In this work an exhaustive review and evaluation of heuristics and metaheuristics for the permutation flowshop problem is presented. Published reviews usually deal with no more than 5 heuristics, no recent methods are compared and no standard benchmarks are used. We lack an updated review with comparable results. We have implemented a total of 23 heuristic and metaheuristic methods and we have analyzed their performance under the well known benchmark of Taillard. In this comparison we study from the classical Johnson algorithm or the NEH heuristic to the most recent genetic algorithms, tabu search, simulated annealing or iterated local search.

3 : Local Search Algorithms for Multiprocessor Task Scheduling. Ceyda Oguz, The Hong Kong Polytechnic University; Ercan, M. Fikret.

In this study, we propose local search algorithms to obtain good approximate solutions to the multiprocessor task scheduling problem. The objective is to minimize makespan and the machine environment is a flow-shop. We introduce the notion of processing order to be used in two of the algorithms to increase the efficiency of these local search algorithms. In the third algorithm we use genetic operators to capture the characteristics of the problem. In this talk, we will present the results of our computational experiments.

4 : Augmented Neural Networks for Open Shop Scheduling Problem. Selcuk Colak, Universtiy of Florida; Agarwal, Anurag.

We apply the Augmented Neural Network approach for solving the Open Shop Scheduling Problem. This approach is a hybrid of heuristic and adaptive learning approaches. We test the method on several benchmark problems from the literature. Computational results show that we obtain optimal or near-optimal solutions with small number of iterations in relatively short time.

: MC07 **New Directions in Supply Chain Research**

Invited Session Room: M31

Chair: Ananth Iyer
Purdue University

1 : Secure Supply-Chain Collaboration. Leroy Schwartz, Krannert School of Management; Desphande, Vinayak; Atallah, Mikhail.

"Secure Supply-Chain Collaboration (SSCC)" employs known theoretical results from computer science to enable supply-chain partners to make cooperative decisions without revealing any private information. This talk will describe a program to develop and apply SSCC to several well-known supply-chain management models and develop proof-of-concept to demonstrate its use and effectiveness.

2 : Risk-Pooling in Supply Chains: Scope, Tradeoffs, and Determinants of Benefits. Yigal Gerchak, Tel-Aviv University.

Many operational strategies derive their benefits from pooling risks. Examples include delayed differentiation, assembling-to-order with component commonality and substitution. We discuss determinants of risk-pooling's benefits (e,g., extent of demand randomness) as well as tradeoffs like negative effect on demand and expensive modularization.

3 : Information Sharing in Decentralized Supply Chains. Ananth Iyer, Purdue University; Preckel, Paul.

We model the impact of information sharing on expected costs when a number of independent retailers share production resources. Our model, based on a complementarity formulation, permits the evaluation of different levels on information sharing between competitors on expected costs. We show that,

contrary to usual intuition, information sharing can increase expected costs in decentralized supply chains. We then explore the impact of different degrees of asymmetry of information across a supply chain. The results suggest the need for careful evaluation of the extent of information sharing and its consequent impact on individual retailers before embarking on collaboration initiatives.

4 : Product Availability Competition and the Effect of Shortages in a Dynamic Duopoly. Mordecai Henig, Tel Aviv University; Gerchak, Yigal.

A key negative consequence of product shortages, beyond the immediate loss of revenue, is the effect on future demand. Unsatisfied customers are likely to shop at the competition next time they need the item. We model such dynamic two-firm scenario, where unsatisfied customers of one firm will try the other firm next time, and vice versa. In each period a certain number of customers are tentatively affiliated with each firm, of whom a random proportion will attempt a purchase, and the firm's stocking decision is based on this number. The general functional equation is formulated and the optimal quantity to order is obtained for a family of location-scale demand distributions. In this case there exists a Nash equilibrium in pure strategies where each firm orders proportionally to its number of affiliated customers. We argue that the customary use of shortage penalty or service level may distort optimality.

: MC08 Robust Optimization

Invited Session Room: M32

Chair: John-Paul Clarke
Massachusetts Institute of Technology

1 : Runway Operations Planning: A Multi-Objective Decomposition-based Solution Methodology. Ioannis Anagnostakis, Massachusetts Institute of Technology; Clarke, John-Paul.

Careful planning of the different types of runway operations that share a runway is required if runway utilization is to be maximized. Therefore, Runway Operations Planning (ROP) is a critical component of airport operations planning. This paper presents a decomposition-based algorithmic approach for solving ROP problems, i.e. optimally allocating runway time for departures given the time required for arrivals and crossings. ROP problems typically involve: a)Multiple objectives, e.g. maximization of runway throughput and minimization of delays and other operational inefficiencies, and b)Various constraints, e.g. physical space limitations and constraints related to safety, fairness among users and controller workload.

2 : Robust Mean-Covariance Solutions for Stochastic Optimization Problems. Ioana Popescu, INSEAD.

We provide a method for deriving robust solutions to stochastic optimization problems with general objective, based only on mean-covariance information about the distributions underlying the uncertain parameters. We provide sufficient conditions under which solving the robust optimization problem is equivalent to solving a certain deterministic parametric quadratic program. Interesting results arise from comparing the robust solutions with those corresponding to entropy maximizing distributions for various criteria, such as target, fractile and option-type. We explore applications in robust portfolio management, salesforce compensation and optimal scanning in tomography.

3 : Multi-Airport Air Traffic Flow Management Problem with Uncertain Arrival Capacities. Mark Hansen, UC Berkeley; Mukherjee, Avijit.

We study the multi-airport air traffic flow management problem when capacities at the arrival airports are uncertain. Our solution approach combines the deterministic, integer, formulation of Bertsimas et al with continuous approximation methods that are more computationally tractable. We demonstrate our approach on the U.S. domestic system, using a representative day from the summer of 2002.

4 : Collaborative Routing Resource Allocation. Robert Hoffman, Metron Aviation, Inc.

Work is currently underway within the aviation community to apply CDM technology and concepts to the management of enroute traffic (Collaborative Routing). No fixed baseline exists for the enroute airspace. We propose to construct a collaborative routing rationing algorithm (CRRA) to assign use of en route resources to individual flights. It will be shown that such an algorithm is both feasible and that it can be made consistent with traffic management goals and with the CDM paradigm.

: MC09 Consumer Expectations and Marketing Strategy

Invited Session Room: L15

Chair: Tülin Erdem
University of California Berkeley

1 : The Long-Run Effects of Advertising and Pricing Strategies when Price and Advertising Signal Product Quality: An Empirical Assessment. Baohong Sun, Kenan-Flagler Business School; Erdem, Tülin; Keane, Michael.

In this paper, we develop a structural dynamic model of household behavior when both prices and advertising signal quality. We seek to answer questions such as (1) What is the impact of pricing strategy (e.g., frequent temporary price cuts) on consumer brand choice probabilities in the long run? (2) Does intensive advertising in conjunction with increased price variability mitigate any adverse effects of frequent price cuts on perceived quality and, hence, on sales? (3) Does advertising reduce consumer perceived risk through direct information and/or serve as a quality signal and which has a higher impact on brand choice probabilities?

2 : Estimating an Empirical Model of Advertising Dynamics. Guenter Hitsch, University of Chicago; Dube, Jean-Pierre; Manchanda, Puneet.

We revisit a prominent question in marketing -- how to schedule advertising optimally over time in the presence of competition. Many actual advertising campaigns exhibit interesting dynamic patterns such as "pulsing" and "flighting". We provide analytical explanations for this advertising behavior related to both the nature of consumer demand (S-shaped advertising response curves) as well as supply-side institutional factors. Our model captures equilibrium behavior in a dynamically competitive industry. Using a dataset from a CPG category, we estimate the underlying structure of demand. Our demand estimates are

then used to compute the corresponding optimal advertising and pricing policies over time.

3 : Structural Estimable Model of Memory based Choices. Nitin Mehta, University of Toronto.

Memory influences the accuracy which the consumer recalls brand related information which further influences which brand is finally chosen Forgetting results when consumer imperfectly recalls the brand related information from her memory which results in her making choices from a depreciated information set. The memory based decision theory suggests three different models: total persistence, partial persistence and non-persistence models. These models differ in the amount of information that the consumers forget with time. We build these three different structural estimable models and see which of those explain observed brand choices for FPPS the best.

4 : Learning About Computers: An Analysis of Information Search and Technology Choice. Tülin Erdem, University of California Berkeley; Keane, Michael; Strebel, Judi.

This paper examines consumer search for and choice of high-tech durable goods. In our model, consumers decide in each period whether to obtain information from several sources. After obtaining information, the consumer decides whether (and what) to buy at that time. We estimate the model on a unique panel data set collected in collaboration with a major U.S. PC manufacturer. Given the estimated model, we also run policy experiments to investigate issues such as how altering accuracy and cost of various information sources would alter consumer information acquisition and technology choice behavior.

: MC10 **Information Technology and Closed-Loop Supply Chains**

Invited Session Room: L19

Chair: Jo van Nunen
Erasmus University Rotterdam

1 : Integrating Knowledge Management and Decision Making in Reverse Logistics. Nikos Karacapilidis, Industrial Management Lab.

In the context of Reverse Logistics, which is usually characterized by the existence of ill-structured tasks undertaken by a group of managers representing diverse functions, this paper presents a framework that integrates knowledge management and decision making features. The proposed framework considers a decision as a piece of descriptive or procedural knowledge. The decision making process is thus able to produce new knowledge, such as evidence justifying or challenging an alternative or practices to be followed/avoided after the evaluation of a decision. Much attention is paid to the maximum exploitation and enhancement of the flow of the underlying organizational knowledge.

2 : Assessing the Value of Information in Closed Loop Supply Chains. Rob Zuidwijk, Erasmus University Rotterdam; van Nunen, Jo; Kuik, Roelof.

Closed loop supply chains engage not only in the forward supply of goods to customer markets, but also in the various types of returns that occur in the supply chain. In particular, end-of-life or end-of-lease returns may contain value that can be recovered. Monitoring both customers and products in the market puts the management of markets and processes from a reactive to an anticipating mode. A quantitative assessment of the value of monitored information is proposed and challenges on new products and services are indicated.

3 : Customer Orientation for Independent Recovery Companies. Martin Ploog, TU Braunschweig; Spengler, Thomas.

The reclamation of reusable parts from scrapped products is a practical way to secure output proceeds for an independent recovery centre. In order to fulfill the customers demand for recovered parts, the orders of the customers have to be matched with incurring devices and treatment capacity. For this purpose, a multi-period planning model is developed based on recycling passport product data and on a depiction of recovery operations. The model is applied to the recovery of discarded telephone sets. The solution consists of an optimal allocation of recovery operations as well as of an order fulfillment schedule.

: MC11 **Empirical Applications - I**

Invited Session Room: R20

Chair: Emili Tortosa-Ausina
Universitat Jaume I

1 : A Specific Malmquist Productivity Index. Jesús T. Pastor, Universidad Miguel Hernández.

The definition of a Specific Malmquist Productivity Index is proposed by considering specific frontiers for a given set of available panel data. The productivity index is decomposed into efficiency change and technical change. The latter component is defined with respect to the specific frontier while the former maintains the usual definition. The proposed productivity index has two main features: first, it satisfies the circularity test, even in any of its two components, and second, it can always be evaluated by means of DEA-like methods. Consequently, any returns to scale assumption is feasible.

2 : DEA Models and Their Application to the Evaluation of Efficiency of Central European Firms. Josef Jablonsky, University of Economics Prague.

The aim of the paper is to analyze productivity and efficiency gap between highly developed European economies and several Central European countries accessing the European Union. The study is based on real data sets given by the interview of Central European firms coming from two important industry branches. The analysis uses standard DEA models in order to identify the main inefficiency sources and several definitions of super-efficiency for classification of firms and countries. The results given by different super-efficiency DEA models are compared. All the models are solved by means of original MS Excel / LINGO modeling language add-in application.

3 : Deregulation and Productivity: A Dissection of the Impact of Domestic and European Regulations on Productivity of the Spanish Banking Industry. Ana Lozano-Vivas, University of Málaga; C. Kumbhakar, Subal.

This paper focuses on the association among deregulation and performance of banks using a unified approach. In doing so we

accommodate the effects of different types of deregulation on productivity. Additionally, we measure the total factor productivity (TFP) growth in such way that it avoids the discrepancy found in the literature between the nonparametric (the Divisia) and the parametric measures of TFP change, irrespective of the functional form chosen to represent the production technology. Empirically, we use panel data (1986-2000) on Spanish savings and commercial banks, which went through several deregulatory changes (both at the domestic and community level).

4 : Sensitivity Analysis of Efficiency and Productivity Indices: An Application to Spanish Savings Banks. Emili Tortosa-Ausina, Universitat Jaume I; Grifell-Tatjé, Emili; Armero, Carmen; Conesa, David.

Hypothesis testing in the context of efficiency and productivity measurement has been investigated since the 1990s. Recent contributions focus on this through resampling methods. However, empirical evidence is still practically non-existent. This gap is more noticeable in the case of banking efficiency. We explore productivity and efficiency for Spanish savings banks over the post-deregulation period using DEA and bootstrapping. Results show that productivity growth occurred and efficiency remained constant. The bootstrap yields further evidence, as for many firms productivity growth is not statistically significant. It also reveals that disparities in original efficiency scores are lessened to a great extent.

: MC12 Combinatorial Methods for Graph Problems

Invited Session Room: M39

Chair: Claudio Arbib
University of L'Aquila

1 : Cardinality Constrained Covering Problems in Graphs and Hypergraphs. Nicola Apollonio, Università degli Studi di Roma "La Sapienza"; Caccetta, Lou; Simeone, Bruno.

We deal with the following general problem: given a hypergraph H and a positive integer t, find a subset of t vertices that covers the maximum number of hyperedges. We focus on two particular cases: (i) H is an edge-path hypergraph ; (ii) H is a bipartite graph. For several special subclasses of hypergraphs of type (i) or (ii), we give either polynomial-time algorithms or proofs of NP-completeness. Some interrelations between the existence of polynomial-time algorithms and some structural hypergraph properties, such as the Helly Property or the absence of pies, are discussed.

2 : On d-Threshold Graphs and d-Dimensional Bin Packing. Andrea Lodi, University of Bologna; Caprara, Alberto; Rizzi, Romeo.

2- and 3-dimensional bin packing problems have been widely studied in the operations research literature as they have important practical applications. A few recent papers dealt with the computation of lower bounds on the minimum number of bins (rectangles or cubes) needed to pack a given set of items (rectangles or parallelepipeds). In this paper, we study the lower bounds that can be derived from the compatibility relations between items, which are naturally represented by an undirected graph.

3 : Perfectness is an Elusive Graph Property. Annegret Katrin Wagler, Konrad-Zuse-Zentrum Berlin (ZIB); Hougardy, Stefan.

A graph property is called elusive (or evasive) if every algorithm for testing this property has to read in the worst case all entries of the adjacency matrix of the given graph. Several graph properties have been shown to be elusive, e.g. planarity (Best et al 1974), k-colorability (Bollobas 1978), 2-connectivity (Triesch 1982), or the membership in any minor closed family (Chakrabarti, Khot, Shi 2002) . A famous conjecture of Karp (1973) says that every non-trivial monotone graph property is elusive. We prove that a non-monotone but hereditary graph property is elusive: perfectness.

4 : Mechanism Design Optimization Problems on Graphs. Guido Proietti, University of L'Aquila.

In large networks, components may be owned by different owners, called agents. If one wants to solve any given network optimization problem, these agents are called for declaring a price for using their own components, and they do that by rationally optimizing their self-interest. Therefore, they might negatively influence the behaviour of any solving algorithm, by leading it to return a sub optimal solution. A few studies have suggested a framework, known as mechanism design, for motivating the agents to behave correctly. This gave rise to an interesting family of algorithmic problems on graphs, which will be discussed through the talk.

: MC13 Pricing and Revenue Management - I

Invited Session Room: R21

Chair: Georgia Perakis
Massachusetts Institute of Technology

1 : A Fluid Model of Dynamic Pricing and Inventory Control for Distribution Systems. Soulaymane Kachani, Columbia University; Perakis, Georgia.

In this talk, we propose and analyze a fluid model of dynamic pricing and inventory control for a distribution system with several wholesalers, intermediate distributors, and retailers. All entities are subsidiaries of the same company that is producing and selling multiple products. The model does not require determining how prices at each wholesaler, distributor and retailer affect their corresponding demand. Instead, the model accounts for how price and level of inventory affect the sojourn time of the products at each wholesaler, distributor and retailer in the distribution system.

2 : A Tabu Search Heuristic for a Pricing Problem on a Network. Luce Brotcorne, Universite de Valenciennes; Cirinei, Fabien; Marcotte, Patrice; Savard, Gilles.

We consider a pricing problem where a company (a leader) strives to maximize its revenue raised from tariffs imposed on a set of network connections in its control while taking into account the cost minimizing behavior of the customers. This problem, involving two decision makers acting non-cooperatively and in a sequential way, is modeled through a bilevel program. We propose a tabu search algorithm based on the characterization of feasible followers solutions as a set of paths. To assess the efficiency of the method, a comparison with previously pro-

posed heuristics is made on instances solved to optimality.

3 : Revenue Management of Flexile Products. Guillermo Gallego, Columbia University; Phillips, Robert.

A "flexible product" offered by an airline is a "menu" of two or more alternative flights serving the same market. The airline will assign customers who have chosen a flexible product to one of the alternatives at a later time prior to departure. This paper derives conditions and algorithms for management of flexible products in the case of two flights and uses numerical simulation to determine the benefits from offering flexible products.

4 : Dynamic Pricing in a Competitive Environment through Dynamic Optimization. Georgia Perakis, Massachusetts Institute of Technology; Sood, Anshul.

In this talk we discuss a stochastic, dynamic optimization model for dynamic pricing of perishable products in a competitive and dynamically changing market. This model ties together the competitive with the dynamic aspect of pricing. We establish that the model gives rise to optimal policies using results from game theory, and discuss an algorithm for computing its solution. Our results apply to a number of application areas including the airline, service and retail industries.

: MC14 **Internet and Wireless Networks**

Invited Session Room: R22

Chair: E. Lerzan Örmeci
Koç University

1 : A Formulation of Joint Routing and Power Control for Fixed Wireless Networks. Murat Alanyalı, Boston University; Yener, Bülent; Savaş, Onur.

We consider packet-data communication among wireless stations with arbitrary but fixed geographical locations. Network traffic is comprised of unidirectional, bursty sessions between station pairs. Station locations and mean session data rates are known. Sessions may be routed over multiple relay stations, and stations may employ different transmit powers. Network operation is asynchronous so that packet transmissions are not aligned in time. Linear and nonlinear programming formulations are provided to jointly determine session routes and transmit powers to limit interference at receivers.

2 : On Properties and Applications of Weighted Sums of Exponential Random Variables. Nelly Litvak, University of Twente; van Zwet, Willem R.

It was proved recently that the limiting behavior of a TCP connection with additive-increase multiplicative-decrease algorithm is closely related to weighted sums of exponential random variables. Such distributions have been intensively studied in recent literature. We determine their non-trivial behavior in a positive neighbourhood of zero. The results also apply in performance analysis of carousel systems. Consider the travel time needed to collect n items randomly located on a circle. Surprisingly, the limiting behavior of the minimal travel time is defined by weighted sums of exponentials.

3 : On Scheduling for Spectrally Efficient Resource Allocation for Delay Tolerant Wireless Data Transmission. Oğuz Sunay, Koç University; Ekşim, Ali.

We provide a comparison of practical scheduling algorithms for spectrally efficient resource allocation for delay tolerant wireless data transmission. Performance comparisons are conducted for observed throughput and latency values. There exists a dichotomy between increasing the throughput and decreasing the latency when one uses an opportunistic resource allocation scheme that takes the stochastic behavior of the wireless channel into account. The ultimate scheduler should provide reasonable latency figures without compromising much from throughput. We show that the de-facto standard scheduling algorithm for the upcoming 3G wireless communication system may behave in an unstable, unfair fashion. We propose better performing algorithms.

4 : Admission Control via Pricing in Multiclass Service Systems. Antonis Printezis, Case Western Reserve University; Burnetas, Apostolos.

Consider a service system whose owner can control the incoming load of customers by admission pricing. We examine the effect of splitting the system into two subsystems with separate queues and differentiating pricing for each queue. We show that separation is not efficient for a single class of customers, and discuss the implications when there are multiple classes that differ in their cost of waiting.

: MC15 **Exact and Heuristic Algorithms for Vehicle Routing Problems**

Invited Session Room: R23

Chair: Frederic Semet
University of Valenciennes

1 : Vehicle Routing with Time Windows and Split Deliveries. Dominique Feillet, Université d'Avignon; Dejax, Pierre; Gendreau, Michel; Gueguen, Cyrille.

In this presentation, we consider the Split Delivery Vehicle Routing Problem with Time Windows (SDVRPTW) in which the delivery to a customer can be split between any number of vehicles. This problem has not been extensively studied in the literature. The main contribution of this presentation is a Branch and Price approach for solving the SDVRPTW without imposing restrictions on the split delivery options. The computational results show that this approach works well and that split delivery can lead to significant improvements in terms of cost and number of vehicles used.

2 : A Travelling Salesman Problem with Pickups and Deliveries of Several Products. Juan José Salazar González, Universidad de La Laguna; Hipólito, Hernández Pérez.

We address here new exact and heuristic approaches to solve a variant of the classical "Travelling Salesman Problem with Pickup and Delivery" where several commodities from several sources to several destinations should be transported through a minimum-cost Hamiltonian route. The problem is related with the known "Dial-a-Ride problem" of one vehicle. We will show preliminary results on small instances showing the hardness of the problem.

3 : A Granular Tabu Search Algorithm for the VRPTW. Daniele

Vigo, University of Bologna; Wolfler Calvo, Roberto.

We consider the well-known Vehicle Routing Problem with Time Windows (VRPTW), where a given set of customers must be served, within prefixed time intervals, by a fleet of vehicles in such a way that the total length of the performed routes is a minimum. We present a Tabu Search metaheuristic for the VRPTW based on the use of granular neighborhoods, that are restrictions of more general ones that contain only potentially promising moves and that can be searched quickly. The resulting Granular Tabu Search algorithm is extensively tested on benchmark VRPTW instances from the literature.

4 : A Tabu Search based Method for a Bi-Objective Vehicle Routing Problem. Nicolas Jozefowiez, Laboratoire d'Informatique Fondamentale de Lille; Semet, Frederic; Talbi, El-Ghazali.

In this talk, we present a solution method for a bi-objective vehicle routing problem in which the balance of the route lengths and the total length are the considered objectives. Since Tabu searches are efficient on vehicle routing problems, we have defined a new way to approximate Pareto sets by the mean of Tabu searches. It is based on repeated cooperative Tabu searches with proper suited goals. This approach was used to directly generate approximations of the Pareto set or to improve approximations obtained by standard multi-objective evolutionary algorithms. In both cases, assessments show that the proposed methodology is efficient.

: MC16 **Integer Programming - II**

Invited Session Room: R27

Chair: Claudio Gentile
IASI-CNR

1 : Minimizing the Bandwidth of an Undirected Graph. Juan José Salazar González, Universidad de La Laguna; Caprara, Alberto.

We illustrate a new simple lower bound on the optimal bandwidth of a graph and its extension within an enumerative algorithm, leading to integer linear programming relaxations that can be solved efficiently and provide effective lower bounds if part of the layout is fixed. We show that the resulting method can solve to proven optimality new instances from the literature (i.e. from the Matrix-Market Collection). The new approach is also analyzed on randomly generated instances with up to 1000 nodes.

2 : A Compact Linear Program for Testing Optimality of Perfect Matchings. Paolo Ventura, IASI-CNR; Eisenbrand, Friedrich.

It is a longstanding open problem whether there exists a polynomial size description of the perfect matching polytope. Here we give a partial answer to this question: the polyhedron defined by the constraints of the perfect matching polytope which are active at a given perfect matching can be obtained as the projection of a compact polyhedron. Thus there exists a compact linear program which is bounded if and only if the perfect matching is optimal with respect to a given edge weight. This result provides a simple reduction of the maximum weight perfect matching problem to compact linear programming.

3 : Domination between Traffic Matrices. Gianpaolo Oriolo, Universita' Roma Tor Vergata.

A common network design problem is that of installing capacity over the edges of a network as to support a given traffic demand matrix and satisfy some additional constraints (integrality, resilience etc.). Nevertheless, in many settings we have to support a set X of (non-simultaneous) traffic matrices (e.g. day/night traffic). A sensible question is then the following: is there any matrix X_i in the set dominating the others, i.e. by supporting X_i we also support all the others? In this talk we show a good characterizion for domination and discuss relationships with the so-called VPN-problem.

4 : Student Assignment Problem to Elective Courses: An Integer Programming Approach. Pınar Mızrak, Dokuz Eylül University; Edis, Emrah.

This paper deals with the problem of assigning college students to elective courses according to their choices. Each student should rank his/her preferred courses. Considering the preference list of all students and the quotas of courses, alternative integer programming models were developed with different set of assumptions. All models minimize the sum of preference numbers of all students while assigning them to as many courses as they wish. The difference in-between models is the assignment policy. Results are compared from the student's perspective. This procedure has been applied in Dokuz Eylül University Industrial Engineering Department for the last two semesters.

: MC17 **Applications of Simulation**

Invited Session Room: R24

Chair: Jaume Barcelo
Technical University of Catalonia

1 : A Note on the Methodology for the Validation and Calibration of Microscopic Simulation Models. Jaume Barcelo, Technical University of Catalonia.

The decision making process using simulation models relies on the ability of simulation models to replicate the behaviour of the system to provide valid answers to questions on the system. The determination on whether a microscopic traffic simulation model is valid is achieved calibrating and validating of model, that is adjusting model parameters (car-following, lane change, route choice,...) to the observations, and comparing observed against simulated data by statistical techniques. This paper proposes an adhoc methodological framework for traffic simulation models, suited to the special characteristics of traffic data, and the traffic flow theory that the data must verify.

2 : Simulation of Istanbul's Traffic Network: Insights about Passageways between Two Continents. Mert C. Demir, Marmara University; Çomut, Tuncer.

In this work, we try different network models for Istanbul's traffic, deliberately incorporating flows over the heavily loaded Bosphorus bridges. Models include nonlinear flow costs, flows from rural areas to downtown and catastrophic events. Stochastic elements are added by means of random cost functions, divergences and random closure of the Bosphorus Bridge. Ex-

periments covered two different conditions: current status with two passages and with the addition of a third passageway. The results showed that addition of a third passage does not reduce travel times from one side to another drastically, but the variance is highly affected.

3 : Simulation Assessment of New Inference Tools for Parameters of Endemic Infection Models. Stephen Chick, INSEAD; Soorapanth, Sada.

Infection models are useful in the public health, agricultural sector, and pharmaceutical sectors. Our recent work with the US EPA to assess risk to humans from microbes transmitted through the public water system indicates that some transmission parameters are poorly understood. We examine a mixed deterministic-stochastic model of infection transmission to derive new tools for inferring the parameters of epidemic models using endemic data. The tools incorporate the 'physics of infection' into the inference process. The use of endemic data provides an alternative to waiting for, identifying, then tracking an outbreak, which is required by other techniques.

: MC18 **Location Models**

Invited Session Room: R25

Chair: Oded Berman
University of Toronto

1 : Minmax Relative Regret Location Problems. Igor Averbakh, University of Toronto at Scarborough.

We consider single facility location problems (e.g., 1-median) on networks with uncertain weights of nodes (interval-data case). It is required to find the minmax relative regret location, i.e. a location that minimizes the worst-case ratio (over all possible scenarios) of the achieved objective function value under a scenario to the best possible objective function value under the scenario. Low-order polynomial algorithms for general and special networks are presented.

2 : The Median Problem with Unreliable Facilities. Mozart Menezes, University of Toronto; Berman, Oded; Krass, Dmitry.

This paper generalizes the classical p-Median problem on a network by considering facilities that may fail. Consequently, a consumer may have to be served by a facility which is not the closest one. The problem is analyzed and algorithms and heuristics are presented for the case when all the facilities have the same reliability. Interesting results for a tree network are also discussed.

3 : Location and Pricing Decisions of a Multi-Store Monopoly in a Spatial Market. Abdullah Dasci, University of Alberta; Laporte, Gilbert.

We analyze the location and pricing decisions a monopolist about to open a number of stores in a compact geographical space. The number of stores is made endogenous by the introduction of fixed costs. We propose a novel model in which the firm's location and price decisions are represented as continuous functions defined over the geographical space.

: MC19 **Planning and Resource Allocation Models in Health Care**

Invited Session Room: R26

Chair: Marion Rauner
University of Vienna

1 : Patient Mix Optimisation in Thoracic Surgery Planning: A Case Study. Jan Vissers, Eindhoven University of Technology.

Cardiothoracic surgery planning involves different resources such as operating theatre time, beds, IC beds and nursing staff. Within cardiothoracic surgery different categories of patients can be distinguished on behalf of their requirement of resources. The mix of patients is, therefore, an important decision variable for the hospital to manage the use of these resources. In the paper we will consider the planning problem to generate an operation schedule that realises a given target of patient throughput and optimises an object function for the utilisation of resources. We will discuss a model developed for this planning problem and the results obtained.

2 : Long-Term Modelling of Health Resources in the Period of Aging Population. Martin Dlouhy, University of Economics Prague.

The paper studies the long-term impact of selected factors on the health resources in the case of the Czech Republic. We developed a simplified spreadsheet model to project key health resources. The resources and their costs are related to economic growth. A special attention is paid to expected aging of population. In the model, many restrictive assumptions had to be made - constant economic growth, linearity of production functions, constant technology development etc.

3 : Modeling the Effectiveness of Screening for Depression in Primary Care. Amy Wilson, University of Minnesota; McAlpine, Donna.

The United States Preventive Services Task Force recently issued the recommendation that primary care physicians screen adult patients for depression. Depression is a relatively common condition and good screening tests exist to detect it. Unlike other conditions for which persons are commonly screened, such as cancer, depression can be an episodic illness. This raises challenges for the design of a cost-effective screening policy. We develop a Markov model of depression in a general population and use it to explore questions about what screening interval produces the most cost effective screening strategy.

4 : Economic Impact of Occupational Accidents: Resource Allocation for AUVA's Prevention Programs. Marion Rauner, University of Vienna; Harper, Paul; Shahani, Arjan; Schwarz, Bernhard.

Occupational injuries are a great burden on health care costs worldwide. We present the first detailed analysis of the total direct and indirect costs of individual occupational injury claims for a given year covering costs for: a general injury insurance company, the AUVA, employers, and the Austrian economy. Using classification and regression trees, all patients are clustered into risk groups according to several criteria such as age, gender, and job type with similar resource needs, e.g., lifetime pension costs. The cost-effectiveness thresholds for prevention program costs per injury for certain risk groups helps the AUVA

allocate its prevention budgets optimally.

: MC20 **Classification via Mathematical Programming**

Invited Session Room: M35

Chair: Shuichi Shinmura
Seikei University

1 : Enhanced Algorithm of IP-OLDF. Shuichi Shinmura, Seikei University.

In this paper, I propose an enhanced algorithm of IP-OLDF (Integer programming-Optimal linear discriminant function) that minimizes the sample error rate. IP-OLDF is defined on the discriminant coefficient space. Until now, IP-OLDF looks for a vertex of the optimal convex polyhedron. The every interior point of this optimal convex corresponds to the true IP-OLDF. This time, an enhanced algorithm of IP-OLDF is developed. This new algorithm looks for the interior points of the optimal convex polyhedron.

2 : Latent Class Model with Some Restrictions and Its Applications. Kazunori Yamaguchi, Rikkyo University; Sakurai, Naoko; Watanabe, Michiko.

Latent class modeling was initially introduced by Lazarsfeld as a way of formulating latent attitudinal variables from dichotomous survey items. In contrast to factor analysis, which posits continuous latent variables, LC models assume that the latent variable is categorical, and areas of application are more wide-ranging. The initial methodology was formalized and extended to nominal variables by Goodman. In this paper, we consider several extensions of the LC model with some restrictions and give an optimization algorithm to get the MLE of parameters in the model. We will also give some examples of analysis of POS data.

3 : Efficient Approaches for Support Vector Machine. Yasutoshi Yajima, Tokyo Institute of Technology; Mori, Masao.

In this paper, we consider LP formulations for support vector machines (SVM). We first introduce the LP formulations as an approximation of the quadratic constraint involved in the standard SVM formulations. The linear approximation is obtained by the eigendecomposition of the Gram matrix. The approximation can be viewed as the extraction of an important subspace from the nonlinear feature space. We also introduce LP formulations for multicategory classification problems, in which a K-class nonlinear discriminator is generated in one optimization task. Considering the low dimensional feature subspace extraction, we can also generate nonlinear multicategory discriminators by solving LPs.

: MC21 **Multi-Echelon Systems**

Invited Session Room: M36

Chair: Ton de Kok
Technische Universiteit Eindhoven

1 : Power-of-Two Policies for Series Inventory Systems with Incremental Quantity Discounts. Yale Herer, Technion - Israel Institute of Technology; Rieksts, Brian; Ventura, Jose.

This paper presents power-of-two policies for a series inventory system with an incremental quantity discount in the first stage. To prove the effectiveness of the power-of-two policies, a lower bound to the optimal cost is derived. A policy that is within 94% of the lower bound is developed for a fixed base planning period. For a variable base planning period, a 98% effective policy is provided. An extension is included for a system with price dependent holding cost.

2 : Comparison of Joint Replenishment Policies for a Two-Echelon Inventory System. Banu Yüksel Özkaya, Bilkent University; Gürler, Ülkü; Berk, Emre.

We consider a single item, two-echelon inventory system with a single warehouse and multiple retailers under a new type of ordering policy. In particular, we propose a new type of joint replenishment policy for the retailers which aims to coordinate the orders given to the warehouse. We provide exact expressions for the key operating characteristics of the model. We present numerical results which compare the proposed policy to another recently proposed joint replenishment policy.

3 : Optimization of N-Echelon Distributions Systems under Installation Stock (s,nQ)-Policies. Ton de Kok, Technische Universiteit Eindhoven.

Recent research on echelon order-up-to-policies has shown that the optimality equations to be solved are generalizations of the well-known Newsboy equation. We formulate generalized Newsboy equations in the context of installation stock policies that provide the basis for a heuristic solution to the problem of finding cost-optimal reorder levels.

4 : Competitive Inventory Policies in a Two-Stage Production - Inventory System. Fikri Karaesmen, Koç University; Jemai, Zied.

We investigate the effects of competition on a two-stage supply system, consisting of a capacitated supplier and a retailer. Modeling this system as a two-stage make-to-stock queue, we characterize the equilibrium inventory levels and the corresponding penalty of decentralization. We also investigate coordination issues through simple contracts.

: MC22 **3D Packing**

Invited Session Room: M37

Chair: Eberhard Bischoff
University of Wales Swansea

1 : Lower and Upper Bounds for the Three-Dimensional Finite Bin Packing Problem. Marco Boschetti, University of Bologna; Mingozzi, Aristide.

The 3D-BPP consists determining the minimum number of large identical three-dimensional rectangular boxes, bins, that are required for allocating a given set of three dimensional rectangular items without overlapping and with their edges always parallel or orthogonal to the bin edges. We propose new lower and upper bounds that is able to solve the problem both when the items have a fixed orientation or when they can be rotated by 90°. The proposed algorithms have been evaluated on test problems derived from the literature. The computational results indicate that they are competitive with the other algorithms

proposed in literature.

2 : Non-Populational Meta-Heuristic Approaches to the Container Loading Problem. Ana Moura, INESC-Porto; Oliveira, Jose Fernando; Gomes, A. Miguel.

The problem considered in this paper is the Container Loading Problem. In this problem a set of rectangular boxes has to be packed in one rectangular container so that the available container space usage is maximized. The orientation constraints and the distinction between homogeneous and heterogeneous types of cargo are considered. We present the results obtained with four meta-heuristics: GRASP, Simulated Annealing, Tabu Search and Iterated Local Search. All of them use the same basic packing algorithm. The good performance of the Meta-Heuristics approaches is shown by comparing them with well-known algorithms and results from the literature.

3 : On Random Search Approaches to Container Loading Problems. Eberhard Bischoff, University of Wales Swansea.

The paper deals with single container loading problems involving both weakly and strongly heterogeneous assortments of cargo. It focuses on ways in which various practical requirements - e.g. restrictions on the positioning of items - can be incorporated into the solution procedure. Concrete approaches are described and evaluated.

4 : Embedding Compaction Algorithms in Nesting Problems Resolution. A. Miguel Gomes, FEUP/INESC Porto; Oliveira, Jose Fernando.

Compaction algorithms aim to compact existing layouts, by applying to the irregular pieces in the layout a set of continuous motions (without jumps). In this implementation LP models have been used, together with heuristic rules to tackle the binary variables inherent to the compaction model, to achieve local optimum solutions for each particular relative disposition of pieces. Embedding compaction models in a higher-level search algorithm (e.g. metaheuristics) is a good resolution strategy for nesting problems, since the compaction model ensure the good quality of the layouts (local optimum) and the high-level search algorithm drives the search throughout the solution space.

: MC23 **Market Entry**

Invited Session Room: M38

Chair: Christian Schade
Humboldt-Universität zu Berlin

1 : Impact of Prior Gains and Losses on Behavior in a Simultaneous Market Entry Game: An Experimental Study. Andreas Schroeder, Humboldt-Universität zu Berlin; Schade, Christian; Krause, Kai.

Many situations in entrepreneurship and technology management are coordination games where players have experienced prior gains and losses. Experimental findings from simpler coordination games (such as battle of the sexes) already indicate that prior gain or loss experiences have an impact on behavior. We extend this work to a simultaneous market entry game where players have experienced such gains and losses. We then report on findings from an experiment testing normative (game-theoretic) versus descriptive predictions for this game. Implications for further research as well as entrepreneurial and managerial decision making are outlined.

2 : Venturing into International Markets: A Multiple Criteria Decision Making Approach. Gina Beim, Case Western Reserve University; Levesque, Moren.

Multiple Criteria Decision Making (MCDM) is a valuable tool to help decision makers formalize market entry decision processes. We employ two MCDM software packages to demonstrate how this can be accomplished. A general decision model is developed with emphasis on the role of the MCDM analyst in aiding entrepreneurs assessing the relative importance of criteria for market entry decisions. The model is populated with published international statistics and further subjected to sensitivity analyses. This article concludes with a discussion of the practical applicability of the procedure, with focus on approaches to facilitate greater acceptance on the part of the industry.

3 : Experimental Findings on Bounded Rationality and Market Entry Timing. Christian Schade, Humboldt-Universität zu Berlin; Levesque, Moren.

From a normative perspective, a rational decision maker's timing-of-entry decisions under full-initial information should provide utilities that are at least as large as that under partial-sequential information (information provided from period to period). Our key hypothesis however is that in complex decision situations such as market entry timing, boundedly rational decision makers should prefer a simplified, less demanding choice procedure. Such procedures include an optimal stopping approach where the decision to delay market entry is based on incremental benefit from continuing that activity one more period. We explore this issue with a decision-theoretic framework and an experimental study.

: MC24 **EWG MCAD - II**

Invited Session Room: L17

Chair: Vladimir Bushenkov
University of Evora

1 : Application of Feasible Goals Method to One Problem of Production Planning. Vladimir Bushenkov, University of Evora; Figueira, José.

This report presents results of experimental study of multiple objective linear model in the branch of the aggregated production planning applied to a Portuguese firm producing constructing materials. Our approach is based on the construction of the full variety of feasible combinations of criterion values. The decision maker uses the graphic image of this variety to formulate his solution in interactive manner. The presented approach is compared with the other multiple objective methods.

2 : Multicriteria Modelling and Rational Use of Waste. Norese Maria Franca, Politecnico di Torino; Fabrizio, Vinardi.

A real study is presented to show the potentiality of multicriteria models and modelling procedures in relation to a problem developed in a carpentry company. Its very large quantity of waste wood has been sold for many years to plywood producers. Now this income has been strongly reduced by new market preferences. Waste wood has therefore become a risk problem;

on the other hand it may represent a potential clean and free energy source. Technical, financial and law constraints needed a multicriteria analysis and modelling of the problem. Problem structuring and modelling, solution identification, development and evaluation are analyzed.

3 : A Knowledge Acquisition Approach for Multiple Criteria Problems. Beate Carina Scheubrein, University of Hohenheim; Scheubrein, Ralph; Zionts, Stan.

A basic problem in multiple criteria decision making is the definition of an adequate set of criteria. In the literature, verifying that the right set of criteria is used, is often reduced to the question if the set meets some specific mathematical properties. In order to provide a decision maker with more instruments, several problem structuring techniques were empirically evaluated. This evaluation showed that especially the Kelly's repertory grid technique has several useful features. Accordingly the repertory grid technique was adapted to build a knowledge acquisition fronted to the aspiration-level interactive method (AIM) proposed by Lotfi, Stewart, and Zionts.

4 : Towards Multicriteria Auctions: A Theoretical Framework. Yves De Smet, Université Libre de Bruxelles.

Auctions are popular mechanisms for trading items. Their extension to double, multi-units and multi-objects auctions is a key factor in the growing literature on the subject. Multicriteria auctions, where each item is characterized by several attributes and not only by the price, seem to be the last frontier to this generalization. Our purpose is to outline a theoretical framework to study these new mechanisms. Multi-attribute auctions will be briefly reviewed and then extended to more general structures. The originality of our approach is based on the management of incomparability between bids which is a cornerstone of this multicriterion problematic.

: MC25 Energy and Related Public Sector Applications

Invited Session Room: M34

Chair: Isaac Dyner
Universidad Nacional de Colombia

1 : Dynamic and Stochastic Interactions Between Natural Gas Markets and Gas Discoveries. Isaac Dyner, Universidad Nacional de Colombia; Olaya, Y.; Larsen, Erik.

The assessment of discoveries of natural gas is a complicated issue that depends on the geological prospects of a specific region and other important factors such as investments and technology. The initial evolution of gas-industries often exhibit uncertain behaviour as the findings of large fields might be represented by non-trivial stochastic processes, with "variable parameters". This paper investigates, by means of System Dynamics modelling and stochastic processes, likely hypothetical evolutions of gas markets during its initial stages of development. This is of particular importance to some isolated and developing regions around the world as markets interact dynamically with gas discoveries.

2 : A Game Theoretical Model of Asymmetric Vertical Integration in Electricity Markets. Eloy Pérez, Ecole des HEC, Université de Lausanne; van Ackere, Ann.

A rapid cross sectional observation shows that, despite the willingness of liberalization, vertical integration is still very important in a large proportion of markets. Moreover a time series approach shows that even in well developed markets (UK), reintegration took place after a period of disintegration, without intervention of the regulator. Our model uses a game theoretic approach to describe a situation of asymmetric vertical integration to try to define the incentives for such a phenomenon; while the agents' incentives seem obvious (economies of scale, technological efficiency increase), we try to assess the possible existence of social benefits.

3 : A System Dynamics Approach to Liberalisation of Swiss Energy Market. Patricia Ochoa, Ecole des HEC, Université de Lausanne; Larsen, Erik; van Ackere, Ann; Dyner, Isaac.

This paper presents a model to support the analysis of the impact of liberalisation on the Swiss energy market. System Dynamics techniques have been successfully used for anticipation of the effects of liberalisation in energy markets in different countries like UK, Italy and Colombia. Now we propose to apply this approach to the Swiss energy market to investigate the impact of the proposed liberalisation. A key uncertainty relates to the future of the nuclear generation (currently 38% of power production in Switzerland).

4 : Managing a Reservoir-based Hydro-Energy Plant: Building Understanding in the Buy and Sell Decisions in a Changing Environment. Ann van Ackere, Ecole des HEC; Ruud, Morten; Davidsen, Paal.

We describe a modelling process at a Norwegian chemical producer that owns 20% of a reservoir based hydro-energy plant. While the initial objective was to increase the profitability of the energy plant (in particular by an improved understanding of buying and selling decisions and a reconciliation of the managerial and engineering points of view) the process resulted in the company's decision to refocus on its core-business. The process illustrates how a modelling process can lead to a fundamental reframing of the issue, resulting in major change for the company.

: MC26 OR Applications in South Pacific - II

Invited Session Room: L10

Chair: Dursun Delen
Oklahoma State University

1 : Intelligent Construction Cost Estimating Database. Zeljko Popovic, Parsons Brinckerhoff - PB Power Ltd.

Paper proposes improvements in two major areas: estimating procedure and cost modeling. Estimating procedure is enhanced to include data mining techniques, interactive visualization, comparison of historical costs, and simultaneous usage of several cost models derived from basic data. Cost data model is further extended to incorporate fuzzy logic and enable "flexible queries", as to simulate experts reasoning and provide automated professional advice to the user. Proposed improvements were implemented using combination of standard relational database language and object-oriented programming and tested on a large project. Results matched experts' opinion and "intelligent database" proved to be useful tool in estimating practice.

2 : Normalized Abstraction: Implementing Hierarchical Data Types Within the Relational Model. Kevin Wilkinson, Massey University.

This paper addresses the question: What options are available within the relational model for implementing hierarchical data types? The special characteristics of these types are examined and the prospects for implementing them are assessed separately for both the current (SQL2) and proposed (SQL3) versions of the model. While the proposed version's user-defined types seem to provide a suitable mechanism, the current version leaves no option but to implement hierarchies as features of application programs rather than databases. The findings of an experimental implementation of a hierarchy are described and the requirements of a generalized solution for such implementations are specified.

3 : AHP Method Application in Evaluation of Plant Genetic Resources Conservation Strategy. Biljana Stosic, University of Belgrade; Pekic, Vladimir.

This work deals with the possibilities of AHP method for multicriteria decision making application in an area of conservation of plant genetic resources for food and agriculture (PGRFA). Analytic Hierarchy Process is presented as a tool of important support for evaluating of different PGRFA conservation strategies, illustrated through a real example based on goals and criteria of National Program for Yugoslavia. It was developed at a workshop organized by Federal Institute for Plant and Animal Genetic Resources, held in Belgrade. The objective of the workshop was to evaluate and prioritize conservation strategy for the development of a National PGRFA Program.

4 : Enhancing OLAP Functionality using Neural Networks. Damminda Alahakoon, Monash University; Asghar, Sohail.

The work reported in this paper is an attempt at enhancing the capabilities of OLAP systems. The technique used for enhancing OLAP functionality is a neural network model called the GSOM. A parameter called the spread factor in the GSOM, has been used to develop a cluster generation and analysis technique called the Dynamic SOM Tree. We demonstrate the possibility of using the GSOM to provide initial unbiased guidance to an OLAP engine. Dynamic SOM Tree is used to provide the user with the ability to select data clusters at different levels of abstraction for further detailed analysis.

: MC27 **Modeling and Managing Financial Risk**

Invited Session Room: L11

Chair: Rita D'Ecclesia
Università degli Studi di Roma "La Sapienza"

1 : Value at Risk of Asset Derivative Portfolios: A Semi Parametric Approach. Sergio Ortobelli, University of Bergamo; Lamantia, Fabio; Massabò, Ivar; Iaquinta, Gaetano.

In this paper we describe and apply the estimating function methodology to value the risk of asset derivative portfolios. We first implement the Li's model based on the first four moments and then we show the limits of this model in forecasting the maximum loss of contingent claims. Finally, we propose a model that considers the first six moments and we compare the performances of these models considering a backtest analysis on several portfolios of asset derivatives.

2 : Segmentation in Financial Markets: The Italian Case. Silvana Musti, Università di Foggia; D'Ecclesia, Rita.

The stock exchange structure of Mercato Telematico Azionario has been modified in April 2001 in order to create the STAR sector where stocks of small-medium size companies can be traded with a high level of liquidity and transparency. In this paper we investigate the price dependence between shares belonging to the two sectors: STAR and blue-chip. Intradaily price data from 1/4/2001 to 30/04/2002 for different titles both of financial and industrial market have been analyzed. Results show a strong segmentation in the industrial field, while prices of financial institutions shares seem to be in most of the cases correlated.

3 : Comovements and Correlations in International Stock Markets. Mauro Costantini, Università degli Studi di Roma "La Sapienza"; D'Ecclesia, Rita.

In this paper we focus on analyzing the nature of the relationship between the major international stock markets. We use the VAR methodology and the principal component analysis to identify common factors for single stock markets in order to estimate co-movements between markets which vary across time and countries. We also try to estimate the correaltion structure and its link with the volatility of the markets using the GARCH methodology. The estimation of common factors to explain comovements and correlation among international stock markets have important implications for portfolio management.

4 : Tail Dependence and Value at Risk. Gianna Figà-Talamanca, University of Calabria; Bellini, Fabio.

We provide a simple method to locate and measure dependence in the tails of a time series, based on the "runs test", a non parametric statistical test for detecting dependence in a 0-1 series. The empirical results on many series of daily data reveals a strong departure from independence, which, in most cases can be successfully modeled through a two state Markov chain. We thus exploit this dependence structure to estimate a "jumping" Value at Risk. We show in some empirical examples that this simple approach outperforms standard approaches if a runs based back-testing is applied.

: MC28 **Meta-Heuristics for Scheduling**

Invited Session Room: L12

Chair: Khalil Hindi
American University of Beirut

1 : Improvement Graphs in Large-Scale Neighborhood Search: A Case Study on Scheduling. Ozlem Ergun; Agarwal, Richa; Orlin, Jim; Potts, Chris.

We demonstrate the use of improvement graphs for designing and efficiently searching large-scale neighborhoods for various single and parallel machine scheduling problems. We present the results of a computational study on the parallel machine scheduling problem where the objective is to minimize the weighted sum of completion times.

2 : A Metaheuristic for the Open Vehicle Routing Problem.

Richard Eglese, Lancaster University; Fu, Zhuo; Li, Leon.

The Open Vehicle Routing Problem (OVRP) is a special type of Vehicle Routing Problem (VRP). In the OVRP the vehicles are not required to return to the depot after visiting all their customers in a trip, or they must revisit the customers assigned to them in the reverse order. A form of tabu search heuristic is presented for the solution of the OVRP that takes into account the special structure of this type of problem. The computational results are provided for a set of test problems and compared with two other methods in the literature.

3 : A Constraint Propagation Heuristic for Solving the Single-Hoist, Multiple-Products Scheduling Problem. Khalil Hindi, American University of Beirut; Fleszar, Krzysztof.

A heuristic algorithm for solving the single-hoist, multiple-product scheduling problem is presented. The algorithm uses a non-standard Constraint Satisfaction Problem (CSP) model and employs variable ordering, forward checking and backtracking. Computational results, including comparison with existing algorithms in terms of solution quality and speed, are presented.

: MC29 **Airline Applications - II**

Invited Session Room: L13

Chair: Christine Strauss
University of Vienna

1 : Embedding Mobility Support in Airline Crew Pairing, Rostering, and Operations. Gabriele Kotsis, Johannes Kepler Universität Linz; Doerner, Karl; Strauss, Christine.

With the airline industry being characterised as a labor-intensive industry, efficient planning of personnel resources is a crucial success factor. Most of the airline personnel is by definition "mobile" thus also requiring appropriate support in accessing the underlying planning and information systems. Existing tools in crew scheduling, rostering, and operations only provide limited support in ubiquitous information access. In this paper we will study in detail the requirements for tool support and present a component-based software architecture which is capable of providing mobility support. We will illustrate the architectural concept on selected examples of mobile access in different usage scenarios.

2 : An Integrated Approach To Multiple-Domicile Airline Crew Scheduling with Teaming and Heterogeneous Crew Capacities. Markus P. Thiel, Universität Paderborn; Guo, Yufeng; Mellouli, Taieb; Suhl, Leena.

We propose an integrated approach based on two coupled components: The first constructs chains of crew pairings spaced by weekly rests, where crew capacities at domiciles and time-dependent availabilities are considered. The second rearranges parts of these pairing chains into individual crew schedules with even distribution of flight time. Considering the teaming aspect, the pairing distribution among home bases delivered by the first component minimizes costs (hotel overnights and crew proceedings), but it may differ for crew types having different availabilities. To reach a high degree of teaming, the second component is enhanced by special strategies within the assignment process.

3 : Airline Seat Inventory Control under Uncertainty. Nicholas Nechval, Université de Liège; Moldovan, Max; Nechval, Konstantin; Vasermanis, Edgars.

In this paper, optimal booking policies for multiple fare classes that share the same seating pool on one leg of an airline flight are determined. The paper deals with the cases when the functional forms of probability distributions of passenger demands are given, but some or all of the parametric values are left unspecified. The aim of the present paper is to show how the invariance principle may be employed in the particular case of finding optimal booking policies for multiple fare classes under uncertainty. Numerical examples are given.

4 : Development of a Transportation Scheduling Model for the Reallocation of Parts Prompted by Schedule Changes . Funda Samanlioglu, Clemson University; Melloy, Brian J.; Leonard, Michael S.

In the airline industry, airlines change flight routes and schedules of aircraft routinely to balance their number of flight cycles, flight hours and exposure to the elements. When these changes occur, spare parts that are held in inventory at repair stations need to be reallocated in accordance with these changes. The underlying problem is fundamentally a multi-index transportation problem constrained by several conditions and operational requirements. An algorithm is developed to generate a station-to-station shipping schedule for the reallocation of spare parts. Subsequently, several scenarios are presented to illustrate both the versatility of the modeling approach and the algorithm's implementation.

: MC30 **Education Arcade**

Invited Session Room: L14

Chair: Gary Waissi
University of Michigan-Dearborn

1 : OR/MS in a New MBA Program. Snjolfur Olafsson, University of Iceland.

The University of Iceland started a two-year executive MBA program in September 2000. The chairman of the program's three-person board (the author) is a professor of OR and together with the director had the most influence on the planning and development of the program. I describe where and how OR/MS was included in the program and why. One compulsory course and one optional course was called Operations Management although the second was essentially an OR course. Statistics and OR was taught in three courses although neither statistics or OR was used in the name of the courses.

2 : The Queueing ToolPak: A Spreadsheet Add-in for Waiting Line Analysis. Armann Ingolfsson, University of Alberta.

The Queueing ToolPak is a spreadsheet add-in that provides a library of functions to calculate performance measures for M/M/s/s+C queues. We discuss design the goals that the add-in was intended to achieve, experience with its use in teaching and practice, and its continuing development.

3 : webMBA - Experiences from an Online Program. Gary Waissi, University of Michigan-Dearborn.

This presentation discusses the online MBA program (webMBA) of the University of Michigan-Dearborn, School of Management. The program was introduced in the Fall 2001. Topics covered include: issues relating to online teaching and learning, program development and implementation, acceptance by faculty, short demonstration of a webMBA course, student feedback, assessment of student learning, as well as summary data relating to enrollments, costs, and revenues after two years.

: MC31 **AHP - C2**

Contributed Session Room: M33

Chair: Yuji Sato
Matsusaka University

1 : Application of Analytical Hierarchy Process to Investment Decisions. Neli Tomic - Plazibat, EFST; Hunjak, Tihomir.

Scientific support to establishment and survival of enterprices, especially small enterprises, is a particularly important factor of development and creation of stimulating conditions in Croatian economy. Therefore this paper expounds, first theoretically and then practically, an approach to the procedure of the optimal investment project selection. Owing to a large number of criteria and their different characters, it was necessary to consider investment possibilities and rank the investment projects by simultaneously taking into account several criteria using the AHP.Investment projects were evaluated in terms of the market and the socio-economic aspect, as well as in terms of risk and uncertainty.

2 : Recently Alleged AHP Rank Reversal Unriddled. Diederik J.D. Wijnmalen, TNO-FEL.

Two recently published papers claim new types of rank reversal with the AHP. This presentation focuses on the first one that deals with a transitivity violation when a three-or-more-alternative problem is considered as several two-alternative problems. Assuming perfect consistency, both ways should produce equal results but fail to do so. It will be shown that the cause of the trouble is that the weights are not revised although the reference for weighting has changed. Appropriate (and straightforward) weight adjustment violates AHP's independence axiom but ensures successively consistent results, maintaining ratio stability and thus preventing rank reversal.

3 : The Effectiveness of Scales Employed in a Pairwise Comparison. Yuji Sato, Matsusaka University.

The objective of this study was to find a scale appropriate for representing human perception. Specifically, 11 scales including Saaty's scale employed in a pairwise comparison of AHP were evaluated. The evaluation was conducted empirically using two types of data, non-biased and biased, where the criteria of appropriateness were the size of CI-how large a CI would be, the robustness of the ranking of alternatives--how often rank reversals would occur with respect to a change in the range of a scale, and discriminating sensitivity-how well the AHP would discriminate an important alternative from others.

: MD01 **Applications of Quantitative Methods in Entrepreneurship Research**

Tutorial Room: MB I

Applications of Quantitative Methods in Entrepreneurship Research. Raphael Amit, University of Pennsylvania.

This highly interactive active learning workshop will review a range of key issues in entrepreneurship research and offer insights into the use of a variety of analytical, statistical, econometric, and optimization techniques in entrepreneurship research. Workshop participants will work in groups and will be expected to actively contribute their ideas to enhance their learning experience.

: MD02 **Multiple Criteria Decision Making**

Tutorial Room: MB II

Multiple Criteria Decision Making. Murat Köksalan, METU.

The area of Multiple Criteria Decision Making (MCDM) has seen major developments during the last 40 years. In this tutorial, we discuss these developments and describe some of them in detail. We consider the problems where the solution space is defined as a set of alternatives as well as the problems where the solution space is continuous. We summarize a variety of approaches developed for each case and cover some of them in detail. In addition to the problem of selecting the best solution, we also discuss subset selection and classification problems under multiple criteria. Many researchers have been working on developing heuristic approaches for combinatorial multiple criteria problems in recent years. We briefly discuss some of these developments as well.

: MD03 **Aircraft and Crew Scheduling**

Tutorial Room: MB III

Aircraft and Crew Scheduling. Cynthia Barnhart, Massachusetts Institute of Technology.

In this tutorial, we survey the state-of-the-art in aircraft and crew scheduling, problems rich in complexity, with significant associated costs and revenues. We present selected fleeting, routing and crew scheduling optimization models and algorithms, and describe their impact in practice. We also survey the status of efforts to integrate these models and enhance them to achieve operational robustness. We examine trends in airline passenger delays and explore the effects of various scheduling and recovery strategies on passengers. Finally, we describe remaining challenges and research opportunities in aircraft and crew scheduling.

: MD04 **Radiation Oncology**

Invited Session Room: JB A

Chair: Allen Holder
Trinity University

1 : Pruning Radiotherapy Treatment Plans. Allen Holder, Trin-

ity University.

Radiotherapy is the treatment of cancerous tissues with external beams of radiation, and treatment planning is the process of selecting how to focus these beams onto the cancer so that the damage to surrounding organs is limited. Most optimization models are clinic specific to guarantee that the treatment may be administered with the clinic's technology. Our approach is different because we design treatment strategies that are not constrained by a clinic's limitations. These plans must be 'pruned' to a clinic's capabilities, and this talk focuses on how to optimally adjust a treatment plan.

2 : Optimisation of Beam Directions in Radiotherapy Planning. Matthias Ehrgott, University of Auckland; Johnston, Rick.

We present a multicriteria mixed integer programming model for the optimisation of beam intensities and beam directions in radiotherapy treatment planning. We explore a number of solution techniques based on scalarization of the multicriteria problem. These include solution of the MIP and heuristic techniques based on LP relaxation, local search and set covering. Our numerical results illustrate the importance of optimising beam directions.

3 : New LP Model for Multileaf Collimators in Radiation Therapy. Davaatseren Baatar, Universität Kaiserslautern; Hamacher, Horst.

The leaf sequencing problem is equivalent to some representation of an integer matrix as positive integer linear combination of so-called consecutive-1 matrices. In this talk, we present a model of the problem under leaf collision constraint as LP with TU constraint matrix such that integer radiation times are provided. It has considerably smaller number of constraints and variables than previous models. We show that our approach can also be used to solve the problem of minimizing the number of matrices (shown by Burkard (2002) to be NP-hard) with a heuristic which performs well in practice.

4 : Column Generation for IMRT Cancer Therapy Optimization with Implementable Segments. Ronald L. Rardin, National Science Foundation; Langer, Mark P.; Preciado-Walters, Felisa; Thai, Van.

IMRT delivers shaped patterns across beams to facilitate pinpoint radiation therapy for cancer. We apply column generation to construct these intensity maps while optimizing the overall treatment plan. Chosen columns can be implemented directly as segments for IMRT collimators, which speeds planning and avoids errors introduced by current optimize-then-segment approaches.

: MD05 **Air Traffic Management**

Invited Session Room: JB B

Chair: Dusan Teodorovic
Virginia Tech

1 : Intelligent Air Traffic Control Management System. Dusan Teodorovic, Virginia Tech; Baik, Hojong; Trani, Antonio.

In recent years, congestion has appeared in some elements of the air traffic control system (many airports, some air routes, and air traffic control sectors). The Intelligent Air Traffic Control Management System (IATCMS) that is based on the combination of fuzzy logic and integer programming techniques has been developed in this paper. The developed system is capable to make high quality real time decisions regarding the following problem: For known airline schedules, and approximately known airport capacities in the network, calculate ground holding delays, airborne delays, and determine cancelled flights in the network. The obtained results are very promising.

2 : Agent-based Computational Approach to Solve Airport Congestion Problems. Junhyuk Kim, Virginia Tech; Teodorovic, Dusan; Trani, Antonio.

In this paper an agent-based model, to study the effects of air transportation congestion, is developed. Our model considers that each agent (airline, airport, passengers) act based on their local knowledge and cooperates and/or competes with other agents. Model developed allows airport-agents to increase the capacity, or to significantly change landing fee policies, while the agents that represent airlines learn all the time, change their markets, fares structure, flight frequencies, and schedules. The Agent-based model developed is appropriate tool that can help us to predict and/or control the overall performance of a complex air transportation system.

3 : Study on the Impact of Alternative En-Route Air Navigation Charges in Europe. Lorenzo Castelli, University of Trieste; Pesenti, Raffaele; Ukovich, Walter.

This paper presents a research project within the framework of the EUROCONTROL CARE Innovative Action. Its final purpose is to study the impact of alternative route charge pricing schemes with the objective of increasing both ATC providers performance and airline efficiency. First, an econometric model for identifying the different factors affecting the passenger demand for air transportation is defined. Then, a characterisation of European airspace users, the study of ATS demand elasticity and operational attitudes of airspace users and the application of economic measures to promote status and ways of operation positively affecting the behaviour of the system are presented.

4 : An Approximated Algorithm for Solving the Flight Level Assignment Problem. Sophie Constans, INRETS; Fondacci, Rémy; Goldschmidt, Olivier.

Commercial flights usually concentrate on very few flight levels for economic reasons, leading to high saturation or potential conflict risk, i.e. to situations where aircraft may be too close to each other. Here, we aim at distributing the aircraft among the flight levels so as to ease traffic flow and avoid conflicts, while limiting the increase in fuel consumption induced by a change in the flight level. This flight level assignment problem is computationally hard. A heuristic method is therefore proposed, based on a graph modelling approach. Results showing a good reduction of the potential conflicts are presented and discussed.

: MD06 **Scheduling in Production Systems**

Invited Session Room: M30

Chair: Ceyda Oguz
The Hong Kong Polytechnic University

1 : A Machine Scheduling System for a Glass Factory. Ariadna Fuertes, University of Valencia; Alvarez-Valdes, Ramon; Ramos, Rafael; Tamarit, Jose; Gimenez, Guillermo.

We describe the design and implementation of a scheduling system in a glass factory. The factory produces a large variety of manufactured glass objects in a complex process ranging from melting the glass at the furnaces and blowing it, automatically or manually, to decorating, assembling and packing it. The structure corresponds to a flexible-job-shop scheduling problem, with some special characteristics. On the one hand, dealing with hot liquid glass imposes no-wait constraints to some operations. On the other hand, skilled workers performing some manual tasks are modelled as special machines. The system is used for short and mid-term planning.

2 : Single-Machine Scheduling with Multiple Job Families and Sequence-Dependent Setup Times. Selçuk Karabati, Koç University; Akkan, Can.

In this talk, we address the single-machine scheduling problem with multiple job families and sequence-dependent family setup times, and present a branch-and-bound algorithm for the sum of completion times performance criterion. The main feature of the branch-and-bound algorithm is a new lower bounding scheme that is based on a network formulation of the problem. We analyze the performance of the proposed branch-and-bound algorithm with extensive computational experiments.

3 : A Mixed Model Flow Line Sequencing Problem with Makespan Minimization. Banu Soylu, METU; Kırca, Ömer; Azizoğlu, Meral.

In this study, we consider a mixed-model flow line sequencing problem. We assume that speed of the transfer mechanism is adjusted by the end of each unit completion; i.e. cycle. Our objective is to minimize the completion of the last unit; i.e. total cycle time. We show that the problem is equivalent to classical flow shop problem with makespan minimization and synchronous transfers. We describe a branch&bound algorithm together with several bounding procedures. Our algorithm returns optimal solutions to moderate-sized problems in reasonable solution times. For larger sized instances, upper bounding procedures can be used to generate near-optimal solutions.

4 : Robustness and Stability Measures and Policies for a Single Machine Scheduling Problem. İhsan Sabuncuoğlu, Bilkent University; Gören, Selçuk.

Scheduling is a decision making process that concerns allocation of limited resources to competing tasks over time with the goal of optimizing one or more objectives. The output is time/machine/operation assignments. In theory, the objective is generally maximizing some performance measures. In this paper we consider two new criteria: "robustness" and "stability". We define robustness and stability, and develop develop several surrogate measures since the exact measures are difficult to calculate. These measures are embedded in the tabu search algorithm to generate robust and stable schedules in the single machine environment with random machine breakdowns.

: MD07 **Inventory Management**

Invited Session Room: M31

Chair: Geert-Jan van Houtum
Eindhoven University of Technology

1 : Information Sharing in Supply Networks with Dynamic Demand. Charles Sox, University of Alabama.

This research examines the effects of information sharing on inventory management in supply networks that are subject to dynamic, random demand. The customer demand is modeled as a Markov-modulated process, and various information sharing strategies are considered. The value and role of information sharing are characterized for certain supply network structures.

2 : Inventory Systems with Order Fullfilment within a Specified Time Window. Fikri Karaesmen, Koç University; Jemai, Zied.

We investigate a simple supply chain where a manufacturer places orders to its supplier and specifies a future time window for deliveries. The time window is specified by a latest delivery time after which backlog costs are incurred and an earliest delivery time before which the manufacturer does not accept deliveries. We analyze the performance of the supply chain and show how the time window selection can act as a coordination mechanism.

3 : Batch Production Policies for an Inventory System with Advance Customer Ordering. Lynette Frick, University of Exeter; Hill, Roger; Smith, David.

We consider a batch manufacturing process where customers give advance notice of their requirements. We know at the beginning of a week the total orders that must be dispatched to customers during that week. In addition some of the orders for future weeks have already been placed. When we do not have enough stock in hand to satisfy orders for the coming week we need to manufacture a new batch. The batch size depends on the known orders for the coming week as well as the known and unknown orders for future weeks.

4 : Bounds, Heuristics and Approximations for Distribution Systems. Ozalp Ozer, Stanford University; Gallego, Guillermo; Zipkin, Paul.

We develop simple approximation methods to analyze a two-level distribution system facing random demands. We provide extensions of these results to more complex distribution structures. These results provide insights into stock positing issues, drivers of systems performance and the value of centralization.

: MD08 **GDN Keynote Session (Opening) - I**

Invited Session Room: M32

Chair: Marc Kilgour
Wilfrid Laurier University

1 : The Science and Engineering of E-negotiation: Review of the Emerging Field. Gregory Kersten, University of Ottawa.

Negotiations are increasingly conducted over the internet, with support systems based on both quantitative and qualitative models. Traditionally, negotiation support was normative and prescriptive, for use by analysts and experts. But recently

developed e-negotiation systems adopt a software engineering orientation, aiming to satisfy negotiators' requirements rather than direct their activities based on principles of rationality and optimality. E-negotiation design specifications are usually based on descriptive approaches, with no prescriptive component. After a review of negotiation and e-negotiation research and scientific and engineering perspectives, this paper proposes an e-negotiation model that integrates behavioural, scientific and engineering views on e-negotiation support.

2 : Use of DSS Methodology for Distributed Decision Making. Pascale Zaraté, Institut de Recherche en Informatique de Toulouse; Soubie, Jean-Luc.

The aim of this communication is to present a methodology of DSS use for the particular case of Distributed Decision Making. This work is based on a multicriteria approach where each decision maker is seen as a criterion. A methodology is proposed in order to take into account every decision makers. The aggregations of the preferences are run with a multicriteria methodology.

3 : Going from Theory to Practice: The Mixed Success of Approval Voting. Steven J. Brams, New York University.

Beginning in the late 1980s, several scientific and engineering societies now comprise about 600,000 members, adopted approval voting. Their successful experience is discussed, based in part on analyses made of ballot data. Approval voting's failure to be adopted in public elections seems to stem from a lack of "insider" support.

: MD09 **Customer Relationship Management - I**

Invited Session Room: L15

Chair: Eitan Gerstner
University of California at Davis

1 : What is the True Value of a Lost Customer? Barak Libai, Tel Aviv University; Hogan, John; Lemon, Katherine.

This study suggests that conventional customer profitability models may be inappropriate for markets involving new products or services because they fail to account for the social effects (e.g., word-of-mouth) that can influence future customer acquisitions. Using Monte-Carlo simulations and empirical data from the online banking industry, it is shown that the indirect financial impact of disadoptions can be substantial. The results demonstrate how the value of a lost customer changes throughout the product lifecycle and demonstrate how firms suffer financial losses not only when their own customers disadopt a new product, but also when their competitors' customers disadopt.

2 : Automation of Customer Complaint Management System. Prasad Naik, University of California; Raman, Kalyan.

Complaint management plays an important role in acquiring and retaining new customers. However, customer complaints are made in natural languages (e.g., English). The richness of a natural language leads to high-dimensional textual data. In addition, natural languages are inherently ambiguous. Consequently, an automated system for managing complaints needs to analyze textual information and handle linguistic ambiguity. To accomplish both these goals, we develop an approach that not only reduces high-dimensional textual data to a few factors, but also incorporates desired constraints to extract unambiguous factors. Preliminary findings based on Monte Carlo studies are encouraging.

3 : The Economics of Service Upgrades. Eyal Biyalogorsky, UC-Davis; Gerstner, Eitan.

Service providers sell, in advance, upgradeable tickets that entitle the holder to an upgrade if space becomes available. Upgradeable tickets increase profits if the probability of obtaining full price is high. With upgradeable tickets more capacity is reserved for high paying customers and social welfare may decrease.

4 : Coop Advertising Programs under Competitive Market Structures. Salma Karray, HEC Montréal; Zaccour, Georges.

We examine whether cooperative advertising programs are an effective tool to coordinate competitive channels. Previous studies showed that such coop advertising increases channel's profit in bilateral monopolies. However, no evidence has been provided for competitive channels. We consider a channel formed of two manufacturers and two retailers and propose a model that accounts for brand and store competition. Efficiency is investigated by comparing Nash equilibria of two non-cooperative games (with and without coop program). We show that when brand and spatial competition is introduced, efficiency of coop program is no more guaranteed for players. However, such program is always beneficial for consumers.

: MD10 **Rework Issues in Closed-Loop Supply Chains**

Invited Session Room: L19

Chair: Simme Douwe Flapper
Technische Universiteit Eindhoven

1 : Optimal Lotsizing in Rework Systems with Deteriorating Reworkables. Karl Inderfurth, University of Magdeburg; Lindner, Gerd; Rahaniotis, Nikolaos.

Manufacturing new and recovering defective products often takes place in lotwise production on a common facility. Consequently, there is a necessity to coordinate the production and rework activities with respect to lotsizing and timing of operations. Thereby, it has to be taken into account whether the state of defective items worsens by deterioration while awaiting rework (resulting in increasing rework times and costs) or not. EPQ models are presented which address all of these aspects. Considering set-up and inventory holding costs as well as set-up times, optimisation algorithms are developed covering planning situations without and with production bottlenecks.

2 : Rework and Postponement: A Comparison of Bottling Strategies. Simme Douwe Flapper, Technische Universiteit Eindhoven; Teunter, Ruud.

The problem considered is that of finding the best bottling strategy for produced batches in situations with uncertain quality and test requiring much time. A batch can be bottled directly after production, after positive intermediate test results, or after positive final test results. However, a production batch can only be reworked as long as it has not been bottled. Per-

formance measures are presented for comparing the different strategies and closed form expressions are derived for them. The results obtained for the considered case are presented and topics for further research indicated.

3 : Lot Scheduling in Disassembly Processes. Pär Brander, Luleå University of Technology; Sommer-Dittrich, Thomas.

Due to environmental and legislative reasons, the importance of recycling is steadily increasing. Ecologically harmless recycling of used technical products will become mandatory for their producers. New recycling policies focus on closed loops, where used products are disassembled and recycled. Therefore, disassembly is an important operation when recycling technical products. In a collaborative research centre in Germany, prototypical disassembly facilities are designed by systematic research of disassembly processes. In the context of this research project, lot scheduling in disassembly-processes is investigated. This paper presents heuristic scheduling policies to use for the disassembly of different products.

4 : Profit Maximization in Partial Disassembly Line Balancing. F. Tevhide Altekin, METU; Özdemirel, Nur Evin; Kandiller, Levent.

In this study we deal with the disassembly line balancing problem (DLBP). We consider a single product subject to a variety of precedence relations involving AND and OR restrictions. We assume that part revenues and demands, task times and costs, and station opening costs are given. We try to find a feasible assignment of disassembly tasks to workstations such that the profit is maximized under partial disassembly. Two DLBP formulations are proposed where the first one maximizes the profit per disassembled product and the second one over the whole planning horizon. Proposed formulations and the computational results are discussed.

: MD11 **Theoretical Issues in DEA - I**

Invited Session Room: R20

Chair: Victor Podinovski
University of Warwick

1 : Is the VRS Model in DEA Useful? Gautam Appa, London School of Economics; Bana e Costa, Carlos.

We look at some philosophical, theoretical and practical problems with the VRS model in DEA. First we show that it fails to compare DMUs of similar size. It is demonstrated that the model has little to do with measuring variable returns to scale. In practical applications it always declares DMUs with largest absolute value of an output or the smallest input value of an input efficient, giving very strange results. Ideas for overcoming these problems are discussed.

2 : A Necessary and Sufficient Condition for Weight Restrictions Preserving the Radial Nature of Efficiency Measures. Victor Podinovski, University of Warwick.

In DEA, the efficiency measures in the presence of weight restrictions are generally not radial, which invalidates the traditional interpretation of efficiency as a radial improvement factor. The purpose of this paper is two-fold. Firstly, it shows that, if the weight restrictions reflect existing trade-offs between inputs and outputs, then the efficiency measures remain radial. Secondly, it shows that the trade-off approach to the assessment of weight restrictions is the only one, which is consistent with the radial measures. This is a pure mathematical fact, valid under both constant and variable returns-to-scale assumptions. A simple example illustrates the method.

3 : Effectiveness of DEA for Robust Design. Cengiz Haksever, Rider University.

Traditional methods for selecting parameters for robust product design are limited to optimizing a single response variable. However, most product design projects aim at optimizing multiple responses. Statisticians and quality experts have developed various approaches to the optimization of multiple responses. Most of these approaches try to achieve their goal by combining multiple responses into a single function. This paper will present some ideas and examples of how data envelopment analysis can be used for the optimization of multiple responses in designing robust products.

4 : Construction of Three-Dimensional Cross-Sections in DEA and Productivity Analysis of Russian Banks. Vladimir Krivonozhko, Institute for Systems Analysis of Russian Academy of Sciences; Utkin, Oleg B.; Volodin, Andrei V.

In this work we develop methods for construction of three-dimensional cross-sections of the frontier in DEA. These methods allow us to visualize the DEA modeling results and to investigate the behavior of production units globally. This approach is based on the family of the parametric optimization algorithms proposed by the authors. Using this approach we construct facets of the frontier successively. Thus, we can avoid exponential computational complexity under construction of the frontier. The proposed methods are applied to the analysis of the Russian banks.

: MD12 **Telecommunications Network Design**

Invited Session Room: M39

Chair: Roberto Tadei
Politecnico di Torino

1 : A Branch and Cut Algorithm for the Quadratic Capacitated Hub Location Problem with Single Assignment. Martine Labbé, Université Libre de Bruxelles; Yaman, Hande.

We consider the concentrator location problem in telecommunication networks which consists in choosing a subset of nodes to install concentrators and to assign the remaining nodes to concentrators. Each node that does not receive a concentrator must be assigned to a single concentrator. The concentrators have fixed capacities concerning the traffic traversing them. A complete backbone network connects all the concentrators. The aim is to minimize the sum of the cost for installing concentrators, assigning other nodes and routing the traffic in the backbone network. We present a branch and cut algorithm to solve this problem.

2 : Network Reinforcement. Francisco Barahona, IBM Research.

We study the following problem: given a graph G=(V,E) with edge-weights and a nonnegative integer k, find a minimum cost

set of edges that contains k disjoint spanning trees. This also solves the following reinforcement problem: given a network, a number k and a set of candidate edges, each of them with an associated cost, find a minimum cost set of candidate edges to be added to the network so it contains k disjoint spanning trees. We show that this can be solved with |V| applications of the minimum cut algorithm of Goldberg & Tarjan.

3 : Network Design Issues for the Next Generation Internet. Brunilde Sansò, École Polytechnique de Montréal; Degila, Jules.

Given the increasing demand for services and the high bandwidth consuming applications that are expected for the future Internet, new high capacity strategic architectures have been proposed, based on agile photonic technology. One proposal is the Yottaweb, that yields a global capacity of Yotta (10^24) bits/ sec. A fundamental question is how to address the design of such a network so that it can gracefully expand, and how to facilitate the network management. In this talk, we provide an overview of the design problems involved, and we discuss a particular architecture and a powerful resolution approach .

4 : Optimizing Network Topology with Reliability and Routing Constraints. Roberto Tadei, Politecnico di Torino; De Giovanni, Luigi; Della Croce, Federico.

Given a set of nodes and a set of traffic demands, we want to define the minimum cost network topology such that all traffic is routed. In the IP-like networks, the traffic must be routed on the shortest path and split on different equivalent minimum paths. A constraint on the maximum number of arcs in a path may be added. The network must be robust: in case of single node fault, a subset of the traffic demand must be re-routed on the survived network. We use a Tabu search approach with an enhanced IP-routing procedure.

: MD13 **Pricing and Auctions**

Invited Session Room: R21

Chair: Yalçın Akçay
Koç University

1 : Optimal Auctioning and Ordering in an Infinite Horizon Inventory-Pricing System. Gustavo Vulcano, New York University; van Ryzin, Garret.

We consider a joint inventory-pricing problem in which buyers act strategically and bid for units over an infinite horizon. The firm must decide how to conduct its auctions and how to replenish its stock over time to maximize its profits. We show that the optimal auction and replenishment policy for this problem is quite simple, consisting of running a standard first-price or second-price auction with a fixed reserve price in each period and using an order-up-to (base stock) policy for replenishing inventory. Numerical comparisons with list pricing are presented.

2 : Bidding in Combinatorial Auctions. Wedad Elmaghraby, Georgia Institute of Technology; Keskinocak, Pinar; An, Na.

Participating in combinatorial auctions can pose a huge computational burden on bidders. In this paper, we explore methods for bidders to exploit the underlying synergy structure of their valuations so as to generate bids in a computationally efficient manner. We then test the performance of these bidding strategies.

3 : Sequential Pricing with Uncertain Demand: Computationally Tractable Approximations. Miguel Sousa Lobo, Duke University.

Models and policies for dynamic pricing are presented and compared. Of particular interest are active learning policies in a Bayesian setting, and the tradeoff between exploitation and experimentation. We discuss computational strategies and approximations, qualitative results obtained from such approximations, and some issues relating to practical applicability. Special consideration is given to problems with continuous variable decisions over a finite number of time periods.

4 : Style Goods Pricing with Learning. Alper Sen, Bilkent University.

We model periodic pricing of seasonal goods with systematic learning about the demand. A Bayesian learning mechanism is used. Some structural properties are developed. A computational study is performed to analyze the impact of initial demand uncertainty, price sensitivity of demand and initial inventory. A pure pricing model is compared with a model where replenishment within the season is possible. The comparison is used to gain insight to the penetration ratios of imports to different segments in the U.S. apparel industry.

: MD14 **Mobile Communications**

Invited Session Room: R22

Chair: Ali Amiri
Oklahoma State University

1 : The Bandwidth Scheduling Problem. Ali Amiri, Oklahoma State University.

We consider the bandwidth scheduling problem with time windows that consists of selecting and scheduling calls from a list of available calls to be routed on a bandwidth-capacitated telecommunication network in order to maximize profit. Each accepted call should be routed within a permissible scheduling time window for a required duration. To author's knowledge, this study represents the first work on bandwidth scheduling with time windows. We present an integer programming formulation of the problem. We also propose a heuristic solution procedure based on the well-established Lagrangean relaxation technique and report computational results.

2 : Heavy Traffic Limits of a Packet Generation Model in Telecommunications. Mine Çağlar, Koç University.

We consider a probabilistic model that captures the dynamics of packet generation in data traffic as well as accounting for long-range dependence and self-similarity exhibited by real traces in a telecommunication system. The workload is found by aggregating the size of packets generated by the arriving sessions. The arrival time, the duration and the packet generation process of a session are all governed by a Poisson random measure. We prove that the workload process can be approximated by either a fractional Brownian motion or a Levy process depending on the nature of the heavy traffic limit.

3 : How Individuals' Differences Affect Beliefs Leading to

the Use of Mobile Phone Services: An Empirical Study of the Influence of Individuals' Differences. Onur Yaprak, Clemson University; Thatcher, Jason Bennett.

Mobile phone services provide many services to their customers. Some of these services are used commonly; however some are not used by many customers. To better understand how individual differences influence the use of mobile phone services, this study models and tests the relationship among the individual's self-efficacy (Individuals' judgment of their capabilities to use different technologies), individuals' technology acceptance, usefulness and ease of use, trust in technology and vendor, price & access to service, and use of different mobile services.

: MD15 ✓ **Rich Vehicle Routing Problems - I**

Invited Session Room: R23

Chair: Geir Hasle
SINTEF Applied Mathematics

1 : The Synchronized Vehicle Dispatching Problem. Michel Gendreau, Université de Montréal; Rousseau, Louis-Martin; Pesant, Gilles.

This paper addresses a particular class of the Real Time Vehicle Dispatching Problem where there is need to service some customers with multiple resources subject to synchronization constraints. Real world applications are presented and flexible solution methods, based on Constraint Programming, are proposed. In order to facilitate future comparisons, benchmark problems are derived from well-known vehicle routing benchmark problems and a transformation method is detailed. Results on these problems show that solutions are sensitive to the number synchronization constraints as well as the request arrival rate.

2 : Dynamic Planning of Pickup and Delivery Operations by means of Genetic Algorithms. Giselher Pankratz, FernUniversität/University of Hagen.

The Dynamic Pickup and Delivery Problem with Time Windows (DPDPTW) is a dynamic generalization of the well studied Vehicle Routing Problem with Time Windows (VRPTW). This contribution proposes a Genetic Algorithm based approach for solving the DPDPTW. At the basic level, a Grouping Genetic Algorithm (GGA) is employed in order to solve the static PDPTW. The GGA is embedded in a dynamic planning environment featuring special synchronization and updating mechanisms. The solution approach is evaluated using a suite of DPDPTW instances with varying dynamic properties. The results obtained seem to justify the proposed dynamic approach.

3 : A Construction Heuristic for Rich VRPs. Geir Hasle, SINTEF Applied Mathematics; Bräysy, Olli; Dahl, Tore; Kloster, Oddvar; Riise, Atle; Smedsrud, Morten.

Classical route construction heuristics, e.g., those of Solomon and Clarke and Wright, were originally designed for rather idealized VRPs. Whereas several extensions of classical constructors to accommodate richer models are straightforward, this is not always the case. A rich VRP model with several types of orders, an inhomogeneous fleet, multiple time windows, alternative order locations, and objectives involving fleet size and mix, calls for novel approaches to route construction. We have designed and investigated a new construction heuristic that performs and scales well across a large variety of rich VRPs.

4 : A Hybrid Heuristic for the Vehicle Routing Problem with Time Windows. Ekim Özaydın, Sabancı University; Ünlüyurt, Tonguç.

In this study, a hybrid heuristic algorithm for the Capacitated Vehicle Routing Problem with Time Windows (VRPTW) where the objective is to minimize the total distance traveled. Vehicles are identical and time window constraints are assumed to be strict. First part of the algorithm finds a "good" initial solution. Second part is a hybrid improvement heuristic which is a combination of three procedures: Inter-route exchange and moves, intra-route exchanges and diversification for escaping local optima. The algorithm has been tested on 56 benchmark problems of Solomon. The proposed algorithm produces competitive results compared with the results in the literature.

: MD16 **Integer Programming - C1**

Contributed Session Room: R27

Chair: Cristian Oliva
Université d'Avignon et des Pays de Vaucluse

1 : Cross Decomposition: Mechanism, Applications, and Problems. Nezih Altay, University of Richmond; Robinson, Powell; Bretthauer, Kurt.

Cross decomposition seems to have tremendous potential in mixed integer and nonlinear programming. It combines the advantages of Lagrangean and Benders decomposition methods in one approach. However, the algorithm has advantages and disadvantages. We discuss some of these issues in the context of a coordinated replenishment lot sizing application.

2 : Exploiting Surrogate Constraint Analysis for Fixing Variables in Both Bounds for MKD Problems. Maria Osorio-Lama, Autonomous University of Puebla.

The Osorio et al. exploiting of surrogate constraints and constraint pairing is strengthened to give better results in MKD problems, by excluding simple bounding constraints as component constraints. The surrogate constraint is obtained by weighting the original problem constraints by their associated dual values in the LP relaxation of the problem. This surrogate constraint is paired with the objective function to obtain a combined constraint where negative variables are replaced by complemented variables and the resulting constraint used to fix variables to zero or one.

3 : A Comparison of Lower Bounds for the Capacitated Lot Sizing Problem. Raf Jans, Erasmus University Rotterdam; Degraeve, Zeger.

We compare several decompositions for the capacitated lot sizing problem with set up times. The problem can be decomposed either per item or per period. Further we can apply the decompositions to the original formulation or the network reformulation. The bounds can be computed by Dantzig-Wolfe decomposition and Lagrange relaxation. The relationships between these different bounds are discussed. Further, computational results are presented. A comparison is made with other lower bounds from the literature.

4 : A Hybrid Approach for Solving the Frequency Assignment Problem. Cristian Oliva, Université d'Avignon et des Pays de Vaucluse; Artigues, Christian; Michelon, Philippe.

In this talk we deal with the Minimun Span and Minimun Interference for the Frequency Assignment Problem. Our model takes into account three types of constraints : First, classical constraints, where each pair of interfering links is associated with a minimun separation between the assigned frequencies to ensure that communication is not distorted. Second, hard constraints where the frequencies assigned for a pair of links must differ by a given distance. Third, cumulative constraints, where several links may disturb another link. We present a hybrid Constraint / Linear Programming approach for solving these problems. The preliminary results are encouraging.

: MD17 **Metamodels in Simulation**

Invited Session Room: R24

Chair: Jack Kleijnen
Tilburg University

1 : Application-Driven Sequential Designs for Simulation Experiments. Wim van Beers, Tilburg University; Kleijnen, Jack.

We propose a novel method for selecting an experimental design for interpolation in simulation. Though we focus on Kriging metamodels for deterministic simulation, our method also applies to other types of metamodels and to stochastic simulation. We concentrate on simulations that require much computer time, so it is important to select a small design. Our method is therefore sequential. The novelty of our method is that it accounts for the specific simulation model; i.e., our method is application-driven. This customization is achieved through cross-validation and jackknifing. Three academic applications demonstrate that our method gives better results than a single-stage design.

2 : Robust Estimation in Simulation Metamodeling. İnci Batmaz, METU.

Regression metamodels have long been used in simulation to evaluate the performance of complex systems. To estimate regression metamodels generally the ordinary least squares method is used. Obtaining valid results from this method, however, depends on satisfying some assumptions, which include normal error distribution. When normality assumption is violated, we often transform the response variable. Unfortunately, all non-normal data can not be responsive to normalizing transformation. Besides, it is usually difficult to interpret transformations. Therefore, in this study, we adopt the method of modified likelihood which produces efficient and robust estimators for a regression metamodel.

3 : Robust Simulation with an Expected Environment. Henri Pierreval, IFMA; Durieux, Séverine.

Often, the comparison of design solutions using simulation is performed with fixed environmental conditions. In practice, unexpected changes can occur. A solution S1, better than S2 on a given environment, can yield poorer performance than S2 on others. Thus, robust approaches consider several environments. We focus on problems where a distinction needs to be made between the environment that is expected and the others. The robustness of a solution is evaluated according to the performance it would save or loose in the case of unexpected environments. Referee curves allow solutions to be compared in accordance with the decision-makers' requirements.

: MD18 **Location Models under Uncertainty**

Invited Session Room: R25

Chair: Mark Daskin
Northwestern University

1 : A Facility Location Problem to Expedite Disaster Relief: A Case Study in Turkey. Esma Gel, Arizona State University; Smith, Cole; Ozel, Filiz.

Consider a set of possible disasters, each of which destroys certain passageways and renders areas in need of emergency supplies. We determine the optimal placement of relief facilitites in order to minimize the expected disaster relief time. Our methodology is illustrated using real economic and fault line analysis in Turkey.

2 : Socially Optimal Location of Facilities with Fixed Servers, Stochastic Demand, and Congestion. Armann Ingolfsson, University of Alberta; Castillo, Ignacio; Sim, Thaddeus.

We present two capacity choice scenarios for the "socially optimal" location of facilities with fixed servers, stochastic demand, and congestion. Choice of locations for such facilities influences not only travel distances but also user waiting times for users. In contrast to most previous research, we include both travel and delay costs in the objective function and solve the location-allocation and capacity choice problems simultaneously. In queueing terminology, facility capacity could mean the service rate (scenario 1) or the number of servers (scenario 2). We express the optimal capacity for both scenarios in closed form, leading to tractable mixed-integer nonlinear programs.

3 : Selection and Sizing of Congested Connections for a Transportation Network. Rajan Batta, SUNY at Buffalo; Huang, Simin; Nagi, Rakesh.

This paper focuses on a transportation network in which flow must go through connections that are subject to congestion. Connections serve as transshipment and/or switching points and are modeled as M/G/1 queues. The goal is to select connections, assign flows to the connections, and size their capacities, simultaneously. Mathematical programming formulations are presented for both the fixed and variable service rate cases. Heuristic solution approaches are developed and computational results are reported.

4 : The Reliability P-Median Problem. Mark Daskin, Northwestern University; Snyder, Lawrence.

This paper extends the classical P-median problem to account for unreliable facilities. The motivation for the problem is discussed and two different formulations are presented. An optimal solution algorithm is outlined for one of the formulations and preliminary computational results are provided.

: MD19 Simulation Models in Health Care

Invited Session Room: R26

Chair: Kevin Leonard
University of Toronto

1 : Database Modelling in Storing and Analysing Output Data From Health Simulation Models. Christos Vasilakis, University of Westminster; El-Darzi, Elia; Chountas, Panos.

Discrete event simulation modelling has been extensively used in modelling healthcare systems. Although it offers great flexibility in modelling real life systems, it is well documented that simulation modelling is not only computationally expensive but also data intensive. Previously developed models for evaluating patient flow through hospital departments generate millions of observations to achieve satisfactory point and confidence interval estimations for the model variables. It is exceptionally cumbersome to conduct the required output and sensitivity analysis in a spreadsheet-based environment. In this paper, we will highlight the advantages of employing data warehousing techniques in terms of output and sensitivity analysis.

2 : Using an ILP Model in a Simulation Decision Support System. Martha A. Centeno, Florida International University; Ismail, Abdullah.

Healthcare facilities have been under medical pressure to control cost: One element that affects cost significantly is staff. We present a heuristic for Emergency Departments staff scheduling. It integrates a simulation model and an integer linear program (ILP). The simulation model established the staffing requirements for each period, and the ILP produces a calendar schedule for the staff. The two models are fully integrated, under a Visual Basic interface that allows a non expert user of the heuristic to interact with it on a repetitive planning basis.

3 : Matching Workforce Resources to Patient Need. Paul Harper, University of Southampton; Powell, Naomi.

Recent UK Department of Health reports have concluded that health authorities and hospitals are utilising rudimentary and inaccurate approaches to plan their workforce needs. Research to date has linked workforce to patients through simple calculations, such as nurses per occupied bed. In this paper we discuss collaborative work with the Workforce Development Confederation and NHS Trusts in building a comprehensive simulation model to capture nurse, doctor and support service resources by matching them to patient case-mix through an acuity-dependency approach. We discuss the findings so far.

4 : Involvement in the Development of Information Systems: The Case of Applying Simulation Techniques to Design a Patient Interface. Kevin Leonard, University of Toronto.

The Electronic Patient Record (EPR) has grown significantly in usage over the last decade. However, issues pertaining to database structure, data capture consistency, network communications and security have dampened the enthusiasm for more widespread application. The objective of this research was to document patient needs and preferences pertaining to the design and layout of an electronic patient record by allowing patients to exercise their input through a simulated patient environment. Based on our findings and incorporating literature from other areas of computer systems design, we identify the critical success factors pertaining to electronic patient record development and implementation.

: MD20 Discrete and Continuous Non-Convex Optimization

Invited Session Room: M35

Chair: Alper Atamtürk
University of California at Berkeley

1 : An Active-Set Algorithm for Mathematical Programs with Eqilibrium Constraints and for Bilevel Programs. Isabel Ribeiro, Universidade do Porto; Júdice, Joaquim; Sherali, Hanif.

An active-set algorithm is described for finding a stationary point of a Mathematical Program with Equilibrium Constraints (MPEC) when the set of constraints constitutes a General Linear Complementarity Problem (GLCP). Finding stationary points for bilevel programs is a special case of this approach. Global convergence and implementation issues are discussed.

2 : Enhanced Optimality Conditions and Informative Multipliers for Convex Programming. Asuman Ozdaglar, Massachusetts Institute of Technology; Bertsekas, Dimitri; Tseng, Paul.

In this talk, we focus on convex constrained optimization problems and present enhanced Fritz John type optimality conditions without assuming the existence of a primal optimal solution. Under general conditions, we show the existence of informative multipliers that carry sensitivity information by indicating the constraints to relax to affect a cost reduction. We also present enhanced optimality conditions for the dual optimization problem and investigate existence of informative dual optimal solutions. This work is part of the new book "Convex Analysis and Optimization" by D. Bertsekas, with A. Nedic, and A. Ozdaglar, published in April 2003.

3 : Facets of the Inventory-Capacitated Lot-Sizing Problem. Alper Atamtürk, University of California at Berkeley; Küçükyavuz, Simge.

Strong inequalities known for lot-sizing problems are weak in the presence of inventory capacities. In this talk, we address how to find strong inequalities for inventory-capacitated lot-sizing problems and give a summary of computational experiments with a cutting plane algorithm.

: MD21 Lot Sizing and Scheduling

Invited Session Room: M36

Chair: Heinrich Kuhn
Catholic University of Eichstaett-Ingolstadt

1 : Loss of Customer Goodwill in the Single Item Lot-Sizing Problem with Immediate Lost Sales. Deniz Aksen, Koç University; Altınkemer, Kemal.

We consider a single-item deterministic lot-sizing problem with finite planning horizon, where unsatisfied demand is immediately lost. Demand cannot be backlogged, but it doesn't have to be satisfied, either. Lost demand incurs a cost at the rate of marginal profit. The objective is to maximize total profit resulting from the procurement and sales of goods. Different

than other models with lost sales, we assume whenever demand in a given period is lost, a certain ratio of that lost demand is deducted from the next period's demand. An exhaustive search-and-restoration method is proposed to solve this problem in quadratic time.

2 : A New Procedure for the Parallel Machine Capacitated Lot-Sizing and Scheduling Problem. Daniel Quadt, Catholic University of Eichstaett-Ingolstadt; Kuhn, Heinrich.

We present a new solution procedure for the single-stage, multi-product capacitated parallel machine lot-sizing and scheduling problem with back-orders, setup times and setup carry-over. A new mixed integer model formulation constitutes the core of the procedure. The model contains only a single machine explicitly. It accounts for the parallel resources implicitly by using fixed-step setup costs occurring whenever a parallel machine has to be set up for a product, avoiding the symmetry problem of traditional parallel machine lot-sizing models. The procedure is a period-by-period heuristic that solves an instance of the new model in each iteration. Computational results are illustrated.

3 : A Partially Observable Process: An Optimal Lot Sizing and Off-Line Inspection. Shoshana Anily, Tel Aviv University; Grosfeld-Nir, Abraham.

A batch production process that is initially in-control state can get out-of-control with a constant failure-rate. The success probability of a unit produced while the process is in-control is constant and higher than while the process is out-of-control. After production, units are inspected in the order they were produced. The objective is to design a minimum expected total cost production and inspection policies that guarantee a zero defective delivery. The inspection problem is formulated as a Partially Observable Markov Decision Process. The optimal policy is of the Control-Limit-Threshold (CLT) type. Structural properties satisfied by the various CLT values are presented.

4 : Economic Lot Scheduling with Random Co-Product Rates. Selma Öner, Boğaziçi University; Bilgiç, Taner.

In this paper, we introduce co-product randomness to the asymmetric model with two products. The co-product rate has a probability distribution. The demand is deterministic, the policy is asymmetric, that is, during the production of product A, product B can be produced as co-production whereas during the production of product B, product A can not be produced as co-production. We develop the expected cost function of the model. The cost function is quite complex, it is not possible to obtain closed-form solutions even for two products. Thus, we propose a way to approximate the expected cost function.

: MD22 **Additional Objectives and Constraints in C&P**

Invited Session Room: M37

Chair: Horacio Yanasse
INPE

1 : Enforcing Minimum Runlength in the Trim Loss Problem. Adolf Diegel, Cutline Research; Miller, Garth.

The trim loss, cutting stock or deckling problem arises when short units are to be cut from long ones. The main aim is to fill demand with a minimum of integer stock units. One prefers plans with few setups and long runs. We examine the feasibility and the economics of making the shortest run longer. We show that a formal constraint cannot formally enforce long runs, yet can help to prove that they add at least one stock unit to an otherwise optimal plan. In turn, a relaxed stock constraint may improve runs as well as setups and surplus.

2 : Integrating Cutting and Inventory Planning: an Optimization Model. Claudio Arbib, University of L'Aquila; Marinelli, Fabrizio.

We consider a real cutting process with skiving option, i.e., with the possibility of recombining items to obtain required parts. Our purpose is showing how one can benefit from inventory control by integrating planning issues with process details. The integration is provided through an integer programming model aiming to minimize production, holding and transportation costs. The result of a computational test is described, and the model performance is discussed.

3 : Minimizing the Number of Different Cutting Patterns - A Minimum Path Approach. Maria Cristina Nogueira Gramani, Mackenzie University - School of Engineering.

In this paper we consider the one dimensional cutting stock problem minimizing the number of different cutting patterns. We propose a new resolution method consisting in the representation of the problem in a graph, where the nodes denote the items demanded and the arcs represent the number of different cutting patterns to be processed. After the construction of this graph, it only remains to solve a minimum path problem.

4 : A New Proposal for Solving the Minimization of the Maximum Number of Open Stacks Problem. Horacio Yanasse, INPE; Pinto, Maria José.

In this work we analyze a new formulation for the minimization of the maximum number of open stacks problem (MOSP), based on a recent network flow formulation of the minimization of tool switches problem. A branch and cut algorithm is proposed and some computational results are presented.

: MD23 **Financial Modelling**

Invited Session Room: M38

Chair: Jaap Spronk
Erasmus University Rotterdam

1 : Overfitting Control in Genetic Programming for Financial Applications. Paolo Falbo, Università di Brescia; Ceccarossi, Guido.

Recent financial studies on speculative trading rules have somehow dealt with overfitting. Solutions have varied from introduction of a selection period, between the training and the out-of-sample, to composing a portfolio of rules to be tested out-of-sample. However these represent partial solutions. A detailed analysis of the problem and a specific method to control it is required to validate results. In this work a method is proposed to optimally set genetic program parameters, to minimize the overfitting problem. Next to traditional parameters (i.e. tree depth, maximum iterations number, etc.), training and out-of-sample periods are generalised as sets of sub-samples.

2 : Some New Properties of Risk Measures. Salvatore Greco, Università degli Studi di Catania; Matarazzo, Benedetto; Platania, Pietro; Bonaccorso, Luca.

Recently, a large interest in the axiomatic definition of risk measures arose. Coherent risk measures were the first class of risk measures to be proposed in this context; they are characterized by the four axioms: monotonicity, positive homogeneity, translation invariance and subadditivity. In this paper we propose some new properties, called conservatism (a risk measure should depend only on the losses of an investment) and robustness (characterised by peculiar axioms, quite different from those of coherent risk measures). We give also the financial interpretations of all the axioms considered and we discuss their specific relations with the Sugeno integral.

3 : The Pretension Index in Portfolio Management. Jaap Spronk, Erasmus University Rotterdam; Matarazzo, Benedetto; Greco, Salvatore.

Usually in portfolio analysis synthetic information is used, for example, expected return and variance. This kind of information tells nothing about the composition of the considered portfolio: what kind of assets (stocks, bonds,...) are held in what proportions. Such information is crucial in characterizing. In this presentation we introduce a pretension index (or index of pretentious information), describing the composition of a portfolio as a consequence of the belief of investor in using his good information. We discuss axiomatic foundation of the index. Moreover we propose efficient frontiers describing portfolios in terms of expected return, risk and pretension.

4 : Evaluating Utility and Risk within Italian Financial Market. Damiano Rossello, Università degli Studi di Catania; Angilella, Silvia; Greco, Salvatore; Matarazzo, Benedetto.

Historically, the Italian households' portfolios composition has been influenced by the fact that the high interest rates of the government bonds made stocks unattractive. In the last decade an inversion in this trend has been observed by economists and financial analysts. We are interested in analyzing whether this fact can be quantitatively justified on the basis of a utility model. In particular, we want to compare the classical expected utility model to the Cumulative Prospect Theory. Using simulation, we will show that CPT can explain the shift of the Italian households towards risky assets.

: MD24 **DSS Applications - C1**

Contributed Session Room: L17

Chair: Byoung Chan Lee
Keimyung University

1 : Development of a Web-based Decision Support Model for Business Process Reengineering in a Health-Care System. N. K. Kwak, St. Louis University; Lee, Chang W.

In this paper, an attempt is made to develop a web-based decision support model for designing, evaluating, and implementing a strategic plan for business process reengineering (BPR) based on the data obtained from a health-care organization in Korea. A multicriteria decision model is developed and analyzed to simulate real business settings. Goal criteria and priorities are identified and established using the analytic hierarchy process. The model results are evaluated and sensitivity analyses are performed to enhance the model applicability. The decision support model provides administrators valuable information for planning and controlling health-care activities and services.

2 : Strategic Supply Chain Management with Customer Relationship in e-Business Industry. H.K. Shin, Kumoh National Institute of Technology; Jung, Choong Yung; Lee, Byoung Chan; Song, Jae Kee; Lee, Chang W.

Supply chain management (SCM) and customer relationship management (CRM) has recently received a great deal of attention due to the strategic importance of e-business industry. This study presents a case that considers several alternatives to expand existing or to construct new customer relationship. MCDM utilizes to resolve this strategic matter. The satisfying solution to maintain effective SCM-CRM is identified and discussed. The case compares the satisfying system with the current system.

3 : New Approach to Solving Possibilistic Programming. Byoung Chan Lee, Keimyung University; Jung, Choong Yung; Song, Jae Kee; Shin, H.K.; Lee, Chang W.; Yoon, Sang Hyun.

A possibilistic programming is a new approach to solve multicriteria decision making models where strategic factor for the operations of both traditional and e-business environments are important. This paper presents a case study that considers some business scenarios. In order to solve the strategic decision making problems about uncertain business environments, a possibilistic programming model using alpha cut and non membership method is developed to solve the current business situation. The problem is solved using a mathematical approach, based on the data obtained from Korea. The solution is identified and analyzed, and sensitivity analyses are performed for model flexibility.

: MD25 **Environmental and Ecological Applications**

Invited Session Room: M34

Chair: Ali Kerem Saysel
University of Bergen

1 : Model Minimization: From Case Specific to Generally Applicable Models. Ali Kerem Saysel, University of Bergen.

One of the long reaching objectives of system dynamics has been to build generally applicable models, which represent a wider class of problems occurring in a specific application domain, i.e. market growth, economic development and others. If meaningful generally applicable models can be isolated and understood, they can form a body of systems theory, which can be transferred from situation to situation. In this paper, we present a minimized version of a dynamic model originally built for long-term comprehensive environmental analysis of an irrigation scheme - GAP. The purpose is to show the general applicability of the minimized version.

2 : The Impact of Environmental Issues on Reverse Logistics Capacity Planning. Patroklos Georgiadis, Aristoteles University of Thessaloniki; Vlachos, Dimitrios.

Economical and environmental issues are the main driving forces for the development of reverse logistics networks. This

paper examines the impact of environmental issues on capacity planning strategies for the reverse channel. The environmental issues examined are the state campaigns for proper disposal of used products, the take back obligation imposed by legislation and the firm's 'green image' effect on customer demand. The behaviour of the system is analyzed through a dynamic simulation model based on the principles of the System Dynamics methodology, which is used to evaluate the effect of environmental issues on long-term decision making.

3 : Modeling the Differences and Conflicts between North and South in the Context of Global Sustainability. Gönenç Yücel, Boğaziçi University; Barlas, Yaman.

Today, the world is divided into two main blocks: Developed nations with excess capital, or North, and underdeveloped nations with excess labor, or South. It is a widely accepted fact that interactions and conflicts between these two blocks play a major role in the context of global sustainability. In this paper, a global SD model with North-South differentiation is built in order to investigate the long-term outcomes of certain policies regarding interactions between these blocks (such as natural resource transfers, capital investments, external debt, immigrations, and trade) in terms of welfare distribution, global persistent pollution, population growth and non-renewable resources.

4 : Developing a System Dynamics Viewpoint for the "Terra Dinamica". Özcan Esmer, METU.

In the "Traditional" language, earthquake explanation is as follows: "Stress accumulates on the fault. A critical stage is reached with an extreme susceptibility to perturbations. Small stress increases trigger failures. The fault tends to rupture." Paper attempts to transform the similar explanations into the SD language and develop Causal-Loop diagrams. Deviations from "Normal" ground conditions are regarded as (+) feedbacks. Aims to obtain a draft Flow-Diagram where the Level, Rate and other variables are identified. Incorporation problems of random variables and catastrophic "sudden" changes with the model are discussed. SD is for "Terra Non -Firma" -

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: MD26 **OR Applications in South Pacific - III**

Invited Session Room: L10

Chair: Azuma Ohuchi
Hokkaido University

1 : Development of GPS based Small Mowing Robots and Its Control Strategies. Keiji Suzuki, Future University-Hakodate.

It is introduced that the development of GPS based small mowing robots. The small platform of the robot system has advantage to keep safety for people. However, the performance of small robots will become inefficient. In addition, several control issues arises in the practical field including obstacle avoidances and escape from stuck areas. To treat these issues, the autonomous control strategies are developed for adapting the several situations. One of the important strategies is the management of the task plans. Throughout the primary experiments, the performance of the robot system is shown as the sufficient for the real mowing task.

2 : A New Approach to Evaluate Tourism Promotion in Local Government. Hajime Saito, Hokkaido Information University; Ohuchi, Azuma.

We propose a new approach to evaluate organization on tourism based on some methods in operations research. The tourism is one of the most important industries in Hokkaido in Japan. We focus on the "tourism promotion section (TPS)" in local government in Hokkaido. We try to evaluate TPS using multiple points of view; these are "Do", "See", and "Plan" as processes of the organization. In addition to evaluating three points, we evaluate TPS using "Software", "Hardware", and "Human-ware" as fundamental resources. Proposal method provides each feature to improve TPS, and describes some visualized forms.

3 : Modeling and Analysis of Person Trip Information in Tourism using Automobile. Mitsuyoshi Nagao, Hokkaido University; Kawamura, Hidenori; Ohuchi, Azuma; Kakazu, Yukinori.

In this paper, we propose methods for modeling and analysis of person trip information in tourism using automobile. It is important for promotion of tourism industry to collect and analyze the person trip information that represents the history of tourist's action. We perform the collection of person trip information on the basis of portable GPS and questionnaire. In addition, we perform modeling and analysis of the person trip information collected by GPS and questionnaire on the basis of the network theory. We confirm the effectiveness of our proposed methods through computational experiments.

: MD27 **Special Topics in Risk Management**

Invited Session Room: L11

Chair: George Jabbour
George Washington University

1 : The Performance of Alternative Interest Rate Measures and Immunization Strategies. Senay Agca, George Washington University.

This study analyzes how traditional risk measures and immunization strategies perform under a Heath-Jarrow-Morton (HJM) framework. Under active portfolio management, and with duration matching strategy, HJM and traditional duration measures have similar immunization performance with low volatilities. When there is high volatility, traditional measures have poor immunization performance compared to HJM measures. With duration-convexity matching strategy, immunization performance of traditional measures improves considerably. Under passive portfolio management, performances of both traditional and HJM measures are poor with duration matching strategy. With duration-convexity matching strategy, immunization performance of HJM measures improves substantially, but this is not guaranteed for traditional measures.

2 : Equity-Index Behavior: Implications for Value-at-Risk. George Jabbour, George Washington University; Kramin, Marat; Young, Stephen.

Assumptions regarding the statistical behavior of asset prices are at the core of Value-at-Risk. Using historical time series from the period 1990 through 2002, the focus of the paper is to examine the statistical properties of the S&P 500, Nikkei, FTSE, CAC, and DAX with implications for Value-at-Risk measures. In

particular, as tail related events are of critical importance for risk-management, non-normality is explored and various numerical examples serve to illustrate the differences among the standard-normal methods versus other approaches. The results support a cautious approach to risk-management and call into question the blind adoption of standard-normal methods.

3 : Modeling Dependence with m-Variate Copulas: Applications to Dow Jones and BUX Equities. Adam Kobor, World Bank; Pataki, Attila; Benedek, Gabor.

We consider the problem of modeling the dependence in financial markets. As a result of recent theoretical research sophisticated tools have become available involving multivariate models and alternative dependence concepts. In construction of such models copulas play an important role. This assures a flexible framework of analysis and enables us to drop restrictions such as normality, the use of linear correlation as an exclusive measure of dependence and also mean a departure from univariate or bivariate analysis toward higher dimensional models with more general dependence structures. Applications of copulas in risk management are illustrated and tested in this paper.

: MD28 **Meta-Heuristics for Routing**

Invited Session Room: L12

Chair: Richard Eglese
Lancaster University

1 : A Tabu Search Algorithm for the Vehicle Routing Problem with Simultaneous Pick-up and Delivery Service. Roberto Galvao, Federal University of Rio de Janeiro; Tang, Fermin.

We develop a tabu search metaheuristic for the Vehicle Routing Problem with Simultaneous Pick-up and Delivery Service; clients demand simultaneous pick-up and delivery and each client must be visited exactly once. We initially implement constructive and local search heuristics. A tabu search metaheuristic is then developed. Two types of movement, inter and intra route movements, are implemented. Efficient mechanisms are proposed to verify the feasibility of the movements. Several sizes and management policies are compared for the tabu lists. Computational results are given for two sets of test problems: nodes defined in the Euclidean space and in a grid.

2 : A Reactive Clustering-Routing Heuristic for the Assistants Dispatching Problem. Jaber Jemai, University of Tunis-Institut Superieur de Gestion; Mellouli, Khaled.

The SNDP commercial assistants problem consists of finding the set of stations to be served by each assistant and then find the minimal routing cost with respect to the number of visits predefined for each station. We propose a reactive two phase heuristic that partite the network into clusters and apply a Tabu Search implementation with intensification and diversification schemes. Clusters are updated iteratively with respect to the routing cost and the candidate list. The content of the candidate list is guided by a reactively adjusted parameter that defines the maximal distance between two stations allowing beneficially their swapping.

3 : A Tabu Search Algorithm for the Periodic Vehicle Routing and Scheduling Problem with Multiple Use of Vehicles and Accessibility Restrictions. Fernando Alonso, TECNUN - University of Navarra; Alvarez, María Jesús.

A periodic distribution model is proposed based on the Periodic Vehicle Routing Problem that includes, in addition to the classic constraints, the possibility of the vehicles doing more than one route per day and some constraints of accessibility of the vehicles to the customers, in the sense that not every vehicle can visit every customer. A Tabu Search algorithm is presented and executed on randomly generated instances of the problem. The method is also tested on routing problems from the literature that constitute particular cases of the proposed problem (PVRP, SDVRP, MTVRP, VRP) with encouraging results.

4 : A Set of Software for the Optimum Design of Multivariate Statistical Process Control Employing GA. Francisco Aparisi, Universidad Politecnica de Valencia; García, Juan Carlos.

In this work several Windows programs that have been developed for the optimization of the MEWMA control chart are shown. The first one finds the optimum scheme for detecting a process shift given the shift magnitude. The second software yields the best design when in-control and out-of-control areas are taken into account. Also, a program that finds the optimum solution for the MEWMA chart when an economic model is applied has been developed. In these programs MEWMA control chart is considered as a case of the MEWMA chart, and Genetic Algorithms have been successfully applied to make the optimization.

: MD29 **Hazmat - I**

Invited Session Room: L13

Chair: Deniz Ozdemir
INSEAD

1 : Hazardous Materials Risk Assessment in a Rail Yard. Ted Glickman, George Washington University; Erkut, Erhan.

This paper provides an example of quantitative risk assessment in a rail yard where tank cars of hazardous materials are received and stored. We consider a case study that deals with community concerns about a proposed yard expansion. Six different chemicals are involved. For each one the average monthly volume and the hazard of most concern are specified. We use an event tree with industry data to compute the probability of a major spill in each case and we estimate the corresponding critical impact distances using available modeling tools. After summarizing the results, we discuss possible extensions.

2 : An Analysis of Hazardous Waste Management Problem from Perspectives of Different Decision-Makers: The Case for Turkey. Evren Emek, Bilkent University; Kara, Bahar.

In the OR literature, general trend in approaching to the hazardous waste management problem is to use multicriteria modeling. However, we observe that there are more than one decision-makers involved in this problem. We also observe that literature lacks what exactly happens in real life. In this study, a detailed analysis of Turkish government laws and legislation related to hazardous waste management is performed in order to reflect the real life situation in the modeling phase. Decisions are analyzed in order to determine which actions are under the authority of which decision-maker. Finally a new bilevel model

is proposed.

3 : Time-Dependent Shortest Path Routing of a Hazmat Truck in the Presence of Weather Systems. Amit Parekh, University at Buffalo; Batta, Rajan; Rump, Christopher.

This study focuses on the effects of weather systems on Hazmat-Routing and develops models for routing decisions in the presence of such systems. The accident probabilities, risk, equity and cost of the route(s) selected are affected by atmospheric conditions. The time-dependent attributes of the link are determined in presence of the effects of a weather system on a vehicle traversing a single link of the transportation network. This analysis is used to get the preferred path(s) for hazardous material transportation on a network exposed to such weather systems. Exact algorithms and heuristic methods are developed, and computational results are reported.

4 : Semi Desirable or Undesirable Facility Location and Hazardous Materials Logistics: A Modelling Approach. Deniz Ozdemir, INSEAD.

A multiobjective model for locating "mutually undesirable" facilities and routing hazmat through an underlying transportation network is presented. It is assumed that the facilities concerned have strategic importance. Following objectives are concerned: (1) Maximization of dispersion between facilities, (2) Minimization of transfer cost, (3) Minimization of total disutility of plants to the society, (4) Minimization of total perceived risk, (5) Equitable distribution of perceived risk per population centre and (6) Equitable distribution of disutility caused by undesirable facilities. Based on Lagrangian relaxation, an iterative solution procedure is proposed and possible uses of the model are discussed.

: MD30 **Artificial Intelligence, Expert Systems and Neural Networks - I**

Invited Session Room: L14

Chair: Gary Koehler
University of Florida

1 : Prediction of Rainfall from WSR-88D Radar using Kernel-based Regression Methods. Theodore Trafalis, University of Oklahoma; Santosa, Budi; Richman, Michael.

The main objective of this paper is to utilize kernel-based regression methods, Support Vector Regression (SVR) and Least Squares Support Vector Regression (LS-SVR), and compare to other regression methods, to facilitate rainfall estimation. Ground truth rainfall data are necessary to apply intelligent systems techniques. A unique source of such data, owing to the dense spatial and temporal sampling, is the Oklahoma Mesonet. Recently, with the advent of a national network of advanced radars (i.e., WSR-88D), massive archived data sets are available for data mining. SVR and LS-SVR is discussed and preliminary results are provided. Comparisons with neural networks are provided.

2 : Run Time Behavior of the Simple GA in the Presence of Multiple Optima. Haldun Aytug, University of Florida; Koehler, Gary.

We derive bounds on the run time complexity of the simple genetic algorithm when multiple-optima exist. We show that this drastically reduces the computational requirements of the algorithm. We also show how this can be used to derive worst-case error bounds for optimizing certain functions.

3 : New Methods for Noise Removal in Digital Image Processing. Özgür Uysal, Fatih University; Türkyılmaz, Ali.

When an image is acquired by a camera or other imaging system, often the vision system for which it is intended is unable to use it directly. The image may be corrupted by random variations in intensity, variations in illumination, or poor contrast. The variations in intensity values are called "noise". There are many well-established filtering techniques for image enhancement aimed at eliminating these undesirable characteristics. In this study; two new filters are designed for noise removal. A special computer program is developed to demonstrate the relative performance of the well-known filters and the newly designed ones.

: MD31 **AHP - C3**

Contributed Session Room: M33

Chair: Shai Finger
Ben-Gurion University of the Negev

1 : VNS in Global Optimization. Milan Drazic, Serbian Academy of Sciences and Arts; Cangalovic, Mirjana; Mladenovic, Nenad; Kovacevic-Vujcic, Vera.

A software package in ANSI C programming language has been developed for solving box constrained global optimization problems by using variable neighbourhood search metaheuristic. Several local optimization algorithms have been implemented: Nelder-Mead, Hook-Jeeves, Rosenbrock, steepest descend, Fletcher-Powell, Fletcher-Reeves. Extensive testing on number of test problems justifies the VNS approach for finding global minimum of a function with large number of local minima.

2 : An Application of the Analytic Hierarchy Process to the Regional Headquarters Location Decision of a Multinational Corporation. Shai Finger, Ben-Gurion University of the Negev.

This paper presents a model for selecting a location in which to establish a multinational corporation's regional headquarters (RHQ), using the Analytic Hierarchy Process (AHP). The model proposed is based on relevant location factors cited in the literature. A practical approach for handling the different alternatives is suggested, based on country competitiveness scoring. This is useful for incorporating objective assessments of country performance, and for substantially reducing the number of pair-wise comparisons required. For purpose of demonstration, the model is applied to a sample case involving the location of regional headquarters of a multinational corporation in the Asia-Pacific region.

: ME01 **OR Applications in Maritime Transportation**

Tutorial Room: MB I

OR Applications in Maritime Transportation. Marielle Christiansen, Norwegian University of Science and Technology.

In this tutorial, we will give an overview of some planning problems within maritime transportation at the various planning levels. We start at the strategic fleet planning level and discuss the design of fleets and sea transport systems. We continue with the tactical and operational fleet planning level and consider problems that comprise various ship routing and scheduling aspects. Here we discuss the different modes of operations separately, namely industrial, tramp and liner shipping. Examples of real cases, elements of models and solution methods will be given. A commercial decision support system used for ship routing and scheduling will be presented, and some experiences with the system will be given. Finally, we present some trends regarding future developments and use of optimization-based decision support systems for ship routing and scheduling. Several of the trends indicate both accelerating needs for and benefits from such systems.

: ME02 **OR/MS in Health Care: Contemporary Issues and Solutions**

Tutorial Room: MB II

OR/MS in Health Care: Contemporary Issues and Solutions. Yaşar A. Özcan, Virginia Commonwealth University.

Problems in the health care industry present a unique platform for operations research and management science professionals. This session will identify past, current and potential future research questions concerned with operations research and health care applications. The session will disseminate solutions to the above questions, and explore the application of OR/MS methods to health care. While finances in health care is a force which drives policy decisions from cost/reimbursement perspectives, on the other hand OR/MS methods that can enhance efficiency and quality play a more integral part in hospital and clinic management. More specifically, benchmarking the health services practice became one of the contemporary issues. This session will present OR/MS tools and applications for benchmarking in health services.

: ME03 **Supply Chain Management and Advanced Planning**

Tutorial Room: MB III

Supply Chain Management and Advanced Planning. Hartmut Stadtler, Technische Universität Darmstadt.

More and more companies collaborate with their suppliers and customers in order to better serve the ultimate customer and to gain competitive advantage. The design, planning and control of these - so called supply chains - is the task of Supply Chain Management (SCM). We will start the tutorial by outlining the building blocks of SCM which we feel constitute some degree of novelty of this management paradigm. One of the building blocks - Advanced Planning - will be discussed in greater detail based on the standard architecture underlying Advanced Planning Systems today - like those from i2 technologies, JD Edwards or SAP AG. By means of a hypothetical example we will illustrate the models used and their interactions to support the different planning tasks facing an intra-organisational Supply Chain (SC). Finally we will consider inter-organisational SCs, especially the issue of collaborative planning.

: ME04 **Combinatorial Optimization - I**

Invited Session Room: JB A

Chair: Toshihide Ibaraki
Kyoto university

1 : A Relaxation Method for Topology Optimization of Framed Structures under Stress and Local Constraints. Naoki Katoh, Kyoto University; Ohsaki, Makoto.

In this paper, the topology optimization problem of trusses and frames under stress constraints corresponding to multiple loading conditions is first formulated as a mixed integer nonlinear programming problem. The local constraints such as constraints on nodal instability and intersection of members are considered, and a moderately large lower-bound cross-sectional area is given for an existing member. A relaxed problem with continuous variables is then formulated. A linear programming problem is solved ignoring the compatibility conditions to obtain a lower-bound solution. Based on this lower bound, we shall propose a branch and bound method.

2 : Guided Evolution Strategies for Large Scale Vehicle Routing Problem with Time Windows. Olli Bräysy, Sintef Applied Mathematics; Mester, David.

We present a new and effective metaheuristic algorithm, Guided Evolution Strategies, for the Vehicle Routing Problem with Time Windows. The described algorithm combines the strengths of Guided Local Search (Voudouris, 1997) and Evolution Strategies (Rechenberg, 1973) into an iterative two-stage procedure. The computational experiments were carried out on 200-1000-customer benchmark problems of Gehring and Homberger (1999), and two real-life problems by Russell (1995). The results demonstrate that the suggested method is highly competitive, providing best-known solutions to 82% of all test instances within reasonable CPU times.

3 : A Tabu Search Framework for Solving Combinatorial Optimization Problems. Hoong Chuin Lau, National University of Singapore; Wan, Wee Chong.

In this talk, we propose a tabu search framework for solving combinatorial problems. Our proposed Tabu Search Framework (TSF++) provides developers with a control mechanism that guides the local search adaptively and a diversification mechanism that attempts to escape from local optimal. TSF++ is a well-structured framework that gives a clear design of tabu search approach as well as the ease of implementing various strategies for different combinatorial optimization problems. To demonstrate the capability of TSF++, we experimented on the Vehicle Routing Problem with Time Windows (VRPTW) and the Quadratic Assignment Problem (QAP).

4 : A Duality Result for 0/1 Programming. Robert Weismantel, Otto-von-Guericke-University of Magdeburg; Bertsimas, Dimitris.

Motivated by results from algebraic geometry, we develop a duality theory for binary programming that is analogous to linear programming duality. We prove that every binary problem has an explicit dual linear program with exponentially many variables and constraints for which weak duality, strong duality and

complementary slackness hold. Some insight into the structure of the optimal dual solutions gives rise to a couple of algorithmic ideas that we will explain.

: ME05 **Models for Freight Transportation**

Invited Session Room: JB B

Chair: Teodor Gabriel Crainic
Université du Quebec a Montréal

1 : Economies of Scale in Empty Freight Car Distribution in Scheduled Railways. Teodor Gabriel Crainic, Université du Quebec a Montréal; Gendreau, Michel; Holmberg, Kaj; Joborn, Martin; Lundgren, Jan T.

We consider empty freight car distribution in a scheduled railway system. The cost structure for repositioning empty cars shows economies of scale relative to the number of car groups moved. We present an optimization model that explicitly takes these economies of scale effect into account. We use a time-dependent network to describe the possible car movements in time and space, and show how this network can be transformed a capacitated network design model, where each capacity constraint limits the flow on several arcs. We describe a tabu heuristic for solving the model and present computational results.

2 : Solving a Large-Scale Real-World Multimodal Container Load. Tore Gruenert, RWTH Aachen.

Multimodal container transportation is very common in some countries within the European Union. Specially designed containers can be transferred very quickly from trucks to railcars and vice versa. In this talk we describe the characteristics of the problem and show how it can be attacked using powerful optimization techniques. The problem includes aspects, such as empty container balancing, multi-period vehicle scheduling, and vehicle routing. The vehicle routing aspect is especially demanding, since pickup and delivery instances with multiple time windows, driver legislation constraints, nonlinear cost functions and up to 8,000 requests have to be solved within five minutes.

3 : Planning Models for City Logistics Operations. Nicoletta Ricciardi, Università degli Studi di Roma "La Sapienza"; Crainic, Teodor Gabriel; Storchi, Giovanni.

Freight transportation in urban areas is one of the most important activities in modern cities. The first objective of the presentation is to emphasize the growing importance of integrated freight transportation planning and control within urban zones. Our proposal for an improved transportation system involves an integrated policy. To obtain a system more efficient it is necessary a daily time-dependent planning of operations. This means that the demand is know pretty well at least 1 or 2 days in advance. With this information we will must to solve a routing and scheduling problem for the trucks and the city-freighter routing.

4 : A Model for the Traffic Equilibrium Assignment Problem in a Multimodal Transportation Network. Neila Bhouri, INRETS; Lebacque, Jean Patrick.

In this paper we propose a macroscopic model for the traffic equilibrium assignment problem in a multimodal transportation network. Only main paths joining the origin/destination (O/D) pairs are considered. These paths can be either "pure modes" or "combined modes". User choice behaviour concerns whether a potential user decides to make a trip or not, and in the former case, by which mode and along which route. Because we don't consider all possible paths between any O/D pair but only the main ones, we introduce the concept of "local users". The model results in a variational inequality problem, solved by Gauss-Seidel.

: ME06 **Flow-Shop and Just-In-Time Scheduling**

Invited Session Room: M30

Chair: Wieslaw Kubiak
MUN

1 : The Maximum Deviation Just-in-Time Scheduling Problem. Yves Crama, University of Liège; Brauner, Nadia.

We revisit the maximum deviation just-in-time (MDJIT) problem previously introduced by Steiner and Yeomans (1993). These authors provided a thorough analysis of the problem, including structural and algorithmic results. The purpose of our work is to clarify some of the remaining open issues. Our main result is a set of algebraic necessary and sufficient conditions for the existence of a MDJIT schedule with a given objective function value. We further establish that MDJIT is in coNP and that it is polynomially solvable for a fixed number of part types. Finally, we investigate various special cases of the MDJIT problem.

2 : Exact Methods for the Multiprocessor Flowshop Problem. Erwin Pesch, University of Siegen; Kis, Tamas.

The flexible flowshop problem is a generalization of the flowshop in such a way that every job can be processed by one among several machines on each machine stage. In recent years a number of effective exact methods have been developed. A major reason for this progress is the development of new job and machine based lower bounds as well as the rapidly increasing importance of constraint programming. We provide the comprehensive overview on exact solution methods for flexible flowshops with branching, bounding and propagation of constraints under two different objective functions: minimizing the makespan or the mean flow time.

3 : Applications of Just-in-Time Sequencing. Wieslaw Kubiak, MUN.

The just-in-time sequencing problem, known also as the Product Rate Variation (PRV) problem, has been introduced to sequence mixed-model just-in-time systems. We show that its applications are much broader and include periodic scheduling of hard real-time systems, distance-constrained scheduling, stride scheduling, and fair sequencing.

4 : Flow-Shop Batch Scheduling with Identical Processing-Time Jobs. Daniel Oron, The Hebrew University of Jerusalem; Mosheiov, Gur; Ritov, Yaacov.

In many practical situations of production scheduling, it is either necessary or recommended to group a large number of jobs into a relatively small number of batches. A decision needs to be made regarding both the batching (number and size of batches) and the sequencing (of batches and of jobs within batches). A setup cost is incurred whenever a batch begins processing. This

paper focuses on batch scheduling of identical processing-time jobs, and machine- and sequence-independent setup times on an m-machine flow-shop. The objective is minimum flow-time. We introduce a surprising and non-intuitive polynomial time solution for the problem.

: ME07 **New Approaches in Inventory Management**

Invited Session Room: M31

Chair: Refik Güllü
METU

1 : Using Advance Demand Information in Ordering and Rationing Decisions. Tarkan Tan, Atılım University; Güllü, Refik; Erkip, Nesim.

In this talk we consider an inventory system with two customer classes and the availability of imperfect advance demand information. Our aim is to develop optimal ordering policies for the system and rationing rules among demand classes as a function of available information. Our computational setting combines analytical results with a Monte Carlo simulation.

2 : Capacitated Inventory Management in the Presence of a Spot Market. Victor Araman, New York University; Ozer, Ozalp.

Consider a capacitated supplier that is involved in a long-term contract with a buyer. The supplier also has the option to sell at the spot market. The sales price for the long-term contract is predefined whereas the spot market price is the result of a clearance mechanism with random outcomes. We consider a finite horizon multi-period problem, and study the supplier's capacity allocation and inventory management problem.

3 : Information Asymmetry in a Two-Echelon Supply Chain with Limited Capacity. İsmail Bakal, METU; Güllü, Refik; Erkip, Nesim.

In this talk we consider a system with a single supplier and multiple retailers. Random customer demand occurs at the retailer level. There is a limit on the amount that the supplier can fulfill orders from the retailers. We investigate information asymmetry with respect to supplier's capacity and retailer demands

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: ME08 **Social Choice**

Invited Session Room: M32

Chair: Steven J. Brams
New York University

1 : Spatial Approval Voting. Jean-François Laslier, Ecole Polytechnique.

The paper provides a model for analyzing approval voting elections. Within a standard probabilistic spatial voting setting, we show that Principal Component Analysis makes it possible to derive the candidate locations from the approval votes. We apply this technique to experimental data from the French 2002 presidential election.

2 : Voter Sovereignty and Election Outcomes. Remzi Sanver, Bilgi University.

We characterize approval-voting outcomes. Showing that there may be a plethora - including all scoring-rule, Condorcet, and single-transferable-vote winners - we argue that this multiplicity is not a curse but a reasonable expression of the sovereign judgments of voters. We also analyze Nash and strong Nash equilibrium under the different voting systems.

3 : An Axiomatic Charaterization of Fuzzy Decision Rules based on Difference of Votes. Jose-Luis Garcia Lapresta, Universidad de Valladolid; Llamazares, Bonifacio.

We generalize and characterize social choice rules based on difference of votes by considering individual intensities of preferences represented by fuzzy preferences.

4 : Almost all Social Choice Correspondences are subject to the Gibbard-Satterthwaite Theorem. Selçuk Özyurt, Boğaziçi University.

We show that non-dictatorial and unanimous social choice rules defined over a very narrow domain of lexicographic preference orderings of sets are manipulable. This result prevails for all "regular" superdomains of this lexicographic domain. Hence, we conclude that the Gibbard-Satterthwaite theorem holds under almost all reasonable domain restrictions.

: ME09 **Competitive Marketing Strategy**

Invited Session Room: L15

Chair: K. Sudhir
Yale University

1 : Investigating Time Varying Competitive Behavior. K. Sudhir, Yale University; Chintagunta, Pradeep; Kadiyali, Vrinda.

Normative models suggest that firms should raise prices in periods of high demand and high costs. This is not always borne out empirically. We propose that this discrepancy occurs because competitive intensity is maintained invariant to demand and cost conditions. We develop and test a model to study the relationship between competitive intensity and demand and cost variables.

2 : Firm Choice of an Advertising Agent. Sharon Horsky, Interdisciplinary Center Herzliya.

In contrast to other marketing activities, advertising is usually outsourced; historically, to an integrated full-service advertising agency. Such an agency offers expertise and resources covering consumer and media research, creative copy, and media planning and buying. In the last two decades, changes have occurred in the architecture of advertising agencies and firms have begun to unbundle the advertising tasks to separate specialized agencies. This paper addresses both theoretically and empirically how firms choose their advertising services. A random coefficients logit model is used in the analysis of current choices of advertising agents by a large sample of U.S. firms.

3 : Integrating Multi-Attribute Utility Into Scanner-based Choice Models. Dan Horsky, University of Rochester; Misra, Sanjog; Nelson, Paul.

In deciding whether to buy a brand the consumer trades off between the performance of the brand on a set of relevant at-

tributes and the brand's price. Multi-attribute models addressing these tradeoffs are a popular research topic. In addition, the marketing community has shown great interest in discrete choice scanner data models measuring the impact of price and promotion but not brand attribute levels - on brand choice. This paper develops a methodology that combines these research tracks. We illustrate it using a unique dataset that combines survey and scanner data collected from the same individuals.

: ME10 **Inventory Control and Reverse Logistics - I**

Invited Session Room: L19

Chair: Karl Inderfurth
University of Magdeburg

1 : When to Prioritize Remanufacturing in Hybrid Systems? Necati Aras, Boğaziçi University; Boyaci, Tamer; Verter, Vedat.

We compare alternative strategies which give priority to either remanufacturing or manufacturing in replenishing finished goods inventory. Using simulation-based optimization, we identify the best priority strategy under various inventory management policies.

2 : Comparison of Alternative Inventory Control Policies for a Probabilistic Recovery System. Z. Pelin Bayindir, Erasmus University Rotterdam; Dekker, Rommert; Porras, Eric.

We consider a recoverable item inventory system subject to stochastic demand originated in the inner-firm. New items are supplied from an outside supplier. Each item has a stochastic usage time. The items completing their usage time go under a probabilistic recovery operation. We assume that the success of recovery operation is a function of the expected time spent for it. The objective is to determine the optimal recovery and stocking levels to minimize the average expected cost in the steady-state. Two system-wide order-up-to level policies are proposed. In this talk, the proposed policies and the computational results are discussed.

3 : Optimal Ordering of Seasonal Products in the Presence of Large Return Flows. Julien Mostard, Erasmus University Rotterdam.

Large return flows complicate inventory control when most of these returns can be resold. We examine a large mail order company selling fashion goods with high return percentages. This company faces two problems: (1) Forecasting demand and returns. Since fashion goods are seasonal, there are no historical data. (2) When and how much to order of every product, while guaranteeing a certain service level. Long delivery lead times restrict the number of order moments to three. Using real data provided by the company, we come up with an optimal ordering rule and compare the results to the company's current performance.

4 : Remanufacturing Economics: Product and Contract Design. Baris Yalabik, University of Illinois at Urbana-Champaign; Chhajed, Dilip; Petruzzi, Nicholas C.

We develop an economic model investigating the interrelationships between the optimal product and contract design decisions of a remanufacturer. We establish the optimal product and sales contract offered to the market so that profits are maximized.

: ME11 **Theoretical Issues in DEA - II**

Invited Session Room: R20

Chair: John Cubbin
City University

1 : A Slack-based Measure of Efficiency in Context-Dependent Data Envelopment Analysis. Hiroshi Morita, Osaka University; Hirokawa, Koichiro; Zhu, Joe.

We propose a slack-based measure of efficiency in context-dependent data envelopment analysis. The decision making units are categorized into several levels in context-dependent DEA using the efficiency scores, where the nonzero slacks in input and output are not considered. Since the number of DMUs became small in upper levels, it is very likely that nonzero slacks exist in these DMUs with efficiency score of one. Therefore, it is necessary to introduce a measure incorporating the amount of slack into efficiency scores. By the proposed measure, we obtain have more frontier levels. We also discuss the dual model of context-dependent DEA.

2 : Some More Statistical Pproperties of DEA. John Cubbin, City University.

It is known that the quality of DEA estimates of inefficiency depends on a number of aspects of the data generating process, including: the number of observations, the dimensionality of the problem, the degree of convexity, the variance of the variables used in the analysis, and the statistical form of the inefficiency term. This paper presents some Monte Carlo simulations which explore some aspects of the interrelations between these factors, which gives some insights into the situations where DEA is likely to give useful results and those where its value is likely to be limited.

3 : Non-Discretionary and Discretionary Factors and Scale in DEA. Mikko Syrjanen, Helsinki School of Economics.

This paper first compares different approaches to the inclusion of continuous non-discretionary factors in a one-stage Data Envelopment Analysis (DEA) model. The approaches are compared theoretically, on the basis of axiomatic systems, and empirically, on the basis of examples and simulated data. The key differences are 1) in the interpretation of non-discretionary factors, i.e. whether these are interpreted as scale dependent volume measures or indices, which are scale independent, and 2) in the returns to scale properties of the models. Second, a generalised DEA model, which combines the properties of the compared models, is presented.

4 : On Linear Transformation of Input and Output Variables in DEA. Pekka Korhonen, Helsinki School of Economics.

Sometimes there is a need to reduce the number of input/output variables in DEA. At the first glance, statistical multivariate methods like principal component analysis and multivariate regression analysis seem to provide good tools for this problem. However, we need to apply these methods with care. Those methods use the variances and correlations of the variables for reduction, whereas the main concept in DEA is dominance. In this paper, we discuss a non-singular and singular linear transformation of original variables and especially the use of statisti-

cal methods for reducing the variables in DEA.

: ME12 Cutting Plane Methods for Graph and Flow Problems

Invited Session Room: M39

Chair: Antonio Frangioni
Universita' di Pisa

1 : Valid Inequalities for a Multicommodity Non-Linear Node-Cost Network Design Problem. Lorenzo Brunetta, Università di Padova; Belotti, Pietro; Malucelli, Federico.

A multiflow problem with an undirected graph and an integer origin-destination matrix asks to send a required flow from each origin to each destination, minimizing a given objective cost function while not exceeding arc capacities. We also require that the flow should not exceed the node capacities: each node must be assigned a capacity with a cost that is a non-linear function of the node degree. The objective is to minimize the sum of node and arc costs. We introduce an integer linear programming model, new valid inequalities and polynomial separation algorithms. Computational tests on real-world instances are reported.

2 : Accelerating Column Generation for Planar Multicommodity Flow Problems. Filipe Alvelos, Universidade do Minho; de Carvalho, J. M. Valério.

In this work, we present a way of accelerating a column generation algorithm for the linear minimum cost multicommodity flow problem. The main idea is that by adding a polynomial number of extra variables, corresponding to flow on circuits, prior to the beginning of the column generation process we can improve the efficiency of the method. We present computational results for the comparison of this new approach with standard column generation, a bundle method and a general-purpose solver. For the tested instances, there is an effective improvement in computational time of the column generation method when extra variables are used.

3 : Lagrangean Approaches for Optimization over the Semi-Metric Polytope . Andrea Lodi, University of Bologna; Frangioni, Antonio; Rinaldi, Giovanni.

The semimetric polytope M(G) associated with a complete undirected graph G is important in combinatorial optimization, e.g. related to the max-cut. The facet-defining inequalities for M(G) triangle inequalities yield an ILP formulation for max-cut and provide its standard LP relaxation. The LP defined by these inequalities, is very degenerate and is hard to solve for large graphs, even with state-of-the-art LP software and constraint-generation techniques. We propose a new algorithm for efficiently optimizing a linear function over a relaxation of M(G). Building on this, we construct some Lagrangean-based approaches for maximizing a linear function over M(G), comparing different algorithms.

4 : Comparing Lagrangean Approaches for Multicommodity Network Design Problems. Antonio Frangioni, Universita' di Pisa; Alvelos, Filipe; de Carvalho, J. M. Valério.

We analyze the computational efficiency of two Lagrangean relaxations (flow and knapsack) for the Multicommodity Fixed Charge problem. Both relaxations give the same bound and result in a very-large scale NonDifferentiable Optimization problem; choosing the right NDO algorithm is crucial for obtaining good bounds in reasonable running time. This is especially important in view of using these bounds within enumerative approaches (B&B, B&C) to the integer problem. We analyze both aggregated and disaggregated relaxations with different NDO algorithms (Bundle, Cutting-Plane, Volume, ...) for different classes of instances, and compare the results with those of standard LP technology.

: ME13 Revenue Management in Services

Invited Session Room: R21

Chair: Yalçın Akçay
Koç University

1 : Simulation-based Optimization of Virtual Nesting Controls. Garret van Ryzin, Columbia University; Vulcano, Gustavo.

Bertsimas and de Boer recently proposed an interesting simulation-based optimization method for improving protection levels in virtual nesting controls. We develop an alternative approach that provides several theoretical and computational advantages. Specifically, use a continuous demand and capacity approximation for the discrete problem, allowing for partial acceptance of requests. The advantage of the continuous model is that sample path subgradients can be computed exactly and efficiently. Moreover, we prove the local convergence of the method. Numerical examples show the method provided significant improvements in revenue.

2 : Hotel Revenue Management at the Distribution Channel Level. Sunmee Choi, Pennsylvania State University.

The potential to increase contribution (revenue less variable cost of booking) by applying revenue management approaches at the distribution channel level has been discussed (Boyd 2000). The present study tested the potential to increase contribution by the application of the proposed approach under various hotel-operating environments, which varied by five factors. Study results showed that the amount of contribution enhancement accomplished by the proposed approach varied by the hotel-operating environment. Hotels with larger capacity, higher demand intensity, higher room rates, a smaller gap between room rates, and a larger gap between booking costs by channel benefited most.

3 : Pricing Access Services in the Presence of Flexible Capacity. Skander Essegaier, Stern School of Business, New York University.

How online access services are priced is an issue of considerable importance to the firms in these industries. Online information providers, for example, have traditionally charged for their services on the basis of the time customers are connected to the database - a pricing scheme referred to as connect-time pricing. A significant number of online information providers have started adopting a different pricing strategy where consumers pay on a per-search-session basis. Flexibility in Service capacity is a key feature of these industries. This paper focuses on the role of flexibility on firms' choice among various pricing scheme.

4 : Online Assignment of Flexible Resources. Yalçın Akçay, Koç University; Xu, Susan; Balakrishnan, Anant.

Our paper addresses a revenue management problem in a new application area: the workplace learning industry. This industry has been growing rapidly in recent years, and the potential of revenue management is encouraging. We focus on the acceptance decisions of the incoming client requests for training programs, and the assignment decisions of instructors to the accepted requests. We model the revenue maximization problem as a stochastic dynamic program. Based on our insights gained from the analysis of special cases of the problem, we propose several approximate solutions; rollout, threshold, newsboy and dynamic randomization heuristics.

: ME14 **Management Information Systems**

Contributed Session Room: R22

Chair: Susan Lippert
Drexel University

1 : The Relationship between Human Resource Information Systems (HRIS) and Technology Trust: Propositions for Implementation Success. Susan Lippert, Drexel University; Swiercz, Paul.

Scholars in various disciplines have considered the nature, antecedents and consequences of trust. This paper introduces the concept of "technology trust" and offers various propositions regarding the relationship between technology trust and Human Resource Information Systems (HRIS) implementation success. Nine propositions are presented which suggest that organizational trust, interdependence, community relevance, organizational culture, utility and usability, and sensitivity to privacy influence an individual's level of trust in the technology and ultimately the success of an HRIS implementation process. Directions for future research are suggested.

2 : Agent-based Shop-Floor Management System. İnci Sarıçiçek, Osmangazi University; Yüzügüllü, Nihat.

Recently, manufacturing research have started to study potential applications of agent theory to production planning and control. In this study, an Agent-Based Shop-Floor Management System called ATAYS is designed. Agents in the system are Marketing, Production Planning, Purchasing and Shop-Floor Agents. The distributed system forming heterogeneous units is designed by hybrid control architecture. Agent-based collaborative scheduling system is capable of scheduling by considering heterogeneous objectives of the shop-floor agents. Shop-Floor Agents collaborate in order to achive forward and backward schedules. The schedule for the best interest of the system as a whole is selected by the Production Planning Agent.

3 : The Acquisition and Implementation Process for ERP Systems: A Classification of Critical Success Factors (CSF). Tariq Bhatti, Zayed University; Jayraman, V.

The complexity of ERP systems, and their associated high costs are forcing many organizations to think carefully on their plans in acquiring and implementing such enterprise wide systems. It is found in literature that there are many factors that influence the acquisition and implementation process of ERP. However, there is a considerable overlap in these factors. In this paper, a literature review of the factors that influence the acquisition and implementation process of ERP systems is carried out, and a taxonomy of the critical success factors is proposed.

: ME15 **Location Routing Problems**

Invited Session Room: R23

Chair: Juan José Salazar González
Universidad de La Laguna

1 : A Solution Approach for a Stochastic Location Routing Problem. Maria Albareda Sambola, Universitat Politècnica de Catalunya; Fernandez, Elena; Laporte, Gilbert.

In this work we study a stochastic location routing problem that consists of finding a set of plants to open and one route from each, to serve clients and minimize the overall costs. The stochastic nature of the problem comes from the uncertainty in the presence of each customer, which follows a Bernoulli distribution. We consider the decision as a two stage problem where a recourse action is taken when the capacity constraints are violated. Upper bounds are obtained using a local search heuristic, whereas lower bounds are derived from the structure of the problem. Computational experiences are reported.

2 : A Cutting Plane Algorithm for the General Routing Problem on a Mixed Graph. Angel Corberan, Universitat de Valencia; Sanchis, Jose Maria.

In this talk we deal with the resolution of the Mixed General Routing Problem (MGRP). This problem, in which the service activity occurs both at some of the nodes and some of the arcs and edges of a mixed graph, contains a large number of important routing problems as special cases. Here, we present a cutting plane algorithm for the MGRP that incorporates separation routines for several families of facet defining inequalities.

3 : Description of the ALGACEA-2 Algorithm to Solve the CVRP. Javier Faulin, Public University of Navarra; Gil, Israel.

We have built the ALGACEA-2 algorithm for solving the CVRP in an intuitive way using probabilistic techniques. This method is a metaheuristics, based on the well-known Clarke-Wright's Savings Algorithm, developed for calculating outstanding routes in real delivery problems. This algorithm has undergone some transformations since its initial construction (ALGACEA-1). We focus our method on the calculus of traditional savings, choosing the nodes whose saving has been selected according to a Monte Carlo method. Nonetheless, this procedure is controlled by the use of bounded Entropy concept. Finally, some computational results in order to test the ALGACEA-2 method are provided.

4 : Heuristic Approaches for the Vehicle Routing Problem with Accessibility Constraints. Frederic Semet, University of Valenciennes; Hanafi, Said; Souid, Mahdi.

In the vehicle routing problem with accessibility constraints (VRPAC), a route can be covered by two types of vehicles: trucks and road-trains. A road-train is a truck pulling a trailer. Some customers are accessible by both vehicles types, others solely by trucks. A route performed by a road-train has a special character. It decomposes into a circuit covered by the road-train and into subtours covered by the truck alone. In this talk,

we present two location-based heuristics as well as a variable neighborhood algorithm for the VRPAC.

: ME16 **Integer Programming - C2**

Contributed Session Room: R27

Chair: Andrew Mason
University of Auckland

1 : Stochastic Programs with Binary First Stage: A Regularized Decomposition Approach. Andrew J. Schaefer, University of Pittsburgh; Alagoz, Oguzhan; Smith, Cole.

We consider a class of two-stage stochastic programs where the first-stage decision variables are binary and the second-stage decision variables are continuous. Conventional solution techniques such as L-Shaped Method may not always be the best approach for this class of problems. Ruszczynski (1986) proposed regularized decomposition for stochastic linear programs to address these shortcomings. In this study, we describe and discuss the results of a modified version of the regularized decomposition algorithm in which we linearize the quadratic function in the standard regularized decomposition algorithm.

2 : Multicriteria Shortest Paths Problems. Moncef Abbas, USTHB.

The problems of shortest paths constitute a traditional topic in operations research whose applications are very numerous. Our contribution is focused on two problems of the shortest paths in the context of multicriteria approach. The first problem consist to obtain a shortest path between two fixed vertices and the second is to obtain a shortest path between a fixed vertex and any other vertex of the network. We establish some results, in particular, the characterization of the existence of pareto-optimal solutions. We give also the multicriteria mathematical formulation of these two problems as well as the various methods of resolution.

3 : A Combined Customer Service and Staff Scheduling Model for NZ Customs. Andrew Mason, University of Auckland; Name, Phil.

We develop a new scheduling model that improves the efficiency with which New Zealand Customs staff process passengers entering and leaving New Zealand at the Auckland International Airport. In the past, the work requirements problem (choosing how many staff should work in each period) was solved by a heuristic, and then shifts were constructed to cover this work requirement. In this work, we combine these two problems into one mixed integer programming problem. This allows us to quantify the performance of the heuristic and make improvements on its performance.

: ME17 **Modeling and Analysis Methodology**

Invited Session Room: R24

Chair: Bahar Biller
Carnegie Mellon University

1 : On the Performance of the ARTA Fitting Algorithm. Bahar Biller, Carnegie Mellon University; Nelson, Barry L.

Providing accurate and automated input-modeling support is one of the challenging problems in the application of computer simulation. The models incorporated in current input-modeling software packages often fall short of what is needed because they emphasize independent and identically distributed processes, while dependent time-series processes occur naturally in the simulation of many real-life systems. Recently, we developed an algorithm for fitting stochastic models to dependent time-series input processes. In this talk, we discuss the performance of this algorithm by using the results drawn from an empirical comparison/analysis.

2 : Modifying the NORTA Method for Better Performance in Higher Dimensions. Soumyadip Ghosh, Cornell University; Henderson, Shane.

The NORTA method for multivariate generation has been shown to fail to work for some feasible correlation matrices. Simulation results have shown that this feasibility problem becomes acute rapidly as the dimension of the random vector is increased. In Ghosh and Henderson (2002), we have proposed a modified NORTA procedure, augmented by a semidefinite program (SDP), that aims to generate a correlation matrix "close" to the desired one. We find that though the performance of this modified NORTA method is satisfactory as the dimension increases, we are required to solve increasingly harder SDP problems. We discuss other NORTA-modification procedures.

3 : Modeling Queueing Systems using HCFG Models and HiMASS. Robert Sargent, Syracuse University; Daum, Thorsten.

We discuss how to model queueing systems using Hierarchical Control Flow Graph (HCFG) Models via the Hierarchical Modeling and Simulation System (HiMASS). This includes (1) how to develop models from scratch using the basic HCFG Model elements and (2) how to build models using already developed components of queueing subsystems, which can be stored in reusable component libraries. The HCFG Model paradigm is a hierarchical and graphical representation of the process world view and model specification in HiMASS is by hierarchical and visual interactive modeling.

4 : High Performance Simulation of High Speed Manufacturing Plant. Michael Pidd; Gunal, Murat.

Most of the Visual Simulation packages aimed at manufacturing assume that discrete parts move through a network of workstations. However, much manufacturing is not like that and it is common to find production plants that mix discrete and continuous processes that run at high speed. This paper describes the development of a java-based simulator for quasi-continuous manufacturing and discusses the development of a high performance simulator that will allow fine-grained modelling of these plants using high performance computer clusters.

: ME18 **Location Methodology**

Invited Session Room: R25

Chair: Teresa Melo
Fraunhofer Institute for Industrial Mathematics

1 : A Probibilistic Minimax Location Problem on a Network. Zvi Drezner, California State University; Berman, Oded.

In this paper we consider the one center problem on a network when the speeds on each link are stochastic rather than deterministic. We have a desirable time to get to a node and would like to find the location for a facility such that the probability we reach all nodes within this time threshold is maximized. The problem is formulated, analyzed and demonstrated on an example problem.

2 : Column Generation for a Combined Location Routing Problem. Maria Albareda Sambola, Universitat Politècnica de Catalunya; Fernandez, Elena.

In this paper we present a column generation algorithm to find lower bounds for the capacitated location routing problem. In this problem, three decisions are taken simultaneously; the location of the facilities, the assignment of customers to facilities and the order in which customers are served within each group. Columns represent feasible routes associated to potential locations. The pricing problem is interesting on its own and its resolution is quite time consuming. Nevertheless, the bounds obtained are of high quality.

3 : An Efficient Approach for Flow Intercepting Spatial Interaction Model. Robert Aboolian, California State University San Marcos; Berman, Oded; Krass, Dmitry.

Consider the problem of locating competitive facilities that derive their demand from both special-purpose trips and from "intercepting" facilities while en route to other destination on the network. Efficient exact and approximate solutions for this problem are developed.

4 : Dynamic Multi-Commodity Capacitated Location: A Mathematical Modeling Framework for Strategic Supply Chain Planning. Teresa Melo, Fraunhofer Institute for Industrial Mathematics; Nickel, Stefan.

In this talk we propose a mathematical modeling framework capturing many practical aspects of network design problems simultaneously but which have not received adequate attention in the literature. The aspects considered include: dynamic planning horizon, generic supply chain structure, inventory and distribution of goods, facility configuration, budget constraints, and storage limitations. Moreover, the gradual relocation of facilities over the planning horizon is considered. The relation of our modeling framework with existing models is discussed. Finally, we report on our computational experience with standard mathematical programming software and provide useful insights on the impact of various factors on network design decisions.

: ME19 **Issues in Long-Term Care and Quality**

Invited Session Room: R26

Chair: Thomas T. H. Wan
Virginia Commonwealth University

1 : A Systems Framework for Evaluating Nursing Care Quality in Nursing Homes. Lynn Unruh, University of Central Florida; Wan, Thomas T. H.

The quality of care in nursing homes has been a concern for some time. Due to reports of inadequate, negligent, or abusive care, and litigation over these problems, nursing homes have come under increasing scrutiny and regulation. This article explores the development of a systems framework for evaluating nursing home quality of care by applying a structure-process-outcomes (SPO) model to nursing home quality components. A multilevel modeling is used to investigate the direct and indirect effects of institutional factors such as market and contextual changes on each of the SPO components of quality.

2 : Nursing Home Staffing Adequacy, Rehabilitation Orientation, and Quality. Diana G. Venskus, Marymount University.

This study examines the effects of changing levels of nursing home staffing adequacy, variations in rehabilitation orientation, and the resultant impact on facility deficiency citations during in response to introduction of the Balanced Budge Act of 1997 and Balanced Budget Refinement Act of 1999. Personnel costs are among the most expensive resources utilized in the nursing home industry. Implementation of the Balanced Budget Act of 1997 prompted strategic reductions in staffing levels. During the same period significant increases in facility deficiencies are noted, however the deficiencies are not directly related to the changed staffing levels.

3 : Detecting the Effects of Institutional Mechanisms on Nursing Homes' Quality. Ning Zhang, Virginia Commonwealth University; Wan, Thomas T. H.

This paper investigate the relative influence of institutional mechanisms on the variation in nursing home quality (NHQ) in United States and examine the stability of quality measured by nursing home deficiencies in 1997-2001. Multi-level analysis was performed to examine the predictor variables at both the institutional and market-area levels. Among the three institutional mechanisms studied, coercive mechanism was found to be one of the most dominant factors in determining the quality of nursing homes, which explained 23 percent of the total variation of NHQ. NHQ was disproportionately influenced by the Medicaid reimbursement rate regulations, and market characteristics.

4 : A Pilot Study on Resource Utilization Groups of Nursing Home Residents in Taiwan. Herng-Chia Chiu, Kaohsiung Medical University; Yang, Si-Su; Mau, Lih-Wen.

With the increased demand for long-term care, the nursing home market has grown rapidly in Taiwan. However, the absence of a fair payment system for nursing home care has engendered the difficulty in their operations. The major purpose of this study was to classify the resource utilization groups of nursing home residents, which can serve as a base for the development of case mix index of nursing home residents. Specifically, nursing home resident characteristics were compared by facility region, ownership, and size. Further, the interrelationships between staff working time, resident characteristics, and service utilization were analyzed.

: ME20 **Approximation Algorithms and Interior Point Methods**

Invited Session Room: M35

Chair: Osman Guler
University of Maryland Baltimore County

1 : Approximation Algorithms for Conic Program with Extreme Ray Constraints. Paul Tseng, University of Washington.

Consider a problem of minimizing a linear function subject to linear constraints and a constraint of belonging to an extreme ray of a closed convex cone K. We study approximation algorithms based on relaxing the extreme ray constraint. Examples with K being the semidefinite cone or the second-order cone will be discussed.

2 : Interior-Point Methods on Homogeneous Cones. Osman Guler, University of Maryland Baltimore County.

In interior-point theory, one usually formulates a program as minimizing a linear function over a slice of a convex cone K. Once a self-concordant barrier function for K is at hand, we have a (short-step) interior-point method (IPM). In practice, one is interested in primal-dual and long-step IPM. The nature of the cone K is important here. Homogeneous cones form a large class with a rich theory, and a classification. Computable barriers exist on such cones which satisfy properties suitable for development of long-step IPM. In this talk, we elaborate on various aspects of IPM on homogeneous cones.

3 : Evaluation of Subgradients for the Primal Gap Function of Variational Inequalities and an Application to the Demand Adjustment Problem. Esteve Codina, Universitat Politecnica de Catalunya; Montero, Lídia.

In this paper the use of primal gap functions for variational inequalities for solving bilevel programming problems with equilibrium constraints is addressed. First a sufficient condition is presented so that the Clarke's subgradient of a Lipschitz continuous function can be evaluated by means of partial subgradients. This sufficient condition is shown to be verified by the primal gap function of a variational inequality defined on a polyhedral set and an application is developed for the demand adjustment problem on traffic networks formulated as a bilevel programming consisting in the approximation of the subgradient of the upper level objective function.

4 : A Note on the Existence of Zeroes of Convexly Regularized Sums of Maximal Monotone Operators. Regina Sandra Burachik, The Federal University of Rio de Janeiro; Scheimberg, Susana; Silva, Paulo.

Many algorithms for solving the problem of finding zeroes of a sum of two maximal monotone operators have regularized subproblems of the kind: $0\in T_1(x)+T_2(x)+\partial D(x)$, where D is a convex function. We develop a unified analysis for existence of solutions of these subproblems, through the introduction of the concept of convex regularization, which includes several well-known cases in the literature. Finally, we establish conditions, either on D or on the operators, which assure solvability of the subproblems.

: ME21 **Performance Evaluation and Optimization of Stochastic Models - I**

Invited Session Room: M36

Chair: Stéphane Mocanu
Laboratoire d'Automatique de Grenoble

1 : A Benchmark for Homogenization Methods for Continuous Flow Production Lines. Stéphane Mocanu, Laboratoire d'Automatique de Grenoble.

Performance evaluation of continuous flow production lines by analytical methods has been studied from years by various approaches. We are interested by the so called inhomogeneous lines (i.e. machines with different production rates). The most popular approach for performance evaluation is based on decomposition methods. The homogenization methods try to build an equivalent homogeneous production line before applying the decomposition algorithm. Various homogenization methods actually exist. The purpose of this paper is to propose a benchmarking methodology for homogenization algorithm. This method is based on a new approach to decomposition algorithms, using arrival and service processes analysis.

2 : A New Approach to Buffer Allocation in Production Lines: The Line Balancing Algorithm. Murat Fadıloğlu, Bilkent University; Selvi, Ömer.

Buffer allocation is a challenging issue that needs to be addressed in the design of serial production lines. A good allocation can increase the throughput while keeping WIP under control. Once the total number of buffer spaces -in terms of parts- is fixed, the WIP is bounded by this number. Yet, different allocation of these buffer spaces can significantly affect the throughput of the system. We propose a new approach for this allocation problem based on balancing the throughput of the line with respect to buffer locations. We then report on the performance of the algorithm.

3 : Alternatives to Gradients in Transfer Line Space Allocation. Stan Gershwin, Massachusetts Institute of Technology; Tanizar, Ketty.

We study the optimal allocation of buffer space in a production line. Buffers diminish disturbance propagation by transforming disruptions into buffer level variations. Buffers with more variation should therefore be larger. We use characteristics specific to production lines. Following Meerkov, we investigate the correlation between the gradient of production rate and deviations of average buffer levels from half full and the differences between probabilities of starvation and blockage. We also study the standard deviations of buffer levels in optimized lines, which are strongly correlated with buffer sizes. We investigate using these quantities in the optimization of buffer space allocation.

4 : Optimal Threshold Levels/Hedging Points via Simulation-based Optimization. Gul Gurkan, Tilburg University; Karaesmen, Fikri; Ozdemir, Ozge.

A number of important problems in production control involve optimization of multiple threshold levels or hedging points. We address the problem of finding such levels in a stochastic system whose dynamics can be modelled using generalized semi-Markov processes (GSMP). The GSMP framework enables us to compute several performance measures and their sensitivities from a single simulation. We then use a simulation-based optimization method for finding optimal hedging points; numerical results are reported. Some applications falling into this framework include designing manufacturing flow controllers, using capacity options and subcontracting strategies under demand uncertainty, and production planning throughout the product life-cycle.

: ME22 **Nesting - I**

Invited Session Room: M37

Chair: Julia Bennell
University of Southampton

1 : Solving Nesting Problems with Metaheuristics: A Survey. Jose Fernando Oliveira, FEUP/INESC Porto.

Nesting problems are characterized by the non-rectangular shape of the pieces to cut or pack. This leads to geometric sub-problems, generated by the constraints of no overlap among pieces, hard and time-consuming to solve. For this reason metaheuristics are not the most popular approach to the resolution of nesting problems once they tend to take too much time to produce good solutions. However, being the results promising, effort has been put on the efficient solution of the geometric sub-problems in order to make metaheuristics based algorithms competitive. In this talk a survey on nesting algorithms based on metaheuristics is presented.

2 : Cutting and Packing Problems and Their Solution Approaches. Ramazan Yaman, Balıkesir University; Eid, Sadek; Ergün, Kadriye.

Cutting and packing problems, also known as Nesting Problems, have received attention from different Engineering disciplines. Civil, Mechanical, Electrical, Chemical, etc. and Industrial engineers in particular have focused attention and spent time to solve these types of problems and their derivatives. This study reviews the related basic literature relative to this problem. The study is then followed by an assessment and a classification of the solution approaches that have been offered in literature The study also presents some benchmark problems, the solution methods adopted to reach an optimum solution, as well as a comparison with results obtained from heuristic algorithms.

3 : Combining CLP with Heuristics to Solve Nesting Problems. Antonia Carravilla, FEUP/INESC Porto; Ribeiro, Cristina; Oliveira, Jose Fernando.

In the nesting problem that we are solving, a set of polygonal pieces must be placed over a rectangular plate with a given width, with the objective of minimizing the required length. The search for solutions depends heavily on the order in which pieces are considered to be positioned. The use of heuristics to define input sequences for the pieces, combined with constraint logic programming to generate tight layouts has proven to be a promising approach.

4 : Investigating Local Search Frameworks for the Irregular Stock Cutting Problem. Julia Bennell, University of Southampton.

Local search has been applied to the irregular stock cutting problem under many guises. Each implementation employs a combination of extended search heuristics and problem specific modifications to converge on good solutions. In addition various search frameworks, move types and evaluation functions are implemented. The variety of algorithms with respect to these aspects and others makes it difficult to identify generic features of local search algorithms that work well. This paper builds on the work presented in IFORS 2002 that investigated the relative success of a number of neighbourhood structures using an iterated local search (ILS) framework.

: ME23 **Innovation and Growth**

Invited Session Room: M38

Chair: Thomas Lechler
Stevens Institute of Technology

1 : Commercializing Emerging Technologies. Lois Peters, Rensselaer Polytechnic Institute.

Knowledge management and innovation practices of nanotechnology, biotechnology superconductivity and fuel cell startup firms founded within similar time frames are compared. A network perspective on commercialization of these emerging technologies is taken to identify how different contexts shape knowledge development and opportunities for new organizations and their generation of knowledge to change environments. Our analysis draws on our databases of startup companies in these emerging sectors and interviews with selected firms. The implication of these findings for entrepreneurial organizational populations and paths of technology development and their outcomes are discussed and in turn observations are made about commercial policy.

2 : Risk Analysis for Innovative Market Entries: Results from Computer Simulations. Tobias Krebs, Humboldt-Universität zu Berlin; Schade, Christian.

A number of factors have an impact on so-called new-product diffusion processes. Consumer demand is not easily predictable, and hence a company faces a substantial risk when introducing an innovation. In reality, each individual separately makes the decision whether or not to purchase a new product, and individual decisions are not independent of each others. This study emphasizes agent-based simulations as a method to tackle such problems, in particular the risk inherent in diffusion processes. Different, complex market entry situations are compared through this method. Not only different levels of processes but also different risks emerge.

3 : Exploration or Exploitation? Decision Rules for Entrepreneurs of New Ventures. Moren Levesque, Case Western Reserve University; Choi, Young Rok; Shepherd, Dean.

Entrepreneurs create new ventures to explore and hopefully exploit a newly theorized business opportunity. The decision of when to change focus from exploring its viability to exploiting it impacts a new venture's profitability and its survival chances. Specifically, the uncertainty embedded in the new opportunity is the driving force behind both the new venture's risk of failure and its entrepreneurial rents, and is therefore an important criterion for the decision to begin exploitation. We propose the notion of an uncertainty threshold as the basis for a number of decision rules for deciding when to shift focus from exploration to exploitation.

4 : The Impact of Entrepreneurial Strategies on New Venture Growth. Thomas Lechler, Stevens Institute of Technology; Koeller, Timothy.

Recent literature argues that "any theory of new venture performance should be treated as a special case of strategic management theory". This position is empirically challenged with data of 159 German new ventures by using a novel metric

measuring strategic fit to competitive barriers. The results are: First, greater strategic fit is observed in larger firms operating in slowly growing markets, and requiring little flexibility in their market, innovation and management activities. Second, firms' strategic fit has no significant independent effect on their early sales growth. Our research findings are therefore inconsistent with the position taken in the literature.

: ME24 **Tutorial on Cross Entropy Method for Combinatorial Optimization**

Invited Session Room: L17

Chair: Reuven Y. Rubinstein
Technion

1 : Tutorial on the Cross-Entropy Method for Combinatorial Optimization. Reuven Y. Rubinstein, Technion.

We survey the cross-entropy (CE) method for solving constrained deterministic and "noisy" combinatorial and continuous optimization problems. By "noisy" optimization we mean that each measurement of the objective or/and the constrained functions are corrupted with noise. A typical example of noisy optimization is simulation-based optimization. The CE method transforms optimizes instead of the original problem an associated stochastic one. We present extensive numericall results for various problems, like the travelling salesman problem (TSP), the quadratic assignment problem, buffer allocation problem, clique, which clearly indicate fast convergence and that the CE method has polynomial complexity in the size of the problem.

: ME25 **Health and Related Sector Applications**

Invited Session Room: M34

Chair: Khalid Hafeez
Sheffield Hallam University

1 : Systems Design of a UK NHS Trust Logistics Supply Chain. Khalid Hafeez, Sheffield Hallam University; Al-Qatawneh, Lina.

This paper argues how system dynamics can provide a structured mechanism for analysing health care supply chains using qualitative as well as quantitative tools such as: input-output analysis, conceptual modelling, block diagramming, and computer simulation. A brief introduction the way in which purchasing and supply is approached and organised within the NHS is given. An integrated system dynamics framework (Hafeez et al., 1996) is used to model and simulate the dynamic behaviour of a NHS UK hospital logistics supply chain. Through our analysis a number of redesign strategies and guidelines are extracted in order to improve the operational performance.

2 : Simulation Modeling for Strategy Evaluation in Health Care Organizations: A System Dynamics Approach. Cuneyd Gulut, Akademi Consulting.

Scientific methodology inevitably involves experimentation of hypotheses prior to their implementation in real life. Different branches of science have their own approaches in fulfilling this requirement. In strategic management, computer simulations can be used for this purpose. This study aims at developing a simulation model for use in experimenting proposed strategies in health care organizations. The model is built using system dynamics methodology and is good for evaluating the impact of strategies on strategic-level performance measures. Evaluation of strategies' prospect for success prior to their execution may be critical in minimizing the cost of worthless strategies.

3 : Assessing the Impact of Innovation in Health and Social Care Delivery - A System Dynamics Approach. Steffen Bayer, Imperial College London; Barlow, James; Curry, Richard.

Studying innovative approaches to the delivery of care services in pilot projects gives important insights into their individual cost and benefits. However, their influences on other parts of the care system cannot be captured if innovations are studied in isolation. A system dynamics model can be a powerful tool to explore the feedbacks influencing the tension between systemic and individual/local goals as well as the unintended consequences accompanying innovation implementation in a complex service delivery system. This presentation examines the potential of SD to evaluate the systemic impact of an innovation (telecare) within a local care system.

: ME26 **OR Applications in South Pacific - IV**

Invited Session Room: L10

Chair: Yasuki Sekiguchi
Hokkaido University

1 : Performance Evaluation and Capacity Planning of a Web-Legacy System. Naoki Makimoto, The University of Tsukuba, Tokyo; Sakata, Hiroyuki.

We introduce an approach to capacity planning for a Web c/s system using distributed object technology whose transactions are partly executed on a legacy system. Based on the measurement and simulation under various circumstances, stochastic behavior of the system is first investigated. Then, we construct and analyze a queueing model of the system to evaluate such performance measures as turn around time and throughput. Since the legacy can easily be bottleneck, how processes on the legacy have the effect on these measures is of particular interest.

2 : Allocation and Scheduling in Mixed Model Assembly. Robert Burdett, Queensland University of Technology; Kozan, Erhan.

In mixed model assembly environments where operations are performed manually, a number of important allocation issues arise that affect sequencing and scheduling. These issues are related with the number of work groups, and the allocation of machines and workers to these groups. Large improvements in production efficiency may be possible when these parameters are suitably chosen. This paper provides a mathematical basis and solution techniques for addressing these issues. From a numerical analysis the effect that these parameters have in particular production environment are reported.

3 : Supporting Tour-activity Planning to Promote the Industry in a Tourist Resort. Yasuki Sekiguchi, Hokkaido University; Ueda, Masayuki; Okuda, Kazushige.

In a local tourist resort in Japan, the fact that a major part of visitors was group tours sold by travel agents made profitability

of many tourist traders worse. There is a recent tendency of increasing personal tours in a small party. Moreover, proliferation of information technology and the Internet have made direct marketing to tourists possible. This research briefly introduces a survey of local tourist traders conducted in such a resort, and investigates, in conjunction with promotion of the local economy, how to support personal tourists who plan a tour and activities at each visiting locations.

4 : Circulation-type Vehicle Routing System with Interference: Analysis and Optimization. Hiroshi Kise, Kyoto Institute of Technology; Hu, Guiyan; Kuwata, Joe.

We present a study on operational issues on a circulation-type vehicle routing system in which a fleet of vehicles unidirectionally and repeatedly circulate on a loop with a short cut in order to carry items to stations located along the loop. Some kinds of interferences which may occur between vehicles as the number of vehicles increases and seriously affect the system performances are analyzed and minimized by routing and scheduling.

: ME27 **Risk Management - C1**

Contributed Session Room: L11

Chair: Ioana Popescu
INSEAD

1 : Real Option Valuation for Managing Strategic Decision of the Divestment and Acquisition. Medha Ashtekar, Systems Research Institute; Bose, Dwiraj; Kukade, Swati.

Real Option Valuation is emerging as a new standard for valuing and managing strategic investments. This paper analyses the case study of the acquisition of the chain of hotel properties after divesting funds from the real estate property. The strategic decision of acquisition of chain of assets at the cost of real estate sale was viewed as the series of call and put real options against the usual discounted cash flow method of valuation.The assets were spread across the 17 countries and 41 hotels. Hence we have formulated series of individual options for each asset and examined valuation decision.

2 : Risk-based Model of Project Performance in the Presence of Uncertainty. Zoran Ciric, Univerzitetu u Novom Sadu; Sedlak, Otilija.

This paper examines the concept of the system managing, requirements uncertainty, dynamic changes of the environment and project performances. In this study, the risk is conceptualized as the extent of difficulty in estimating the consequences of the project, regardless of the specific estimation technique used by the project team. The specific estimation technique propose to use fuzzy set modeling to treat the kind uncertainty in estimating performance outcomes which are imprecision, vagueness or linguistic decrypted. While uncertainties increase the difficulty in estimating performance outcomes, risk-based research has repeatedly stressed the negative relationship between the risk and performance.

3 : Optimal Classification for Presenting of Actors' Profiles in Fraud Detection Tasks. Vitaly Podobedov, STB CARD.

The problems of discovering the complex events in a transaction flow through a large transactional system are considered. An approach to creating metrics for the system and its actors is offered. Namely, a metric for an actor is constructed in the form of species or rank distribution received after classifying all actors' transactions. Global optimization task is solved in order to find the classification that provides the most stable distribution (and so the most adequate metric). These metrics are used for describing typical actor profiles, and significant changes in the profile could indicate latent, non-evident risky events, or chances.

4 : Ruin Theory and Decision Making. Konstantinos Terzidis, Technological Institute of Kavala; Papadopoulos, Dimitrios.

This project is trying to combine ruin theory with decision making theory. Although the approach is from a mathematical point of view it will try to minimize uncertainty in decision making situations. An Implementation of the above are shown with an example on insurance companies. As the purpose of an insurance or investing company -generally speaking- company is to make profit from the occurrence of unexpected events e.g. house fire, injury, death, stock market losses, those events need to be predicted with respect to the rate of occurrence and the amount of money that is needed for loses covering.

5 : Optimal Dynamic Effort and Risk Decisions for a Risk-Averse Sales Agent. Ioana Popescu, INSEAD; Kocabiyikoglu, Ayse.

We investigate a dynamic decision problem where in each period a risk-averse sales agent can choose the level of effort and risk of his performance, with the objective to maximize the utility of his final payoff. This extends in two directions the sales force compensation literature, which traditionally focuses on a single period model and where the amount of effort is the agent's sole decision variable. We model the problem as a dynamic program and provide comparative static results regarding the influence of time horizon and past performance on the agents' effort and risk-taking decisions.

: ME28 **Parallel Meta-Heuristics**

Contributed Session Room: L12

Chair: Tatjana Davidovic
Serbian Academy of Sciences and Arts

1 : Parallel VNS for Task Scheduling with Precedence and Communications. Tatjana Davidovic, Serbian Academy of Sciences and Arts; Crainic, Teodor Gabriel.

To increase the power of Variable Neighborhood Search (VNS) heuristic for scheduling tasks with precedence constraints and significant communication delays to different architectures of multiprocessor system we propose several parallel strategies. We report on our implementations and compare the performances of the various strategies.

2 : Parallel Evolutionary Algorithms to Optimize the Configuration of Cogeneration Systems based on Natural Gas. Marco César Goldbarg, Universidade Federal do Rio Grande do Norte; Goldbarg, Elizabeth; Dantas Neto, Francisco.

Cogeneration is the simultaneous production of electricity and thermal energy from a single energy source such as natural gas, although a variety of fuels can be used. To define the

components of a cogeneration system is a hard task. Besides several technical constraints, there are a number of possibilities to organize a viable configuration of a given cogeneration system to meet a given load. This paper compares two parallel evolutionary algorithms to solve the problem of determining the minimum cost viable configuration of a cogeneration system that uses natural gas as its primary source of energy.

3 : Gas Network Pipe Sizing with Evolutionary Algorithms. Elizabeth Goldbarg, Universidade Federal do Rio Grande do Norte; Goldbarg, Marco César; Castro, Melissa.

The design of a gas network involves defining its layout and, having done this, choosing the pipes to be laid. The selection of the types of pipes is a constrained optimization problem with two main restrictions: the pipes should allow the costumer demands to be met or above a minimum design pressure; each pipe (other than those incident to a source) should have at least one upstream pipe of the same or greater diameter. This paper presents an evolutionary approach to this problem and shows that it produces better results than an existing genetic algorithm and an industrial heuristic.

4 : On Merging Sequencing and Scheduling Theory with Genetic Algorithms to Solve Stochastic Job Shops. Ibrahim Alharkan, King Saud University.

Standard GA was modified to address the job shop problem by constraining the genes in the chromosomes during genetic operators implementations. The constrained algorithm improved the average percentage errors by 27.44% when minimizing makespan. Constrained algorithm improved the average percentage errors by 248.77% when to minimizing total tardiness. The stochastic job shop problem was solved using two stochastic constrained GAs to minimize total tardiness. One evaluated chromosomes using probability Gantt charting and the other evaluated chromosomes using simulation. The probability Gantt charting deviated from the true mean for both makespan and average flow time by 3% and 1.7% respectively.

: ME29 **Hazmat - II**

Invited Session Room: L13

Chair: Vedat Verter
McGill University

1 : OptiPath: A Hazmat Routing Model Complying with Risk Acceptability Criteria. Sarah Bonvicini, Università di Bologna; Spadoni, Gigliola.

One way to reduce the risk due to transportation routes consists in sending the flows of hazmat shipments on alternative routes. In order to identify these paths the OPTIPATH procedure has been developed, which allows the determination of the flows of all substances on all network arcs, so to minimise societal risk (though taking into account the economical feasibility of the transport), while complying with acceptability criteria on both individual and societal risk. In this work the theoretical foundations of the OPTIPATH methodology are described and the results of its application to a real area are discussed.

2 : Loss of Containment in Road Tankers Carrying Hazardous Materials. Adrian Gheorghe, ETH Zürich; Birchmeier, Juerg.

This paper concerns a new analytical approach using a detailed Master Logical Diagram, which comprehends all main sequences that lead to an accidental situation, and subsequently to the loss of containment. Such sequences are understood as accident initiating events leading to collision, like cars during overtaking, cars in front reducing speed, cars encountering on crossings, or overtaking, or the suites of a flat tire or a break failure. These sequences are analysed and quantified with a set of event trees including related input data, taking into account a variety of basic events.

3 : An Optimisation Network Flow Model for Hazmat Routing. Pasquale Carotenuto, Consiglio Nazionale delle Ricerche; Giordani, Stefano; Ricciardelli, Salvatore.

One of the main problem in hazmat routing is the generation of alternative paths for each (O,D) pair. These paths must comply with a given threshold of risk acceptability and meanwhile are to be effective with respect to some sort of cost function. Furthermore, a basic requirement is that the paths generated must be sufficiently far off each other. In fact, one must take into account that any accident influences a certain neighbour area around it. In this paper we propose an optimisation network flow model to find for any (O,D) pair a set of least-cost dissimilar paths.

4 : Designing Emergency Response Systems for Hazmat Transport. Vedat Verter, McGill University; Berman, Oded; Kara, Bahar.

We present a model for determining the optimal locations for emergency response teams that specialize on dangerous goods accidents. The model extends the coverage concept to incorporate possible accidents at any point on the transport network. Computational results with real data will be provided.

: ME30 **Artificial Intelligence, Expert Systems and Neural Networks - C1**

Contributed Session Room: L14

Chair: Jorge Valenzuela
Auburn University

1 : Neural Networks and Bankruptcy Prediction. Rochdi Feki, Sfax Graduate Business School; Khoufi, Walid.

Bankruptcy prediction has developed a large number of techniques aimed at helping decision makers. The multivariate statistical models are generally applied in this field despite their insuffiencies and the problems that they create. In overcoming these problems, the tools provided by artificial neural networks have shown that they are the most appropriate for bankruptcy prediction. The aim of this paper is to present the neural networks techniques and their advantage in bankruptcy prediction. We put forward a comparison between the classic model using discriminate analysis and the neural networks technique.

2 : The Use of Prior Information in the Updates of Kohonen Type Clustering Algorithms. Kerem Özkısacık, Boğaziçi University; Altınel, İ. Kuban; Aras, Necati.

Over the past two decades, an enormous amount of work has been done in designing new applications of Kohonen's self-organizing map (SOM). In this paper we concentrate on clustering

and introduce two new self-organizing neural networks: RSOM and KNIES Cluster. The primary difference between them and the SOM is the fact that they both consider prior information learned from data in their updates. RSOM incorporates the dissimilarity measure estimated from the data, which is a deviation from using squared Euclidean metric, in its update equations. KNIES_Cluster extends further a recently introduced scheme, which incorporates centroid of data vectors in neighboors' updates.

3 : EvolLP: Evolving Constraints for Integer Linear Programming Problems. Nikola Nikolov, University of Limerick; O'Neill, Michael; Tarassov, Alexandre.

We study the application of Genetic Programming (GP) to the generation of Integer Linear Programs (ILPs) which model the discrete solution space of an NP-hard Combinatorial Optimisation (CO) problem as precise as possible. Normally, an NP-hard problem can be easily represented by an ILP and there are a number of well-studied approaches to solving ILPs. However, their efficiency greatly depends on the set of linear constraints involved in the ILP. A good set of constraints is typically very hard to obtain and requires long-term research effort. GP is a promising technique for automated generation of efficient ILP models.

4 : Scheduling Thermal Generating Units using Particle Swarm Optimization. Jorge Valenzuela, Auburn University; Balci, H. Hakan.

This presentation shows that the use of Particle Swarm Optimization (PSO) is effective and efficient for solving unit commitment problems (UCP) in electric power systems. UCP is to determine a minimal cost turn-on and turn-off schedule of a set of electrical power generating units to meet demand for electricity while satisfying a set of operational constraints. PSO is a population based search algorithm, which is motivated from the simulation of social behavior in order to manipulate the individuals towards better solution areas. The algorithm has been tested with several problem sizes.

: ME31 **Strategic Management - I**

Invited Session Room: M33

Chair: Maureen Meadows
University of Warwick

1 : Diagnosis of Performance Measurement Practices -The Case of Airline Industry. Jae H. Min, Sogang University.

The purpose of this paper is to diagnose performance measurement practices of airline industry and suggest useful guidelines to make their measurement system aligned with their strategy. To serve this purpose, we design structured questionnaire to survey their current measurement practices from various view points, and employ gap analyses such as alignment analysis, congruence analysis, consensus analysis, and confusion analysis to identify the points to improve their performance measurement system.

2 : A Three Dimensional Fuzzy Strategic Vulnerability Assessment Analysis. Javad Jassbi, I.A.U. Science & Research Campus; Khanmohammadi, Sohrab; Radfar, Reza; Hajiha, Ali.

In this paper a new methodology based on fuzzy logic is introduced for strategic analysis and decision making in large scale systems. In traditional vulnerability assessment analysis, the critical point of systems is distinguished from other situations based on two major factors, the impact and the ability to react. In this paper the probability of threat is also considered as the third dimension for analyzing the vulnerability of organizations in the presence of threats. The fuzzy surface of the situation of system is plotted for a case study and analyzed from the view point of endanger.

3 : Bridging Tie Decay and the Sustainability of Network-based Competitive Positions. Stan Li, University of Alberta; Rowley, Timothy.

This study is motivated by two insights from prior research: In many contexts, interfirm bridging ties create firm-level competitive advantage; and bridging ties, at the individual level, tend to weaken and dissolve more quickly than non-bridging ties. We argue and find evidence from a longitudinal study of the U.S. investment banking industry that interfirm bridging ties decay relatively quickly suggesting network-based advantages are not sustainable. However, our results also suggest that three factors - past success, bridging tie experience and role heterogeneity - dampen this decay rate by increasing the partners' economic incentives, awareness of network benefits and trust, respectively.

4 : On the Economics of OR/MS Consulting. Yanni Papadakis, Drexel University.

The economics of Operations Research / Management Science (ORMS) consulting projects is investigated with an emphasis on the institutional barriers to the implementation of these business planning studies, that require disparate skills and thus may be performed more cost-effectively by more than one party. A basic understanding of ORMS procedures by the management of organizations commissioning the planning study is shown to increase the likelihood of ORMS projects taking place. The implications of this paper about the profitability of ORMS services and the determinants of major consulting firms adopting ORMS as their main business planning service are also interesting.

5 : Combinatorial Options: Managing Technology Portfolios through Flexibility, Diversity and Synergies. Ozgur Gurtuna, Concordia University / Futuraspace.

In recent years, the real option valuation method has emerged as a promising tool for planning and managing technology development. There have also been significant developments in portfolio-based methods. However, when it comes to integrating the real options framework with portfolio management, there seems to be a gap in the literature. By modeling technology management as a combinatorial optimization problem and using real options as the basic method of analysis, an integrated framework for technology management is proposed: combinatorial options (or comboptions). The theoretical and practical implications of this framework are presented, focusing on flexibility, diversity and synergies.

: TA01 **Routing in Telecommunication and Traffic Networks**

Tutorial Room: MB I

Routing in Telecommunication and Traffic Networks. Rolf H. Möhring, Technische Universität Berlin.

Networks, such as telephone networks, the Internet, airline, railway and bus networks are omnipresent and play a fundamental role for communication and mobility in our society. We almost take their permanent availability, reliability, and quality at low cost for granted. However, traffic jams, ill-designed train schedules, canceled flights, break-downs of telephone and computing networks, and slow Internet access are reminders that networks are not automatically good networks. In fact, designing and operating communication and traffic networks are extremely complex tasks that involve many OR-type problems. The increasing use of existing networks and the resulting capacity problems have led to the development of new methods for "optimizing" network usage. This lecture will give an overview on such network optimization methods in telecommunication (reliable networks) and traffic (route assignment under rush hour conditions). The common methodological themes in these applications are complex multicommodity flows and dynamic flows.

: TA02 Group Decisions and Intergenerational Equity

Tutorial — Room: MB II

Group Decisions and Intergenerational Equity. Rakesh K. Sarin, The Anderson School at UCLA.

In this presentation, we focus on group decisions where a group of individuals or a committee collectively shares the responsibility for choosing among alternative proposals for action. Individuals or committee members may have different views on the relative merit of each proposal. Therefore, the problem boils down to how one should aggregate the preferences of the committee members to arrive at a preferred decision. We propose an approach and hint at possible applications. In the second part of the presentation, we focus on those decisions where equity and fairness are paramount in the group's choice of a preferred decision. Some suggestions for incorporating equity and fairness in-group decisions are offered. Some issues with decisions that involve consequences deep into the future are highlighted.

: TA03 Financial Engineering

Tutorial — Room: MB III

Financial Engineering. Salih N. Neftçi, City University of New York and University of Reading.

Financial engineering is the application of synthetic asset creation or, of replicating portfolios to solving real world problems. These problems fall into several categories and the methods to be applied follow some clear principles. In this tutorial we present a general overview of these methods and provide the minimum formal modeling that one needs as a common ground to solving these problems.

: TA04 Quadratic Assignment and Network Design

Invited Session — Room: JB A

Chair: J. MacGregor Smith
University of Massachusetts at Amherst

1 : A Level-1 Reformulation-Linearization Technique Bound for Solving the Axial 3-Dimensional Quadratic Assignment Problem. Peter Hahn, University of Pennsylvania; Hightower, William.

We introduce the axial 3-dimensional quadratic assignment problem (Q3AP) and propose a level-1 reformulation-linearization technique (RLT) lower bound for its exact solution. The technique has its roots in the level-1 RLT of Adams and Sherali. Our implementation is a generalization of the dual ascent procedure we developed for the QAP. In this paper, we demonstrate its usefulness in a branch-and-bound algorithm, specifically designed to exploit the RLT properties of the calculation. The results achieved on test problems of size 8, 12 and 16 again demonstrate the effectiveness of RLT methods.

2 : Packet Scheduling with Smart Antennas: Models and Algorithms. Federico Malucelli, Politecnico di Milano; Amaldi, Edoardo; Capone, Antonio.

Smart antennas are used in third generation wireless systems. A smart antenna can be viewed as a set of co-located directive antennas whose orientations can be adapted (via software) according to users positions. We investigate combinatorial optimization problems arising in packet scheduling with smart antennas. The users are distributed within the area covered by a smart antenna and each user has a set of packets to be transmitted. One problem consists in selecting a maximum user subset whose transmissions do not interfere one another. Another problem is to partition the users into the minimum number of subsets of non-interfering transmissions.

3 : Optimal Buffer Allocation in Finite Closed Queueing Networks with Multiple Servers. Mustafa Yuzukirmizi, University of Massachusetts at Amherst; Smith, J. MacGregor.

We study the problem of allocating a finite number of buffers in a closed queueing network with multiple servers, production blocking and an arbitrary topology. The problem is formulated as stochastic, nonlinear integer program with the objective of optimizing a cost function of system throughput, cycle time and number of buffer spaces. The performance measures are calculated numerically using two approaches: the first methodology is an extension of the well-established Expansion Method for finite queues. The second methodology is based upon approximate Mean Value Analysis algorithm. Results obtained from these methods are used to solve the optimal buffer allocation problem.

: TA05 Freight Transport Management

Invited Session — Room: JB B

Chair: Jacek Zak
Poznan University of Technology

1 : Identification of the Most Important Quality Evaluation Characteristics of Freight Transportation Systems. Piotr Sawicki, Poznan University of Technology; Zak, Jacek; Kicinski, Marcin.

The procedure of defining a comprehensive set of characteristics

(both criteria and attributes) applied to evaluate the quality of freight transportation systems is presented. In the first step of the procedure, the questionnaire survey is carried out to identify the characteristics that, in customers' opinions, influence on quality of transportation systems. Customers' expectations regarding the values of those characteristics, are also determined. In the second step, using the rough sets concept, based on indiscernibility and dominance relations, the equivalent subsets of characteristics (reducts) and their intersection (core) are generated. A thorough analysis of the reducts is carried out.

2 : Computer-based Method for the Optimal Strategic Fleet Management in Freight Transportation Companies. Adam Redmer, Poznan University of Technology; Zak, Jacek.

The paper presents a computer-based method focused on solving fleet replacement and fleet composition problems. The problem is formulated in terms of bi-criteria (operational profit and efficiency of replacement) combinatorial optimisation. The decision consists in assigning particular vehicles to transportation jobs. The company's own and hired vehicles (trucks, trailers, semi-trailers) are considered. The problem is solved by a two-step procedure. In the first step a multiobjective metaheuristic method is applied to generate a sample of Pareto-optimal solutions. In the second step this sample is reviewed and the most satisfactory solution is selected with an application of an interactive MCDA method.

3 : Modelling Rail-Rail Exchange Operations in the Intermodal Hub-and-Spoke Freight Transport Networks by using Queueing Networks. Yvonne Bontekoning, OTB Research Institute; Janic, Milan.

A lot of efforts have been made to improve railway operations, particularly those in shunting yards. Recently, the new rail-rail terminals have been designed with the aim to replace "classical" shunting operations and thus improve performance of the rail freight hub-and-spoke networks. At these new terminals, instead of decomposing trains and shunting rail wagons, standardised load units such as containers, swap bodies and semi-trailers are transhipped between trains of fixed configuration. The paper aims at developing a queueing network model for analysing and comparing the rail classical shunting and terminal operations in the scope of the rail hub-and-spoke networks.

4 : Quantitative Methods for Evaluation of Safety in Railway Operation: A Critical Analysis. Stefano Impastato, Università degli Studi di Roma "La Sapienza".

Risk assessment needs, on one hand, a high knowledge of the system to analyze, on the other hand, the creation of general and appropriate strategies and procedures for safety analysis. This paper concerns the results of a research on the present status specifically aimed to give methodological suggestions usable for the evaluation of the safety in railway operation and, specifically, in station management. The main activities of this research are: evaluation of risk and safety: human behaviours, operational, functional and infrastructural factors; analysis of potential conflicts between train routes; identification of measures for risk reduction.

: TA06 **Scheduling - I**

Invited Session Room: M30

Chair: Chris Potts
University of Southampton

1 : On Extension of Lawler's Result for the Traveling Salesman Problem. Valery Gordon, United Institute of Informatics Problems; Demidenko, Vitali; Proth, Jean-Marie.

A system of linear inequalities is described that defines a specific cone K in matrix space and represents set of matrices for which a solution to the assignment problem with one fixed assignment gives an upper bound for the optimum of the traveling salesman problem (TSP). This allows to extend the result obtained for the TSP on strictly-upper-triangular matrices for which Lawler (Math. Programming, 1971) proved polynomial solvability of the TSP: we show that the TSP is polynomially solvable on the matrices of linear subspace of cone K and this subspace includes as a subset all strictly-upper-triangular matrices.

2 : Minimizing the Weighted Number of Tardy Jobs on a Two Machine Flowshop. Bob Bulfin, Auburn University; M'Hallah, Rym.

In this paper, we describe an exact algorithm to solve the weighted number of tardy jobs two-machine flow shop scheduling problem. The algorithm uses branch-and-bound; a surrogate relaxation resulting in a multiple- choice knapsack provides the bounds. Extensive computational experiments indicate problems with 100 jobs can be solved quickly.

3 : Scheduling Arriving Aircraft on Runways at an Airport. Adam Brentnall, The University of Southampton; Potts, Chris; Drew, Alan; Cheng, Russell.

This paper considers the problem of scheduling the landing of aircraft on runways, where aircraft must respect minimum separation distances based on their weight. Several polynomial-time dynamic programming algorithms are proposed for determining optimal landing sequences. Dynamic programs are developed to sequence aircraft out of holds onto several runways for any regular objective function. Dynamic programs are also developed to sequence aircraft onto a single runway based on their release dates to minimize makespan and total tardiness (assuming each job's release and due date are the same). The algorithms are applied to a discrete-event simulation model of Stockholm Arlanda airport.

4 : The Coordination of Scheduling and Batch Deliveries. Chris Potts, University of Southampton; Hall, Nicholas.

This paper considers several single and identical parallel machine scheduling problems where deliveries are made in batches and the aim is to minimize the overall scheduling and delivery cost. This is achieved by forming batches of orders, each of which is delivered from manufacturer to customer in a single shipment. Since batching is undertaken for purposes of delivery, the scheduling cost of a job is determined by the delivery time of the batch which contains that job. For many combinations of scheduling and delivery cost, we provide efficient algorithms or we show that the problem is intractable.

: TA07 **Spare Parts Management - I**

Invited Session Room: M31

Chair: Geert-Jan van Houtum
Eindhoven University of Technology

1 : A Multi-Item Spare Parts Inventory Model with Customer Differentiation. Bram Kranenburg, Eindhoven University of Technology; van Houtum, Geert-Jan.

An Original Equipment Manufacturer (ASML) keeps many expensive spare parts on stock in local warehouses, from where customers with different target service levels are being served. A multi-item, single-stage inventory model with critical-level policies is formulated for this real-life problem. For this model, we determine an optimal solution, together with an efficient algorithm.

2 : Tool Control for a Two-Echelon Repair. Jan Van Der Wal, Eindhoven University of Technology; Curseu, Alina; Rosca, Natalia.

ASML has service contracts specifying service levels for repairs. Repair tools are expensive, so repairmen cannot have their own tools. Tools are available in the local warehouse, a neighbouring warehouse or the central warehouse. We discuss a model for the tool stocking policy in the local warehouses.

3 : Algorithms for Pooling Inventory with Linear Transportation Costs. Kathryn Caggiano, University of Wisconsin-Madison; Jackson, Peter; Muckstadt, John; Rappold, James.

We consider a problem of assigning customers to service locations to fulfill demands for service parts. Safety stock holding costs and transportation costs are significant. The location-dependence of the transportation costs makes the problem difficult, and we discuss practical heuristic approaches.

4 : Spare Parts Control using SAP R/3 in a Petrochemical Plant: A Case Study. Rommert Dekker, Erasmus University Rotterdam.

In this presentation we discuss the result of a study aimed at optimising the use of SAP R/3's modules for spare parts control in a petrochemical plant. We first present the methods available in R/3 and next investigate how they can be used best. Moreover, we present results from experiments using real data concerning the performance of the methods. Forecasting will be discussed shortly as we concentrate on lot sizing and re-order levels.

: TA08 Facilitation, Collaboration and Distributed Decision Making

Invited Session Room: M32

Chair: Jürgen van Grinsven
Delft University of Technology

1 : An Agent-based Model for Co-Operative Water Management in the Orb Valley. Annabelle Boutet, Cemagref IRMO; Barreteau, Olivier; Garin, Patrice.

An interactive process was used to design Phylou, an agent-based model for water and pesticides management in the Orb valley, France. Three categories of stakeholders - researchers, basin managers and local users, including wine-producers - were active participants. We analyse the effectiveness of participatory modelling in this development process. "Collaborative Risk Management"

2 : Success Isn't All It's Cracked up to Be - Case Studies of Two Distributed Teams. Rodney B. Jarman, Curtin University of Technology.

Two distributed teams were studied over six-months. The cases indicate that working in distributed mode can be problematic if team work issues are not addressed and a technological focus adopted. The results are compared to an existing framework (Tung & Turban, 1998). Some additions to the framework are suggested.

3 : Intelligent Facilitation in Distributed Asynchronous Small Group Decision Making. Georgios P. Papamichail, Athens University of Economics and Business.

This paper discusses the effects of intelligent facilitation on asynchronous group decision making in the case of small groups performing complex intellectual tasks. It begins with the architecture and characteristics of distributed group decision support tools that incorporate intelligent features in a case-based reasoning mediated memory, permitting the uniform and consistent coordination of group activity over time and space. Then it presents a real world study in which a small group performs complex decision tasks in network management. Finally it discusses the findings and implications of this approach concluding with future research issues.

4 : Critical Context for Decision Making: An Approach based on a Cooperative Decision Support System. Guy Camilleri, Institut de Recherche en Informatique de Toulouse; Soubie, Jean-Luc; Zaraté, Pascale.

The idea of this work focuses on decision making situations in which the context of the decision is completely unusual. The problem is no more to make the satisficing decision but to make the least bad decision. The objective is to show that the re-planning mechanism can find a collaborative approach to solve unknown problems.

: TA09 Bounded Rationality and Marketing Strategy

Invited Session Room: L15

Chair: Ganesh Iyer
Haas School of Business

1 : A Cognitive Hierarchy of One-Shot Games. Teck Ho, UC, Berkeley.

Strategic thinking, best-response, and mutual consistency (equilibrium) are three key modelling principles in noncooperative game theory. This paper relaxes mutual consistency to predict how players are likely to behave in in one-shot games before they can learn to equilibrate. We show that our model predicts better than Nash across 80 experimental samples of matrix games, entry games, mixed-equilibrium games, and dominance-solvable p-beauty contests. The CH model also has economic value because subjects would have raised their earnings substantially if they had best-responded to model forecasts instead of making the choices they did.

2 : Limited Memory and Market Competition. Ganesh Iyer, Haas School of Business; Pazgal, Amit; Chen, Yuxin.

This paper investigates the effects of limited consumer memory on price competition. In the model a set of consumers (who search between firms) are unable to perfectly recall the prices they observe in a store. They can only assign the prices into categories and remember the average category price. When consumers optimally choose the cutoffs between the memory categories, we find that the optimal memory partitions for the consumers imply finer categorization towards the bottom of the price distribution. We find that even with few memory categories the expected price charged is very close to the perfect recall case.

3 : Voluntary Payments for Information Products. Jose Silva, Haas School of Business.

In this paper we show that reliance on voluntary payments is a feasible way of monetizing online content for some distributions of value of said content. We develop an analytical model based on a sequential-move incomplete-information extension of Rabin's Fairness Equilibrium concept . Our model predicts that consumers' preferences for fairness reduce the monopoly price for sellers. We characterize the distributions of value of content for which the seller is better off relying on a posted price and those distributions for which the seller is better off relying on voluntary payments.

: TA10 Inventory Control and Reverse Logistics - II

Invited Session — Room: L19

Chair: Karl Inderfurth
University of Magdeburg

1 : Analysis of Inventory Systems under Signed Demand. Roelof Kuik, Erasmus Universiteit.

Inventory management under item returns has been attracting much attention of late. A special case of item returns is one in which (part of) returns can be re-used without much processing or delays. In that case the inventory level is driven by the resultant of demand and returns. The resultant of demand and returns is referred to as signed demand. The presentation shows that by splitting inventory signed demand models can often be reduced to conventional models with (nonnegative) demand only. Applicability, advantages and disadvantages of this 'inventory splitting' technique will be discussed.

2 : Inventory Control with Product Returns: The Impact of (Mis)Information. Erwin van der Laan, Erasmus University Rotterdam; de Brito, M.

Product returns are often characterized by a dual uncertainty on time and quantity. In the literature on inventory management with product returns, best forecasts have been associated with methods that use the most information regarding product return history. In practice however, data is often scarce and unreliable. In this presentation we investigate the impact of (mis)information on inventory performance.

3 : Economic Implications of Refurbishing Concepts in an Integrated Product Policy. Wiebke Stölting, Technical University of Braunschweig; Spengler, Thomas.

Considering the economic potential of closed-loop supply chains and the increasing recognition of an Integrated Product Policy, the development and implementation of measures concerning product related environmental protection is encouraged. A far reaching instrument is the take-back and refurbishing of discarded products in order to extend their useful life and to decrease disposal. This contribution focuses on the support of the producer concerning the strategic question if and for which products he should implement a refurbishing strategy. The developed economic evaluation instrument is based on the Life Cycle Costing approach extended by essential aspects of closed-loop supply chain management.

4 : Closing the Loop: Environmental Software for Decision Making at a Product End of Life. Beatriz González, University of Oviedo; Díaz, Adenso.

Waste represents the loss of both material and energy resources. Therefore, the increasing waste generation rates characterising most of the countries represents a symptom of lack of efficiency in product consumption, manufacturing and design. In this paper, a program (CTL) is presented for helping designers and manufactures to fulfill future environmental requirements. The program will select the optimum end of life strategy for each part of a product, having as bases its graphical CAD/CAM representation and a set of criteria related to cost, benefit, available resources and time.

: TA11 Applications on the Financial Sector

Invited Session — Room: R20

Chair: José Manuel Pastor
Universidad de Valencia e IVIE

1 : Using Stochastic Dominance Criteria in Data Envelopment Analysis of Mutual Funds: The Case of Environmentally Responsible Funds. Timo Kuosmanen, Wageningen University.

This paper links Data Envelopment Analysis (DEA) approach to assessing efficiency of mutual funds to the recent developments in the theory of Stochastic Dominance (SD). We show how measures of SD portfolio efficiency can be decomposed using DEA frontiers to the effects of transaction efficiency and diversification efficiency. We illustrate the approach by an empirical application to a sample of US based mutual funds to compare whether environmentally responsible mutual funds differ from traditional equity funds in terms of their portfolio efficiency.

2 : Productivity Growth in Transition Economy Banking: A Distance Function Approach. Meryem Duygun Fethi, University of Leicester; Jackson, Peter M.; Weyman-jones, Thomas G.

This study is focused on the performance of Turkish commercial banking industry over the period of 1992 to 2000. The panel includes both state owned and private banks, which allows us to review the comparative performance of both types of institutions. The empirical measurement in the paper is based on distance function estimation, in particular, the comparison of a time-varying stochastic parametric distance function with the DEA nonparametric model. Conventionally, the DEA nonparametric estimation has been the basis of Malmquist productivity index measurement. This paper however, uses both methodologies in measuring banking efficiency and productivity growth.

3 : Comparative Efficiency Analysis of Portuguese Bank

Branches. Maria Portela, Universidade Catolica Portuguesa; Thanassoulis, Emmanuel.

The advent of Internet banking and phone banking is changing the role of bank branches from a predominantly transaction-based one to a sales-oriented role. We report on an assessment of branches of a Portuguese bank in terms of their performance in their new roles in three different areas: Their effectiveness in fostering the use of new transaction channels such as the internet and the telephone, their effectiveness in increasing sales and their customer base, and their effectiveness in generating profits. We have used DEA for the assessment, departing from the basic models to accommodate non-radial and non-oriented measures of performance.

4 : Cost Efficiency and Specialisation in European Banking: Composition and Intra-Specialisation Effects. José Manuel Pastor, Universidad de Valencia e IVIE; Serrano, Lorenzo.

This study analyses the cost efficiency of the European banking systems into the part due to the composition of specialisations and the part due to inefficiencies specific to the firms within their specialisation. The methodology consists is based on the non-parametric DEA technique and cluster analysis. The results show the existence of high inefficiencies. However, the intra-specialisation inefficiencies indicate that the inefficiencies are much smaller when the effect of productive composition is discounted. This effect is much more evident in those banking systems specialising in the more costly types of business (retail banking) because their composition inefficiency is higher.

: TA12 **Graph Applications**

Invited Session Room: M39

Chair: Alessandro Agnetis
Università di Siena

1 : A Simple Mixed-Integer Set Related to Network Design. Oktay Gunluk, IBM Research.

We study a simple mixed-integer set related to network design. This set can be considered as a combination of the fixed-charge set introduced by Padbeg et. al (1985) and the "arc design set" introduced by Magnanti et. al. (1993). We present polyhedral results, discuss the separation problem and present computational results.

2 : Mean Completion Time Minimization as a Graph Ordering Problem. Fabrizio Marinelli, University of L'Aquila; Arbib, Claudio; Flammini, Michele.

Consider an m-job scheduling problem where each job requires two (out of n) unit-time operations to be done in any order, and let the completion time of a job be the time when the second operation is over. We want to find an order of the n operations that minimizes the average completion time. We formulate the problem in terms of graph ordering, prove its NP-hardness and provide a 2-approximate algorithm. We also investigate properties of optimal solutions, devise a branch-and-bound algorithm and compare it to variants of tournaments 0-1 linear programming formulations.

3 : Optimal Allocation of Customers to Centres with Linear Transportation Costs. Carlo Filippi, University of Padova; Romanin-Jacur, Giorgio.

Consider a minimum cost districting problem where customers and facilities are located at given points. Each customer shall be assigned to one facility, implying a transportation cost proportional to the customer request. Each facility pays a cost which is a convex function of the sum of assigned requests. Several applications are reported. For this strongly NP-hard problem, a binary nonlinear programming model is proposed and solved by a branch-and-bound procedure, where every sub problem with relaxed integrality constraints is solved by generating cutting planes arising from the underlying transportation structure. Computational experience reveals short computing times for actual size instances.

4 : The Dominating Trail Problem: Algorithms and Applications. Paolo Detti, Università di Siena; Agnetis, Alessandro; Meloni, Carlo.

This talk addresses the problem of finding a set of pair wise edge-disjoint trails that altogether dominate the edges of a graph, i.e., such that each edge has at least one end vertex on some trail. This problem is known in literature as the Dominating Trail Set problem. Here we address the problem of finding Dominating Trail Set of Minimum cardinality (MDTS). Such problem is known to be NP-complete for general graphs and even for bipartite graphs. Different well-solvable cases of the MDTS problem are reviewed and a heuristic approach for general graphs is presented, along with some computational results.

: TA13 **Pricing and Revenue Management - II**

Invited Session Room: R21

Chair: Hayri Onal
University of Illinoiss at Urbana-Champaign

1 : Multiservice Loss Networks: From Pricing to Distributed Resource Allocation. Yannis Paschalidis, Boston University.

We consider arbitrary networks where arriving sessions request resources from a sequence of links (route of the session) and are rejected if these resources are not available. Such models can represent a variety of systems: communication networks the Internet, networked control systems, sensor networks, etc. We explore the use of pricing as means of either revenue maximization or welfare maximization. We provide simple to implement policies that are asymptotically optimal in a certain limit of large networks. In the welfare maximization case, our policies yield decomposition results that lead to distributed and asynchronous implementation.

2 : A New Resource Formulation of Multi-Product Revenue Management Problems. Costis Maglaras, Columbia University; Meissner, Joern.

In this talk we describe a new formulation for multi-product revenue management problems that provides new structural and computational insights. Roughly speaking, we show that rather than formulating such problems in terms of the high-dimensional product pricing strategies, one can equivalently formulate it in terms of the lower-dimensional aggregate rates at which all products together consume capacity. This formulation is algorithmically simpler, and highlights the essential features

of good pricing/allocation policies. Finally, this resource formulation is extended to network revenue management problems.

3 : A Bilevel Model of Revenue Management: Modeling and Computational Issues. Patrice Marcotte, Universite de Montréal; Savard, Gilles; Côté, Jean-Philippe.

We consider a model for revenue optimization that takes explicitly into account the rational behaviour of customers with respect to price schedules set by the leader company and its competitors. On the surface, the infinite-dimensional, non-convex structure looks intractable. However, we show how a hybrid approach based on non-differentiable and combinatorial optimization offers hope of solving to near-optimality real-life instances that occur in the airline industry.

4 : Pricing with Explicit Consideration of Customer's Response: A Bilevel Programming Study. John Hibbard, Pioneer Hi-Bred International Inc.; Onal, Hayri.

This paper presents a bilevel programming approach to optimal pricing of multiple seed hybrids produced and marketed by an agribusiness firm. Different prices and agronomic traits influence the customer's purchase decisions. The firm's pricing problem is formulated as a hierarchical optimization model. The farm-level decision problem is replaced by the optimality conditions and by using linearization and approximation techniques the bilevel program is converted into a computationally convenient linear mixed-integer program. The paper also presents an empirical application of the methodology.

: TA14 **AHP/ANP and Applications**

Invited Session Room: R22

Chair: Birsen Karpak
Youngstown State University

1 : Analytic Network Process and Applications to Business and International Conflicts. Mujgan Sagir Ozdemir, Osmangazi University.

The Analytic Network Process is a general framework for a comprehensive analysis of societal, governmental and corporate decisions. It allows both interaction and feedback within clusters of elements and between clusters. Such feedback best captures the complex effects of interplay in human society, especially when risk and uncertainty are involved. This paper addresses the difficulties and important concepts that need to be considered in ANP applications. As case studies the inter-organizational coordination in response to extreme events (such as the September 11 attack) in a dynamic way and the relations between Turkey and EU are analyzed by using the ANP.

2 : The Impact of Information Load and DSS Use on Errors and Decision Quality. Antonie Stam, University of Missouri; Dennis, Alan; Williams, Michael; Aronson, Jay.

The authors examine the effect of information load and DSS use on the decision maker's error patterns and decision quality. The DSS used in our experiments is the Expert Choice (EC). Our experiments do not support the assumption that the use of a DSS improves decision quality. We find that, whereas a DSS can help decision makers develop a better understanding of a decision problem and can reduce logical error, it is also susceptible to introducing accidental effects. Specifically, in one of our two experiments the accidental effects outweigh the benefits of using a DSS, leading to lower quality decisions.

3 : An Application of Analytic Hierarchy Process: A Case in Vendor Selection Decisions. Birsen Karpak, Youngstown State University; Bayazit, Ozden.

Selecting suppliers is perhaps one of the most important activities performed by companies. Supplier selection decisions usually are complex by the fact that various selection criteria must be considered. The main purpose of this research is to show how the Analytical Hierarchy Process (AHP) may be used as a decision tool for supplier selection problems. In this study an AHP model will be proposed to choose the best supplier and place the optimum order quantities among lime suppliers based on a research at a Turkish Construction Company.

: TA15 **Rich Vehicle Routing Problems - II**

Invited Session Room: R23

Chair: Geir Hasle
SINTEF Applied Mathematics

1 : Maximizing the Value of a Satellite Mission: A Variant of the Selective Traveling Salesman Problem. Gilbert Laporte, HEC Montréal; Cordeau, Jean-Francois.

As satellites orbit the earth they must take photographs of precise areas at the request of customers. each day planners must decide which requests should be accomodated in order to maximize the total value of the mission for that day. Various constraints are imposed on the sequencing and combinations of these requests, and the objective is non-linear. The problem can be viewed as a variant of the Selective Traveling Salesman Problem Problem. The problem is formulated as an integer non-linear program and solved by means of a tabu search heuristic. Computational results are provided.

2 : Multidimensional Tariffs for Less-Than-Truckload Routing Services. Wout Dullaert, University of Antwerp; Bräysy, Olli; Hasle, Geir.

Good estimates of the incremental cost of customers or customer types are essential for pricing routing services. After all, the additional cost of servicing a customer acts as a price-floor. It can be estimated by comparing the routing costs of the vehicle routing problem with the customer included to the one excluding the customer under consideration. First, a number of cost determining strategies based on a recent local search heuristics are presented to efficiently estimate the incremental costs. Second, the cost estimates are combined with cost drivers and demand information to design a multidimensional tariff.

3 : Online Dispatching of Service Vehicles. Sven Krumke, Konrad-Zuse Zentrum fuer Informationstechnik, Berlin; Rambau, Joerg; Torres, Luis.

The German automobile club ADAC (Allgemeiner Deutscher Automobil-Club) maintains a heterogeneous fleet of service vehicles in order to assist people whose cars break down. The current manual dispatching process is now subject to automatization. The goal of the optimization is to provide for a good quality of service and low operational costs. The dispatching

problem is an online-problem, i.e., decisions have to be made before complete information is available. We describe the design and the analysis of online algorithms for the dispatching problem. We also provide first computational results of a prototype system which is currently being evaluated.

4 : Optimizing the Collection and Transport of Urban Solid Wastes in a Metropolitan Municipality in Greece. Avraam Karagiannidis, Aristotle University of Thessaloniki; Papadopoulos, Agis; Georgiou, Andreas; Tsiotras, George.

This paper presents a study aiming at optimizing the allocation of human and material resources used in the management of urban solid wastes at the municipality of Thessaloniki, Greece. The results of an extended field survey were used to determine typical profiles for the use of personnel and tracks, which were then subjected to an optimization of the collection routes in the different collection districts. Respectively, a crew rostering model for the deployment of personnel was developed using integer linear programming. It was applied under different scenarios for improving the shift design and the overall functionality of the system.

: TA16 **Advanced Topics in Project Scheduling**

Invited Session Room: R27

Chair: Erik Demeulemeester
Katholieke Universiteit Leuven

1 : Review of Project Scheduling Under Uncertainty. Willy Herroelen, Katholieke Universiteit Leuven; Leus, Roel.

Most research efforts in project scheduling assume complete information about the scheduling problem to be solved and assume a static deterministic environment within which the pre-computed baseline schedule (predictive schedule) will be executed. However, in the real world, project activities are subject to considerable uncertainty, that is gradually resolved during project execution. In this survey we review the fundamental approaches for project scheduling under uncertainty: stochastic project scheduling, scheduling of networks with stochastic evolution structure, fuzzy project scheduling, robust (proactive) scheduling, sensitivity analysis and reactive scheduling. We discuss the potentials of these approaches and highlight future research directions.

2 : Stability and Resource Allocation in Project Planning. Roel Leus, Katholieke Universiteit Leuven; Herroelen, Willy.

The majority of resource-constrained project scheduling efforts assumes perfect information about the scheduling problem to be solved and a static deterministic environment within which the pre-computed baseline schedule is executed. In reality, project activities are subject to considerable uncertainty, which generally leads to numerous schedule disruptions. In this paper, we present a resource allocation model that protects a given baseline schedule against activity duration variability. A branch-and-bound algorithm is developed that solves the proposed resource allocation problem. We report on computational results obtained on a set of benchmark problems.

3 : Discrete Time/Cost Trade-Off Problems with Time-Switch Constraints. Mario Vanhoucke, Ghent University and Vlerick Leuven Gent Management School.

Basically, these constraints impose a specified starting time on the project activities and force them to be inactive during specified time periods. This type of constraints have been incorporated into the well-known discrete time/cost trade-off problem in order to cope with day, night and weekend shifts. We propose a new branch-and-bound algorithm which makes use of a lower bound calculation for the discrete time/cost trade-off problem (without time-switch constraints). The procedure has been coded validated on a randomly generated problem set.

4 : On Finding Improved Lower Bounds for the RCPSP. Erik Demeulemeester, Katholieke Universiteit Leuven.

The resource-constrained project scheduling problem (RCPSP) is widely considered as the basic problem for the project scheduling community. Aiming to find optimal solutions quicker or better heuristic solutions within a certain allotted computation time, we concentrate in this research on finding better lower bounds in very small computation times. To that purpose, we extend previous ideas of n-machine scheduling lower bounds (Carlier and Latapie 1991) and of the weighted node packing lower bounds (Mingozzi et al. 1998). Extensive computational results will be presented.

: TA17 **Simulation - C1**

Contributed Session Room: R24

Chair: Li Zhou
Cardiff University

1 : Future Heterogeneous Mobile Telecommunication Networks - An Economic Simulation of Strategic Behaviour and Market Development. Markus Lips, Dresden University of Technology; Schefczyk, Michael; Wylegalla, Joerg.

Overcoming present oligopolistic network structures, future wireless telecommunication systems will be carried by clusters of heterogeneous networks being interconnected. A model has been developed to determine the economic behaviour of such systems, considering the theory of network externalities. The analysis is based on a discrete simulation to determine the development of the market structure of the proposed network architecture. Simulation as a tool was chosen due to its ability to reduce complexity of the theoretic model. Results, including pricing and investment strategies for network operators and recommendations for legislation and regulation, are of direct relevance for practitioners and policy makers.

2 : Combining Standardized Time Series Area and Cramer-von Mises Variance Estimators. David Goldsman, Georgia Tech; Kang, Keebom; Kim, Seong-Hee; Seila, Andrew; Tokol, Gamze.

We propose three related estimators for the variance parameter arising from a steady-state simulation process. All are based on combinations of standardized-time-series area and Cramer--von Mises (CvM) estimators. Analytical and empirical results show that the new estimators often perform better than the pure area, pure CvM, and benchmark nonoverlapping batch means estimators, especially in terms of variance.

3 : Bullwhip in Continuous Time: A Medley of Approaches. Li Zhou, Cardiff University; Disney, Stephen; Towill, Denis.

A review of several approaches to calculate closed form expressions of the bullwhip problem in supply chains is given. We focus our efforts on a continuous time model of the order-up-to policy. We also exploit a state space formulation of the ordering policy. We present ten different ways to investigate bullwhip in continuous time, highlighting the strengths and weakness of each method as we proceed. As we discuss each individual method of calculating bullwhip some managerial insights will be highlighted. This contribution will also be a useful starting point for supply chain analysts who wish to undertake similar studies.

: TA18 **Practical Facility Location Models**

Invited Session Room: R25

Chair: Stefan Nickel
Fraunhofer Institute for Industrial Mathematics

1 : Effects of Congestion in Public Services Competing Against Private Services. Vladimir Marianov, Pontificia Universidad Catolica de Chile; Rios, Miguel.

We find the best locations of public health centers, so to maximize the capture of high-income customers when there are private centers already in place. Both provide paid services to high-income customers, while public centers provide also subsidized services to low-income customers. An equilibrium must be found between low-income population coverage and high-income population capture. Capture is achieved by distance and short waiting time or queue length at the center. Our model can be used for planning purposes. Computational experience with optimal, as well as special purpose heuristics is described.

2 : Decision Support for Location Problems in Urban Development. Christiane Tammer, Martin-Luther-University Halle-Wittenberg.

Urban development and town planning are connected with the conflicting requirements of areas for dwelling, traffic, provision supply, green and open spaces, disposal of waste, recovering, trade and others. Using mathematical methods of location theory may be one way of supporting the urban planning to determine the best location for a special new laying-out, establishment or for arrangements. We present a new proximal point algorithm for solving location problems. Furthermore, we apply methods of multiple criteria optimization and the proximal point algorithm for solving location problems in new landscaping of former lignite mining areas.

3 : Territory Planning in Geo Marketing. Stefan Nickel, Fraunhofer Institute for Industrial Mathematics; Kalcsics, Joerg; Schröder, Michael.

Sales territories are a common tool to structure the operation of a companies' sales force. Typically the territories are required to be balanced with respect to measures like sales potential and workload and should be easily accessible for the salespersons. To facilitate the management of the territories they are made up by grouping together small sales coverage units (e.g. zip code areas). It can be modelled as a capacitated p-median problem with side constraints. For practical purposes however it is necessary to have very fast methods available that can handle different combinations of requirements and restrictions.

4 : Hub-and-Spoke Network Alliances and Mergers. Nicole Adler, Hebrew University of Jerusalem; Smilowitz, Karen.

This paper analyses alliances and mergers in the airline industry under competition. This research adapts cost-based network design formulations into profit-maximizing objectives within a game theoretic framework. Such analysis enables merging airlines to locate appropriate international hubs for their integrated network based on their own and their competitors' best response functions. The results of an illustrative example suggest that some mergers may be more successful than others and optimal international gateway choices change according to number of competitors remaining in the market. Perhaps surprisingly, the solution outcomes whereby all airlines merge or ally are not equilibria in the overall game.

: TA19 **Performance/Efficiency and Financing in Health Care**

Invited Session Room: R26

Chair: Liam O'Neill
Cornell University

1 : Performance Measurement: A Synthesis Approach. Lucas Delesie, Katholieke Universiteit Leuven; Bartholomeeusen, Stefaan; Croes, Ludo.

The approaches to the management of drug prescription profiles touch the extremes. Either do government agencies, professional organisations, etc campaign for better drug prescriptions by way of general, woolly words or do regulating agencies focus on one physician and one drug (category) for one (group of) patients. The synthetic approach GLOBALDETAIL relates the physician's diagnostic profile to his prescription profile in a dynamic way: the wood for the trees. Zooming in towards specific diagnostic and drug categories allows piloted managing of specific practice patterns of individual physicians. We present the approach, illustrate it and discuss results.

2 : Financing Mechanisms and Information Asymmetries in Dental Care. Julie Swann, Georgia Institute of Technology; Griffin, Paul; Griffin, Susan.

Health care in the US is at a crisis due to rising costs and disparities in preventative care. We focus on dental care for the elderly, first estimating current and future demand for dental services. In addition, we estimate information asymmetries including moral hazard and adverse selection and discuss how they affect financing mechanisms. Our results have implications for policy-makers who may consider extending public health services to dental care.

3 : Longitudinal Analysis of Efficiency in Dialysis. Hacer Özgen, Hacettepe University; Ozcan, Yasar.

Provider efficiency in the dialysis industry in the US has been of great interest for a variety of parties due mainly to its ongoing growth both in the number of patients and providers. This study aimed to address technical efficiency among freestanding facilities, as a dominant group of providers, performing DEA window analysis. Data were obtained from Independent Renal Facility Cost Report Data Files for the years 1995-2000. Resulting sample was 138 facilities that operated throughout the six study years

and jointly produced all dialysis outputs with nonzero inputs. Results show that one-third of facilities were classified as efficient.

4 : Taking DEA inside the Hospital: Evaluating the Technical Efficiency of Perioperative Services. Liam O'Neill, Cornell University; Dexter, Franklin.

Urban hospitals in the U.S. face a competitive environment in which strategic planning is paramount. Data Envelopment Analysis(DEA) is used to measure the technical efficiency of Perioperative Services for 60 urban hospitals. Eight procedures are studied, representing a wide spectrum of elective, scheduled, inpatient surgery. The results identify how much more of each procedure the hospitals should be able to do, as well as the percentage of market capture among its surgeons. Hospital managers can use these results as an important tool for resource allocation and strategic planning among different surgical specialties.

: TA20 Graphs, Approximation and Complexity

Invited Session Room: M35

Chair: Dorit Hochbaum
University of California Berkeley

1 : The Online Set Cover Problem. Seffi Naor, Technion; Alon, Noga; Awerbuch, Baruch; Azar, Yossi; Buchbinder, Niv.

Consider the following online version of the classic set cover problem. An adversary gives elements to the algorithm one-by-one. Once a new element is given, the algorithm has to cover it by some set containing it. The set cover instance is known in advance to the algorithm. However, the algorithm may not be required to cover all the elements. The competitive ratio is the ratio between the cost of the algorithm and the cost of an optimal cover of the elements given to the algorithm. Almost tight upper and lower bounds on the competitive ratio are proved.

2 : Cyclical Scheduling Problems: Algorithms, Complexity and Approximations. Dorit Hochbaum, University of California Berkeley; Levin, Asaf.

Cyclical scheduling problems are special cases of multi-cover problem that include cover with consecutive 1s or with circular 1s per column. We discuss the complexity of these problems as a function of the limit on the number, k, of consecutive interval assignments per schedule, and describe a k-approximation algorithm.

3 : Synthesis of Tree Networks. Bernard Fortz, Université Catholique de Louvain; van Hoesel, Stan.

We study different models for planning the capacity of telecommunication networks, with the restriction that the capacity has to be installed on a tree. Some polynomially solvable cases are identified, while the general problem is shown to be NP-hard. For the special case of unit costs in a complete graph, the optimal solution turns is a Gomory-Hu tree representing the minimum cuts in the graph. We present the complete description of the associated polyhedron for small instances of this special case and provide a conjecture on the polyhedron in higher dimensions.

: TA21 Performance Evaluation and Optimization of Stochastic Models - II

Invited Session Room: M36

Chair: George Liberopoulos
University of Thessaly

1 : A Capacitated Production Inventory Model with Nonlinear Cost Structure and Stochastic Demand. Okan Orsan Özener, METU; Güllü, Refik; Erkip, Nesim.

In this study we investigate a single item, periodic review inventory problem where the amount that can be ordered is limited. The demand for the item is a random variable. We investigate the effects of fixed ordering cost and capacitated supply on order policies. We examine some specific cases where optimality conditions can be determined, and we complement these results with a computational study. Also in the light of these results we intend to develop efficient heuristics to the original problem.

2 : Supply Chain Production Planning with Dynamic Lead Time and Probabilistic. Osman Murat Anli, Boston University; Caramanis, Michael C.

We model supply chains as networks of production facilities. Facilities are further modeled as stochastic queueing workstation networks with hourly dynamics. The planning period's weekly deterministic dynamics enable time scale decomposition: average facility performance and sensitivity is estimated at a distributed sub-problem layer, supply chain production scheduling at a centralized deterministic optimization layer. We optimize weekly production schedules that minimize inventory and backlog costs subject to non-linear production constraints imposed by dynamic lead-times and inter-facility quality of service driven inventory hedging policies. Computational experience demonstrates faster supply chain velocity relative to static lead-time state of the art approaches.

3 : Inventory Models with Multiple Vendors and Random Yield. Aslı Erdem Sencer, Boğaziçi University; Fadıloğlu, Murat; Özekici, Süleyman.

We discuss issues related to the yield randomness and multiple vendors in the context of an Economic Order Quantity (EOQ) model. We assume a continuous review, single item inventory system with multiple unidentical vendors. Yields are random due to random capacities of the vendors, i.e., a given order to any vendor is fully satisfied if it is less than the random capacity of that vendor, otherwise only the available capacity can be received. Implicit characterizations are derived for the optimal ordering quantity of each vendor. Next assuming uniform capacities in each vendor, optimal ordering policies and experimentations are provided.

4 : Inferred Stockout Cost Coefficients. George Liberopoulos, University of Thessaly; Tsikis, Isidoros.

We review existing and develop new inventory control models with backorders, where the demand rate is affected by stock outs and the objective is to minimize ordering and inventory holding costs. We examine cases where the demand rate is a decreasing function of the average number of backorders, the average backorder time, or the percentage of backorders. In

each case, we infer stock out cost coefficients to be used in classical inventory control models with backorders, where the demand rate is constant and the objective is to minimize ordering, inventory holding, and backorder costs.

: TA22 **2D Packing**

Invited Session Room: M37

Chair: Andrea Lodi
University of Bologna

Approximation Algorithms for 2-Dimensional Packing Problems. Alberto Caprara, University of Bologna.

Multidimensional packing problems are a natural generalization of the famous (monodimensional) knapsack and bin packing problems and arise in several real-world applications. Despite they were studied since the late 60s, many questions concerning their theoretical approximability remain open, while the situation for their monodimensional counterparts has been settled to a large extent. In this talk, we survey the main results and open problems for the 2-dimensional case, on which most of the research efforts were concentrated, illustrating some of the techniques that were used in the design and analysis of approximation algorithms.

: TA23 **Financial Risk Management**

Invited Session Room: M38

Chair: Hercules Vladimirou
University of Cyprus

1 : A Moment-based Analysis of Hedging under Discrete Trading. James Primbs, Stanford University.

We compute the moments of the error in discrete dynamic hedges and use this as a basis for performance comparison. Specifically, we test a delta hedge, a Taylor expansion based hedge, and a mean square optimal hedge for a call option, a digital option, and a barrier option.

2 : On Mean-Risk Optimization for Fixed Income Assets and Liabilities Management Under Uncertainty. M. Araceli Garín, Universidad del País Vasco; Escudero, Laureano Fernando; Diez, Galindo; Merino, María; Sainz de Rozas, Pérez.

We present an algorithmic framework for optimizing the mean-risk of the terminal wealth for a fixed income asset portfolio restructuring with uncertainty in some parameters, such that the interest rate path and others along a given time horizon. The uncertainty is dealt with by a multistage stochastic mixed 0-1 approach. The problem is represented by a splitting variable version of the Deterministic Equivalent Model of the stochastic model, where the 0-1 variables and the continuous variables appear in any stage. A specialization of the Branch-and-Fix Coordination approach is considered for problem solving.

3 : Models for Managing Risk in International Investment Portfolios. Hercules Vladimirou, University of Cyprus; Topaloglou, Nikolas; Zenios, Stavros A.

We develop models for risk management in international portfolios. Scenario-based stochastic programs jointly determine asset selections and hedging levels for each market. The models utilize the conditional value-at-risk risk measure. Alternative hedging strategies are examined using currency futures and derivatives. The use of derivatives requires arbitrage-free pricing in the setting of the postulated scenarios. We investigate the models' performance on portfolios of indices using historical data. We establish that the introduction of derivatives is effective in controlling risk, and jointly hedging market and currency risk yields the most effective tactic.

4 : Optimal Static-Dynamic Hedges for Barrier Options. Aytac Ilhan, Princeton University; Sircar, Ronnie.

We study optimal hedging of barrier options using a combination of a static position in vanilla options and dynamic trading of the underlying asset. We discuss computational approaches within the context of stochastic volatility models. Under the assumption of exponential utility, the problem reduces to analyzing the indifference price of barrier options.

: TA24 **Cross Entropy**

Invited Session Room: L17

Chair: Reuven Y. Rubinstein
Technion

1 : The Cross Entropy Method and Reinforcement Learning. Reuven Y. Rubinstein, Technion.

We present a learning framework for Markovian decision processes that is based on optimization in the policy space. Instead of using relatively slow gradient-based optimization we use the fast Cross Entropy method. The suggested framework is provided for several reward criteria and its effectiveness is demonstrated via Monte Carlo simulations.

2 : The Cross-Entropy Method for Rare Event Simulation with Heavy Tails. Rostislav Man, Technion - Israel Institute of Technology; Y. Rubinstein, Reuven.

We show how the cross-entropy method can be efficiently used for estimation of rare event probabilities with heavy-tailed distributions. We first use a transformation technique which reduces the original rare event probability estimation with heavy tail distributions to an equivalent one, with light tail distributions. Once this transformation has been established, we can either apply the classical exponential change of measure, in which the importance sampling distribution is chosen from the same parametric family as the original one. We estimate the optimal parameter-vector of the importance sampling distribution using the cross-entropy method.

3 : A Measure of Information Discrepancy. Weiwu Fang, Chinese Academy of Sciences; Fang, Shunlan.

Based on a group of axioms, a measure of information discrepancy among multiple information sources has been introduced in [1,2,3]. It has some peculiar features compared with other measures of information discrepancy. In this paper, we show its further properties and illustrate some applications to DNA and protein comparisons, financial market, questionnaire analysis, and so on. 1.Weiwu Fang, Mathematical Social Sciences, 28 (2), 1994. 2.Weiwu Fang, J. of Global Optimization, 11, 1997.

3.Weiwu Fang, Information Science, Vol.125, 2000. 4.Weiwu Fang et al., Information Science, Vol.137, 2001. 5.Shunlan Fang and Weiwu Fang, J. System Engineering and System Sciences, Vol.12, 2002.

: TA25 Alternative Modeling Formalisms and Formulations

Invited Session — Room: M34

Chair: Yaman Barlas
Boğaziçi University

1 : System Dynamics Simulation of Common Pool Resource Field Experiments. Daniel Castillo, Pontificia Universidad Javeriana; Saysel, Ali Kerem.

This study investigates the decision rules adopted by the individuals in local communities whose livelihoods depend on common pool resource stocks and who face the cooperation dilemma. Field experiments in Providence Island (Colombia) are modeled and the model structure and output are confronted with experimental data and with relevant theories of collective action. The variables and decision rules built into the model structure provide the basis for a dialogue between the theories and future experimental designs to test and improve them. Modeling can be used to generate hypothesis about the causes of observed behavior, and to design future experiments.

2 : The Generic Stock Management Model and Decision Structures. Hakan Yaşarcan, Boğaziçi University; Barlas, Yaman.

In many systems (biological, mechanical, production, human, ...) there is a level (stock) to be controlled. Typically there are delays in such systems. In this research we consider control of a single stock system and we focus on the delay between the decision and the result of that decision. This type of delay can be supply line delay, information delay or a secondary stock (such as managing the production capacity to control the production). Stock control decisions must consider delays for stable behavior. Information delay and control via secondary stock can be shown to be equivalent to supply line delay.

3 : Structural Analysis of a Dynamic Forest Growth Model Under Parameter Uncertainty. Burak Güneralp, University of Illinois at Urbana-Champaign.

Most parameter values employed in models are imperfect estimates of their true values. Sensitivities in a model to such uncertainties can vary significantly both in time and space. Understanding which parameters highly influence model behavior helps to focus new parameterization efforts. In this research, important processes in the model will be identified using a combination of eigenvalue and Monte Carlo simulation analyses. The effect of uncertainty in each significant parameter on model behavior will be analyzed through error budgets. This study will attempt to firmly establish the importance of feedback loop concept in the forest -modeling- literature.

4 : Integrating System Dynamics and Intelligent Agent-based Modelling. Kambiz Maani, University of Auckland; Pourdehnad, John; Sedehi, Habib.

Recent advances in video game technology allow the development of multi-agent, artificial 'society' simulators with capabilities for modeling physiology, stress, emotion, and course-of-action decision-making. An agent-based model consists of a system of agents and their relationships. Experience with agent-based modelling shows that even a simple agent-based model can exhibit complex behaviour patterns and provide valuable information about the dynamics of the real world system that emulates them. In this paper the two simulation approaches are compared and contrasted and the potential synergy between them is discussed through a case study at GM.

: TA26 Capacity Planning

Invited Session — Room: L10

Chair: Shanling Li
McGill University

1 : Capacity Expansion Model (CAPEX) for the Electricity Sector - An Israeli Case Study. David Soloveitchik, Ministry of National Infrastructures; Grinman, Mira.

Several policies of pollution reductions were examined and the decision process was supported by the CAPEX system. The optimization is based on dynamic programming and the objective function is a weighted sum of up to ten components. CAPEX helps the policy makers in analyzing the impact of various issues: -Pollution reduction methods (scrubbers vs. fuel-quality); -Introduction on new fuels; -Introduction of new generating units (like IGCC, SCPC). In this paper we describe how we dealt with the "emission taxes" uncertainty and different options of pollutions reduction. The results are based on real data of the Israeli Electricity Sector.

3 : Selection of Contract Suppliers Under Price and Demand Uncertainty in a Dynamic Market. Shanling Li, McGill University; Huang, Wanzhen; Murat, E. Alper.

In this paper, we consider a supply contract problem in supply chain management in an uncertain environment. The buyer firm, facing price and demand uncertainty in the future, aims at minimizing its expected total purchasing costs over the planning horizon. We developed a stochastic dynamic programming model to describe the problem. We first derive analytical results and then we conducted extensive computational experiments to derive more managerial insights. Overall, our computational results provide both intuitive and non-intuitive managerial insights in outsourcing strategies.

3 : A Model for Integrated Load Balancing and Order Release based on the Workload Control Concept. Hubert Missbauer, University of Innsbruck.

Most workload control (WLC) order release mechanisms perform input control for a limited time-horizon and fixed capacities. These limitations require a separate load balancing step, which is not fully consistent with the WLC concept. This paper structures the order release function into two hierarchical levels: (1) Aggregate order release planning, determining the "budget" of orders (or work) to be released in the periods of the planning horizon, (2) decision on the orders to be released in the next period. A model for aggregate order release planning is presented and the extension to integrate overtime etc. is outlined.

: TA27 Supply Chain Management - I

Invited Session Room: L11

Chair: Tamer Boyaci
McGill University

1 : An Agent-based Approach to Support Automation of Business Process Execution. Jean-Marc Frayret, Universite Laval; D'Amours, Sophie; Rousseau, Alain.

We propose to discuss the role of agent-based technology in the automation of business processes execution and in the integration of distributed decision-making across supply chain networks. Beyond inter-enterprise application integration, agents hold the potential to bring a new dimension to e-business. During this discussion, we will present what agents can do to support distributed enterprises and their partners to plan and execute their operations in the context of the Canadian forest products supply chain.

2 : Free Shipping Decisions of Online Merchants: A Game-Theoretical Analysis. Mahmut Parlar, McMaster University; Leng, Mingming.

For online merchants free shipping is one of the most effective means of attracting and keeping customers. In this paper we consider the problem of selecting the best free shipping cutoff point in a leader-follower game where the leader is the online merchant and the follower is the customer. We determine the best response functions for each player for any given value of the opponent's decision and present some structural results related to the response functions. We then compute the Stackelberg solution and discuss the managerial implications of our findings.

3 : Optimal Prices and Trade-in Rebates for Durable Products. Saibal Ray, McGill University; Boyaci, Tamer; Aras, Necati.

We develop the optimal pricing/trade-in strategy for the first-time buyers as well as for replacement customers of durable products, which integrates pricing decisions with the age distribution of the products in use and the age-dependent revenues associated with the returns. We show how the structure of the optimal policy as well as the behavior of the optimal price/trade-in rebate is affected crucially by two factors---durability of the product and the product age distribution. We are able to identify their individual effects as well as their joint effect. Our analysis provides useful managerial insights not available in the existing literature.

4 : Product Differentiation and Capacity Cost Interaction in Time and Price Sensitive Markets. Tamer Boyaci, McGill University; Ray, Saibal.

We study a profit-maximizing firm selling two substitutable products in a price-and-time-sensitive market. The firm has dedicated capacities for each product and there is an industry norm delivery time. The objective is to determine the delivery time of the express product and appropriately price the two products, considering the impact of delivery time reduction on capacity costs. We study scenarios where the firm is constrained in capacity for none, one or both product(s). We show how product differentiation decisions are influenced by capacity costs, and how the firm should adapt its differentiation strategy to changes in its operating dynamics.

5 : Optimizing Transportation Decisions in a Manufacturing Supply Chain. Suleyman Karabuk, University of Oklahoma.

We study a multiple depot pick up and delivery problem with time windows in a three tier manufacturing supply chain. The problem is complicated by less than truckload shipments and possibilities of using a central depot for relaying and consolidation of transportation requests.

: TA28 Meta-Heuristics for Optimization

Invited Session Room: L12

Chair: Berna Dengiz
Gazi University

1 : Computing the Temperature of Simulated Annealing. Walid Ben-Ameur, Institut National des Télécommunications.

Simulated annealing is generally based on a cooling schedule. The initial temperature is set such that the acceptance probability of bad moves is equal to a given value. In this presentation, we propose a simple algorithm to compute a temperature which is compatible with a given acceptance probability. Then we study the properties of the accpetance probability. We show that this function is convex for low temperatures and concave for high temperatures. A lower bound is provided for the number of plateaux of a simulated annealing based on a geometric cooling schedule. Finally, many numerical experiments are reported.

2 : A Continuous Tabu Search Training Algorithm for Neural Networks. Berna Dengiz, Gazi University; Alabaş, Çiğdem.

There has been increased interest in the use of Meta Heuristic global search techniques for the training of Neural Networks, which is the foundation of the neural network modeling process. Training of the most widely used neural network paradigm, back propagation, involves gradient based search and is extremely computationally intensive. Global optimization techniques such as Genetic Algorithm, Tabu Search and Simulated Annealing have been recently used cope with the two major shortcomings of back propagation: local optimality and slow convergence rate. In this presentation, we present an efficient tabu search algorithm using different meta strategies.

3 : On the Distribution of the Initial Population for Genetic Algorithms. Heikki Maaranen, University of Jyväskylä; Miettinen, Kaisa; Mäkelä, Marko M.

If the initial population of a genetic algorithm is not diverse enough, the algorithm may fail in finding the optimal solution or several generations may be needed to recover the diversity of the population. Our earlier results involving quasi random sequences in the intial population verify the important role of that first population. In this paper, we consider global continuous optimization and employ statistical spatial point processes to generate initial populations with a lot of diversity. We compare the results with the ones obtained using quasi random sequences and traditional pseudo random numbers.

4 : Parent Selection in Evolutionary Algorithms for Simulation Optimization. Talip Kerem Koçkesen, METU; Özdemirel, Nur Evin; Köksalan, Murat.

In this study, we propose an evolutionary algorithm (EA) for simulation optimization. The main idea is to adapt EAs to a stochastic environment. Since simulation yields only estimates for performance measures, deterministic parent selection techniques used in EAs are not suitable. We propose different parent selection techniques which take into account the randomness associated with simulation output. These techniques make use of the variance of the point estimator in choosing parents for reproduction. They are tested on functions representing simulation output.

: TA29 **Hazmat - III**

Invited Session Room: L13

Chair: Erhan Erkut
University of Alberta

1 : A New Model on Hazardous Waste Location-Routing Problem: An Application in Turkey. Sibel Alumur, Bilkent University; Kara, Bahar.

In this paper an extensive survey on location and routing models for hazardous wastes is presented. The existing models in the literature are analyzed in terms of applicability. A new model by combining the applicable aspects from different models is proposed. Our model also includes the constraints that reflect certain requirements that have been observed in the literature but could not been incorporated into the models correctly together with the additional constraints that we propose. The performance of the model is experimented on the highway network of Turkey.

2 : Tactical Planning of Hazardous Materials Shipments with Network Interactions. Michel Gendreau, Université de Montréal; Crainic, Teodor Gabriel; Benterki, Amina.

Models for routing hazardous materials usually account only for individual shipments. When this approach is used, some parts of the transportation network are used to route a large number of shipments, thus subjecting the neighbouring population to high level of risk. We propose a different approach that accounts simultaneously for all hazmat shipments over an extended planning horizon, and we describe a multi-commodity flow formulation to implement it. This formulation includes various risk exposure constraints to enforce equity among the exposed population. Numerical results on medium-sized networks will be provided to illustrate the potential gains of the proposed approach.

3 : A Metaheuristic Approach for Routing and Scheduling Vehicles in Hazmat Transport. Pasquale Carotenuto, Consiglio Nazionale delle Ricerche; Giordani, Stefano; Rismondo, Silvia.

Vehicle routing and scheduling are two main issues in hazardous material transportation. We consider n hazmat (O,D) transportation requests with preferred departure times, each one being satisfied by using one of a given set of feasible (O,D) vehicle routes with given levels of risk. The problem is to select a feasible vehicle route and define a vehicle departure time for each request, minimizing total risk on the network and total delay on departure times while satisfying risk thresholds on the zones crossed by the vehicles. We propose a resolution algorithm based on a metaheuristic approach, and analyze some computational results.

4 : Revisiting Transport Risk Models for HazMats. Erhan Erkut, University of Alberta.

We consider hazmat transport risk models proposed in the literature in light of several reasonable axioms and identify those that violate the axioms. Consideration of the ways in which some of the models fail to satisfy the axioms leads us to classify hazmat transport according to purpose and material type and propose a new set of risk models that satisfy the axioms.

: TA30 **Large Scale Optimization**

Contributed Session Room: L14

Chair: Marc Goetschalckx
Georgia Institute of Technology

1 : The Goal-Oriented Approach of Developing Monetary Policy Program in Transition Countries. Karen Yeghoyan, Yerevan State University; Toroyan, Vasak; Petrosyan, Lilit.

The elaboration and realization of a quite new monetary policy are important means of achieving financial stabilization in transition countries are (MP). The main problem of MP program elaboration is the co-ordination of possible situations of social-economic system's different levels in the program of transition economy regulation. In practice it is a formation of feasible variants of the "upper level" on the basis of the feasible variants of the "lower level". For its adequate and efficient realization, a network model of a goal-oriented MP program should be worked out. This will make it possible to select MP scenarios.

2 : Large-Scale Supply Chain Network Optimization via Nested Partitions. Leyuan Shi, University of Wisconsin-Madison; Bozbay, Mehmet; Meyer, Robert R.

In this research, we demonstrate that the nested partition (NP) method is capable of efficiently producing very high quality solutions to large-scale supply chain problems by taking advantage of their structure to generate an appropriate set of restricted subproblems. The implementation of NP that we describe here first employs an optimization-based heuristic to generate an efficiency ranking of the available warehouses and then employs biased sampling (from the ranked warehouse set) guided by the NP global optimization framework.

3 : Strategic Design of Robust Supply Chains under Uncertainty. Marc Goetschalckx, Georgia Institute of Technology; Ahmed, Shabbir; Shapiro, Alexander; Santoso, Tjendera.

We have developed a two-stage stochastic decomposition method, which does explicitly incorporate interactions of the various stochastic parameters of the supply chain. Our method is also capable of of solving problem instances for realistically sized industrial cases. We will report on the results of the computational experiment that compares the performance of a commercial MIP solver, Benders decomposition, and our acceleration techniques. We applied this procedure to two industrial cases in a processing industry. We will also discuss the robustness of the stochastic solutions with respect to the variability of the problem data.

: TA31 **Strategic Management - II**

Invited Session Room: M33

Chair: Maureen Meadows
University of Warwick

1 : A Strategic Framework for Achieving Sustainable Organisational Excellence. Graeme Cocks, Mt Eliza Business School.

This paper will describe the results of a major three year research project at Mt Eliza Business School to identify the key factors behind the long-term success of some of Australia's leading organisations. The findings are organised into nine core elements that set these winning organisations apart. These elements will be discussed and presented as a framework that can be applied to organisations of all types from all industry sectors to achieve long-term and sustained success. Comparisons will be made between this framework and other international studies of excellent organisations, particularly the U.S.A.

2 : Scenario Development for Validating Models of the Strategy Process. Eduardo Munive-Hernandez, UMIST; Dewhurst, Frank; Barber, Kevin.

The need for supporting strategic decisions is well documented and the authors have developed models of the strategy process. Model validation often employs empirical data taken from studying the history of the system or process being modelled. However, in some cases (e.g. generic OR/MS models and/or soft-systems) such as generic models of the strategy process, no historical empirical data is available. This paper presents a model of the strategy process and the ongoing development of a case company to enable different strategy scenarios to be developed, explored and evaluated in order to validate the model.

3 : Strategy Deployment: Linking Formulation and Implementation. Zainuddin Mohamad, UMIST; Barber, Kevin.

The link between strategy formulation and strategy implementation is often obscure in the conventional strategic management literatures and partly contributed to the low success rate of strategy implementation. Proposing that the link be considered as a distinct component of the strategy process, namely deployment due to its importance, the paper discusses and compares methods of bridging this formulation-implementation gap. These are the BSC (Balanced scorecard), MBO (Management by objective) and Policy deployment (common translation in the West for Japan's Hoshin kanri). Each method will be critically evaluated with a view towards proposing a conceptual deployment framework.

4 : Strategic Development: A Survey of UK Organisations. Maureen Meadows, University of Warwick; Tapinos, Stathis; Dyson, Robert.

This paper will describe a research project led by Warwick Business School which seeks to gain an up-to-date understanding of the strategic development process in a large sample of UK organisations. The research method is both quantitative and qualitative (using a structured questionnaire, and in-depth interviews). The aims are to move towards an understanding of the current position of strategic planning, with observations about 'best practice', and to update past work on an effective framework for the strategic planning process in organisations.

: TC02 **Complex Societal Issues Workshop - I**

Invited Session Room: MB II

Chair: Dorien De Tombe

: TC03 **Integer Programming - III**

Invited Session Room: MB III

Chair: Alberto Caprara
University of Bologna

1 : Pivot and Shift - A Heuristic for Mixed Integer Programming. Egon Balas, Carnegie Mellon University.

Through joint work with C. H. Martin, S. Schmieta and C. Wallace, the well known heuristic for 0-1 programming, Pivot and Complement, is extended to general mixed integer programming. Like its original prototype, the current procedure is essentially a sophisticated rounding algorithm. Starting from the LP optimum, it performs several types of nonstandard pivots and value shifts of the integer variables meant to find a feasible integer solution with a minimum loss of quality. Computational experience on a variety of publicly available benchmark problems will be presented.

2 : A Set Covering based Heuristic Approach for Bin-Packing Problems. Paolo Toth, University of Bologna; Monaci, Michele.

Several combinatorial optimization problems can be formulated as large size Set-Covering Problems. We use the Set-Covering formulation to obtain a general heuristic algorithm for this type of problems, and describe our implementation of the algorithm for solving two variants of the well-known Bin Packing Problem: the Two-Constraint Bin Packing Problem and the Two-Dimensional Bin Packing Problem. Computational experiments on test instances from the literature show that, for the two considered problems, this heuristic approach is competitive, with respect to both the quality of the solution and the computing time, with the best heuristic and metaheuristic algorithms proposed so far.

3 : Local Branching. Andrea Lodi, University of Bologna; Fischetti, Matteo.

The availability of effective exact or heuristic solution methods for general Mixed-Integer Programs (MIPs) is of paramount importance for practical applications. We investigate the use of a generic MIP solver as a black-box "tactical" tool to explore effectively suitable solution subspaces defined and controlled at a "strategic" level by a simple external branching framework. The procedure is in the spirit of well-known local search metaheuristics, but the neighborhoods are obtained through the introduction in the MIP model of completely general linear inequalities called local branching cuts.

: TC04 **Network Routing and Telecommunication Applications**

Invited Session Room: JB A

Chair: Oya Ekin-Karasan
Bilkent University

1 : Integer Linear Programming Formulation of the Generalized Vehicle Routing Problem. İmdat Kara, Başkent University; Bektaş, Tolga.

The Generalized Vehicle Routing Problem is an extension of the VRP where the nodes are grouped into a given number of mutually exclusive and exhaustive clusters. The problem consists of determining optimal routes starting and ending at the depot, with each cluster visited exactly once, such that demands are satisfied and vehicle capacities are respected. In this paper, we model the GVRP as an integer linear program with O(n^2) binary variables and O(n^2) constraints. It is shown that, the proposed model reduces to the Generalized mTSP and the Generalized TSP, as well as the classical VRP, mTSP and the TSP.

2 : Polyhedral Analysis of the Uncapacitated Concentrator Location Problem with Star Routing. Hande Yaman, Universite Libre de Bruxelles; Labbé, Martine.

We consider the problem of locating concentrators in a telecommunication network. Given a set of terminals, we choose a subset to be concentrator locations and assign each remaining terminal to a concentrator. A concentrator is connected to a root node by a direct link. This leads to a network with a star backbone and star access networks. The aim is to minimize the cost of location, assignment and routing. This problem is called the "Uncapacitated Concentrator Location Problem with Star Routing". We study its polyhedral properties. We present a branch and cut algorithm to solve it and computational results.

3 : Placement of Wavelength Converters in Optical Networks. Oya Ekin-Karasan, Bilkent University; Karasan, Ezhan; Erdoğan, Güneş.

The placement of wavelength converters in wavelength division multiplexing (WDM) optical networks is studied. With sparse wavelength conversion, the problem of routing and wavelength assignment has to be considered in conjunction with the converter placement problem. Due to computational challenge, we decouple this problem into two sub problems. In the first stage, under the assumption of full wavelength conversion, routes are determined such that total fiber cost is minimized. In the second stage, using the fixed routes we jointly solve the interchanger placement and wavelength assignment problems that achieve the same fiber cost as the first stage. Numerical studies are provided.

: TC05 **Fleet Management**

Invited Session Room: JB B

Chair: Walter Ukovich
University of Trieste

1 : Efficient Fleet Management for a Container Road Carrier. Luca Coslovich, University of Trieste; Pesenti, Raffaele; Ukovich, Walter.

A fleet management problem that occurs in container transportation industry is presented. From the carrier perspective, the incurred operations costs to minimize can be divided in three components: the routing costs, the resource (i.e., driver and truck) assignment costs and the container repositioning costs (i.e., the costs of restoring a given container fleet distribution over the served territory, as expected by the shipper that owns the containers). Our solution approach is based on the relaxation of this problem in three separate simpler sub-problems associated to each of the costs considered above.

2 : A System for Reprogramming Load Vehicle Routes. Vania Barcellos Gouvêa Campos, Instituto Militar de Engenharia; Ribeiro, Glaydston.

This paper presents a system for rescheduling vehicle routes for collecting and distributing fractioned load in urban areas. This system has been developed in order to aid the transportations companies to solve the problem of solicitations for new collecting services when the collecting/delivery load vehicle is already in operation. This system associates Geographic Information Systems-GIS and Global Positioning Systems- GPS technologies and utilizes a procedure that evaluates the inclusion of a new pick up in one of the several routes. This system allows deciding which vehicle route gives the best solution by analyzing all the vehicle capacity and routes.

3 : Containers Distribution Planning when Zone Tariffs Exist. Milorad Vidovic, University of Belgrade; Kim, Kap Hwan; Kalic, Milica.

Containers' flows may exist between port and several types of inland origins and destinations. Also, those flows may be flows of empty and/or loaded containers. Specificity of those distribution (collecting) problems lies in fact that truck may carry simultaneously only one 40ft, or two 20ft containers. Hence, mentioned problem may be, generally, considered as a special case of the routing problem with multiple use of vehicles. In addition, the problem studied here comprises case with "zone tariff system", where price for delivering goods inside zone is the same, and does not depend on distance.

4 : Multi-Depot Bus Scheduling: Exact and Heuristic Approaches and Model Variations. Natalia Kliewer, University of Paderborn; Gintner, Vitali; Koberstein, Achim.

This work presents exact and heuristic network-flow based methods for the bus scheduling problem with consideration of multiple depots and vehicle types. We analyse a number of model variations such as depot groups and different cost structures. Computational experiments are carried out on large-scale real world instances.

: TC06 **Scheduling - C1**

Contributed Session Room: M30

Chair: Aslı Erdiller
Uludağ University

1 : A Literature Survey of Deterministic Job Shop Scheduling using Genetic Algorithms and Simulated Annealing by means of Local Search Algorithms. Mehmet Mutlu Yenisey, İstanbul Technical University; Şevkli, Mehmet.

Job-shop scheduling problem is one of the well-known hardest combinatorial optimization problems. A lot of literature has been published, but no efficient solution algorithm has been found yet for solving it to optimality in polynomial time. As a re-

sult much effort has recently been concentrated on meta-strategy which guides the search out of local optima. The purpose of this study is to give a survey of recent works on deterministic job shop scheduling by local search techniques. The impact of the major contributions is indicated by applying these techniques to a set of standard benchmark problems.

2 : A Hybrid Genetic Algorithm for the Early/Tardy Scheduling Problem. Rui Alves, Universidade do Porto; Valente, Jorge; Gonçalves, Jose.

This paper presents a hybrid genetic algorithm for the Early/Tardy scheduling problem in which no unforced idle time may be inserted. The chromosome representation is based on random keys. The genetic algorithm is used to establish the order in which the jobs are initially scheduled, and a local search procedure is subsequently applied to detect possible improvements. The approach is tested on a set of randomly generated problems and compared with existing procedures based on dispatch rules and local search. The computational results show that this new approach, although requiring slightly longer computing times, outperforms the previous algorithms.

3 : A Genetic Algorithm for Parallel Machine Total Tardiness Problem. Furkan Kıraç, Boğaziçi University; Bilge, Ümit; Kurtulan, Müjde.

A Genetic Algorithm (GA) approach is employed to solve a generalized version of Parallel Machine Total Tardiness problem where a set of independent jobs with sequence dependent setups, non-identical due dates and arrival times are to be sequenced on a set of uniform parallel machines. Several adaptive control mechanisms that try to control the population diversity in order to overcome premature convergence are developed and incorporated in GA. Extensive tests on a set of problems obtained from the literature not only yield very good results with respect to the best-known values, but also further improve some of these best-known solutions.

4 : A Genetic Algorithm based Approach for the Integrated Job Shop Scheduling and Operations Planning Problem. Aslı Erdiller, Uludağ University; Orbak, Ali Yurdun.

In job shop scheduling problems, it's difficult to prepare applicable schedules with the dynamic constraints of the job shop, such as machine breakdowns, dynamic change of demand, etc. Thus, techniques that produce flexible and rapid response are desirable. In this paper, a genetic algorithm based approach will be illustrated and analyzed for the solution of scheduling and operations planning problem for job shop. The schedules that are obtained with this approach are active and non-delay. In addition, high fitness valued schedules constitutes alternative operation plans. With the proposed approach, near optimal solutions are obtained in a very short computation time.

: TC07 **Spare Parts Management - II**

Invited Session Room: M31

Chair: Geert-Jan van Houtum
Eindhoven University of Technology

1 : Availability of a k-out-of-N System Given the Number of Spares, Repair Capacity and a Condition based Maintenance Strategy. Karin de Smidt-Destombes, TNO-FEL.

We consider a k-out-of-N system, with identical components. Given a maintenance strategy, number of spares and repair capacity, we determine the availability. The system's condition initiates maintenance, components need to be replaced and failed ones restored. For the availability of spares we also include their repair cycle.

2 : Determining Component and Finished Goods Inventory Levels in Large-Scale Capacitated Repair Systems. James Rappold, University of Wisconsin-Madison; Resnick, Adam; Shi, Leyuan.

We present a periodic-review production and inventory planning model that determines component and finished product inventory levels when demand is highly uncertain and repair capacity is finite. We compare the performance of our solution approach to management practices currently used in the firm that motivated our research.

3 : Performance Optimization in Multi-Echelon, Multi-Indenture Systems for Repairable Spare Parts with Capacity Restrictions at Repair Facilities. Andrei Sleptchenko, University of Twente; Van Der Heijden, Matthieu; Van Harten, Aart.

The existing methods for repairable spare parts supply models either ignore server capacities at repair facilities or use methods inappropriate for big systems. We present here models, which encounter repair capacities, can be applied to big systems and can use more parameters (number of servers and repair priorities) for optimization.

4 : Multi-Echelon Repairable Item Systems, Modeled as Closed Queueing Networks. Henk Zijm, University of Twente; van Ommeren, Jan-Kees; Daryanto, Ahmad.

Repairable item systems with multiple repair facilities and stock locations are modeled as multi-echelon closed queueing networks where at each echelon items can be stocked. We present an algorithm based on approximations that exploit Norton's theorem. Examples and numerical results are presented. In addition, multi-indenture models are briefly discussed.

: TC08 **GDN Keynote Session - II**

Invited Session Room: M32

Chair: Gregory Kersten
University of Ottawa

1 : Systems and Right Problem Solving in Group Decision and Negotiation. Melvin Shakun, New York University.

The paper discusses right problem solving and in so doing considers operationally purposeful complex adaptive systems (PCAS), Evolutionary Systems Design (ESD), group/negotiation support systems, consciousness, connectedness, spirituality, rationality, problems, and right rationality in theory and practice. System agents may be natural (human) and/or artificial.

2 : The Graph Model for Conflict Resolution: Past, Present, and Future. Marc Kilgour, Wilfrid Laurier University.

The history and development of the graph model for conflict resolution is reviewed. New ways of structuring and analyzing a

graph model of a strategic conflict are now under development, including some that incorporate significant variations in the original definitions and principles. The presentation concludes with a recent application to an environmental management problem.

: TC09 **Customer Relationship Management - II**

Invited Session Room: L15

Chair: Russell Winer
New York University

1 : The Effects of Customization Procedure on Consumer Preferences and Satisfaction. Florian Zettelmeyer, University of California, Berkeley and NBER; Dhar, Ravi; Valenzuela, Ana.

The proliferation of options in many product-markets and the potential for information overload has increased the importance of customization. Although the measurement of preferences is a key antecedent to enhancing the fit with customer needs, the literature shows that consumer preferences are constructed in the process of choosing, and task difficulty affects the final outcome. We propose that different tasks for arriving at customer preferences will systematically distort final outcomes as well as the satisfaction with the customization process. We examine these propositions in a series of studies using two commonly used methods of preference elicitation.

2 : Does Who Asks Whom for Help Matter? Factors that Affect Satisfaction in Web and Retail Shopping Environments. Russell Winer, New York University; Greenleaf, Eric; Morwitz, Vicki.

In a retail environment, an important part of customer service is the assistance given customers while they are shopping. There are many different ways that customers can obtain and receive help, and it is important for firms to understand how consumers' reactions to help vary with these different ways. Interestingly, there has been little research in marketing on this help-seeking and providing aspect of CRM. This research is a first attempt to better understand these and other questions about the customer-company interaction in both retail and Web-based environments.

3 : A Super-Efficiency Model for Product Evaluation. Matthias Staat, University of Mannheim; Hammerschmidt, Maik.

We apply a superefficiency-model to evaluate the efficiency of the 48 best selling compact cars in Germany. We conceptualize efficiency from a customers' perspective. Extending Staat/Bauer/Hammerschmidt(2002), we integrate a multifaceted set of customer-relevant-attributes on the output side such as non-functional benefits and brand equity. More than 60% of the cars are efficient but the superefficiency-analysis shows marked differences regarding their efficiency. Strongly superefficient products could demand a high increase in customers' inputs (price) preserving the provision of maximum customer value. Based on the parameter weights, we extract clusters of cars providing similar input-output-patterns and therefore belong to the same submarkets.

: TC10 **Strategic and Quality Issues in Closed-Loop Supply Chains**

Invited Session Room: L19

Chair: George Tagaras
Aristoteles University of Thessaloniki

1 : Long Term Analysis of Closed-Loop Supply Chains with System Dynamics. Dimitrios Vlachos, Aristoteles University of Thessaloniki; Georgiadis, Patroklos; Tagaras, George.

The development of operational and tactical-level models to study specific operations in reverse logistics systems is not suitable for and transferable to the evaluation and selection of long-term strategies. Thus, when long-term strategic issues are considered, it is necessary to develop comprehensive models, which include both qualitative and quantitative variables with linear or non-linear dependencies. System dynamics is a powerful tool that allows the development and analysis of models with exactly these features. We present the key ideas for the development of a general model that aims at encompassing the main strategic characteristics of a reverse logistics network.

2 : On the Acquisition, Reallocation and Disposal of Assets by Lessors. Simme Douwe Flapper, Technische Universiteit Eindhoven.

For all kinds of reasons, leasing has become important. Usually, once assets are at a lessee, they become available for another lessee when the present contract ends. However, there seem to be situations where it may be worthwhile to terminate existing contracts, for instance in order to free the asset for use in the context of another more profitable contract. In the paper attention is paid to the termination of contracts in the context of the acquisition and lay-off of assets by a lessor. A mathematical model is presented to support the lessor. Topics for further research are indicated.

3 : Time Value of Commercial Product Returns. Luk Van Wassenhove, INSEAD; Souza, Gilvan; Guide, Jr., V. Daniel R.; Blackburn, Joseph D.

The management of commercial product returns is an area where there are significant opportunities to build competitive advantages from the appropriate choices in reverse supply chain design. In this paper we use a simple queueing network model to provide managerial insights into the marginal value of time in the product returns stream. We illustrate our approach with actual examples from two companies in different industries and show how industry clock speed affects the choice between an efficient and a responsive returns network.

4 : Life Cycle Pricing in a Remanufacturing Environment. Umut Aytekin, Northwestern University; Savaskan, Canan Rezzan.

Remanufacturing is increasingly being recognized as a cost efficient way of supplying new products to consumers. We investigate the new product pricing strategy of a monopolist in a dynamic setting, which jointly optimizes the revenues from new product sales and the cost savings from remanufacturing. This paper develops an accurate characterization of the new product demand dynamics and the supply dynamics of used products. We address (i) in a remanufacturing environment, how would the price of the new product be set at each time point (ii)

What would the price pattern look like over time compared to a purely manufacturing environment.

: TC11 **Applications in the Utilities Sector - II**

Invited Session Room: R20

Chair: Barbara Casu
The University of Reading

1 : Measuring Quality-Quantity Trade-Offs in the Regulation of Brazilian "Privatized" Railways. Perelman Sergio, Université de Liège; Antonio, Estache; Lourdes, Trujillo Castellano.

Railways privatization have become a mainstream policy option in many countries reforming their transport sector. This paper looks at the experience of Brazil's railways concession contracts that offered an innovative solution to ensure a close monitoring of the quantity-quality trade-off in a price cap regulatory regime. To contribute to the policy debate, we compare several alternative approaches using DEA and Malmquist index of productivity change. The index proposed by Färe, Grosskopf and Roos (1993) appears to be the best adapted. It is decomposable into quantity and quality productivity changes that constitute the main information needed in the price-cap regulation process.

2 : Efficiency and Commercial Policy in Railway Transport in Europe: A Non-Parametric Analysis. Pedro Cantos, Universidad de Valencia; Pastor, José Manuel; Serrano, Lorenzo.

The aim of this study is to analyse technical and revenue efficiency for the period 1970-98, in order to assess whether recent changes in organisation and management have significantly influenced companies' efficiency levels. Four areas of reform are analysed: separation of infrastructure from operations, changes in legal structure, regulation of fares and public regulation of railway investment. Our results suggest that these measures, and especially the first mentioned, seem adequate to favour more efficient behaviour of the companies at a technical level. However, at allocative and revenue level no significant modifications are observed in efficiency levels.

3 : Measuring the Performance of Universities: An Application of DEA with 3D-Illustrations. Roland Gilles, RWTH Aachen.

Recently, a ranking of German universities has been published, which especially focused on the evaluation of universities' research activities. The first part of the presentation focuses on the results, which have been gained by examining the data set with DEA. These results concern major similarities and differences. Furthermore, thought has been given to the question, if the 'revenues' of DEA (additional information), exceed the 'expenses' (implementation of DEA and verification of the results). The second part of the presentation contains a 3D-visualization of the applied DEA-models. Different efficiency hulls have been plotted to provide deeper insights into several DEA-specific phenomena.

4 : Identifying Benchmarks for Central Administrative Services. Barbara Casu, The University of Reading; Thanassoulis, Emmanuel.

The increased importance of the administrative function in today's higher education coupled with the substantial cost of this function, highlights the need for identifying cost-efficient practices in the delivery of good-quality administrative services in universities. This paper draws on work carried out to identify UK university administrations, which may offer cost-efficient practices. The analysis sets up a DEA framework to identify benchmark institutions and highlights how the information derived may be used to improve efficiency in the sector. The work also highlights how students, research and staff in universities combine to drive efficient expenditure levels.

: TC12 **Optimization Opportunities Arising in Real Problems**

Invited Session Room: M39

Chair: Paola Zuddas
University of Cagliari

1 : Large-Scale Local Search Algorithms for the Capacitated Vertex P-Center Problem. Maria Grazia Scutella', Universita' di Pisa; Pallottino, Stefano; Scaparra, Maria Paola.

We investigate the application of very-large neighborhood search techniques for solving the capacitated vertex p-center problem. We characterize a local search neighborhood in terms of path and cyclic exchanges of customers among facilities, and exploit principles borrowed from network optimization theory to efficiently detect cost decreasing solutions in such a neighborhood. We complement the multi-exchange methodology with a local reoptimization mechanism specifically designed to perform facility location adjustments. The validity of the proposed approach is supported by empirical investigation and performance comparisons with the commercial code CPLEX.

2 : Exploring an Unknown Graph by an Entropy-based Algorithm. Luca Scardovi, University of Genoa; Baglietto, Marco; Paolucci, Massimo; Zoppoli, Riccardo.

The problem of mapping an unknown environment by a team of autonomous decision makers is addressed. The environment is given by a discrete grid in which each cell is labelled as free or not free, depending on the presence of an obstacle. The decision makers can communicate with one another and coordinate their actions. This example can be extended to the exploration of any graph with possibly impracticable links. The problem is formulated in the framework of stochastic optimal control. An exploration law is described that exploits the concept of entropy. Numerical results show the effectiveness of the approach.

3 : Planning of Supply Chains under Uncertainty: Stochastic Programming Approach. Alexei Gaivoronski, Norwegian University of Science and Technology; Klungland, Yngvar; Nersund, S.

We consider the problem of supply chain design and related production decision for an enterprise which is engaged in production of components for a complex product. We are specifically interested in the case when demand for the product is uncertain. Stochastic programming approach based on conbination of simulation and optimization is considered and numerical experiments are reported

4 : The Simple Equal Flow Problem: Algorithms and Computational Comparison. Paola Zuddas, University of Cagliari; Manca, Antonio; Sechi, Giovanni.

In this paper, we present different algorithms for the Simple Equal Flow problem. We present a wide experimentation and comparison performed by two efficient equal flow algorithms, having polynomial complexity. The first algorithm is a variant of the well know network simplex algorithm and the second is a parametric algorithm based on sub-gradient information. The proposed algorithms are tested on a number of general instances and then applied successfully in real instances. All codes tackle basically all needs that an application might have. All algorithms can already be downloaded by CRIFOR web site.

: TC13 Pricing and Revenue Management in Supply Chains

Invited Session — Room: R21

Chair: Itır Karaesmen
University of Maryland

1 : Decentralized Pricing and Capacity Decisions in a Multi-Tier System with Modular Assembly. Fernando Bernstein, Duke University; DeCroix, Gregory.

We consider a modular assembly system facing uncertain demand for the final product. The final assembler sets the prices he will pay to the subassemblers, who then set the prices to pay their suppliers. All parties then choose the amount of capacity to install. Finally, demand is observed and all parties produce (and are paid for) the minimum of demand and system capacity. We characterize the equilibrium price and capacity choices, and derive results to guide the assembler in making higher-level structural choices. We also compare the performance of the system to that of a traditional assembly system.

2 : Coordinating Price and Production to Meet Fuel Economy Constraints. Julie Swann, Georgia Institute of Technology; Biller, Stephan.

Automotive manufacturers are required to meet Corporate Average Fuel Economy (CAFE) constraints for their car and truck consumer fleet. Since price can be used as a tool to alter the composite of the final vehicle portfolio, we develop a mathematical model to integrate price with production scheduling to maximize profit while meeting CAFE constraints for a multiple vehicle fleet. We describe the results of the implementation of this model and discuss demand models to incorporate diversions among multiple products.

3 : Pricing and Production Decisions under Demand Interactions. Mehmet Gümüş, Turkish Navy; Kaminsky, Phil; Ahn, Hyun-Soo.

We consider a joint production and pricing problem where demand realized at each period is influenced by the current price as well as prices at previous periods. We formulate a mathematical program for the general case, characterize the property of an optimal policy in special cases, and propose algorithms to obtain solutions. We devise heuristics for general case of problem. A numerical study demonstrates that the additional profit resulting from considering demand interactions can be significant.

4 : The Benefits of Market Segmentation and Flexibility in Demand Fulfillment for Perishable Goods. Itır Karaesmen, University of Maryland; Deniz, Borga; Scheller-Wolf, Alan.

We study a discrete-time inventory management problem for a retailer selling a perishable product. The market demand is segmented with respect to the age of the product. Segmentation is due to either pricing, or product characteristics. Under a base-stock policy, we look at the effect of segmentation and flexibility in demand fulfillment. We show that, when there is flexibility in fulfillment (indicating a lower degree of segmentation), the goods are on average fresher compared to that of complete segmentation. We also show that flexibility is less costly over the infinite horizon, compared to no flexibility with complete market segmentation.

: TC14 Explorations into Multiple Issue Auction and Negotiation Technologies

Invited Session — Room: R22

Chair: Jeffrey Teich
Erasmus University Rotterdam

1 : Automation Options in Multi-Attribute Business-to-Business Electronic Negotiations. Michael Rebstock, FH Darmstadt University of Applied Sciences.

Electronic negotiations have gained growing attention in electronic markets theory and practice. We present a classification framework for electronic negotiations. There are two basic coordination mechanisms of economic activities, hierarchy and market. Electronic negotiations refer to the second mechanism. The framework distinguishes a strategic and an operational level of negotiations in the business-to-business domain. It introduces an electronic negotiation typology. This typology includes the criteria protocol category, automation degree, attribute cardinality, item cardinality, process cardinality and mediation type. Applying the typology, we discuss the requirements of business negotiations and the question of automation potential.

3 : Xploring NegotiAuction: A Case-Study of Middleware Support for Decision-Making. Reinhard Brandl, Xerox Research Centre Europe; Andreoli, Jean-Marc; Castellani, Stefania.

We claim that negotiation is a powerful abstract notion for the coordination of generic services available from distributed autonomous components. This is the main motivation underlying the development of our prototype, XPlore, a middleware infrastructure for component service negotiation.

4 : An Extension of NegotiAuction to Large Multi-Unit Combinatorial Bundle Auctions. Jyrki Wallenius, Helsinki School of Economics; Teich, Jeffrey; Wallenius, Hannele; Carlyle, Matthew.

We have recently developed and implemented for the WWW environment NegotiAuction, an (iterative) hybrid auction and negotiation system, which deals explicitly with multiple issues. In NegotiAuction bids consist of price and quantity combinations of a (single) good. Other issues, such as delivery time, quality, warranty, etc. are taken into account via 'pricing out'. In NegotiAuction, the bidder is constantly informed of the amount that she must bid to be 'active', in other words to be among the winners of the auction. In this paper we consider large multi-unit combinatorial (reverse) auctions and extend NegotiAuction to such a situation.

: TC15 **Rich Vehicle Routing Problems - III**

Invited Session Room: R23

Chair: Geir Hasle
SINTEF Applied Mathematics

1 : An Exact Algorithm for Period and Multi-Depot Vehicle Routing Problem. Aristide Mingozzi, University of Bologna.

We present an exact method for solving two important generalizations of the classical Capacitated-Vehicle-Routing-Problem (CVRP): the Period-VRP (PVRP) and the Multi-Depot-VRP (MDVRP). The method involves the computation of a lower bound through an additive procedure which combines different relaxations of the integer formulation to derive an effective dual feasible solution. The dual solution is used by an iterative exact procedure which generates a sequence of reduced integer program which can be solved to optimality by an integer programming solver as CPLEX. Computational results on both PVRP and MDVRP test problems from the literature show the effectiveness of the proposed method.

2 : Home Replenishment - A Heuristic for Inventory Routing Problems with Multiple Products. Thomas Sigl, Fraunhofer Institute for Integrated Circuits.

We extend a business practice called vendor managed inventory replenishment (VMI) to the B2C case for home replenishment(HR). With VMI, vendors monitor their customers' inventories and decide when and how much inventory should be replenished. With HR, a service provider monitors his customers' inventories of multiple products and decides when and how much products to buy and deliver to replenish inventory at each customers' home. To solve HR, we present a heuristic for the inventory routing problem (IRP) with multiple products to coordinate buying products, transportation, inventory replenishment in such a way, that cost is minimized over the long run.

3 : Heuristics and Lower Bound for the Mixed Capacitated Arc Routing Problem. Jose M. Belenguer, Universitat de Valèncía; Benavent, Enrique; Lacomme, Philippe; Prins, Christian; Ramdane-Cherif, Wahiba.

The Mixed Capacitated Arc Routing Problem (MCARP) is a problem extending the well-known CARP to a mixed graph and enabling to model complex applications like urban waste collection. This work describes first three constructive heuristics and one memetic algorithm to compute upper bounds and tackle some complications like prohibited turns or windy edges. Then, it presents a linear programming model and valid inequalities, leading to a cutting plane algorithm that compute tight lower bounds. Finally, the lower bounds and the heuristics are compared on two sets of randomly generated instances with up to 806 required links.

4 : A Conceptual Model for Rich VRPs. Geir Hasle, SINTEF Applied Mathematics; Kloster, Oddvar; Bräysy, Olli; Gendreau, Michel; Kjenstad, Dag; Riise, Atle.

The development of more versatile routing methods and faster computers, as well as demands from users of routing tools, has established a general trend towards formulating and solving rich VRP models. In addition to the use of mathematics as a language for expressing routing problems, there is a need for conceptual models that will define the basic concepts in rich VRPs and their interrelation. We describe a conceptual model that has the power of expressing a wide variety of routing problems.

: TC16 **Multi-Project Capacity Planning**

Invited Session Room: R27

Chair: Erwin W. Hans
University of Twente

1 : Algorithms for Robust Resource Capacity Loading. Gerhard Wullink, Universiteit Twente; Hans, Erwin W.; Gademann, Noud; Van Harten, Aart.

Order acceptance decisions in manufacture-to-order environments are often made based on incomplete or uncertain information. To promise reliable due dates and to manage resource capacity adequately, resource capacity loading is an indispensable supporting tool. We propose two approaches for robust resource capacity loading under uncertainty. The first is based on finding a plan that has the best cost-performance over various relevant scenarios. The second approach generates several alternative cost-equal plans with different robustness characteristics. We measure the robustness of these plans with several robustness indicators. This approach allows a planner to make a trade-off between costs and robustness simultaneously.

2 : Resource-Constrained Project Scheduling under Uncertainty. Antonio Alonso Ayuso, Universidad Rey Juan Carlos; Escudero, Laureano Fernando; Clement, María Francisca; Ortuño, M. Teresa; Gil, María Luisa.

We present a pure 0-1 model for scheduling with uncertainty in costs and resources' consumption and availability. Given a set of operations to be executed, the objective is find a schedule to minimise a composite function included by the expected value of the operations cost and the probability that the cost exceeds a given target over all scenarios, subject to: limited availability of the resources, multiperiod operations, exclusivity and implicative constraints, precedence relationships, etc. A multistage scenario analysis with a mixture of full and simple recourse is used. Some computational experience is reported, obtained by the so-called Fix-and-Relax-Coordination Scheme.

3 : Combining Scheduling and Statistical Techniques to Achieve Alpha-reliable Makespan Estimates for Batch Process Industries. Cristina Ivanescu, Eindhoven University of Technology; Fransoo, Jan C.; Bertrand, J. Will M.

We focus on customer order acceptance in batch process industries. Due to complex precedence relationships between operations, the estimation of acceptable workload is very difficult. Since, for large problems, a detailed schedule-based model require a prohibitively large amount of computation time, in earlier work, a regression-based model was proposed that uses point estimates for predicting the makespan of a job set. Here, we predict the makespan by using an á one-sided prediction bound. Furthermore, we derive a combined order acceptance policy that uses both scheduling and statistical techniques. The three order acceptance policies are compared by means of simulation experiments.

4 : Order Acceptance and Resource Loading Methods in a

Rolling Horizon. Erwin W. Hans, University of Twente; Ebben, Mark.

Order acceptance (OA) is a tactical planning activity that deals with accepting and rejecting customer orders, and negotiating due dates. It has much impact on the performance of a manufacturing firm. Accepting too many orders will result in an overloaded production system, increasing lead times, and decreasing delivery performance. We study the behavior of several OA methods in a rolling horizon, by simulating a generic multi-resource job shop production environment with stochastic processing times. We also study the relation of OA with the resource capacity loading function, which supports OA in determining the impact of new customer orders.

: TC17 Optimization and Simulation

Invited Session Room: R24

Chair: Gül Gürkan
Tilburg University

1 : Optimal Exercise Policies and Simulation-based Valuation for American-Asian Options. Michael Fu, University of Maryland; Wu, Rongwen.

American-Asian options are average-price options that allow early exercise. We derive structural properties for the optimal exercise policy, which are then used to develop an efficient numerical algorithm for pricing such options. In particular, we parameterize the exercise boundary, and derive gradient estimators for the option payoff with respect to the parameters of the model. These estimators are then incorporated into a simulation-based algorithm.Numerical results are reported.

2 : Response Surface Methodology with Stochastic Constraints for Expensive Simulation. M. Ebru Angun, Tilburg University; Gürkan, Gül; den Hertog, Dick; Kleijnen, Jack.

In this presentation, we investigate simulation-based optimization problems with a stochastic objective function and stochastic constraints. We generalize Response Surface Methodology replacing steepest descent by a search direction inspired through interior point methods; the new search direction is scale independent. Furthermore, we use our search direction iteratively, assuming expensive simulation. As a stopping rule, we check the Karush-Kuhn-Tucker optimality conditions. For this check, we provide two statistical tests: the first test needs only a small sample and is based on Monte Carlo sampling; the second test is asymptotic and is based on the Delta Method.

3 : Multi-Location Transshipment Problem with Capacitated Transportation. Enver Yücesan, INSEAD; Özdemir, Deniz; Herer, Yale.

We consider a supply chain, consisting of N retailers and one supplier. The retailers, which differ in their cost and demand parameters, may be coordinated through replenishments and transshipments, that is, movement of a product among the locations at the same echelon. It is optimal for each retailer to follow an order-up-to S policy. We introduce a stochastic approximation algorithm to compute the order-up-to quantities using a sample-path-based optimization procedure. Given an order-up-to S policy, we determine an optimal transshipment policy, using a capacitated LP/Network flow framework. Such a combined numerical approach allows us to study complex systems.

4 : Importance Sampling and Approximate Value Iteration for Optimal Stopping Problems. Martin Haugh, Columbia University; Zhang, Ge.

This work focuses on applying the popular duality and approximate dynamic programming (ADP) techniques for pricing deep-out-of-the-money American options. An important sampling approach should be useful for tackling these problems, but knowledge of a good importance sampling measure depends on the unknown optimal stopping strategy. In this talk we propose an algorithm that updates the importance sampling measure at each step of the ADP algorithm. We find that the duality-based upper bounds on the true option price that we obtain are superior to the upper bounds produced by other algorithms.

: TC18 Continuous Location Problems

Invited Session Room: R25

Chair: Jakob Krarup
University of Copenhagen

1 : Cournot Duopoly Competition in Spatially Separated Markets: The Non-Zero Conjectural Variation Case. Pablo Dorta, University of Las Palmas de Gran Canaria; Santos Peñate, Dolores Rosa; Suárez, Rafael.

Consider a two-stage non-cooperative Cournot game with location choice involving two firms. There are n spatially separated markets located at the vertices of a network. Each firm first selects the location of a facility and then selects the quantities to supply to the markets in order to maximize its profit. Non-zero conjectural variation at the second stage in the model by Labbé and Hakimi (1991) is studied. Equilibrium in the quantities offered by each firm in the markets exists. Furthermore, when the demand in each market is sufficiently large, each firm chooses to locate its facility at the vertices.

2 : Maximum Capture Analysis for Petrol Stations Location. Malick M. Ndiaye, King Fahd University of Petroleum And Minerals; Ruhhal, Nasser; Arifusalam, Shaikh.

The location of petrol filling stations is a critical decision issue in this highly competitive retailing activity. In the context of the gulf Arabic countries, characterized by a relatively low and fixed selling price, it is essential to analyse customers' behaviour to identify the main criteria that should be taken into consideration for successful location. Several approaches based on a maximum capture model [MaxCap] are developed to maximize market capture while opening the retailing facility. The methodology is then applied in the context of the Saudi Arabian city of Khobar.

3 : The p/q-Active Facility Location Problem. Jakob Krarup, University of Copenhagen.

In almost all literature on locational decisions where a prespecified number p of facilities are to be located, facilities are either closed or open. There may be optimal solutions where some of the open facilities serve no customers. Thus, an open facility is either active if at least one customer is assigned to it and

passive otherwise. We study the problem of locating p active facilities, each serving at least q customers, q>1, at a minimum total cost. We present a 0-1 MIP formulation, and propose an exact branch and bound algorithm coupled with a dual ascent heuristic.

4 : Enhancements to Two Exact Methods for the Vertex P-Center Problem. Abdulrahman Al-Khedhairi, University of Birmingham; Salhi, Said.

Two ILP formulations are considered for further investigation. In the first approach modifications of some steps are introduced to reduce the number of IP iterations. In the second approach simple enhancements are used to tighten the initial lower and upper bounds. These ideas are tested on a set of known problems from the literature. The obtained results are encouraging.

: TC19 Long-Term Care Models

Invited Session Room: R26

Chair: Thierry Chaussalet
University of Westminster

1 : Continuous-time Markov models for the flow of elderly people in long-term care institutions. Thierry Chaussalet, University of Westminster; Xie, Haifeng.

We develop Markov models in continuous-time for the flow of elderly people within and between residential home care and nursing home care. A procedure to determine the structure of the model and estimate parameters by maximum likelihood is presented. The model is fitted to a real world dataset and reveals important insights into the movement of elderly people in residential care and nursing care facilities. Resource implications are also discussed.

2 : A Simulation Model Concerning the Future Needs of Long-term Care of Elderly Persons in Sweden. Marten Lagergren, Stockholm Center of Gerontology.

The increasing number of elderly persons to be expected in the coming decades raises serious questions concerning the resources that will be demanded for provision of long-term care. A simple model earlier developed by the author showed that the expected increase in the period 2000 - 2030 was reduced from 60% to around 20%, assuming that prevailing health trends should continue. In an effort to corroborate these results and make possible further analysis of different factors pertaining to the estimation of future needs of publicly financed long-term care of elderly, dependent persons, a new model has been developed.

3 : Modelling Survival for Evaluating the Cost of Long Term Care. Thierry Chaussalet, University of Westminster; Pelletier, Christine.

The European population is ageing and the cost of long term care is rising. Annual budgets and weekly costs mask differences in duration of stay of movers and stayers. These differences are important because they influence the resources that are needed and the cost to the individual and the state. We use continuous time Markov models to reflect duration of stay differences in group survival behaviour. Using four years local authority data, we test the validity of the models and profile the characteristics of movers and stayers. The implications of our findings for local authority social service planning are discussed.

: TC20 Applications of Bayesian Methods

Invited Session Room: M35

Chair: Eugene Hahn
Salisbury University

1 : Strategies for Inference in Regressor Causality. Eugene Hahn, Salisbury University.

Dodge and Rousson have proposed a method for distinguishing the response and explanatory variable in regression. Using the properties of cumulants and higher-order correlations, point values of assymetric functions of the correlation coefficient can be computed. If certain inequalities are satisfied, then evidence for conclusions about variable exogeneity/endogeneity exists. While these point estimates are useful for preliminary conclusions, no inferential framework is provided. Here, we enhance the test's utility by placing it in an inferential context via a Bayesian framework and MCMC methods. We illustrate the method using financial data by examining the US dollar's impact on other currencies.

2 : Prioritizing Non-Sampling Errors using Stochastic AHP: A Bayesian Approach. Cynthia Knott, George Washington University; Hahn, Eugene.

An Analytic Hierarchy Process (AHP) weightings model for deriving the relative weights of identified types of non-sampling error is presented. The model is tested using data on the magnitude of various non-sampling error in the U.S. Current Population Survey (CPS). A stochastic AHP model which makes use of Bayesian weighted hierarchical multinomial logit models is used to conduct inference on the priorities. This approach allows survey designers to go one step further in understanding the relative contribution of the various types of non-sampling errors to total error and consequently be better prepared to elect approaches to reduce these errors.

3 : Bayesian ROC Analysis using Normal Mixtures. Al Erkanli, Duke University Medical Center.

In this paper we develop a semi-parametric Bayesian approach to Receiver Operating Characteristics (ROC) using mixtures of Dirichlet Process (DP) priors and Gibbs sampling. The DP mixtures provides a robust way of modeling non-standard distributions. An additional advantage of DP approach is the fact that the estimation of the number of mixing components and the mixing weights are byproducts of the model fitting procedure. Computations are feasible using Gibbs sampling.

: TC21 Information and Accuracy Issues

Invited Session Room: M36

Chair: Beril Toktay
INSEAD

1 : Strategic Commitment for Optimal Capacity Decision under Asymmetric Forecast Information. Ozalp Ozer, Stanford University.

We study the capacity decision in a two-level supply chain. The supplier is responsible for acquiring the necessary capacity before receiving the order from the manufacturer who possesses private forecast information for its end product. We identify two sources of inefficiency due to a wholesale price contract and propose contracts that achieve credible information sharing and channel coordination. By means of these contracts we will also compare a signaling game with a mechanism design.

2 : Selecting a Forecast Collaboration Structure. Beril Toktay, INSEAD; Kurtulus, Mumin.

The CPFR committee now recommends choosing one of three different scenarios for formalizing forecast collaboration between buyer and seller: Unidirectional information exchange from buyer to seller or from seller to buyer, or bidirectional information exchange and forecast updating. We assume that either party can improve the accuracy of its forecast by expending costly effort and that forecasts improve in accuracy if combined. We determine the scenario maximizing total channel profit as a function of the profit sharing arrangement, the relative forecasting capability of each party and the complementarity of information available to each party.

3 : Modeling Accuracy Issues in Inventory Systems. Evren Sahin, Ecole Centrale Paris; Dallery, Yves.

If data recorded in information system concerning inventory on hand, quantities received from suppliers or sent to customers contain errors, the inventory control policy may fail to operate as intended. Our research considers an extension of the well known newsvendor problem where we take into account the discrepancies between recorded and physical inventory levels.

4 : Rolling Horizon Heuristics for Production and Setup Planning with Backlogs and Error-Prone Demand Forecasts. Alistair Clark, University of the West of England.

This paper develops and tests three exact and approximate models for capacity-feasible production lot-sizing plan for a drinks canning line. All three models are first tested under static conditions and then on a rolling horizon basis with differing degrees of forecast accuracy, tightness of capacity, and length of planning horizon. Computational experiments compare the faster approximate models to the exact models under rolling conditions. The degree of capacity tightness and horizon length affects the models' performance and relative effectiveness. Surprisingly, the degree of forecast error appears to have limited impact on the relative performance of the various models tested.

: TC22 **Nesting - II**

Invited Session Room: M37

Chair: Jose Fernando Oliveira
Universidade do Porto

1 : Models and Algorithms for Two-Staged Cutting Stock Problems. Michele Monaci, University of Bologna; Lodi, Andrea.

We are given a unique finite rectangular stock of material, and a list of rectangular shapes to be cut from it. Each shape's type has associated geometric dimensions, a profit, and an upper bound on the number of items of that type available. We consider the problem of determining a cutting pattern in which the maximum number of cuts allowed to obtain each item is 2 and the sum of the profits of the cut items is maximized. For 2TDC we propose ILP formulations and a Tabu Search algorithm, and present computational results on instances from the literature.

2 : Solving the Cutting Stock Problem by Stabilized Column Generation. Hatem Ben Amor, GERAD; Desrosiers, Jacques.

The linear relaxation of the Cutting Stock Problem (CSP) is usually solved by column generation. We propose two stabilization approaches based on prior knowledge on dual optimal solutions. The first approach uses what we call dual-optimal inequalities, whereas the second is based on the knowledge of a very tight approximation of an optimal dual solution for the most difficult problems. Numerical experiments are performed using the well known OR-library problems along with much more difficult new problems.

: TC23 **Artificial Markets Modeling**

Invited Session Room: M38

Chair: Andrea Consiglio
Università di Palermo

1 : Analysis and Simulation of a Double Auction Artificial Financial Market. Silvano Cincotti, University of Genova; Dose, Christian; Focardi, Sergio M.; Marchesi, Michele; Raberto, Marco.

We present a double auction artificial financial market based on heterogeneous agents trading one risky asset in exchange for cash. Agents issue random orders depending on budget constraints and on market volatility. Limit orders are stored in the book while market orders give immediate birth to transactions. We show that fat tails and volatility clustering are recovered by means of very simple assumptions. We also investigate several statistical properties on the simulated market: shape of the average limit order book, statistics of incoming order flow and price impact function, finding similarities with real double auction market data.

2 : Hierarchical Structure of a Financial Portfolio in Real and Artificial Markets. Rosario N Mantegna, Palermo University; Bonanno, Giovanni; Caldarelli, Guido; Lillo, Fabrizio.

We present here a topological characterization of the minimal spanning tree that can be obtained by considering the price return correlations of stocks traded in a financial market. We compare the minimal spanning tree obtained from a large group of stocks traded at the New York Stock Exchange during a 12-year trading period with the one obtained from surrogated data simulated by using simple market models. We find that the empirical tree has features of a complex network that cannot be reproduced, even as a first approximation, by a random market model and by the one-factor model.

3 : Breeds of Risk-Adjusted Fundamentalist Strategies in an Order-Driven Market. Paolo Pellizzari, University of Venice; LiCalzi, Marco.

This paper studies an agent-based model of an order-driven stock market. The agents follow a fundamentalist trading strategy which buys and sells under- or over-valued assets. Agents

are budget-constrained and use heterogeneous risk-adjusted estimates of the fundamental value. This environment generates remarkably leptokurtic and fat-tailed returns, mainly due to the order-book trading mechanism. The model exhibits an increasing relationship between the risk-premia asked by the agents and the volatility of the returns. We conjecture that this effect, coupled with positive dependence of the risk premium on the volatility, generates a positive feedback that might explain volatility bursts.

4 : Modelling Limit Order Trading. Giulia Iori, King's College.

The aim of this paper is to introduce simple auction market models to understand how the placement of limit orders contributes to market liquidity and to the price formation mechanism. We investigate how different trading strategies may affect the dynamics of prices, bid-ask spreads, trading volume and volatility. We analyze the impact of trades of different size on prices, the shape of the book, the distribution of orders at different prices and the distribution of their life time and compare the results of our simulations with real market data.

: TC24 **MCDA - C1**

Contributed Session Room: L17

Chair: Reza Radfar
I.A.U.

1 : Rural Energy Decision-Making using Multicriteria Analysis. Ricardo Smith, Universidad Nacional de Colombia; Cherni, Judith; Sheate, William R.; Jaramillo, Gloria Patricia; Dyner, Isaac.

This paper presents a multicriteria model to support decision-making analysis in the area of rural energization. The system model is currently being developed as part of a multidisciplinary research project on renewable energy for isolated rural areas (RESURL) undertaken in several Latin America and Caribbean countries. The multicriteria system aims to address central questions on energy decision-making such as those related to the selection of technology and projects, the prioritization of projects and communities, and the distribution of available resources. Some applications are presented and results discussed.

4 : Comparing the Selected Countries in Sustainable Development Perspective: A Fuzzy Multiple Attribute Decision Making Approach. Özgür Kabak, İstanbul Technical University; Ülengin, Füsun.

This paper proposes a method for comparing the selected countries in sustainable development perspective by using fuzzy logic. Initially indicators, which make sustainability measurable, are grouped according to correlations among each other. A factor analysis is conducted in order to reveal the mutually independent indicators. Secondly weights of indicators are specified via fuzzy AHP. Targets and minimum levels of indicators are then determined to apply fuzzy normalization and a fuzzy outranking method is proposed to compare and rank the countries. Finally sensitivity analysis is conducted to measure the sensitivity of the rankings to changes in the weights of the indicators.

5 : A New Fuzzy Linear Assignment Method for Criteria Weighting. Reza Radfar, I.A.U.; Toloie, Abbas.

Determination of the priority and importance (weights) of attribute in decision making matrix is the main problem for decision science researchers. Usually, criteria weights define by two way, first internal methods (based on decision making matrix structure) and second external methods (based on DM attitude). This paper presents a new method for criteria weighting by combination of fuzzy sets approach, decision maker preference matrix and linear assignment method to obtain internal viewpoint for determine criteria weights.

: TC25 **Corporate and Organizational Change**

Invited Session Room: M34

Chair: Peter Bradl
Bavarian Research Center for Knowledge-Based Systems

1 : Corporate Planning with System Dynamics. Peter Bradl, Bavarian Research Center for Knowledge-Based Systems.

Expertise of employees is becoming increasingly important for companies. One main task in managing a company is to evaluate the value of human capital properly. Current research focuses on corporate planning with an emphasis on HR. Focus is set on allocating staff to projects and on the provision of the right qualification. This will be achieved by using an SD model that is validated using data from a data warehouse fed from ERP-Systems. The paper will describe the importance SD for strategic planning before explaining the model and its use in a planning environment. Test runs will end the paper.

2 : Dynamics of Organizational Change. Ozge Pala, Nijmegen School of Management; Vennix, Jac.

Organizational change theories have largely overlooked the factors affecting success of change, even though most change processes are known to fail. This paper reports on a system dynamics model based on one of the prominent theories of change, the punctuated equilibrium model. The causal relationships explained in this theory provide information on mechanisms that generate change and the first determinant of success, timing of change. Modelling extends the theory by incorporating two other important success factors, appropriateness of the chosen strategy (determined by information-processing capability) and implementation success (determined by resistance to change). Implications for organizational change theories are discussed.

3 : System Dynamics for Modelling TQM and Organisation Learning. Khalid Hafeez, Sheffield Hallam University; Abdulmeguid, Hamdy.

In this paper system dynamics is used to develop a family of conceptual models representing the major feedback loops to stimulate or inhibits the learning process. Relationships between skill, knowledge, and competence are identified and subsequently mapped onto the TQM and organisation learning process. Relevant influence diagrams are constructed to elaborate the interactions between various learning activities such as, introducing new knowledge, skill acquisition through training and developing organisation competence pool. These models provide guidelines for a company in order to understand its TQM and organisation learning procedures and provide essential

building blocks to conduct computer simulation exercises.

4 : System Dynamics Modeling - HR Planning & Maintenance of Corporate Knowledge. Keith Linard, University of New South Wales; Dvorsky, Lubomir.

This paper encapsulates 10 years of human resource modeling, using the system dynamics paradigm, for the Australian civil service and defense forces. It identifies diverse problems confronting HR managers regarding staff progression, including optimum mix of experience, balancing stability and 'new blood' and maintenance of corporate knowledge. It presents alternative modeling structures, including multi-dimensional arrays, for addressing these. The paper integrates these structures with quantitative factors, such as workflow, and more qualitative factors, including management oversight, workload pressure and morale, to permit the development of powerful HR 'flight simulators' emulating the 'Balanced Scorecard' or the 'Intangible Asset Monitor'.

: TC26 **Capacity Planning - C1**

Contributed Session Room: L10

Chair: Allen Greenwood
Mississippi State University

1 : Improving Production Yield through Learning-by-Doing and Knowledge Sharing. Hasan Arslan, Massachusetts Institute of Technology; Roemer, Thomas; Yassine, Ali.

We study the interaction between the learning process and the strategic production decisions in a high-tech firm. We, first, analyze how learning-by-doing affects the capacity allocation between the newly developed product and the preceding product. We show that optimal allocation policy is allocating the whole capacity either for the newly developed product or for the preceding product until the end of its life cycle. We, then, analyze how induced learning process influences production decisions when knowledge sharing among production lines is feasible. We finally provide a yield control mechanism through knowledge sharing among production lines.

2 : An Investigation of the Effect of Intermittent Operations on Production Line Capacity. Allen Greenwood, Mississippi State University; Guo, Shunri; Bullington, Stanley.

An intermittent operation, as defined in this paper, is a non-preemptive operation that occurs with a variable frequency for each production cycle. The "natural" variability that occurs in most production operations is often ignored in balancing assembly lines; similarly, the variability invoked by intermittent operations is also often ignored. The effect of intermittent operations is usually accounted for only through "averaging." Our investigation into a local company's capacity problems drew our attention to this special type of variability. As shown in this study, intermittent operations may induce very high variability and subsequently severely reduce production capacity.

: TC27 **Supply Chain Management - II**

Invited Session Room: L11

Chair: Yanni Papadakis
Drexel University

1 : Modeling of Supply Chain Inventory Management. Petr Fiala.

Supply chain inventory management goes out the situation that supply chains are usually operated by independent units with individual preferences. There are many inefficiencies in supply chains. To be a supply chain more efficient as a whole it is necessary to apply coordination techniques to manipulate the behavior of one unit to the advantage of another. The Internet has affected inventory management most dramatically in the ability to be proactive and cooperative in the management of inventory systems. The paper presents some modeling approaches for coordination and cooperation activities in inventory management of supply chains.

2 : Supply Chain Integration - What is the Important Issue?. Moshe Eben-Chaime, Ben-Gurion University; David, Israel.

We consider a two-levels supply chain. An item is produced at a fixed rate and delivered to satisfy fixed-rate continuous demand at the next level. Deliveries are instantaneous and in equal quantities. The degree of independence between parties is highlighted. The manufacturer selects the production lot size and once the delivery quantity is selected, the ratio of both quantities is the desired shipment frequency. In contrast, the demand-to production rate ratio is very significant. The main results confirm with intuition; e.g., that batch production is not desired for a single item manufacturing, and is extended to the multiple buyer case.

3 : An Inventory Model for Effective Linkage between Buyer and Supplier. Seung-Lae Kim, Drexel University.

This study develops a buyer-supplier coordination model in a JIT environment to facilitate frequent deliveries in small lot sizes. Two policies, in a single buyer and single supplier scenario for a single product, are discussed: single-setup-multiple-delivery (SSMD) policy and multiple-setup-multiple-delivery (MSMD) policy. We show that the optimal policy adopted by both buyer and supplier in a cooperative manner can be economically beneficial to both parties.

4 : When More Knowledge Is Not Better: Pilot Projects and Codifiability. Moti Levi, Smeal College of Business Administration, Pennsylvania State University; Noe, Thomas.

Pilot project and prototyping are used when transaction knowledge is uncodifiable. We examine such a scenario and find that how buyers and supplier interact in this context. Surprisingly, a buyer may find it beneficial not to codify a transaction when it may have to re-contract with other suppliers. By doing so, it avoids sending out a clearer signal of a low quality project and thus being charged higher prices by the new supplier. Thus, competition and bargaining in conjunction with uncodifiability may create a social welfare reducing behavior.

5 : Operations Risk Management and Supply Chain Design: An Event Study. Yanni Papadakis, Drexel University.

This empirical study provides evidence linking supply chain strategy and company risk structure. An event study on the stock performance of four major PC producers is performed focusing on the 1999 earthquake in Taiwan and the computer

memory price increases that ensued. It is shown that investors associate pull-type supply chains for PCs with lower profitability after abrupt component price increases. A parallel analysis of push-type producer stock returns does not show similar results. Furthermore, in depth analysis of Dell Computer reveals that after the catastrophe-induced disruption the onset of losses to this major pull-type PC producer was very fast.

: TC28 **Multi-Objective Meta-Heuristics**

Invited Session Room: L12

Chair: Jean-Marc Godart
Faculté polytechnique de Mons

1 : A Multiple Objective Metaheuristic Algorithm for Advanced Trip Planning. Jean-Marc Godart, Faculté polytechnique de Mons.

The multiple objective Trip Planning Problem (TPP) proved to be appropriate to provide rather basic decision aid in planning (tourism) trips. This time, a more advanced model is suggested for trip planning and a metaheuristic algorithm is presented to solve the multiple objective combinatorial optimization problem which is underlying this model.

2 : Tabu Search for Multi-Objective Flowshop Problems. Vinícius Armentano, Universidade Estadual de Campinas; Arroyo, José Elias.

We propose a new tabu search algorithm for multi-objective combinatorial problems with the goal of obtaining a good approximation of the Pareto-optimal solutions. The algorithm works with several paths of solutions in parallel and the Pareto dominance concept is used to select solutions from the neighborhoods. Solution dispersion is achieved by a clustering procedure that groups close solutions and then selects the centroids of the clusters as search directions. The algorithm is applied to the flowshop scheduling problem to minimize the criteria of makespan and maximum tardiness. Computational tests involve comparison with algorithms from the literature.

3 : An Hybrid Genetic Algorithm for a Hybrid Flowshop. Sylvain Bertel, Université de Tours; Nikolai, Tchernev.

This paper presents a hybrid genetic algorithm for a hybrid flowshop.The aim of this paper is to propose an effective heuristic . The workshop is an hybrid flowshop, and the problem is to perform jobs between a release date and a due date, in order to minimize the lateness. A linear programming formulation of the problem is proposed as an exact method. A greedy algorithm and a genetic algorithm are proposed as approximate methods. To evaluate these methods, experiments on instances like industrial ones are computed.

4 : Modification of Genetic Algorithm by RSM. Nafiseh Kishian, Ferdowsi University, Mashhad; Najiazimi, Zahra.

In the genetic algorithm there is not a strong mathematical relation between the parameters. We consider a method on the basis of RSM which first of all specifies the obtained solution by GA is near global optimal solution or not? When the response is negative then we choose an approach to obtain a precise solution which is closer than to the optimal solution. This approach is a combination of RSM and GA. We solved some problems such as QAP and Timetabling with this approach and obtained some satisfactory results.

: TC29 **Hazmat - IV**

Invited Session Room: L13

Chair: Bahar Kara
Bilkent University

1 : The Transportation of Hazardous Materials in Congested Networks. Andrea Scozzari, Università degli Studi di Roma "La Sapienza"; Dell'Olmo, Paolo; Fantini, Paolo.

Finding sets of paths is a mandatory requirement for routing fleets of vehicles transporting HazMats between a given set of OD sites. A suitable set of alternative routes allows to equally distribute the risk of an accident among the exposed population. We compare a Multicommodity flow model (MF) with a Congested Multicommodity one (CMF) both on a real application and on test problems for multiple shipments of two materials between two OD pairs. We show that the set of paths generated by CMF is larger than the one provided by MF without increasing too much the total transportation costs.

2 : Monitoring Movement of Hazardous Cargo. Pitu Mirchandani, University of Arizona; Gentili, Monica.

Hazardous material cargo would benefit from close monitoring of their movements. For monitoring hazardous cargo, mobile sensors seem to be particularly suitable. By mobile sensors we mean helicopters from which images of the current situation of the traffic can be taken and "image-processed" for vehicle detection. Clearly, the available fleet of helicopters to monitor the network would be limited and the main problem, in this case, is how to operate the fleet in order to monitor the network efficiently. We develop a family of logistical problems, discuss some of them and provide algorithms and complexity results for some special cases.

3 : Integrated Routing and Scheduling of Hazmat Vehicles. Erhan Erkut, University of Alberta; Alp, Osman.

We consider an integrated routing and scheduling problem in hazmat transportation where the accident rates on highways and the population exposure vary with time of the day. We minimize risk (accident probability multiplied by exposure) subject to a constraint on the total duration of the trip. We allow for stopping at the nodes of the network, which complicates the problem. We consider four versions of this problem in increasing complexity and propose solution methods based on dynamic programming.

4 : A Path-based Approach for the Hazardous Network Design Problem. Bahar Kara, Bilkent University; Verter, Vedat.

We provide a path-based formulation for the hazardous network design problem, which involves the government's decisions on the hazardous materials transportation network. The transport risk is determined by the carriers' routing decisions over the available road network. Alternative solutions can be generated by varying the routing options included in the model. Each solution corresponds to a certain compromise between the two parties in terms of transport risk and economic viability. The proposed framework can be used for identifying mutually

agreeable hazardous materials transport policies. We present an application of the methodology within the provinces of Quebec and Ontario, Canada.

: TC30 **Engineering Management**

Contributed Session Room: L14

Chair: Susana San Matias
Universitat Politècnica de València

1 : Efficient Estimation of System Availability in the Exponential Case. Vladimir Strelchonok, Baltic Russian Institute; Nechval, Nicholas; Nechval, Konstantin; Vasermanis, Edgars.

In the process of determining the worth of system (or equipment) to perform a given task the engineer is often primarily concerned with three quantities: reliability, maintainability, and availability. In many instances the most pertinent of the three is the latter. In this paper, the case is considered when the time between failures and the time to repair are independent negative exponential random variables. A new approach to determining the point and interval estimators of availability that emphasizes pivotal quantities is presented. Numerical examples are given.

2 : Industrial Diagnosis to Improve the Production System. Aboun Nacéra, Ecole Nationale Polytechnique; Belmokhtar, Oumhani.

This paper presents an approach, that permits the improvement of the performances and output of the productive system. The main problem concerns, the search of the reasons of inefficiency of the machines and the losses of raw materials, and the improvement of the system reliability of the production monitoring. For this reason, an industrial diagnosis has been made. In this way, a quantitative and a qualitative analysis of the data and information permitted to identify the most important reasons of the dysfunction of the production process. The interpretation of results permits to find and suggest some solutions.

3 : Expected Qualities of the Engineering Graduates and How the Engineering Schools Can Meet Them. Mustafa Özkaynak, TÜSSİDE.

This paper examines the qualities expected of engineering graduates, as defined by the major stakeholders, including the industry. The approaches and methods used by the engineering schools to understand and meet these quality expectations are explored. We first define the stakeholders of the engineering schools and the role of engineers in the society, the expectations of these stakeholders from graduating engineers are surveyed, how the schools can meet expectations with the current curricula and philosophy is discussed. The paper aims to provide recommendations, with the hope of indicating some specific improvement opportunities in engineering curricula, approaches in engineering education.

4 : A Methodology for the Optimal Determination of Parameters in Quality Control Tools. Vicent Giner, Universitat Politècnica de València; San Matías, Susana.

In this work, our aim is to design an automatic system to select the parameters which determine the performance of some quality control tools. Particularly, we address the case of pre-control. Our scheme is applied in two different contexts. First, when a user intends to use pre-control as a test for the deviation of the process. Next, we present the selection model when the user is going to use pre-control to test the potential capability of the process. We propose the use of optimization techniques of MINLP, and we discuss several proposals and the corresponding results.

: TC31 **Queueing Systems - C1**

Contributed Session Room: M33

Chair: Mehmet Begen
University of British Columbia

1 : A Large Closed Queueing Network Containing Two Type of Nodes. Vyacheslav Abramov, Tel Aviv University.

We study a closed queueing network containing two type of nodes. The first type (server station) is a Markovian-infinite-server queueing system, and the second type (client station) is a single-server queueing system with autonomous service constituting strictly stationary and ergidic sequences of nonnegative random variables. There are N requests in the network, every of which is "assigned" to some server station. One of the single servers is a bottleneck station, while the rest are non-bottleneck stations. We obtain the asymptotic distribution of the queue-lengths at the non-bottleneck stations as N and the service rates in client stations increase to infinity.

2 : Homogeneous Finite-source Retrial Queues with Server Subject to Breakdowns and Repairs. Janos Sztrik, Debrecen University; Almasi, Bela; Roszik, Janos.

This paper deals with a single server retrial queue in which the failure of the server may block or unblock the system's operations and the service of the interrupted request may be resumed or the call can be transmitted to the orbit. The novelty of the investigation is the variability of this non-reliability of the server which makes the system rather complicated. The MOSEL tool was used to formulate and solve the problem, the main performance and reliability measures were derived and graphically displayed. Several numerical calculations were performed to show the effect of the non-reliability of the server.

3 : N-Policy for a Globally Gated Polling Systems with a Dormant Server and Batch Arrivals. Lida Thomo, University of Macedonia.

We study a globally gated polling system with dormant server. When the system is empty, the server becomes dormant at its home base station until the number of new arrivals to the system will be at last N. The arrivals are compound Poisson with different rates at different queues. In order to move from one queue to another the server requires a nonzero switch-over time. We derive an explicit expression for the mean waiting time at each of the queues as function of N. Also we derive the pseudoconservation law.

4 : The 90 - 10 Rule; OR Models Improve Passenger Flows and Customer Service at Vancouver International Airport (YVR). Mehmet Begen, University of British Columbia; Atkins, Derek; Kluczny, Bailey; Parkinson, Anita; Puterman, Martin.

Faced with the challenge of increased security needs the YVR

Airport Authority approached us to identify ways to enhance the efficiency and performance of the pre-board screening operation. The team collected extensive data and then developed and validated an animated computer simulation model of the flow of passengers for the operation. Moreover we developed a methodology to generate staffing schedules from flight schedules and load factors for all the piers. These allowed to identify and remedy bottlenecks, develop staffing rules and achieve the performance standard that 90% of the passengers wait no more than 10 minutes to pass through security.

: TD01 **Landscapes of Modern Heuristic Search**

Tutorial Room: MB I

Landscapes of Modern Heuristic Search. Colin Reeves, Coventry University.

Important steps have been made in the last two decades in developing heuristic search algorithms for hard combinatorial optimization problems. Heuristics may be classified into several broad categories, but much of the impetus for recent developments has come from the application of general heuristic paradigms based on the simple idea of local search methods such as simulated annealing, tabu search and genetic algorithms. These modern approaches (sometimes referred to as 'metaheuristics') have much to offer in terms of generality and flexibility. Perhaps the best way to view the variety of approaches is by making use of the general concept of a landscape in order to obtain a unified treatment. In this talk, I shall discuss the idea of a landscape and show how modern heuristic methods fit into this framework.

: TD02 **A New Approach to Search Theory**

Tutorial Room: MB II

A New Approach to Search Theory. Daron Acemoğlu, Massachusetts Institute of Technology.

Search theory analyzes a class of problems where individuals are imperfectly informed about prices and engage in costly sampling. The standard approach considers a decision problem where an individual sequentially takes random draws from a known or unknown distribution, F(p), and decides when to stop and accept one of the draws. The trade-off is between costly delay and the expectation of obtaining more favorable draws in the future. This talk will survey new research on "directed search models" where individuals are allowed to direct their search towards one of several conditional distributions, F(p|x) for some observable characteristic x. In addition, these models incorporate the possibility that the relative number of sellers with characteristic x vs. buyers sampling from the conditional distribution F(p|x) affects the probability of transaction. An example would be whether to search in different areas with different distribution of prices, while taking into account the possibility of stock-outs as a function of the number of stores in a given area relative to buyers visiting that area. In these models, the key trade-off is between the expectation of better offers and "expected queue lengths". More attractive conditional distributions will attract more buyers, leading to greater expected queue lengths and making stock-out more likely. Therefore, the search strategy of each individual has to be determined as a best-response to the search strategies of other individuals. This approach to search theory requires a different type of modeling strategy, has a variety of applications, and leads to different implications than the random/undirected search approach.

: TD03 **Advances in Financial Modelling and Portfolio Optimization**

Tutorial Room: MB III

Advances in Financial Modelling and Portfolio Optimization. Stavros A. Zenios, University of Cyprus.

Quantitative methods have been gaining increasing importance in finance over the last decades. Not only the celebrated models for options pricing have evolved to unprecedented levels and are used routinely in industry, but policymakers have also come to rely on quantitative models for risk management and control. Within the framework of enterprise-wide risk management methods and techniques drawn from operations research play today an important role. This talk will survey the current state-of-affairs. For related material visit www.hermes.ucy.ac.cy/zenios/

: TD04 **Discrete Models**

Invited Session Room: JB A

Chair: Endre Boros
Rutgers University

1 : A Tabu Search Algorithm for a Generalized Resource Constrained Project Scheduling Problem. Koji Nonobe, Kyoto University; Ibaraki, Toshihide.

We introduce a generalized RCPSP model and propose a tabu search algorithm. Our RCPSP model is based on the multi-mode RCPSP with maximum time lags (MRCPSP/max), but has some other features; e.g., activity splitting is allowed, activities can continue to consume some resources even while they are suspended, and split activities can be processed in parallel to complete them in a shorter time. In our algorithm, we search mode assignments and activity lists, from which schedules are generated by a list scheduling procedure. To find feasible mode assignments, another tabu search algorithm is used as a subroutine.

2 : A Computational Study of Block Linear Majorants in Quadratic 0-1 Optimization. Bruno Simeone, Università degli Studi di Roma "La Sapienza"; Boros, Endre; Lari, Isabella.

In the present work we deal with quadratic 0-1 maximization problems: a general and flexible algorithmic framework is developed for generating tight linear majorants of groups of terms and for exploiting them in order to produce upper bounds on the quadratic optimum that are as sharp as possible. A set of 480 numerical tests with up to 200 variables has been performed: our experimental results on general quadratic 0-1 maximization, maximum clique and max 2-SAT instances provide clear evidence that the proposed technique substantially improves on the bounds given by roof-duality, especially for larger and denser instances.

3 : A Very Large-Scale Neighborhood Search Algorithm for the Multi-Resource Generalized Assignment Problem. Mutsunori Yagiura, Kyoto university; Iwasaki, Shinji; Ibaraki, Toshihide.

We propose a metaheuristic algorithm for the multi-resource generalized assignment problem (MRGAP). MRGAP is a generalization of the generalized assignment problem, which is one of the representative combinatorial optimization problems known to be NP-hard. The algorithm features a very large-scale neighborhood search, which is a mechanism of conducting the search with complex and powerful moves, where the resulting neighborhood is efficiently searched via the improvement graph. We also incorporate an automatic mechanism for adjusting search parameters, to maintain a balance between visits to feasible and infeasible regions. Computational comparisons on benchmark instances show that the method is quite effective.

4 : Strong Formulations and Separation for Multi-Level Lot-Sizing Problems. Kerem Akartunali, University of Wisconsin-Madison; Miller, Andrew J.

Much of the difficulty in solving practical lot-sizing problems arises because strong formulations for the underlying multi-level problems are usually not used. We discuss computational results obtained by using strong reformulations and efficient new methods to separate for strong valid inequalities.

: TD05 **Public Transportation**

Invited Session Room: JB B

Chair: Andrzej Adamski
University of Mining and Metallurgy

1 : Transit Super-Network Multirate and Multicriteria Logistically Integrated Synchronizing Control. Andrzej Adamski, University of Mining and Metallurgy.

In the paper the transit super-network logistic option in an integrated transportation system is presented. In particular, transport super-network synchronizing multirate control problem is formulated and solved in the form of multicriteria integrated control problems of a several single-rate (punctuality, regularity, priority) inter and intra control modes and service synchronization and harmonization logistic costs. The presented problems are illustrated by a wide spectrum of real numerical examples.

2 : Reinforcement Learning Algorithm for Transit Headway Control at Traffic Signals. Amer Shalaby, University of Toronto; Ling, Kenny.

This paper applies an innovative conditional transit signal priority algorithm, based on Reinforcement Learning, to optimize transit and traffic operations. The RL agent is responsible to determine the best duration of each signal phase such that transit vehicles can recover to the scheduled headway taking into consideration practical phase length constraints.A case study was carried out by employing the microscopic traffic simulation software Paramics. Results show that the control policy learned by the agent could effectively reduce the transit headway deviation and causes smaller disruption to cross street traffic compared with the existing unconditional transit signal priority algorithm.

3 : Locating Stops in Public Transportation. Anita Schoebel, Universität Kaiserslautern.

In this paper we deal with the theoretical background of a real-world project, in which we discuss the establishment of new stops in public transportation. The following two effects apply: Many stops are advantageous, since they increase the customers' accessibility. Each stop increases the transportation time, making the service unattractive and costly. In the bicriterial continuous stop location problem our goal is to locate additional stops along the (given) tracks considering both mentioned effects simultaneously. We identify a finite dominating set allowing a transformation into a set covering problem, which can be solved efficiently in many cases.

4 : A Branch and Price Approach for the Bus Driver Scheduling Problem. Ana Paias, Universidade de Lisboa; Paixão, José.

The bus driver scheduling problem is formulated as a set-covering model (SCP). For real life applications, the corresponding SCP have a very large number of columns and are difficult to solve to the optimality. To deal with those instances, we adopted a branch and price approach based on a new branching rule and a combination of state space relaxation with column generation. We present computational results for real instances relative to several mass transit companies operating in Portugal. Advantages and disadvantages of our approach when compared with others based on the linear programming relaxation for the SCP are also discussed.

: TD06 **Scheduling - C2**

Contributed Session Room: M30

Chair: Mohammad Ranjbar
Sharif University of Technology

1 : Optimal Scheduling of Parallel Machines with Set-up and Lot Splitting. Giorgio Romanin-Jacur, University of Padova; Filippi, Carlo.

Consider m parallel machines and n large lots. Lot j may be entirely processed by machine h in time p(h,j) or split into fractions x(h,j), x(i,j), ..., to be processed, also simultaneously, by machines h, i, ... in times p(h,j)x(h,j), p(i,j)x(i,j), ... Every (j,k) lot change on machine h requires sequence set-up time s(h,j,k). We shall allocate lot fractions to machines and sequence them so to minimize either makespan or weighted tardiness. We prove the problem is strongly NP-hard, we state optimal solution characteristics and we suggest tabu search algorithms, able to supply an acceptable solution in short computing time.

2 : Solving Multi-Objective Production Scheduling Problems using Metahuristics a Case Study. Loukil Taicir, Faculté des Sciences Economiques et de Gestion de Sfax; Teghem, Jacques; Tuyttens, Daniel.

Multiple criteria scheduling problems are complex and the use of exact procedures becomes very expensive especially for real size ones . Metaheuristics can give good solutions for those problems. We propose in this paper an application of Simulated Annealing and Tabu Search Algorithms, to solve a real case multiple criteria scheduling problem. We approximate the set

of optimal solutions for any combination of criteria. The two method are compared on the basis of CPU times and the quality of the approximation of the efficient set.

3 : A Metaheuristic for Scheduling in Cellular Manufacturing Systems with Setup times. Farnaz Barzinpour, Tarbiat Modarres University; Zegordi, Seyed Hessameddin.

This research considers the problem of scheduling part family and jobs within each family in a cellular manufacturing where the setup times for each family are sequence dependent and it is desired to minimize earliness and tardiness. This problem from computational point of view is NP-Complete. In this work, we apply metaheuristic method to solve scheduling in cellular manufacturing systems.

4 : An Efficient and Metaheuristic Algorithm for Solving Bi-Objective Fuzzy Job Shop Scheduling Problems using Genetic Algorithms and Data Mining. Mohammad Ranjbar, Sharif University of Technology.

Objectives in this article are minimizing the makespan and minimizing the early and late penalty. Processing time and due date are considered as fuzzy triangular numbers. The proposed algorithm is a combination of genetic algorithms and an attribute-oriented induction algorithm. Whole feasible solutions of a job shop-scheduling problem are considered as a database. Then, AOI algorithm finds similar relationships and latent patterns among this database. This algorithm helps GA to find better optimal or near-optimal solutions much quicker than previous methods. After each iteration, input date of data mining algorithm is updated via outputs of GA and GA via data mining.

: TD07 **Spare Parts Management - III**

Invited Session Room: M31

Chair: Geert-Jan van Houtum
Eindhoven University of Technology

1 : Inventory Pooling of Repairable Spare Parts with Non-Zero Lateral Transshipment Times. Hartanto Wong, Katholieke Universiteit Leuven; Cattrysse, Dirk; Van Oudheusden, Dirk.

A common assumption in the previous research on inventory pooling of repairable spare parts is zero lateral transshipment times. We relax this assumption and develop an approximation model to obtain some steady-state performance measures. The proposed model is used to evaluate how lateral transshipment times affect the effectiveness of inventory pooling.

2 : An Approximate Model for Assembly Systems Controlled by Base Stock Policies. Zeynep Avşar, METU; Zijm, Henk.

Steady-state behaviour of the assembly systems operated under base stock inventory control policies is investigated by approximating a partially aggregated model. It is observed that the approximation is quite accurate for performance measures like fill rate and expected backorder.

3 : Trade-Off between Spare Parts Inventory and Repair Capacity. Aart Van Harten, University of Twente; Sleptchenko, Andrei; Van Der Heijden, Matthieu.

Availability of repairable technical systems depends on: (i) spare parts inventory levels; (ii) repair capacity. We present a procedure for simultaneous optimisation of these two factors allowing for non-integer server capacity. Our method is based on a modification of the well-known VARI-METRIC procedure and results for multi-class, multi-server queueing systems representing repair shops.

4 : Multi-Echelon, Multi-Indenture Spare Parts Systems with Commonality. Geert-Jan van Houtum, Eindhoven University of Technology; Rustenburg, Jan Willem; Zijm, Henk.

We consider a multi-echelon, multi-indenture spare parts network which services identical technical systems. We allow commonality in the material breakdown structure of the technical systems. We present both an exact and an approximate analysis, and we investigate the benefits gained by commonality.

: TD08 **Empirical Research in Cross-Cultural Negotiations**

Invited Session Room: M32

Chair: Sabine Koeszegi
University of Vienna

1 : Cultural Influence on Conflict Resolution. Matthias Raith, University of Magdeburg.

We view intercultural conflicts in a broad sense in order to acknowledge national, professional, as well as disciplinary cultures. Although cultural aspects have a significant influence on the structure of a conflict, we argue that more attention should be directed towards the process of conflict resolution, since the latter requires a specific set of facilitating tools.

2 : Culture and Technology: Cultural Impacts on E-negotiations. Sabine Koeszegi, University of Vienna.

Starting from the elaboration of the two philosophical positions, i.e. technological instrumentalism versus technological determinism, the paper develops through a systematic review of empirical evidence a framework for analysis of cultural impacts on computer-mediated and facilitated negotiation processes.

3 : User Attitudes towards Web-based Intercultural Negotiations: An Extended TAM Model. Gregory Kersten, University of Ottawa; Koeszegi, Sabine; Vetschera, Rudolf.

We present results of an exploratory analysis of data collected during over 2000 inter- and intra-cultural negotiations carried out with the INSPIRE negotiation support system. From an extension of the TAM Model we identify and empirically test individual and outcome-related factors influencing users' perceptions of such systems.

: TD09 **Cross-Selling**

Invited Session Room: L15

Chair: Baohong Sun
Kenan-Flagler Business School

1 : Cross-Selling Sequentially Ordered Products: An Application to Consumer Banking Services. Baohong Sun, Kenan-Flagler Business School; Li, Shibo; Wilcox, Ronald.

In service and high-technology industries, we often observe consumers sequentially purchasing multiple products and services from the same provider. In this paper, we propose a multivariate probit model that investigates the sequential acquisition pattern of these items. Using data obtained from a large Midwestern bank, we demonstrate how the model can be used to predict to whom and when to cross-sell which new products and services. This research contributes to the literature by being the first paper to investigate consumers' sequential acquisition decisions. At a practical level, it can enable managers to develop and execute better cross-selling tactics.

2 : Investigating the Effects of Store Brand Introduction on Retailer Demand and Pricing Behavior. Andre Bonfrer, Singapore Management University; Chintagunta, Pradeep; Song, Inseong.

Researchers have studied drivers of store brand success and factors that motivate retailers to introduce store brands. We study demand and supply-side effects of the introduction of a store brand into a product category. On the demand side, we study the price elasticity and preferences for national brands. On the supply side, we study the effects of the new entrant on the interactions between the national brand manufacturers and the retailer introducing the store brand, including how these interactions influence the retailer's pricing behavior. We test whether the observed data are consistent with commonly used assumptions regarding retailer pricing.

3 : Assessing Cross-Category Impact from Store-Level Scanner Data. Jie Zhang, University of Michigan Business School; Wedel, Michel.

We develop an approach to assessing cross-category effects of marketing mix variables from store level scanner data at the individual brand level that imposes minimal structural constraints on the coefficients. We provide a Bayesian approach to pooling the coefficients to address the instability problem often arisen from estimating a large number of parameters. Our model also accounts for heterogeneity in baseline sales and in the price coefficients using an extended Dirichlet Process Prior-based method which accommodates the effects of demographics, and for longitudinal shifts in baseline sales through a semi-parametric Bayesian version of the local polynomial regression.

4 : Defining and Measuring Reservation Price: Synthesis and Extrapolation. Rabikar Chatterjee, University of Pittsburgh; Wang, Tuo; Venkatesh, R.

There is a lack of consensus on the precise meaning of the reservation price construct and the measurement methodologies to estimate its value. We review and synthesize the relevant literature to (a) understand the concept of reservation price and (b) evaluate the various methods proposed for its measurement. Based on this process and empirical data collected by us, we suggest that the reservation price is best captured by a range of valuations tied to the probability of purchase. We develop a procedure for measuring reservation prices that captures this range and also addresses problems faced by current methods.

: TD10 **Issues in Reverse Logistics Networks**

Invited Session Room: L19

Chair: Rommert Dekker
Erasmus University Rotterdam

1 : Reverse Logistics Network Model for Computer Refurbishment. Ratih Dyah Kusumastuti, Nanyang Technological University; Piplani, Rajesh; Lim, Geok Hian.

Refurbishment is a common activity in the computer industry. However, the rapid change in computer technology and the quick depreciation in the value of refurbished computers may limit their marketing time. Therefore, reverse logistics network that can facilitate reverse flow of used computers in an efficient way is required. This paper proposes a reverse logistics network model for computer refurbishment that considers facility sharing at existing forward chain facilities, and the computer characteristics, namely multiple configurations and modular (product) design. The objective of the modelling effort is to determine the optimal reverse logistics network that maximises the total net revenue.

2 : Optimisation of Disassembly Networks with Fulfillment of WEEE Recycling Targets. Grit Walther, TU Braunschweig; Spengler, Thomas.

As a result of the adoption and national implementation of the EU-Directive on Waste Electrical and Electronic Equipment (WEEE), recycling and recovery targets will have to be fulfilled for certain product categories. However, exact instructions for measurement of these targets are still missing. Thus, an activity based model is developed taking into account different activities, actors and material flows of disassembly networks. Based on this model, economically efficient disassembly with fulfillment of recycling and recovery targets is performed using linear optimisation. Since exact instructions for measurement of quotas are missing, different possibilities are modelled applying scenario technique.

3 : Reverse Logistics Networks: Overview of Models. Rommert Dekker, Erasmus University Rotterdam; Fleischmann, Moritz.

Reverse logistics networks are networks consisting of facilities and transportation units for the collection of discarded or returned products. In this presentation we will give an overview of the various types of networks and of the quantitative models developed to analyse them.

: TD11 **Empirical Applications - II**

Invited Session Room: R20

Chair: Emmanuel Thanassoulis
Aston University

1 : A Framework for Incorporating Environmental Indicators to the Measurement of Human Well-Being. Osman Zaim, Bilkent University.

This study proposes a useful alternative to the "aggregate deprivation index" which is used to measure the well-beings of individuals in different countries or geographic locations. Furthermore, an improvement index which alleviates the well known difficulties associated with overtime comparisons of "aggregate deprivation index" is also proposed. The achievement index proposed in this study relies heavily on the theory

of quantity indexes whose axiomatic properties are well established. The roots of the improvement index proposed are well grounded in the productivity growth literature. All proposed measures depend upon computation of distance functions which are complete characterization of the technology.

2 : The Balance among Risk, Spare Time and Gross Margin in Agriculture. Laura Riesgo, Pablo de Olavide University; Herrero, Ines; Andre, Francisco.

Traditionally, gross margin has been the only factor maximised in production economics in the agricultural sector. However, other factors like maximising the spare time or minimising risk play a key role in the agricultural activity. In this work the weight each land-owner place to each of these factors is analysed using both Data Envelopment Analysis and Multi-Criteria Decision-Making techniques. These methodologies have been developed independently from each other. The study looks for some connections between both of them. An application has been made in an irrigated area in the Duero Basin in Spain.

3 : Human Development in OECD: A Data Envelopment Analysis Assessment. Dimitris Despotis, University of Piraeus.

The Human Development Index is a comprehensive measure for human development that reflects three major dimensions of human development: longevity, knowledge and access to resources for a decent standard of living. We present in this paper a DEA approach for assessing the relative performance of the OECD countries in terms of human development. First, we develop a DEA-like index-maximizing model and then we extend our calculations by applying the global efficiency approach to derive global estimates of relative performance. Finally, we develop a pure DEA model to estimate the relative efficiency of the countries in converting income to human development.

4 : Ranking Hotels in Israel via the DEA Context. Lea Friedman, Ben Gurion University; Hadad, Yossi; Sinuany Stern, Zilla.

In this paper we propose methods for ranking hotels in Israel via the Data Envelopment Analysis context. The inputs that were collected from the advertisement supplement included a total of five attributes: swimming pool, kids activities, entertainment activities for adults, sport activities and number of rooms. The outputs in the dataset included room prices for High Season (HS), Regular Season (RS) and Low Season (LS). We purpose six ranking methods: A&P, CCA/DEA, AHP/DEA, CE, DR/DEA, GE. We compare the ranking scores of the hotels to the quality rating (star rating) of each hotel.

: TD12 **Neural and Other Approximating Networks in Stochastic Optimal Control**

Invited Session Room: M39

Chair: Riccardo Zoppoli
University of Genoa

1 : Bounding the Error in Approximate Functional Optimization. Marcello Sanguineti, University of Genoa; Kurkova, Vera.

We consider optimization problems whose admissible solutions are functions depending on a large number of variables (e.g., the number of nodes in large-scale communication networks). When optimal solutions cannot be found analytically, often classical approaches to approximate optimization require an unmanageably fast growth of the computational load with the number of variables. We investigate properties of approximate optimization over linear combinations of certain classes of "simple" computational units depending on some parameters. We give conditions guaranteeing that the number of computational units necessary for desired optimization accuracy grows "moderately" (e.g., polynomially) with the number of variables in admissible solutions.

2 : Optimization of a Large-Scale Water Reservoir Network by Stochastic Dynamic Programming with Efficient State Space Discretization. Victoria Chen, University of Texas at Arlington; Cervellera, Cristiano; Wen, Aihong.

A numerical solution to a 30-dimensional water reservoir network optimization problem, based on stochastic dynamic programming, is presented. In such problems the amount of water to be released from each reservoir is chosen to maximize a nonlinear benefit function while satisfying proper constraints. Experimental results show how dimensionality issues, given by the large number of basins and realistic modeling of the stochastic inflows, can be mitigated by employing neural approximators for the value functions, and efficient discretizations of the state space, such as orthogonal arrays, Latin hypercube designs and low-discrepancy sequences.

3 : The Extended Ritz Method for Dynamic Routing in Traffic Networks. Marcello Sanguineti, University of Genoa; Baglietto, Marco; Zoppoli, Riccardo.

In general, optimal routing by a "team" of decision makers cannot be solved analytically. Even in a centralized context, a large number of state variables makes dynamic programming unfeasible. We investigate approximate routing in communication networks by the "Extended Ritz Method"(ERIM) that constrains admissible strategies to have the structure of nonlinear approximators dependent on "free" parameters (e.g. neural networks). If routing decisions are d-variable functions with suitable regularity properties, ERIM may substantially outperform the classical Ritz method, which is inapplicable because of the curse of dimensionality. The number of parameters required by ERIM may increase only polynomially with d.

4 : Shortest Path Problems on Stochastic Graphs: A Neuro Dynamic Programming Approach. Giorgio Battistelli, University of Genoa; Baglietto, Marco; Zoppoli, Riccardo.

The problem of computing the optimal decision policy for finding on line the shortest path on stochastic graphs is addressed. A stochastic infinite horizon optimal control problem is stated, for which dynamic programming can be used. The complexity of the problem leads to search for a solution making use of neural networks to approximate the optimal cost-to-go functions to any degree of accuracy. By introducing the concept of "frontier", an equivalent formulation of the problem is provided, for which any feasible policy leads to the destination node. Numerical results show the effectiveness of the method.

: TD13 **Applications of Revenue Management**

Invited Session Room: R21

Chair: Ahmet Kuyumcu
Zilliant, Inc.

1 : Implementing Pricing Systems: A Case Study from Broadcasting. Tankut Atan, Işık University.

In this talk we will focus on the challenges involved in implementing software systems that incorporate mathematical components for not-so-mathematical users. A business problem and implementation in broadcasting will be used for illustration purposes. Some modeling challenges will also be explained.

2 : Options on Air Cargo Capacity. Rolf Hellermann, WHU Otto Beisheim Graduate School of Management; Huchzermeier, Arnd.

In the global air cargo industry, options on service capacity are gaining in importance due to their inherent flexibility. We demonstrate that these contracts are welfare enhancing and being integrated in revenue management systems at leading airlines. Moreover, we discuss implementation paths for e-platforms that enable slot trade and dynamic pricing.

3 : Challenges of Pricing Complex Storage Solutions in a Competitive Market. Kerem Bulbul, Rapt Inc.; Dagum, Paul.

We present a decision support framework for pricing in discrete manufacturing. We address complexities that arise in setting prices, such as configuration pricing, product life cycles, mix and cannibalization, existence of multiple channels with different discount structures, and the difficulty of matching supply and demand. We elaborate on our experience in the storage division of a Fortune 50 company and present insights on how each of these factors impact the corporate objectives of maximizing profit and market share.

4 : On Revenue Optimization of Learning Services Delivery. Gyana Parija, IBM Research.

We describe how stochastic modeling and solver technologies impact ongoing and future business practices at IBM Learning Services, which is the largest IT training services provider in the world in a hyper-fragmented marketplace. Their vision is to be the premier global learning business. In 1999, they were valued primarily for developing and delivering classroom training, mainly in the area of IBM IT and e-business training. Over the past three years, they have moved to a position of developing and delivering training solutions, comprised both of IBM and non-IBM components as well as IT, professional and management development offerings.

5 : Joining Pricing and Inventory Control. Ahmet Kuyumcu, Zilliant, Inc.; Popescu, Ioana.

Revenue management utilizes pricing and inventory control strategies to balance supply and demand to maximize revenue. Pricing and inventory control decisions are closely related, but limited published research addresses their interdependence. This presentation proposes static deterministic optimization models that combine pricing and inventory control strategies for a firm with multiple-products and multiple-resources; these models include substitution effects among products. We present some properties of the proposed models and discuss industry applications.

: TD14 Subjective Probability Judgement

Invited Session Room: R22

Chair: Canan Ulu
Duke University

1 : A Bayesian Model for Self-Calibration of Probability Assessments. Kenneth Charles Lichtendahl Jr., Duke University.

This paper addresses how a decision maker forms probability assignments for continuous random quantities based on his or her own calibration performance. The motivation for this self-calibration model is the non-ignorable possibility of miscalibration described by Dawid (1982) and the calibration performance indicator developed by Morris (1977). We present a prescriptive model to remedy the "over-frequent" surprises that decision makers typically encounter when assessing multiple random quantities. Our Bayesian hierarchical model of a self-calibration function specifically addresses the general case where random quantities are not necessarily independent as in the idealized "almanac questions" assessment task analyzed by Harrison (1977).

2 : The Effects of Measurement Units and Framing of Attributes on the Results of Multi-Attribute Decision Making Methods. Dubravka Pavlicic, University of Belgrade.

We analyse the influence of units used for measuring different attributes, and the influence of framing of attributes on the results of the Multi-Attribute Decision Making methods. We will show that the final choices depend on: 1) the measurement units used for quantitative attributes that are measurable on interval scales; 2) the type of scale used for measuring qualitative attributes, and on 3) the framing of attributes (whether attributes are presented as benefit or cost attributes, when both forms are possible). We conclude that the main cause for inconsistent choices is normalization of data.

3 : Incomplete Holistic Comparisons in Value Tree Analysis. Antti Punkka, Helsinki University of Technology; Salo, Ahti.

The applicability of multicriteria decision analysis can be improved through enhanced possibilities of preference elicitation. In this context, we propose a novel approach where the DM may give not only various kinds of incomplete preference statements about the relative importance of attributes or the alternatives' performance levels, but even incomplete holistic preference comparisons among the alternatives. The resulting incomplete preference information defines sets of feasible parameters from which dominance structures and decision recommendations can be obtained. The potential of holistic preference statements is illustrated by an example, and computational results from a series of simulation studies are also given.

4 : Interior Additivity and Subjective Probabilities: A Support Theory Model. Canan Ulu, Duke University; Clemen, Robert T.

Interior additivity (IA) is the property that P(B) = P(A or B) - P(A) for all disjoint A and B with probabilities strictly between zero and one. We describe a support theory-based subjective probability model that is consistent with IA and provide experimental evidence for the model. We propose a probability elicitation method based on our model and compare our method's performance with that of the conventional elicitation method used in decision and risk analysis.

: TD15 **Routing - C1**

Contributed Session Room: R23

Chair: Alberto V. Donati
IDSIA

1 : A New Enhancement of the Clarke-Wright Savings Heuristic for the Capacitated Vehicle Routing Problem. Temel Öncan, Galatasaray University; Altınel, İ. Kuban.

In this work we are concerned with the Clarke-Wright savings method for the classical capacitated vehicle routing problem which is known to be NP-hard. Recent developments have shown that classical heuristics do not compare with the best metaheuristic implementations. However, some of them are very fast and simple to implement. We propose a new enhancement for the Clarke-Wright method, which differs from the previous ones in its saving criterion. Customer demands are considered in addition to distances. Based on the extensive computational experiments we can say that the new method is not only very fast but also very accurate.

2 : A Dial-a-Ride Model for Clients Transportation in a Service Organization. Ahmet B. Ilhan, Turkish Navy; Melachrinoudis, Emanuel; Min, Hokey.

We present a double request dial-a-ride model with soft time windows and its application to the CAB Health and Recovery Services, Inc., a non-profit organization in the Boston Metropolitan Area. The objective is to minimize a convex combination of total vehicle costs and total clients' inconvenience time. The latter consists of excess riding time, early/late delivery time before service and late pickup time after service. The model was used to compare the benefits of coordination and central dispatching over the current system under which individual centers of the organization schedule their own clients' appointments and route their own vehicles.

3 : Time Dependent Vehicle Routing Problem with an Ant Colony System. Alberto V. Donati, IDSIA; Luca Maria, Gambardella.

The Time Dependent Vehicle Routing Problem (TDVRP) consists in optimally routing vehicles when the traveling times are dependent on the time of the day the trip was initiated. The optimization objective is to minimize the number of tours and the total travel time, and is done with an Ant Colony System using time dependent pheromones. An appropriate technique for local search this context is also introduced. The model is motivated by the fact that in many circumstances, traffic conditions play an important role and can not be ignored in order to carry out a realistic and feasible optimization.

4 : Vehicle Routing Problem with Packing Constraints. Alper Türkay, Uludağ University; Emel, Erdal.

The vehicle routing problem is defined as determining routes for vehicles serving to a set of customers while minimizing the costs. This definition, which ignores the packing conditions in transportation of physical units, lacks of validity of the results. Classical vehicle routing models don't ensure packing of the loads, since load dimensions are not taken into consideration. Solutions obtained from such models are subject to fail because of probable dimensional incompatibility of the loads. By this paper, a new model which considers packing constraints is developed in order to overcome this deficiency and its results are examined.

: TD16 **Project Scheduling with Storage Constraints**

Invited Session Room: R27

Chair: Klaus Neumann
University of Karlsruhe

1 : Project Scheduling with Storage Constraints - Models and Applications. Klaus Neumann, University of Karlsruhe.

We discuss project scheduling problems where a regular objective function (e.g. the project duration) is minimized subject to temporal and resource constraints. In addition to renewable resources (e.g. machines and manpower), we study storage or cumulative resources that have a prescribed minimum inventory (safety stock) and maximum inventory (resource capacity), where the inventory is depleted and replenished over time. Both discontinuous and continuous material flows are considered. Applications are storage facilities in batch or continuous production scheduling in process industries, assembly space for material in manufacturing industry, funds available for investment projects, and modelling of project activities with variable duration.

2 : Project Scheduling with Storage Constraints: Truncated Branch-and-Bound Algorithms. Christoph Schwindt, University of Karlsruhe.

In many applications of resource-constrained project scheduling, the limited availability of storage resources like inventories, assembly space, or investment funds has to be taken into account when scheduling the activities of the project. Depletions and replenishments of storage resources may occur at finite or infinite rates. Dealing with both cases, we discuss truncated branch-and-bound algorithms for minimizing regular objective functions subject to temporal and resource constraints. The algorithms are based on iteratively partitioning the feasible region of the problem by enumerating alternative sets of precedence relationships between activities that compete for the same scarce resources.

3 : Project Scheduling with Storage Constraints: A Priority-rule Method. Norbert Trautmann, Institute for Economic Theory and Operations Research.

We present a priority-rule method for solving project scheduling problems where a regular objective function is to be minimized subject to temporal and storage-resource constraints. Storage resources are depleted and replenished at infinite rates, where for the inventories minimum and maximum levels are prescribed. The basic idea is to consecutively schedule the activities of the project such that any partial schedule satisfies the temporal constraints and observes the minimum inventory levels. We discuss how to cope with partial schedules that are infeasible with respect to the maximum inventory level. We also show how to deal with renewable resources.

4 : Models and Algorithms for Stepwise and Piecewise Shaped Tasks in Constraint Programming. Rogerie Jerome, ILOG SA.

Constraint Programming is widely used for combinatorial problems as scheduling with finite capacity resources. Consistency techniques allow algorithms based on constrained structures that models the capacity calendars of resources or the precedences between activities. Inventory systems involve reservoirs as a case of finite capacity resources. Piecewise reservoirs illustrate the balance constraint that uses both the precedence and capacity constraints. Such constraints are of great interest on sub-problems for Production Systems. Stepwise reservoirs allow applying constraint programming on complex Inventory System with variable slopes or breakages in filling/emptying or overflow and leaks on reservoirs.

: TD17 **Simulation - C2**

Contributed Session Room: R24

Chair: Albert A. Stahel
Swiss Military Academy

1 : Advantages of Spreadsheet-based Simulation and Decision Support Models for Operational Policy Development and Control in Industry. Jim Everett, University of Western Australia.

Mining industry applications demonstrate advantages of simulation and decision support models using spreadsheets, with macros, instead of purpose-designed software. Project success requires user involvement and ownership. Users possess domain knowledge, which the developer lacks. They have spreadsheet experience, so show less resistance and more enthusiasm for spreadsheet models than for unfamiliar computer packages. Workplaces have spreadsheets on every computer, so licensing is easy. In the author's experience, users prefer schematic to representational animation. The flexibility of spreadsheet graphical and statistical reporting is familiar to the user. Spreadsheet-based simulation and decision support models provide "a fishing line, not just a fish".

2 : Comparison of Different Sampling Methods in Simulation. Megdouda Tari, University of Béjaïa; Dahmani, Abdelnacer; Arab, Salim.

Descriptive sampling refined (DSR) based on descriptive sampling (DS), it produces a block of regular samples of prime size and their random permutation. The advantages of DSR is that it eliminates the problems of DS which are the determination of the sample size beforehand and the possibility of producing biased results in simulation. In this paper we evaluate performance measures of a production system using the three phase discrete event simulation. The problem studied has an analytical solution carried out using stochastic Petri network allowing the comparison of different sampling methods which are DS, DSR and random sampling.

3 : Simulation of Job Shop Scheduling using Fuzzy Random Variables with Beta Shape Membership Functions. Sohrab Khanmohammadi, I.A.U, Science & Research Campus; Ghanbari, Ahmad; Jassbi, Javad.

Real world systems are usually non linear. The available modeling data and parameters of these systems are imprecise. It is shown that the theory of fuzzy systems is more suitable procedure for solving problems with uncertain data. One of the well-known complex systems is the Job-Shop scheduling system with probabilistic parameters. In this paper a fuzzy procedure is used for simulation of Job-Shop scheduling problems. The SCSS system is simulated to verify the validity of fuzzy simulation procedure with f shape membership function. The simulation results show that the introduced method is well suited for simulation of such systems.

4 : Simulation of Operation "Enduring Freedom". Albert A. Stahel, Swiss Military Academy.

Operation "Enduring Freedom" was determined by the combined employment of Special Operations Forces, heavy bombers and the Northern Alliance. The Northern Alliance were employed by Special Operations Forces which lead to the precise employment of the bombers against Taliban strongholds. The Taliban themselves tried to defend their positions in a static way. While foreign elements of the Taliban withstood successfully the bombardments, many Afghan units of the Taliban tried to escape from their positions very soon. The simulation pictures the battles between the Northern Alliance and the Taliban, the bombardments and the collapse of the Taliban.

: TD18 **Hub Location**

Invited Session Room: R25

Chair: Bahar Kara
Bilkent University

1 : On a Hub Location Problem with Arc Capacity Constraints. Mihiro Sasaki, Nanzan University; Fukushima, Masao.

In this paper, we consider a one-stop capacitated hub-and-spoke model as a natural extension of the incapacitated one-stop model. The model involves arc capacity constraints as well as hub capacity constraints, which enables us to incorporate some practical factors into the model. We also present a branch-and-bound based exact solution method with Lagrangian relaxation bounding strategy, and report some numerical examples using CAB data and the future enplanements forecast reported by FAA. Computational results show the practical significance of incorporating arc capacities into the model, and the existence of some stable hubs which are insensitive to arc capacities change.

2 : An Iterative Hub Location and Routing Problem for Postal Delivery Systems. Canan Sepil, METU; Çetiner, Selim; Sural, Haldun.

In this study we considered the postal delivery system and developed an algorithm for the combined hub location and routing problem where the location of hub nodes are determined, the city postal offices are allocated to the hubs, and the optimal set of routes are determined for each hub. The algorithm is an iterative one that iterates between the hub-location phase and a routing phase. A locate-first route-second strategy initiates the process by solving a hub-location problem. The second step of the procedure consists of solving a vehicle routing problem. Computational experience is reported.

3 : The Hub Location Problem for Cargo Delivery Systems: A Large Scale Implementation for Turkey. Pınar Tan, Bilkent University; Kara, Bahar; Tansel, Barbaros.

In this study ground transportation based cargo delivery systems, which is an application area of hub location problems, is analyzed. A survey with five different cargo delivery firms that provide service in Turkey is conducted, and as a result of this survey the constraints, requirements, and criteria special to the cargo delivery sector are determined. An integer programming formulation reflecting the real life requirements is proposed. A large scale implementation for Turkey is also provided.

4 : Fuzzy Queueing Location Set Covering Problem for Congested Systems. Hassan Shavandi, Sharif University of Technology; Mahlooji, Hashem.

This article attempts to apply fuzzy theory to the location set covering problem in hope of analyzing the problem in a more realistic environment. The model developed, consider fuzzified constraints and fuzzified sets of nodes covered by each service center. As such, each demand node is not served by just one server. In fact, each node can call of service from several servers according to its degree of membership. The developed fuzzy model is then transformed to mixed integer programming model which can be solved by the exact methods. An example problem is solved and presented along with results.

: TD19 **Clinical Care Models**

Invited Session Room: R26

Chair: Martin Grunow
Technische Universität Berlin

1 : Workload, Quality of Working Life, and Quality of Care among Intensive Care Nurses. Ayse Gurses, University of Wisconsin-Madison; Carayon, Pascale.

Several studies show that high workload in intensive care units (ICUs) may lead to compromised quality of care and patient safety. In this study, we investigate the impact of workload on quality of working life and quality of care among ICU nurses. We also identify the situational constraints in an ICU that increase nurse workload unnecessarily and hinder performance. Situational constraints are factors in a work environment that inhibit people from optimally performing their jobs. A conceptual model that illustrates the relationships among the variables of situational constraints, workload, quality of working life, and quality of care is proposed.

2 : Using Coxian Phase-Type Distributions to Identify Patient Characteristics for Duration of Stay in Hospital. Adele Marshall, Queen's University of Belfast; McClean, Sally.

Coxian phase-type distributions are a special type of Markov model that describes duration until an event occurs in terms of a process consisting of a sequence of latent phases. This paper uses Coxian phase-type distributions for modelling patient duration of stay in hospital. The paper also investigates the potential for using the resulting distribution as a classifying variable to identify common characteristics between different groups of patients according to their length of stay. The identification of such characteristics for patient length of stay groups would offer valuable insight into the overall management and bed allocation of the hospital wards.

3 : Importance of Sensitivity Analysis in Intensity Modulated Radiation Therapy. Delal Dink, Purdue University; Orcun, Seza; Langer, Mark P.; Pekny, Joseph F.; Reklaitis, Gintaras V.; Rardin, Ronald L.

Intensity modulated radiation therapy provides a higher quality in the delivery of clinical dosimetric prescriptions. However, increasing the quality of the delivery means quality of the treatment with improved dosimetric prescriptions. This paper targets the goal of improving the treatment planning and shows the use of linear programming sensitivity analysis (SA) in the area of radiation therapy. Here, we specialize on the usage of SA of the dose-volume limits of the prescription. Utilizing SA, one can avoid unnecessary dose exposure to the radiated volume, by showing the minimum tumor dose range for some given healthy tissue upper bounds.

4 : Workforce Scheduling and Assignment for Clinical Studies. Martin Grunow, Technische Universität Berlin; Günther, Hans-Otto; Yang, Gang.

Motivated by a case study from a company performing clinical studies for the pharmaceutics industry, we investigate the allocation of workforce between different jobs and the assignment of individual workers to tasks. In the first stage of our hierarchical modelling approach, a compact MILP model is solved which determines the starting times of jobs taking the limited availability of personnel into account. The assignment of individual staff members to tasks is then made in the second stage of the procedure using an integer optimization model. Our numerical analysis shows the practicality of the suggested hierarchical approach for the application considered.

: TD20 **Bayesian Methods in Finance**

Invited Session Room: M35

Chair: Nicholas Lynn
Canadian Imperial Bank of Commerce

1 : Building Yield Curves with Bayesian Splines. Nicholas Lynn, Canadian Imperial Bank of Commerce.

The archetypal yield curve construction problem involves solving for a curve that consistently prices a range of financial instruments of differing maturities. In developed markets the quoted prices of instruments are reliable and the resulting yield curve tends to be smooth. In emerging markets, the bid-offer spread is large and curves built from mid-prices using standard approaches tend to suffer from smoothness problems. We develop an approach that maintains smoothness while guaranteeing that instruments re-price within bid-offer spreads. Sensitivity information is calculated that enables yield-curve risk to be re-expressed in terms of the original instruments.

2 : Decision Theory for Stock Trading. Max Mendel, Boston Fund Services.

In this talk I will analyze the trade in listed stocks in terms of subjective probability and utility. I will analyze and define such fundamental concepts as risk, opportunity, discounting, etc., and shown how they determine a trading decision. I will also analyze the interrelationship of the traders through the market mechanism.

3 : Bayesian Portfolio Selection in Random Variance Models.

Kadir Tanyeri, George Washington University; Soyer, Refik.

We consider multiperiod portfolio selection problems for a decision maker with a specified utility function when the variance of security returns is described by a discrete time stochastic model. The solution of these problems involves a dynamic programming formulation and backward induction. We present a simulation-based method to solve these problems adopting an approach which replaces the preposterior analysis by a curve fitting based optimization. We provide examples to illustrate the implementation of our approach.

: TD21 **Supply Chain Design and Contracts**

Invited Session Room: M36

Chair: Sinan Kayalıgil
METU

1 : Lead Time Options with (R,Q) Policy. Metin Cakanyildirim, University of Texas at Dallas; Luo, Sirong.

We analyze lead time options in a manufacturer and a retailer chain where the retailer uses the (R,Q) inventory policy: The retailer places an order to the manufacturer who initially promises to deliver the order a lead time later. The manufacturer also promises to delay or postpone the delivery of the order by a certain amount of time if the retailer makes such a request. Consequently, the retailer has an opportunity to modify the lead time by using most up-to-date demand information before the order is delivered.

2 : Supply Chain Design with Lateral Transshipments. Hussein Naseraldin, Technion - Israel Institute of Technology; Herer, Yale.

We are interested in developing a model that integrates various types of decisions: strategic, tactical and operational. The examined environment contains different echelons: suppliers, plants, distribution centers, retail outlets, and customers. We model decisions such as: 1) strategic decisions such as: number and location of retail outlets. 2) Tactical decisions: replenishment policy at the retail outlets and transshipment policy. 3) Operational decisions: replenishment and transshipment quantities. The above-mentioned decisions are of different horizons and integrating them into one model, in order to gain some insights about the tradeoffs and interactions amongst the decisions is the main objective of this research.

3 : Capacity Planning and Range Setting in Quantity Flexibility Contracts as a Manufacturer. Sinan Kayalıgil, METU; Pesen, Şafak.

Quantity Flexibility contract is an arrangement where parties agree upon a scheme of forming ranges on volumes for their future transactions. The contract is based on setting upper and lower limits on replenishment orders as simple multiples of point estimates updated, published and committed to by the buyer. We introduce a manufacturer with a limited capacity; also capable of subcontracting, for deliveries with a known lead time. On the other hand, the buyer serves a market with given demand distributions (known only to her). Using stochastic programming with recourse we study effects of flexibility multiples on manufacturer's capacity planning.

4 : Business Process Reengineering-Press Shop Management System in Automotive Industry. Oğuzhan Sertsarı, Ford Otosan Motor Company; Gökçe, Mahmut Ali.

Processes govern how well a manufacturing plant is run. On the other hand, requirements of businesses change in time. Successful businesses are the ones that can adapt their processes to new marketplace conditions and requirements. We summarize a success story of business process reengineering in automotive industry specific to press shop information management system. The developed solution includes developing a heuristic for finite capacity job shop scheduling problem and design & development of necessary information systems.

: TD22 **Service Delivery Design**

Invited Session Room: M37

Chair: Philippe Chevalier
Université Catholique de Louvain

1 : Distributed Routing in Services. Robert Shumsky, University of Rochester; Majumder, Pranab; Pinker, Edieal.

We consider a firm that provides customized goods or services and employs workers with heterogeneous skills. Examples include telephone call centers, as well as consulting firms, technical support centers, and health-care operations. There has been significant research on centralized systems for assigning calls to servers ('skill-based routing') but relatively little work on systems in which employees decide upon each job's routing, given the job's attributes, the employees' own skills, and incentives offered by the firm. Here we consider the design of such decentralized systems as well as their relative advantages and disadvantages.

2 : The Use of Blocking Probabilities for Uninterrupted Traffic Flows. Tom Van Woensel, UA-UFSIA; Vandaele, Nico.

We present a queueing approach to modelling uninterrupted traffic flows. A road network can be represented as a open queueing network, where vehicles arrive, spend time and leave. The time spent is dependent upon the occupation of the road network. The approximation used to obtain the relevant performance measures for these networks is the Expansion Method. One of the key elements in this methodology is the blocking probability. Detailed sensitivity analysis is performed to get insights in the behavior of this blocking probability with respect to traffic applications. Moreover, a tool is presented to determine the optimal road segmentation.

3 : Multiclass Loss Systems: A Call Center Application. Philippe Chevalier, Université Catholique de Louvain; Shumsky, Robert; Tabordon, Nathalie.

We consider a call-center that must answer a variety of call types. Calls can be differentiated by their language or the type of content for example. Having cross-trained operators that can handle different types of calls is a way to increase the efficiency of the call-center. Our objective is to find the best combination of specialized operators (that can handle only one type of calls, but are less costly) and cross-trained operators. We find that the best staffing rules depend on the size of the call-center and on the type of call-center (quality driven or efficiency driven).

4 : The Theory of Constraints and Product Development Process. Çağın Karakoç, Kocaeli University; Akman, Gülşen.

Today's turbulent business environment, firms should develop new products to survive and succeed. For developing products that are successful in marketplace, firms should have an effective product development process. The theory of constraints (TOC) should suggested to improve effectiveness of the process. The TOC provides the theoretical framework and the tools with which firms can continually identify constraints in their corporate chain and improve its performance of the entire corporation. TOC could be applied to manufacturing and service sectors. In this study, TOC was integrated to product development process and a case study was realised in service sector.

: TD23 **Financial Planning under Uncertainty**

Invited Session Room: M38

Chair: Georg Pflug
University of Vienna

1 : Artificial Markets for Scenario Generation. Andrea Consiglio, Università di Palermo; Lacagnina, Valerio; Russino, Annalisa.

We build an artificial order-driven financial market with n risky assets and one risk-free bond where investors trade on the basis of their own view about the fundamental value of assets, and try to achieve the asset allocation that is optimal given their characteristics. We model the precise functioning of an order-driven market where traders can post both market and limit orders. Our aim is to generate scenarios of stock prices which are consistent with market stylized facts.

2 : Optimal Index Tracking using Stochastic Programming. Alexei Gaivoronski, Norwegian University of Science and Technology; Krylov, Sergiy.

We consider the problem of constructing portfolio which would reproduce behavior of a given financial index. The methods of solving this problem depend on the measure of risk of deviation from index and on performance targets. Another important issue to be considered is the influence of transaction costs and rebalancing criterions. We address this problem from the point of view of stochastic programming and discuss the architecture of decision support system designed for the purpose of portfolio replication.

3 : The AURORA Financial Management System - Concepts and Algorithms. Georg Pflug, University of Vienna.

The AURORA financial management system is developed at the Vienna University and is sponsored by the Austrian Science Fund. The main concept is to support the whole financial decision process from data and models to decisions and visualizations by appropriately interacting modules. Uncertainty modeling is done through lattice and tree models. A novel scenario generation technique based on transportation distances is used to estimate appropriate structures based on (1) historic data (2) theoretical models and (3) expert opinion. Uncertainty models may be alternatively used for pricing or for stochastic multiperiod optimization. In both areas, new algorithms for parallel hardware were developed.

4 : The AURORA Financial Management System: Implementation and Grid Technology. Ronald Hochreiter, University Of Vienna.

In this paper we present the structure of the Grid-based financial problem solving environment (PSE) of the AURORA financial management system, which is part of the research project AURORA (Advanced Models, Applications and Software Systems for High Performance Computing). The optimization sub-system is a stochastic programming problem solving environment built on Grid and Web technologies. The integrated use of Grid technologies (service layer) and Web technologies (component layer) enables new possibilities for financial modelling. Examples - scenario generation for stochastic asset liability management problems and risk management - will illustrate the practical applicability of this technology.

: TD24 **MCDA - C2**

Contributed Session Room: L17

Chair: Raymond Bisdorff
Centre Universitaire

1 : Assessment of Weighting Methods: The Entropy Method and the Mutual Information Method. Amílcar Serrão, Evora University.

The assignment of weights to each criterion is a crucial step in multi-criteria decision analysis. This research work makes a comparison between the entropy method and the mutual information method. The essential idea is that the importance relative to a criteria is a direct function of the information conveyed by the criteria relative to the whole set of alternatives. The most important criteria are those, which have the greatest discriminating power between alternatives. This research work shows that the discriminating power of the mutual information method is greater than the entropy method.

2 : Enumerative Cutting Planes for Integer Linear Vector Optimization Problems. Walter Habenicht, University of Hohenheim.

We present a new hybrid system for integer linear vector optimization problems. It is the generalization of so called "intersection cuts" in combination with an enumeration component. Traditionally, the intersection cut approach uses as cut-generating sets only convex sets that contain no feasible solution in its interior. In our concept we enlarge the cut-generating sets, allowing feasible points in its interior. So we generate deeper cuts, but on the other hand, we have to enumerate the interior of the cut-generating set. In this way we develop a hybrid approach, combining cutting planes with an enumeration component.

3 : Multicriteria Preference Aggregation with Criteria of Ordinal Significance. Raymond Bisdorff, Centre Universitaire de Luxembourg.

In this communication we propose to extend the classical concordance principle for aggregating multicriteria preferential situations with numerical significance weights to the case where the relative significance of the criteria are known only through a weak order. An practical application to the choice of a postal

parcel sorting machine will illustrate our approach.

4 : Application of the Multicriteria Analysis Method Electre III for the Optimisation of Decentralised Energy Systems. Agis Papadopoulos, Aristotle University of Thessaloniki; Karagiannidis, Avraam.

The optimization of decentralized energy systems has to consider a series of factors, on an approach based on interdisciplinary comprehension. Such a study requests the overall study of the geological, geomorphological and climatic conditions, the capacities of the networks, and furthermore the inclusion of the economic and social limitations, which lead to many alternative solutions. In this paper the results of determining the renewable energy sources penetration achievable in an insular system, for the purpose of electricity generation will be discussed. This was done by means of the Electre III multicriteria analysis method.

: TD25 **Supply Chain Dynamics**

Invited Session Room: M34

Chair: Yaman Barlas
Boğaziçi University

1 : Testing The Decision-Making Heuristics in a Dynamic Feedback Environment. Serhat Aybat, Boğaziçi University; Daysal, Sinem; Tan, Burcu; Topaloğlu, Fulden.

This study aims to demonstrate and provide an understanding of systemic errors underlying the decisionmaking behavior of subjects in a dynamic decision environment, by analyzing the results of controlled gaming experiments and to test various decision heuristics. An interactive stock_management_game; inventory_management_game is used as the experimental medium, which in the simplest case has the order quantity as the only decision_variable. The dynamic complexity is gradually increased by introducing various additional factors. One extension is the control of stock by two simultaneous decisions and a second one is indirect control of a stock. Effects of delays and nonlinearities are also tested.

2 : Information Sharing to Reduce Fluctuations in Supply Chains: A Dynamic Modeling Approach. Barış Gündüz, Ford Otosan; Barlas, Yaman.

Supply chain inventories are prone to fluctuations and instability. Small variations in end item demand create oscillations that amplify throughout the chain (also known as bullwhip effect). Recent research in SCM focuses on information sharing to reduce amplified oscillations. In order to understand the underlying structure that generates this behavior and explore the effects of various information-sharing policies, dynamic models of the supply chain are constructed. Simulations show that information sharing reduces but may not entirely eliminate the bullwhip effect.

3 : Time Will Tell:The Impact of Demand Cyclicality and Supply Lead Times on Customer Order Information Sharing in Supply Chains. Henk Akkermans, Eindhoven University of Technology; van Oorschot, Kim; de Kok, Ton.

Most past research on information sharing in supply chains focuses on commodity products. Associated with those are characteristics such as limited importance of delivery delays for customer demand levels, stationary demand patterns and short supply lead-times. We introduce a generic system dynamics simulation model of a supplier-buyer supply chain to investigate what happens if these characteristics are changed. Here we find that cyclical demand patterns and longer lead times make sharing of end customer order more advantageous for both the supplier and the buyer. We present two empirical examples of such settings from the high-tech electronics industry.

4 : Oscillation and Amplification in Supply Chains: A System Dynamics Perspective on the Bullwhip Effect. Henk Akkermans, Eindhoven University of Technology; Dellaert, Nico.

The term "bullwhip effect" was first introduced in the academic literature by Hau Lee et al in 1997, although the phenomenon it describes of upstream demand amplification in decentralised supply chains was modelled by Forrester using system dynamics back in 1961. This paper uses SD modelling and analysis to investigate to what extent the four root causes for upstream demand amplification that Hau Lee et al mention (demand signalling, order batching, price fluctuations and shortage gaming) can be replicated in a formal SD model and what additional insights can be gained from this on their original analysis.

: TD26 **Financial Models**

Invited Session Room: L10

Chair: Ben Lev
University of Michigan - Dearborn

1 : UMPI Test for Identifying an Observable Process with One of Several Simulation Models. Max Moldovan, Queensland University of Technology; Nechval, Konstantin; Nechval, Nicholas; Vasermanis, Edgars; Strelchonok, Vladimir.

In this paper, for identifying an observable process with one of several simulation models, a uniformly most powerful invariant (UMPI) test is developed from the generalized maximum likelihood ratio (GMLR). This test can be considered as a result of a new approach to solving the Behrens-Fisher problem when covariance matrices of multivariate normal populations (compared with respect to their means) are different and unknown. The test is based on invariant statistic whose distribution, under the null hypothesis, does not depend on the unknown (nuisance) parameters.

2 : Foreign Currency Inventory Management based on the Past Data. Edgars Vasermanis, University of Latvia; Nechval, Nicholas; Nechval, Konstantin; Strelchonok, Vladimir.

This paper presents the branch bank's foreign currency problem as an inventory management problem with proportional holding cost and lump-sum penalty cost. Demand is considered to be positive when the branch depletes its foreign currency stock and negative when the branch accumulates foreign currency. It is assumed that the probability distribution of the demand is known, but its parameters are unknown. The form of the best invariant policy for this type of cash management problem is developed, and several examples are presented in some detail.

3 : Inclusion of Fuzzy Set Theory into the Financial Reliability Evaluation. Zita Bosnjak, University of Novi Sad; Bosnjak, Sasa.

Uncertainty and imprecision are inherent to data relevant for the problem of financial reliability evaluation of companies. In the paper we described and compared the decision-making models of one crisp and one fuzzy expert system solution to this problem. The crisp one is based on the hierarchical aggregation structure, while the later one relies on subjective estimations of experts aggregated by the combination of the LOWA operator, the fuzzy linguistic quantifier "most" and the classical "min-max" operator. The center-of-gravity method is used as a defuzzification method, as we require the "best compromise" among the evaluated degrees of financial reliability.

4 : Bankruptcy Prediction using Logit and Integer Programming. Armando Milioni, Instituto Tecnologico de Aeronautica; Scarpel, Rodrigo.

We use a Logit model to predict the bankruptcy of enterprises using real financial data of Opened Capital Brazilian enterprises. The model had a significant performance in the prediction of bankruptcy, since it classified correctly 87% of the enterprises. We then use the Logit Model together with an Integer Programming Model which aims at supporting decisions of credit concession considering the corporation's solvency probability estimate and minimizing the sum of opportunity and failure to pay costs. The conjoint utilization of both models eliminates limitations found in each of them, when used in isolation.

: TD27 **Strategic Issues in SCM**

Contributed Session Room: L11

Chair: İsmail Çapar
İstanbul Technical University

1 : A Performance Measurement System in an Automotive Supply Chain. Bülent Çatay, Sabancı University; Çapar, İsmail.

Today's fierce market conditions drive companies to effectively evaluate their overall supply chain performance and identify improvement areas for gaining competitive advantages. In this study, we propose a supply chain performance measurement framework. In addition to customer satisfaction perspective and financial perspective a new perspective with respect to new trends in supply chain management is presented: supply chain collaboration perspective. Furthermore, we discuss an appropriate supply chain performance measurement system for a large Turkish automotive company that manufactures passenger cars, light commercial vehicles, and related components.

2 : Inventory and Transportation Planning for Multi-Commodity in n-Supplier and One-Buyer System: A Case Study. Nasrin Asgari, Tarbiat Modares University; Zanjirani Farahani, Reza; Aghdasi, Mohammad.

In this paper is discussed about a multi-supplier and one-buyer model. The buyer is responsible for transporting goods and has eight central warehouses (CW). Each CW covers some regional warehouse (RW). RWs send goods to end-consumer. RWs buy some item from suppliers directly. In this paper, a model is proposed in which inventory and transportation variables are determined. Because of high sensitivity, on-time delivery is the most important indicator. Cost is second important indicator. This two indicators are considered in modeling.

3 : Technology Internalization: The Development of a New Measure for Innovation Adoption. Howard Forman, Drexel University; Lippert, Susan.

Technology adoption along a supply chain is complex because of the interdependencies and level of trust required between supply chain members. Technology adoption theories across research streams were considered for the theoretical foundation of a proposed Supply Chain Internalization Model (SCIM). This paper presents an integrated model of technology adoption and internalization along an automotive supply chain which is theoretically grounded in the supply chain management, information systems, and marketing literature. The proposed model introduces an extension to the traditional dependent variable, intention to adopt. This new measure, internalization, reflects the effective and consistent use of the new innovation.

4 : A Taxonomy of Supply Chain. İsmail Çapar, İstanbul Technical University; Ülengin, Füsun.

We propose a taxonomy of supply chain literature by considering strategic, tactical, and operational level decision-making concepts together with supply chain management literature to examine further research opportunities. The suggested taxonomy consists of three groups: supply chain structure, organizational structure, and performance measurement. Literature in the first group focuses on designing the supply chain network. The second group of literature is mainly about identifying properties of the best organizational structure. The last group tries to show the combined performance of supply chain, the final outcome of the efforts of all members, and new improvement areas through the supply chain.

: TD28 **Timetabling**

Contributed Session Room: L12

Chair: Federico Della Croce
Politecnico di Torino

1 : Implementation of a University Final Examination Timetabling System. Mehmet Şevkli, Fatih University; Çolak, Arife Burcu; Ünsal, Mazhar.

The university final examination timetabling problem is investigated. Most previous investigators have resorted to heuristic methods of solving the university final examination timetabling problem because of the difficult combinatorial nature of this problem considering the voluminous amount of decision variables and constraints involved. A nonlinear integer program formulation of the problem is presented in the present study which is then transformed into a linear integer program. The resulting problem is solved using a commercial software package. Results from the present study together with the limitations of the present method are discussed by means of a practical example.

2 : Determining Feature Weights in a Case-based Reasoning Approach to Nurse Rostering. Gareth Beddoe, University of Nottingham; Petrovic, Sanja.

We present a method for capturing nurse rostering experience and adapting it to solve new problems using the Case-Based Reasoning paradigm. This method allows rostering knowledge to be stored implicitly rather than by using inflexible sets of

IF-THEN rules. Cases are retrieved from the case-base using characteristic feature values. The problem of automatically assigning weights to these features is investigated. These weights must represent the relevance and relative importance of the features based on a set of supplied training cases. We discuss various approaches and present an automated feature weighting algorithm tailored to the case-based rostering method.

3 : Building Quality Timetables with Integer Programming. Sophia Daskalaki, University of Patras; Birbas, Theodore.

We propose an IP formulation for certain types of timetabling problems. Students attend general education, specialized and elective courses. Forming timetables for schools with such system is difficult, because students form groups to attend some courses and then split to form different groups. When compactness in student timetables is required, the problem becomes even harder. With our model we introduce a number of 0-1 variables, very primitive in structure, thus flexible in modeling. The model obeys all hard functional constraints imposed by the educational system. In addition, quality issues are addressed to create more satisfying timetables for the users.

4 : Scheduling the Italian Football League: An ILP-based Approach. Federico Della Croce, Politecnico di Torino; Oliveri, Dario.

We consider the problem of scheduling the Italian Football League. This problem consists in finding a round robin schedule taking into account home-away conditions, twin-schedules for teams belonging to the same home-town, specific "balanced" calendars constraints due to cable televisions requirements and so on. We adapt the ILP-based approach proposed by Nemhauser and Trick to schedule a College Basketball Conference that considers however only half of the teams involved here. The proposed approach allows generating within few minutes several different reasonable "ideally balanced"calendars minimizing the total number of home-away breaks and satisfying various other operational constraints.

: TD29 **EWG Complex Societal Problems - II**

Invited Session Room: L13

Chair: Olga Petkova
Central Connecticut State University

1 : Understanding Methodologies and Systems in Management. Cathal Brugha, University College Dublin; Bowen, Ken.

This paper puts the case that management practice can be understood by reference to the structure underlying the decisions regularly undertaken by managers. Where such decisions are made over a long period they lead to the development of a language that encapsulates a set of constructs that embodies the relevant underlying structure. Because management decisions have much in common it follows that similar settled practices in many different contexts and situations can be related to others by reference to their common underlying structures. Examples are given and rules are presented for the evaluation and improvement of such systems.

2 : Social Impact Assessment of Coastal Zone Regulation: A Case Study in Kerala (India). Bert Enserink, Delft University of Technology.

110/1 Coastal zones are the most densely populated areas and the environmentally most valuable and most vulnerable areas of our planet. Coastal Zone Regulation in India prohibits any economic activity within 250 meters from the shore in areas with tidal influence. Millions of people are living in this zone. Strict regulations to protect the environment and to stop degradation impinge on the social and economical development of the local people. Is there a way out of this dilemma? In this paper the socio-economic impacts of the coastal policy on every day life in Kerala will be assessed.

3 : Community Informatics and Community OR - some comparisons. Doncho Petkov, Eastern Connecticut State University; Petkova, Olga; Donofrio, Marianne.

The theoretical foundations of Community OR have been well established over the last 15 years. On the other hand very little work has been done with respect to the new interdisciplinary field called Community Informatics (CI). The paper provides some comparisons of their methodological foundations, application areas and other relevant issues.

4 : A Multicultural Comparison of Ethical Perceptions of Students. Serap Ekin, İstanbul Bilgi University; Burnaz, Şebnem; Topçu, Y. İlker.

Business ethics is a major controversial issue worldwide. The question of ethics in business conduct has also become one of the most challenging issues confronting Turkish business environment. As business students as well as managerial and industrial engineering students are potential business managers, they should realize the importance of business ethics. The aim of this study is to analyze the ethical perceptions of Turkish students in both graduate and undergraduate levels with respect to business related situations. Finally, the findings of this study will be compared with those conducted in different cultural settings in order to reach a comparative analysis.

: TD30 **Education and Distance Learning - C1**

Contributed Session Room: L14

Chair: Ana Savic
University of Belgrade

1 : Teaching Supply Chain Logistics: A Global Learning Framework. Mehmet Bayram Yildirim, Wichita State University; Barut, Mehmet.

Most graduates are employed in global companies requiring interaction and teamwork with different nationalities possibly located in distant parts of the world. While it is important for the graduates to exhibit superior teamwork and communication skills, understanding of diverse cultural approaches and sharing perspectives are becoming critical. Our goal is to design a global learning framework for teaching logistics and supply chain class where students are required to team up with students from overseas to solve real life global logistics problems. Issues related to team formation, online communication and discussion, and multimedia presentations will also be discussed.

2 : Operations Research for High School Students. Kenneth Chelst, Wayne State University; Edwards, Thomas.

We present an overview of OR modules that were designed and developed by operations researchers, math educators and a team of high school math teachers. They motivate a variety of high school math topics by using real-world contexts. The modules include the topics of queueing, math programming, simulation, MAUT, decision trees and network routing. Each module contains a classroom activity and a teacher's guide and can be found on the internet at www.hsor.org. We will also discuss the launch of a nationwide network of INFORMS volunteers who will be offering workshops based on these modules in their respective locales.

3 : Success in Education. Ayşe Cilacı, Boğaziçi University.

Turkey has problems in economy and related issues, especially for the last two years. Most of the experts agree that lack of education is the underlying problem and should be cured as soon as possible to handle with the other problems even in the long run. This study deals with analyzing the different factors that will help to determine the ones, which significantly affect student's achievements by the hope that the results of this study would may help to educators, families and politicians to be aware of student's problems more and to improve the quality of education.

4 : Internet Services as Support of Traditional Educational Process in Teaching Mathematics. Ana Savic, University of Belgrade; Radenkovic, Bozidar.

The paper is presenting the internet technology application as the support to the traditional education method. The special emphasize is dedicated to the teaching process of mathematics at technical faculties or college for engineering. The developed methodology for efficient teaching process of mathematics supported by Internet services is presented. The real system ready for application for active teaching in Internet environment and the results analyses is reported.

: TD31 **Queueing Systems - C2**

Contributed Session Room: M33

Chair: Nassim Nahavandi
Tarbiat Modarres University

1 : Approximations for Markovian Multi-Class Queues with Preemptive Priorities. Matthieu Van Der Heijden, University of Twente.

We discuss the approximation of performance measures in multi-class M/M/k queues with preemptive priorities for large problem instances (many classes and servers) using class aggregation and server reduction. We compared our approximations to exact and simulation results and found that our approach yields small to moderate approximation errors. We show how our approximate method can be embedded in the METRIC framework for spare part optimisation. Here, we use our queueing model to represent repair shops handling various job types (spare parts) with given priorities.

2 : A Solution Algorithm for Open Arbitrary Queueing Networks with Blocking. Ahmet Hasköse, Kırıkkale University; Kingsman, Brian; Worthington, Dave.

Jobbing and flow shops in MTO manufacturing can be viewed as open queueing networks. Workload control for planning production imposes limited buffer capacities on the network at each workstation. Such networks cannot be solved exactly if there are more than 4 workstations. A new approximate algorithm any number of workstations, for forward and backward flows, based on Server Vacation models to derive the steady state behaviour of individual nodes is presented. Server vacation is used to represent the blocking of a node by one of its destination nodes. Accuracy tests are described and insights for manufacturing strategies.

3 : On the Two-Class M/M/1 System under Preemptive Resume and Impatience of the Prioritized Customers. Andreas Brandt, Humboldt-Universität zu Berlin; Brandt, Manfred.

The two-class priority M/M/1 system is considered, where the prioritized class-1 customers may become impatient and are served under FCFS preemptive resume discipline. The class-2 customers have no impatience. The mean service times may depend on the customer class. As the dynamics of class-1 customers are related to the well analyzed M/M/1+GI system, we derive characteristics for class-2 customers and the whole system. The balance equations for the partial probability generating functions of the system are solved analytically. Formulae for the joint occupancy distribution and for the sojourn and waiting times are derived, generalizing results by Choi et al.

4 : An Approximation Method for Determining Performance Measures in Flow Lines. Nassim Nahavandi, Tarbiat Modarres University; Heidarpour, Vahid; Chaharsooghi, Seyed Kamal.

In this paper we have proposed an approximate method for determining throughput rate. We have shown by examples that this algorithm is fairly good. Proposed method is simple and it has good results in compare with other methods. Since the results are fairly good, the proposed method is well presented the behavior of the system. Future works with this methodology will extend our results to the other flow line systems with general service distribution and multiple servers.

: TE01 **Modeling and Algorithmic Challenges in Forestry: Twenty Open Problems**

Tutorial Room: MB I

Modeling and Algorithmic Challenges in Forestry: Twenty Open Problems. Andrés P. Weintraub, Universidad de Chile.

Operations Research has had a very significant role in forestry, both in methodological proposals, and in real use. Decisions supported by OR techniques include long range strategic planning, tactical decisions of sequencing of areas to harvest and road building, scheduling short term harvesting, machine location and transportation. A major source of problems relates to environmental issues such as the protection of wildlife, soil and water quality, sustainability, and diversity. Main algorithmic approaches include LP, Nonlinear Programming, Mixed Integer LP, Heuristics, and Metaheuristics, in particular Tabu search and simulated annealing, Simulation, Dynamic and Stochastic programming. An issue of importance is the integration of models to information technologies, data and communication. The talk will concentrate in state of the art results obtained so far, and in particular in open problems, that have not been resolved as yet and are in the frontier of research. This includes so far intrac-

table combinatorial problems, finding adequate representations and models of complex real problems, dealing with soft data, as well as incorporating uncertainty and multiple attribute issues into actual decision making.

: TE02 **Operations Research and Planning of Radiation Therapy**

Tutorial Room: MB II

Operations Research and Planning of Radiation Therapy. Horst W. Hamacher, University of Kaiserslautern

In fighting cancer, finding good, patient-specific radiation plans is extremely important for the success of radiation therapy. In addition to its practical importance, this problem very interesting is from an Operation Research point of view. In order to design good radiation plans, various decisions have to be made, which can be tackled by OR methods. For example, one can use global optimization to find promising radiation angles. The problem is to decide where to stop with the radiation gantry in order to send off radiation. In the past equidistant angles have been used as rules of thumb, but these can be improved. Another interesting problem deals with multicriteria optimization to balance radiation dosage. In order to kill all cancerous cells, one would want to send as much radiation as possible. But this imposes significant risks of destroying one or more of the healthy organs. The idea is to produce a well-chosen set of Pareto solutions which correspond to high quality radiation plans, from which the doctors can choose the ultimate plan. A third example deals with integer programming and network optimization to implement a radiation plan. Here we concentrate on devices used to shape the radiation field. In this talk we will report on research performed at research groups in Kaiserslautern in cooperation with the German Cancer Research Center, MRC Systems, and Harvard Medical School/Mass General Hospital.

: TE03 **Option Pricing with Constraints**

Tutorial Room: MB III

Option Pricing with Constraints. H. Mete Soner, Koç University

This tutorial surveys several methods for pricing in markets with constraints. In the classical Black-Scholes model, the financial market consists of two instruments: money market with a deterministic return and a risky asset called stock. Stock dynamics is assumed to be a geometric Brownian motion. Under the assumptions that there are no constraints and transaction costs, it is known that any contingent claim or equivalently any instrument designed by using the two underlying assets can be replicated by the underlyings. Hence, any pricing approach to this claim gives the same answer, namely the Black-Scholes price. However, in the presence of constraints, transaction costs or any other market imperfection, there is no unique arbitrage price but rather there is a no-arbitrage interval: If the initial price of the claim is in this interval there is no sure way of arbitrage. Hence, any pricing approach yields prices in this interval and the characterization of this interval of is important. Convex duality and partial differential equations techniques used to study this interval will be outlined in this tutorial. A stochastic representation for geometric flows is also obtained as a corollary.

: TE04 **Boolean Functions**

Invited Session Room: JB A

Chair: Endre Boros
Rutgers University

1 : Improved Semi definite Programming Relaxations for Satisfiability. Miguel Anjos, University of Southampton.

We introduce a semi definite programming (SDP) relaxation for the satisfiability problem which arises from the recently introduced paradigm of "higher liftings" for constructing SDP relaxations of discrete optimization problems. The important characteristics of the SDP relaxation are its ability to prove that a given SAT formula is unsatisfiable independently of the lengths of the clauses in the formula, its potential to yield truth assignments satisfying the SAT instance if a feasible matrix of sufficiently low rank is computed, and the fact that it is more amenable to practical computation than previous SDPs arising from higher liftings.

2 : Subclasses of Horn CNFs with Polynomial Time Minimization. Ondrej Cepek, Charles University in Prague; Boros, Endre; Kogan, Alex; Kucera, Petr.

The problem of Horn Minimization (HM) can be stated as follows: given a Horn CNF representing a Boolean function, find its CNF representation which consists of a minimum possible number of clauses. This problem is a formalization of the knowledge compression problem, and it is known to be NP-hard. There are two subclasses of Horn functions for which HM is known to be solvable in polynomial time: acyclic Horn functions and quasi-acyclic Horn functions. Here we define a new class properly containing both of the known classes, and design a polynomial time HM algorithm for this new class.

3 : On Some Extremal Properties of Sets of Boolean Vectors. Béla Vízvári, Eötvös Loránd University; Foldes, Stephan.

First was proven by Jeroslow that if $\cal S\in\{0,1\}^n$ then in the worst case 2^{n-1} linear inequalities are required to describe the set $\cal S$. From the point of view of logic a set of constraints is a conjunction. In this paper we pose the question that what is the number of the required inequalities if more general logical expressions can be used.

4 : Generalizations of Horn formulae with Polynomial Time SAT Testing. Petr Kucera, Charles University in Prague; Cepek, Ondrej.

In this paper we study several classes of Boolean formulae which generalize Horn formulae while preserving one of their main properties, namely the fact that satisfiability is decidable in polynomial time. We compare the known classes with respect to inclusion and define a hierarchy of new classes which propertly contains some of the known classes.

: TE05 **Transportation Systems**

Invited Session Room: JB B

Chair: Kerry Malone
TNO Inro

1 : Cybernetic Transport Systems Deployment: State of the Art, State of the Practice and Future Research Issues. Kerry Malone, TNO Inro; Janse, Marten; Uwland, Jan.

This paper provides an overview of the state of the art of Cyber cars, and identifies the future research areas necessary for deployment of systems. Cyber cars are road vehicles with fully automated driving capabilities. A fleet of such vehicles forms a Cybernetic Transport System, for passengers or goods, on a network of roads with on-demand and door-to-door capability. This paper provides the overview of the European technological state of the art and state of the practice in terms of deployment of such systems in pilots and in full-fledged functioning systems, and concludes with the major research questions for these systems.

2 : Heuristic Algorithms for the O D Matrix Adjustment Problem. Ricardo Garcia, Universidad de Castilla La Mancha; Verastegui, Doroteo; Lopez, Maria Luz.

We consider the problem of estimating an origin-destination matrix of a congested traffic network by using observed flows and a target matrix. This problem is denoted DAP and it is formulated as a mathematical program with equilibrium constraints. We propose a column generation algorithm for solving DAP which operates in the path flow space, and we prove that converges to a local minimum of DAP. We discuss some heuristic strategies to apply the above algorithm in large scale problems. Particular algorithms of this class have been developed in Literature. Numerical tests on small and large network examples are reported.

4 : Using Scatter Search Algorithm to Solve a Multi-Objective Transportation Problem: A Case Study. Hamed Reza Tareghian, Ferdowsi University of Mashhad, Iran; Taheri, Said Hasan; Mirrazavi, Said Reza; Najiazimi, Zahra.

Routing buses for schools and similar services is one of the most visible applications of operations research in improving services and reducing operating costs. In this paper, a solution procedure for a multi-objective transportation problem based on scatter search is proposed. In this problem, operating costs as well as equality of service to passengers are considered. The solution procedure consist of developing feasible solutions,then improving the solutions by using local and global search operands. The improved solutions are then combined to obtain near optimum solutions. The validity and the merits of the proposed solution is tested with real data.

: TE06 Modern Scheduling Problems and Solutions

Invited Session Room: M30

Chair: Chris Potts
University of Southampton

1 : On-Line Algorithms for Due Date Quotation. Phil Kaminsky, University of California; Lee, Zu-Hsu.

We present a model for due date quotation. Jobs arrive at a flow shop over time. Upon arrival, due dates must be quoted for each job. We present an on-line heuristic that minimizes the average quoted due date, and sequences jobs to meet quoted due dates. We develop analytical bounds for this heuristic.

2 : A Note on Weighted Completion Time Minimization in an Open Shop. George Kyparisis, Florida International University; Koulamas, Christos.

We consider the open shop scheduling problem with the weighted completion time minimization objective. We show that the WSPT heuristic applied to the open shop case yields the worst-case ratio bound of m, where m is the number of machines. Our result, with a slight modification, also applies to the flow shop weighted completion time minimization problem.

3 : A Model for Scheduling Steelmaking - Continuous Casting Production. Adil Bellabdaoui, Faculté Polytechnique de Mons; Fiordaliso, Antonio; Teghem, Jacques.

This paper presents a model for flow management in steelmaking-continuous casting. The system under study is based on an industrial application which aims at maximizing productivity and reducing the sojourn of the product in the system. This model is solved by using heuristic techniques based on eliminating machine conflicts. Some numerical results are presented and discussed.

: TE07 Topics in Supply and Demand Management

Invited Session Room: M31

Chair: Ozalp Ozer
Stanford University

1 : Coordinating Inventory Control and Pricing Strategies with Random Demand and Fixed Ordering Cost. David Simchi-Levi, Massachusetts Institute of Technology; Chen, Xin.

We analyze a single product, periodic review model in which pricing and production/inventory decisions are made simultaneously. Demands in different periods are random variables that are independent of each other and their distributions depend on the product price. Pricing and ordering decisions are made at the beginning of each period and all shortages are backlogged. Ordering cost includes both a fixed cost and a variable cost proportional to the amount ordered. We consider both the finite and infinite horizon models.

2 : Optimal Ordering Policies for Multiple Procurement Modes. Guillermo Gallego, Columbia University; Sethi, Suresh; Wang, Zheng; Yan, Houmin; Zhang, Hanqin.

We investigate an infinite-horizon, periodic-review procurement system with multiple procurement modes. We establish an optimal stationary ordering policy and develop a simple algorithm to compute the optimal policy parameters for the case of two procurement modes with consecutive lead times for stationary and stochastically increasing demands. We extend this algorithm to the case of three or more procurement modes and show that it leads to optimal solutions under restrictive conditions. A numerical study indicates that the policy performs well even when these conditions are not met.

3 : Simulation-based Optimization of Revenue Management Controls under Consumer Choice. Garret van Ryzin, Columbia University; Vulcano, Gustavo.

We analyze a simulation based optimization method for setting protection levels when consumers chose among the set of products offered. The model has application to revenue management problems in which consumers chose departure times, routes or fare classes. We prove the local convergence of the method and illustrate the effect of such choice behavior via several numerical examples.

4 : Capacity Allocation to Support Customer Segmentation by Product Preference. Robert Phillips, Manugistics; Gallego, Guillermo; Ozer, Ozalp.

A capacity-constrained supplier sells into a market with exogenous prices and customers segmented by product preferences. What product should the supplier offer to buyers from each segment as they arrive? How should the supplier update this decision? We present results and simulations of different policies.

: TE08 **Group Collaboration**

Invited Session Room: M32

Chair: Camille Rosenthal-Sabroux
Université de Paris XI - Dauphine

1 : The Social Capital Contribution to Business Network Efficacy: Structural and Relational Arguments. Marina Burakova-Lorgnier, Bordeaux School of Business; Bouzdine, Tatiana.

There is a great need for technologies, means, and resources to create an efficient business network to achieve organisational success. Social capital theory helps achieve this objective by facilitating understanding of the tacit phenomena of business success through the quality of social relations in business: trust; the structure of communication flows; the contribution to intellectual capital, etc. We consider approaches to defining the dimensions of social capital and their interactions, examining the network as its source and form, and analysing network characteristics to draw up an architecture for an efficient business network.

2 : Multi-Dimensional Decision Modelling for Distributed Group Decision Making. Georgios P. Papamichail, Athens University of Economics and Business.

A computational framework to support distributed group decision-making identifies group decision needs and represents them using computational geometry to model multi-attribute arguments and compare them in real time. Representative algorithms are analysed and the implications for distributed group decision are assessed.

3 : Modeling the Emergence of Shared Vision in Group Decision Making using a Phase Transition Approach. Tatiana Bouzdine, Bordeaux Ecole de Management.

Group decision making is a complex phenomenon that is difficult to model because it depends on rational and irrational factors, personal determination, group dynamics, etc. Interaction is an important stage in this process - as different opinions are sorted out, a shared vision emerges. We model this emergence using the mean field model of phase transition, a well-known approach to disordered, complex systems. Our two scenarios refer to whether, or not, group members feel external influence during the meeting. We discuss our model and use it in simulations to study the dependence of emergence time on group size.

4 : Multicriteria Classification Method to Identify Crucial Knowledge. Inès Saad, Université de Paris XI - Dauphine; Rosenthal-Sabroux, Camille.

The aim of this communication is to present a multicriteria classification method for locating crucial knowledge for a French company in order to choose investment to launch a knowledge management program. In an industrial context, it is very important to preserve and to enhance the knowledge produce in different project. Our approach is based on the cooperative work in order to construct objective criteria.

: TE09 **Marketing Mix Management**

Invited Session Room: L15

Chair: Lutz Hildebrandt
Humboldt-Universität zu Berlin

1 : Advertising Competition in Differentiated Product Markets. Toker Doganoglu, University of Munich; Klapper, Daniel.

We develop a game theoretic model of advertising competition between manufacturers in differentiated product markets. As advertising competition, especially TV-advertising competition, takes place at national level, we adopt a two-step procedure that allows us to use store-level scanner data along with national advertising budgets. First, we introduce a structural model of demand and supply to infer wholesale prices and costs. The estimated wholesale price-cost margins are used in step-two in a structural model of manufacturer competition in advertising. The model results allow investigation of the impact of advertising strategies on profits as well as analysis of competitive behavior.

2 : Marketing-Mix and Resources as Determinants of Successful Entry Strategies. Lutz Hildebrandt, Humboldt-Universität zu Berlin; Kamlage, Kerstin.

First mover advantages and the order of entry are subjects of numerous theoretical and empirical studies in marketing management to explain successful market entry strategies. Based on marketing-mix effects, order of entry and company resources a conceptual model is developed to test hypotheses regarding the successful entry strategy in the food market. The empirical tests are conducted with aggregated household panel data and the application of a hierarchical model. It is shown, that besides marketing-mix effects different indicators of resources and capabilities can be important for a successful pioneering and follower strategy.

: TE10 **Reverse Logistics**

Invited Session Room: L19

Chair: Arcan Nalca
METU

1 : An Inventory Model for Recyclable Goods with a Disposal Option. Cerag Pince, Bilkent University; Gürler, Ülkü; Berk, Emre.

In this study, we develop and analyze a control policy for a continuous review inventory system of recyclable goods with a disposal option. We assume that the return and demand flows are independent and the net demand pattern is governed by a Brownian motion process. Under the fixed procurement lead-time and backordering assumptions, we derive the analytical expressions of the cost rate function for the cases where the net demand rate is zero and positive. A numerical analysis is conducted to see the effects of the net demand rate over the policy parameters and to illustrate the advantages of using the model.

2 : Game Theoretic Analysis of a Competitive Newsboy Model with Dependent Demands. Arcan Nalca, METU; Serin, Yasemin.

In this study we deal with a single-period newsboy problem with two substitutable products with dependent demands. Two players that represent the agencies supplying these products are considered. The aggregate industry demand is distributed between these players and excess demand of any player is perfectly allocated to the other player. Each firm's strategy is its order quantity. Game Theoretic analysis is carried out and the existence of Nash equilibrium is shown. In this talk construction and analysis of the model is going to be discussed.

3 : A Facility Location Model and Algorithm for the Strategic Planning of Reverse Logistics System in the Case of Recycling Activities. Zhiqiang Lu, Ecole des Mines de Nantes; Dejax, Pierre; Bostel, Nathalie.

We present a two-echelon location problem in a reverse logistics system for recycling. In such a system, used products are collected from customers and recycled as reusable materials at recycling centers, and then sent to the reuse market. Depending of the parameters of the system, we formulate the model according to two distinct situations: a) the quantity of recycled materials in system is greater than the demands at reuse market; b) in the opposite situation. An algorithm based on lagrangian heuristic is developed. The model is tested by numerical experiments, and the results are presented.

: TE11 **Empirical Applications - III**

Invited Session Room: R20

Chair: Jesús T. Pastor
Universidad Miguel Hernández

1 : Measuring Technical Efficiency in Advanced Business Services. Maria Rosalía Vicente, University of Oviedo; Quindos, Mª del Pilar; Rubiera, Fernando.

Advanced business services enterprises tend to locate in those regions with an easy access to wide markets. This leads to space concentration around certain nodes, causing a low supply in the rest of the regions. There are some evidences that highlight that regions with a lower supply of advanced business services face a smaller competitiveness of these firms, so there will be important efficiency differences in this sector between regions. In this paper we study technical efficiency in this kind of enterprises in a Spanish region, by using the Data Envelopment Analysis.

2 : The Measurement of Dynamic Productive Efficiency: A System Dynamics Approach. Konstantinos Triantis, Virginia Tech; Warren, Vaneman.

Dynamic productive efficiency is a measure of a system's ability to convert inputs to outputs at a specific time t, during a transient period. This research builds on the theoretical foundation established by Vaneman and Triantis (2003) for defining dynamic productive efficiency by exploring the behavior of production frontiers in a dynamic realm. With this stage being set, a System Dynamics (SD) optimization model is developed and used to measure and evaluate dynamic productive efficiency. Finally the efficiency results obtained by Kopp (1981) using constrained optimization procedures are replicated using the SD optimization model.

3 : An Integrated Model for Strategy Generation. Ridha Hachicha, ISCAE.

We propose interactive models that permit macroeconomics quantitative specification for strategic objectives. The proposed methodology is founded on a quantitative analysis and based on DEA technique. The models are used to specify a strategic objective expression (targets values) in a multi-dimensional context. Such an approach, permits to specify strategies, is guided by targets values consideration. Theses values are represented by the competitiveness elementary indicators (favourable and / or unfavourable). These targets values give a perfectly competitive level to a nation. An empirical application is developed while considering the data of the world competitiveness yearbook.

4 : Conjoint Analysis and Its Application to Design of New Medicine. Hiroaki Ishii, Osaka University; Miichi, Akira; Kawasaki, Makoto.

We apply conjoint analysis to the numerical data (activation value) to the clinical test as new medicines list up. We regard it to as the total evaluation and each substitution product as the part worth value. We consider multi-categorized numerical data, some are to be maximized and the other should be minimized. Usually these categories have different importance. First using DEA, these data of each candidate of new medicine is transformed into the total score. To them, we apply conjoint analysis and focus some candidates with good combinations of substitutes. Case of repeated tested data is also checked.

: TE12 **Graphs & Networks - C1**

Contributed Session Room: M39

Chair: Victoria Chen
University of Texas at Arlington

1 : Maximizing the Number of Feasible Paths on a Capacitated Network with Time Constraints. Monica Gentili, Università degli Studi di Roma "La Sapienza".

A set of facilities is connected by a transportation network, where the weight of each arc corresponds to its travel time. Each facility is capable of providing a specific service during prespecified set of time windows. A visiting feasible path of length k visits exactly k different facilities, respecting the time window of each facility within a given time limit. This paper examines the specific problem of finding the maximum number

of feasible paths that visit k facilities. A neighbourhood search algorithm to get a feasible solution of this NP-hard problem is given and extended experimental results are presented.

2 : Approximation Algorithms for Feedback Set Problem. Raffaele Cerulli, University of Salerno; Festa, Paola.

The most general feedback set problem consists in finding a minimum-weight (or minimum cardinality) set of vertices (arcs) that meets all cycles in a collection C of cycles in a graph (G,w), where w is a non-negative function defined on the set of vertices (on the set of edges). We present four algorithms for approximatively solving this problem. The first two are practical algorithms based on different heuristic methods for the WFVS problem. The third algorithm is a random algorithm. The last and more interesting algorithm uses a different interpretation of the greedy approach.

3 : Solution of Quadratic Network Optimization Problem using Epsilon-Relaxation Methods: Computational Results. Renato De Leone, Università di Camerino.

In this talk, computational results will be presented for convex quadratic network optimization problems. The algorithm is a variant of the epsilon-relaxation method where the arcs with linear costs and the arcs with strictly quadratic costs are updated in different ways.

4 : Neural Network and Regression Spline Approximations for the Optimal Control of an Inventory Forecasting Model. Victoria Chen, University of Texas at Arlington; Cervellera, Cristiano.

We present numerical solutions to a nine-dimensional inventory forecasting optimal control problem using a statistical perspective that discretizes the state space and estimates the cost-to-go function. Discretizations are based on orthogonal arrays (OAs) and OA-Latin hypercube statistical experimental designs. Solutions via neural network approximations are compared to those via multivariate adaptive regression splines. Computational issues are also explored.

: TE13 Revenue Management and Pricing of Inventories

Invited Session Room: R21

Chair: Ülkü Gürler
Bilkent University

1 : An Investigation on Pricing Management. Ozgur Ozluk, San Francisco State University.

In the past decade, there has been a lot of work on pricing practices of different industries. Possible decision support systems to help firms better their pricing management have been recommended. In this presentation, we will discuss the results of our investigation on what has been published in this area and focus on the similarities and differences between various approaches.

2 : Optimal Strategic Pricing and Availability of Distressed Inventory. Robert Phillips, Manugistics; Gallego, Guillermo.

Maximizing revenue from a fixed stock of perishable goods may require selling distressed inventory at a low price rather than allowing the inventory to "perish". While it is often tactically optimal to sell all remaining inventory at a low price rather than allowing it to perish, this can create the expectation on the part of consumers that they may be able to obtain the good at a lower price by waiting. We present a model in which the decision on a part of a seller to sell distressed inventory can change the future behavior of customers.

3 : A Strategic Seat Allocation Model. Michael Li, Nanyang Technological University.

In this paper, we aim to develop a strategic seat allocation model in the context of two airlines offering two fares. We will first establish the existence of equilibrium solution in pure strategy and then provide analytical charaterizations of the eqiulibrium solution, followed by some numerical simulations.

4 : Perishable Asset Pricing with Mark-up and Mark-down Costs. Emre Berk, Bilkent University; Gürler, Ülkü; Yıldırım, Gonca.

In this talk, we will revisite the perishable asset pricing problem with non-negligible price change costs. Applications of the problem are found in the transportation and hospitality industries, and in retailing. We will discuss the structure of the optimal pricing policy under various modified periodic review policies and mild conditions on the demand distribution. Properties of the optimal pricing policies and bounds on policy parameters will be discussed. The behavior of the optimal policy with respect to the system parameters and comparison of optimal policy to a constant price policy will be presented using numerical examples.

: TE14 Multi-Objective Combinatorial Optimization - I

Invited Session Room: R22

Chair: Matthias Ehrgott
University of Auckland

1 : A Multiobjective Approach for Routing Problems in IP Networks. Xavier Gandibleux, University of Valenciennes; Beugnies, Frédéric; Randriamasy, Sabine.

Due to the evolution of the Internet traffic, it becomes crucial to prevent the network congestion. We propose a procedure based on multiobjective and multiconstraint routing. It computes in realtime the multiobjective shortest paths between one router and all the others routers of the considered network area, by optimizing simultaneously min-sum/max-min objectives. It integrates constraints in filtering phases. The core of the procedure is a label setting algorithm. Numerical experiments, performed on a "conventional" router and using representative random IP networks, show the feasibility of the proposed solution. Keywords : multiobjective shortest paths, label setting, IP routing, traffic engineering

2 : Finding the Efficient Set of a Bicriteria Discrete Optimization Problem using Algorithm Robust. Serpil Sayın, Koç University; Kouvelis, Panos.

We apply Algorithm Robust to certain bicriteria discrete optimization problems such as the knapsack problem, the assignment problem and the shortest path problem. Algorithm Robust utilizes sub problems of robust optimization origin along with

a parametric search to find the entire efficient set. It can also be modified to sample from the efficient set with prespecified quality guarantees. We discuss implementation issues and report computational results. The sampling aspect of the algorithm seems to be especially promising.

3 : Multiobjective Bin Packing Problem. Işıl Ilıcak, METU; Karasakal, Esra; Azizoğlu, Meral.

In this study, we consider multiobjective bin packing problem so as to assign the number of weighted items to bins having identical capacities. We aim to minimize total deviation over bin capacity and minimize number of bins. We propose exact procedures that generate efficient solutions relative to two objectives. We test the efficiencies on randomly generated problems taken from literature.

4 : Integer Programming Duality in Multiple Objective Programming. Kathrin Klamroth, University of Erlangen-Nuremberg; Tind, Jørgen; Zust, Sibylle.

The weighted sums approach for convex multiple criteria optimization is well studied. The weights determine a linear function of the criteria approximating a decision maker's utility. Any efficient solution may be found in this way. This is not the case for integer programming. However, we show how the e-constraint approach can be used to generate a composite utility function of the criteria. Any efficient solution can be found using appropriate composite functions, and their level curves provide bounds on the efficient frontier. They may be generated by the classical solution methods as cutting plane and branch and bound algorithms.

: TE15 **Routing - C2**

Contributed Session Room: R23

Chair: Niaz Wassan
University of Kent

1 : Optimal Solution of Vehicle Routing Problem with Time Windows. Arda Gezdur, Koç University; Türkay, Metin; Savaş, Selçuk.

The objective of the VRPTW (vehicle routing problem with time windows) is to satisfy the customer orders within predefined delivery time windows at minimum cost. Initial bounds on the solution are tightened using different preprocessing techniques including column generation and 2-path cuts. An MILP problem is then solved, after fixing some of the integer variables obtained during the solution of initial bounds, using sub tour elimination constraints and 2-path cuts. The model is also extended to serve for different vehicle capacities (VRPTWDC), and it is capable of solving problems up to one hundred customers and three vehicle types.

2 : Double-Horizon based Heuristics for the Dynamic Pickup and Delivery Problem with Time Windows. Snezana Mitrovic-Minic, Simon Fraser University; Krishnamurti, Ramesh; Laporte, Gilbert.

The dynamic Pickup and Delivery Problem with Time Windows (PDPTW) is faced by courier companies serving same-day pickup and delivery requests for the transport of letters. The standard solution methodology for the dynamic PDPTW, whose future requests are not stochastically modelled, is the use of a rolling time horizon as proposed by Psaraftis. We suggest that when assigning a new request to a vehicle it may be preferable to consider the impact of a decision both on a short-term and on a long-term horizon. We would describe double-horizon based heuristics for the dynamic PDPTW. Computational results will be presented.

3 : Recent Improvements in Exact Methods for Deterministic Vehicle Routing Problems with Side Constraints. Stefan Irnich, RWTH Aachen.

The talk gives an overview over recent developments in branch-and-price methods for exactly solving vehicle routing problems (VRP) with side constraints. These methods are applicable to VRP that are based on the general resource model of (Desaulniers et al. 1998). The proposed improvements are the following: The addition of k-cycle elimination constraints into the shortest path subproblem. Using reduced costs of routes to remove some arcs of the underlying pricing network. New effective branching rules are helpful to attack some hard problem instances. The proposed improvements allow for solving several well-known hard VRPTW instances from Solomon's benchmark problems.

4 : Improvement Algorithms and Estimation Methods for the Vehicle Routing Problem and Its Variants. Niaz Wassan, University of Kent; Nagy, Gabor.

Methods for the Vehicle Routing Problem and its Variants The aims of this research are twofold: to find improved solutions for the VRP and its variants (Back-hauling and Fleet-mix) and to develop and improve statistical estimation formulae for total route length. A number of tabu search methodologies are developed using different neighbourhood schemes. Computational results are found for various benchmark problems. The aim of Route Length Estimation formulae is to relate route length to the problem data without actually finding routing solutions. This is useful as solving VRPs is time-consuming. Formulae are developed for the VRP and variants. A statistical testing of these formulae is carried out.

: TE16 **Managing High Technology Projects**

Invited Session Room: R27

Chair: Abdelghani Elimam
College of Business

1 : Management of Pharmaceutical Research Projects. Rainer Kolisch, TU Muenchen; Meyer, Konrad.

We consider the multi-project selection and scheduling problem of the lead optimization phase of pharmaceutical research. Employing an aggregated view on the problem we decide by means of a LP-model on the selection of projects and the intensity on how selected projects are processed. The derived intensities can be utilized in order to assign priorities when processing the projects in a matrix project organization. Computational results will be presented.

2 : Project Scheduling to Maximize Net Present Value: The Owner's Perspective. Joseph Szmerekovsky, North Dakota State University.

The problem of a project owner in choosing a payment schedule is considered. The project owner would like to select a payment schedule which maximizes the net present value of his project benefits minus the payments to the contractor. However, contractors tend to schedule activities for completion to maximize their own net present value, not that of the project owner. Hence, mathematical models are considered in which the owner selects an optimal payment schedule given that the contractor behaves in his own best interest rather than that of the project owner.

3 : A Methodology for Constructing and Evaluating Portfolios of R&D Projects. Boaz Golany, Technion - Israel Institute of Technology; Eilat, Harel; Shtub, Avraham.

The proposed methodology responds to three major goals of R&D organizations - maximizing value; maintaining balance; following organizational strategy. The methodology is based on the Data Envelopment Analysis and the Balanced Scorecard methods. Two model variations are used: first, to evaluate candidate R&D projects; second, to evaluate alternative R&D portfolios. Both entities are modeled as virtual decision making units used in DEA. To generate portfolio alternatives, we apply a branch-and-bound algorithm, and use an accumulation function that accounts for possible interactions among projects. The methodology is illustrated via an example of a governmental agency charged with selecting technological projects.

4 : Uncertainties in Activities and Their Durations in High Technology Projects. Bajis Dodin, University of California; Elimam, Abdelghani.

The scheduling of high technology projects involves high level of uncertainties where undertaking an activity with a given duration relies heavily on the outcome of the preceding activities. In this work, we propose formulating high technology projects into a sequence of sub-networks, each consists of a known set of activities and durations. Sub-networks are connected by probabilistic key decision points to identify the succeeding sub-networks that are selected based on the outcome of its predecessor(s). A deterministic model is developed to deal with the scheduling of activities in each sub-network. We illustrate our approach with examples and computational results.

5 : Managing Innovation with the Design Breakdown Structure. Olaf Diegel, Massey University.

Current project management practices are lacking when managing product development projects. Most project management techniques deal with costs, scheduling, resource allocation, etc. of project elements that are well understood. Unknown factors are dealt with passivity through avoidance or insurance. Innovative product development involves many unknowns. One does not know at the start of the project how one will achieve its goal. It is this state of "not knowing" that opens the door to unlimited innovative solutions. A refinement to the traditional Work Breakdown Structure called a Design Breakdown Structure provides a tool that permits us to manage these unknowns.

: TE17 **Simulation - C3**

Contributed Session Room: R24

Chair: Burak Güneralp

University of Illinois at Urbana-Champaign

1 : A Dynamic Stochastic Job Shop Simulator. Şerafettin Alpay, Osmangazi University; Yüzügüllü, Nihat.

In this paper we present a dynamic stochastic job shop simulator. By using this simulator, it is possible of simulating 15 dispatching rules such as FIFO, SPT, EDD, MOD, CR, etc., with 11 due date assignment models such as SLK, NOP, TWK, PPW, JIQ, etc., in dynamic stochastic multimachine job shop environments. It is also possible to set shop utilization and collect data on most common performance measures like mean flowtime, mean earliness, mean tardiness, mean absolute lateness and mean squared lateness, etc.

2 : Optimizing Vintage and Grape Reception at a Winery. Sergio Maturana, Pontificia Universidad Catolica de Chile; Vera, Jorge; Ferrer, Juan-Carlos; Auger, Andres.

The quality and condition of the grape received at a winery strongly influences the quality of the wine. The decision-maker requires accurate and current information on the condition of the grape in the vineyards and the availability of processing capacity at the winery during the vintage to make optimal decisions. Transportation delays and discrepancies in the amounts actually shipped may result in significant loss of wine quality. We developed a simulation model of the reception of the grape to help redesign the operation of the supply chain of a winery in order to minimize the delays in processing the grapes.

3 : Process Discrimination and Model Validation by using Zero Crossings. Omer Demirel, King Fahd University of Petroleum and Minerals; Willemain, Thomas.

In this research we address two similar problems. Process discrimination: We have many sample realizations from each of two stationary data generating processes. Without making parametric models of the processes, we want to test whether the two data generating processes are the same. Model validation: We have a single realization generated by a stationary real-world process. We also have one or perhaps a few realizations generated by a model of the process and we want to assess the validity of the model. Our solutions use a new statistic which measures the "distance" between two series based on their zero crossings.

4 : Spatial Simulation and Fuzzy Threshold Analyses for Allocating Restoration Areas. Burak Güneralp, University of Illinois at Urbana-Champaign; Mendoza, Gil; Gertner, George; Anderson, Alan.

A methodology for land condition evaluation and restoration allocation is presented. Fuzzy logic is integrated with spatial analysis through GIS. Erosion status is selected as the land condition factor. Two sources of uncertainty are considered: the uncertainty due to incomplete information on land condition and from identifying the condition of a particular parcel of land. The first is addressed using sequential Gaussian simulation. Land allocation is based on fuzzy logic to reflect the continuous transition between different land conditions and the loss that is expected to occur due to misallocation. The incorporation of uncertainty led to more realistic allocation strategies.

: TE18 EWG Location Analysis

Invited Session Room: R25

Chair: Yuri Levin
Queen's University

1 : Plot of Partial Push-Pull Covering Location. Yoshiaki Ohsawa, University of Tsukuba.

This paper considers a bicriteria model to locate a semi-obnoxious facility on Euclidean plane using the maximin distance from inhabitants and the minimax distances of demands to the facility. Our solution method generates not only the tradeoff curve but also the plot of all feasible region within partial covering context based on Voronoi diagrams. We show that our method that supports well-informed decision making to locate a semi-obnoxious facility through an illustrative example.

2 : The Newton-Bracketing Method for Linearly Constrained Convex Minimization with Applications to Location and Least-Squares Problems. Yuri Levin, Queen's University; Ben-Israel, Adi.

The authors' Newton-Bracketing (NB) method for minimization of convex functions (Computational Optimization and Applications 21(2002), 213-229) is extended to linearly constrained problems. The method proceeds by iteratively improving upper and lower bounds on the sought minimum value using Newton iterations. We illustrate the NB Method for two applications: (a) large-scale location problems with facilities located on a given line, or in a given polygonal region, and (b) least-squares and least-norm solutions of linear equations.

3 : Optimal Dwell Point Locations for AGV Systems in a Single Loop Layout. Chulung Lee, National University of Singapore; Ventura, Jose.

Automated guided vehicle (AGV) systems have been an attractive material handling alternative for flexible manufacturing. However, challenging control problems must first be resolved to operate AGV systems. One of the control problems that have not received much attention is how to manage idle vehicles. This study finds the optimal dwell point locations of AGVs in a single loop layout. The dynamic programming algorithm is developed to minimize the maximum response time and optimal properties are identified. Computational results show that the algorithm can solve large-scale problems in reasonable time.

: TE19 Health Care - C1

Contributed Session Room: R26

Chair: Soumia Ichoua
Sultan Qaboos University

1 : Patient Scheduling: Problematic and Simulation Approach. Chrsitine Di Martinelly, FUCAM; Artiba, Albelhakim.

In the healthcare sector, simulation is the easiest approach to test different methods and find an optimal way to allocate patients among rooms. Care unit occupancy rate should be optimised and hospital financial allowances should be maximized while taking into account patient well-being. We apply concepts of production management to patient scheduling modelling: a care unit is compared to the framework of resources allocation to parallel machines and we compared solutions provided by heuristics on this particular problem to the one provided by an exact method.

2 : The Use of Rough Set to Determine Patient's Profile. Philippe Levecq, FUCAM; Meskens, Nadine; Artiba, Albelhakim.

Hospital managers have to optimize their production by meeting the customers' demands. In our researches, we are interested in the operating theatre management. Planning operations is really difficult to get. One of the difficulties encountered is the estimation of the duration of the operation. In our opinion, it is really necessary to link this duration with the operated patient's characteristics. In this paper, we propose a method allowing the adjustment of the temporal information, and more precisely about the duration of operation, according to the patient's profile. To reach this goal, we used methods from data mining (rough set theory).

3 : On the Efficient Development of a Network of Health Care Facilities: A Case Study in Northern Portugal. Antonio Antunes, University of Coimbra.

The Norte Region of Portugal (25000 km2, 4000000 inhabitants) went through major demographic and social transformation in recent years, which led to important changes in the demand for health care facilities. This paper presents a study aimed at identifying efficient directions for the development of the region's health care facility network. The objective of the study was to maximize accessibility to basic and advanced health care services, considering various scenarios for the construction of new health care facilities and the transformation of existing ones.

4 : Location and Allocation of Mobile Medical Units using a Tabu Search Heuristic. Soumia Ichoua, Sultan Qaboos University; Regan, Amelia C.

In this talk, we propose a mathematical model for optimal location of a fleet of mobile medical units that provide first aid in an emergency scene. The model also considers the allocation of ambulances and medical personnel first to the units and then to transporting those in need of further assistance to a set of hospitals. An experimental evaluation of the proposed model is performed using a meta-heuristic based on tabu search approach.

: TE20 Bayesian Stochastic Optimization

Invited Session Room: M35

Chair: Elmira Popova
University of Texas at Austin

1 : Effects of Correlated Defaults in Supply Chains. Apostolos Burnetas, Case Western Reserve University; Babich, Volodymyr; Ritchken, Peter.

We consider a supply chain with one retailer and suppliers competing via wholesale prices who may default during production. The retailer, facing uncertain demand, weighs the benefits of procuring from the cheapest supplier against reducing credit risk through diversification. We identify pricing policies for which, in equilibrium, suppliers and retailer are indifferent between upfront and on-delivery payments. With fixed prices the retailer would benefit from decreasing default correlation. However, for

endogenous prices, decreasing correlation affects competition and lowers wholesale prices. We show that, in equilibrium, the retailer prefers suppliers with positively correlated defaults. In contrast, the suppliers prefer negative correlation.

2 : Sequential Sampling Procedure for Stochastic Programming. Guzin Bayraksan, University of Texas at Austin; Morton, David.

We present a sequential sampling procedure for solving stochastic programs with recourse where we draw samples of increasing size until a desired half-length of confidence interval (CI) is reached. Such sequential sampling procedures can result in undercoverage and invalid CIs. We develop an efficient procedure to construct valid CIs on the optimality gap.

3 : Markov Chain Monte Carlo Algorithm for Bayesian Mixture of Probit Regressions. Elmira Popova, University of Texas at Austin; Popova, Ivilina; George, Edward.

We propose a novel approach for modeling prepayment rates of pools of mortgages. Our goal is to establish a model that will give a good prediction for prepayment rates for individual pools of mortgages. The model incorporates the empirical evidence that prepayment is past dependent via Bayesian methodology. There are many factors that influence the prepayment behavior and for many of them there is no available information. We implement this issue by creating a mixture model and construct a Markov Chain Monte Carlo algorithm to estimate the parameters. We test the model on a large data set from Bloomberg.

: TE21 **Production and Inventory Systems - C1**

Contributed Session Room: M36

Chair: Baha Güney
Sakarya University

1 : Multi-Item Inventory Replenishments with Partial Backordering under Investment Constraint. Arslan Örnek, İzmir Institute of Technology; Ekinci, Esra.

We consider multi-item inventory replenishments using (Q,r) policy with partial backordering. Instead of using traditional cost minimization approach, we minimize stockout measure subject to investment level constraint. NLP model is solved by the Lagrange Multiplier technique. It is more reasonable to assume that only fraction of demand during stockout period can be backordered and remaining fraction is lost forever. This partial backordering policy is utilized in the model. Relationship between optimal value of objective function and constraint value is the most efficient tradeoff curve in the sense that an optimal value is used at all points on the curve.

2 : Determination of Optimal Lot-Sizes and Schedules using Power-of-Two Policy under Technology Dependent Constraints. Esra Ekinci, İzmir Institute of Technology; Örnek, Arslan.

The objective is to obtain realistic and easy-to-schedule lot-sizes in a multi-product, multi-stage environment. Study focuses on paint industry. Model consists of two parts: determination of lot sizes and schedules. In lot-sizing problem, power-of-two policy is chosen. Using a transformation, nonlinear structure is restated as BIP model. In the second part, MIP is employed to secure schedules using the results of the first part for multi-product, multi-stage system with multiple machines. First, products are assigned to basic periods of global cycle length, then for each basic period the model is executed to obtain optimal schedules under technology dependent production sequences.

3 : The Influence of Longer Planned Lead Times in Production Planning using LP Models. Judith Spitter, Technische Universiteit Eindhoven; de Kok, Ton; Dellaert, Nico.

We look at a setting where supply chain planning is executed periodically and where the demand for products in subsequent periods is stochastic. The supply chain structures are arbitrary and the resources have limited capacity. We use Linear Programming models for finding optimal production plans. We investigate the influence, regarding the costs, of having longer planned lead times. We look especially at those items that are produced on resources with high utilization rates. The results indicate that, for higher utilization rates, longer planned lead times can be more suitable.

4 : Material Requirements Planning for Maintenance Management Systems. Baha Güney, Sakarya University; Gündoğar, Emin; Şimşir, Fuat; Kaçamak, Hasan.

To perform maintenance activities, maintenance resources and materials are required. Maintenance materials should be available when they are needed to continue manufacturing systems activities. Keeping low stock of maintenance materials may cause production system unavailability which brings stock-out costs. On the other hand, high level of stock of expensive maintenance materials will cause high stock holding costs. To minimize the total inventory costs, a suitable materials management system for maintenance should be used. In this study an MRP process for maintenance materials planning that is based on preventive maintenance schedule and breakdown forecasts depending on previous failure data is introduced.

: TE22 **Call Center Operations - I**

Invited Session Room: M37

Chair: Costis Maglaras
Columbia University

1 : Analyzing Outsourcing Contracts for Call Centers. Zeynep Akşin, Koç University; de Vericourt, Francis; Karaesmen, Fikri.

We investigate outsourcing contracts between a call center operator and a contract service provider. In fixed-capacity contracts, the provider keeps a constant capacity level during the day. In price-per-call contracts, the provider can fluctuate its capacity level. We propose discrete-time multi-period models to assess the value of such contracts.

2 : Occupancy Approximations for Multi-skill Call Centers. Ger Koole, Vrije Universiteit; Pot, Auke.

The main reason why workforce management tools only partially support skills-based routing is the lack of a generalization of the Erlang formula to the multi-skill situation. We give some simple rules of thumb and show through simulations that they perform well for several reasonable routing schemes.

3 : Admission Control and Scheduling in a Call Center with

One Shared and Two Dedicated Service Facilities. E. Lerzan Örmeci, Koç University.

A call center receives two classes of customers, served by one shared and two dedicated stations. The dedicated stations have finite waiting rooms and servers, whereas the shared station has servers. The system is Markovian with type-dependent rewards, arrival and service rates. Customers may renege. We maximize total expected discounted revenue via dynamic admission/routing decisions. We show that an optimal policy serves a customer in her dedicated station, and never rejects a customer if there is available room in her dedicated station. We derive sufficient conditions under which it is better to accept customers of a class than rejecting them.

4 : Contact Centers with Callbacks. Costis Maglaras, Columbia University; Armony, Mor.

We study a customer contact center that offers two service modes: real-time or postponed (call-back) with a delay guarantee. Customers are informed of anticipated delays based on the system state upon their arrival and select their preferred option. For this system, we propose an estimation scheme for the real-time delay and a routing policy that are asymptotically (as the system size and potential demand grow large) "consistent" and minimize real-time delay subject to the delay constraint for all call-backs. Finally, we show that this system outperforms one that instead announces steady-state waiting time information.

: TE23 **Asset Liability Management**

Invited Session Room: M38

Chair: David Saunders
University of Pittsburgh

1 : A Stochastic Programming Model for Asset Liability Management of a Finnish Pension Company. Teemu Pennanen, Helsinki School of Economics; Hilli, Petri; Koivu, Matti; Ranne, Antero.

This paper describes a stochastic programming model that was developed for asset liability management of a Finnish pension company. In many respects the model resembles those presented in the literature but it has some unique features stemming from the statutory restrictions for Finnish pension companies. Particular attention is paid to the modeling of the stochastic factors, implementation and to numerical testing. Out-of-sample tests clearly favor the strategies suggested by our model over fixed-mix strategies.

2 : On the Mortgage-Backed Securities Portfolio Structuring Problem under Uncertainty. María Merino, Universidad del Pais Vasco; Escudero, Laureano Fernando; Garín, M. Araceli; Sainz de Rozas, Pérez.

We present a framework for structuring a portfolio of Mortgage Backed Securities under uncertainty in the interest rate path along a given time horizon. The uncertainty is represented by a set of scenarios. The model is formulated as a stochastic two stage mixed 0-1 problem with full recourse. The goal is to minimize the expected absolute mismatching of the durations of the MBS portfolio and the liabilities. The approach uses the Twin Node Family concept within the algorithmic framework so-called Branch-and-Fix Coordination for satisfying the nonanticipativity constraints, jointly with a Benders Decomposition scheme. Some computational experience is reported.

3 : A Stochastic Network Approach for Integrating Pension and Corporate Financial Planning. Koray Simsek, Princeton University; Mulvey, John.

We present a stochastic network model for integrating a defined-benefit pension plan with a company's core financial planning system. The model maximizes the combined company's value over a five to seven year planning horizon. By analyzing historical data for some typical pension plans, we show that the recent loss of surplus by many large US companies was largely preventable. The methodology requires three elements: 1) a stochastic scenario generator, 2) a pension/corporate simulator, and 3) a stochastic network optimizer.

4 : Stochastic Programming Models for Insurance Products with Guarantees. David Saunders, University of Pittsburgh; Consiglio, Andrea; Zenios, Stavros A.

We discuss the problem of asset and liability management for different insurance products offering guarantee provisions and surrender options. The resulting mathematical models are nonlinear stochastic programming problems. We discuss relevant modeling, financial and computational issues. Results will be presented for a number of different contract provisions and funding schemes, illustrating the robustness of the model and its potential for application to practical problems in the insurance industry.

: TE24 **MCDA - C3**

Contributed Session Room: L17

Chair: Kejing Zhang
University of Karlsruhe

1 : An Interactive Approach for Multicriteria Decision Making Problems with Imprecise Information. Gül Özerol, Ziraat Bank Head Office; Karasakal, Esra.

We consider the multiple criteria decision making problem with an explicitly given set of alternatives under imprecise information. We develop an interactive approach based on outranking relations among the alternatives in order to choose the most preferred alternative when decision makers are not able to fix precise values for the weights of the criteria. Information on the weighting coefficients is assumed to be in the form of linear inequalities.The suggested approach allows the modelling of preferences by pseudo-criteria if the criterion values of alternatives are imprecise.

2 : Handling Both Probabilistic and Fuzzy Uncertainties in MCDA - The Fuzzy Evidential Reasoning Approach. Jian-Bo Yang, UMIST; Wang, Ying-Ming; Xu, Dong-Ling.

In this paper, a new evidential reasoning (ER) is reported for dealing with MCDA problem with both probabilistic and fuzzy uncertainties. A utility-based grade match method is proposed to transform both numerical data and qualitative (fuzzy) assessment information of various formats into a fuzzy belief structure. A new fuzzy non-recursive ER algorithm is developed to aggregate attributes, providing scope and flexibility

for sensitivity analysis and optimisation. A centroid method is designed to rank alternatives based on their fuzzy distributed assessments. Two numerical examples are provided to illustrate the implementation process of the new approach and its validity and applicability.

3 : Practical Dominance and Process Support in the Even Swaps method. Jyri Mustajoki, Helsinki University of Technology; Hämäläinen, Raimo P.

Two new techniques to help the Even Swaps process (Hammond, Keeney and Raiffa, 1998) are introduced. The idea is to use the pairwise dominance concept as in the PAIRS method (Salo and Hämäläinen, 1992) to identify practically dominated alternatives. Our approach is based on an interval MAVT formulation. We also propose a technique for finding candidates for the trade-offs. The techniques utilize the trade-offs information given by the decision maker in the analysis. These techniques provide help to support the decision maker, and are not intended to automate the process. The practical use is illustrated with the related software.

4 : Sensitivity Analysis for the Outranking Approach PROMETHEE. Kejing Zhang, University of Karlsruhe; Geldermann, Jutta; Rentz, Otto.

This paper seeks to develop a sensitivity analysis instrument for Outranking approach. Sensitivity analysis plays a key role in Multi Attribute Decision Making, to check the quality of decision and the sensitivity of the acquired ranking order to the change of criteria weights. Through the new approach, a sensitivity indicator can be derived, which causes rank reversal on a pair of alternatives. The determination of sensitivity indicator allows the Decision Makers a better understanding of the influence of the change of input data and the structure and assumption in the model. An example illustrates the application of the proposed method.

: TE25 **OR Applications - C1**

Contributed Session Room: M34

Chair: James Freeman
UMIST

1 : Exact Results for Variable Wager HI-LO. James Freeman, UMIST.

The stochastic dynamic programming formulation recently presented1 for analyzing the variable wager version of the game, HI-LO, provides reasonable approximations of gamblers' financial expectations under certain conditions. For exact results, a new formulation has been developed. Details of the results obtained with this new procedure are presented and a comparison undertaken against those based on previous formulae for a range of illustrative data sets.

2 : Evolutionary Models of Production Management for Global World-Class Production. Hassan Farsijani, Shahid Beheshti University.

The paper is based on an ongoing research programme designed of to identify how the concept of world-class production techniques can be made more relevant to achieve world market society. The question in this paper is which problems the management of manufacturing may encounter when it wants to organise the global WCP management of the professional manufacturing more systematically for world market society. The paper uses a case study to illustrate its findings based on company experiencing both rapid growth and increasing international competition.

3 : Vehicle and Crew Scheduling in Public Transport Company "Novi Sad". Nebojsa Gvozdenovic, University of Novi Sad; Mandic, Vladimir.

The organization and realization of the suburban passenger transport is usualy divided into four phases: line planning, time-table creation, vehicle scheduling, crew scheduling. The paper deals with the last two phases, taking into account the first two have already been done, i. e. let's suppose that on the basis of customers' need, line planning and time-table creation were done. The paper presents mathematical models used for vehicle and crew scheduling. The last part of the work presents savings that can be done with the implementation of the models which are the topic of this work in one public transport company.

: TE26 **Mathematical Programming Models**

Contributed Session Room: L10

Chair: Genrikh Levin
United Institute of Informatics Problems

1 : Agrichemical Application Amount Programming Problem Designed for Reducing Residual Pesticides in Crops. Takeshi Itoh, University of Marketing and Distribution Sciences; Ishii, Hiroaki.

Agrichemicals are absolutely imperative for modern agricultural management in order to produce crops efficiently. However, agrichemical influences the environment and human beings very much, and consumers tend to purchase reduced pesticides crops. Therefore, agricultural farms need to decide application amounts of agrichemicals as little as ever they can with ensuring minimum crop yields. We propose a mathematical programming model designed for such situations and its effective solution.

2 : Content Manipulation in an Internet-based Travel Support System. Minor Gordon, Oklahoma State University; Delen, Dursun; Paprzycki, Marcin.

In order for a travel support system to deliver information garnered from the Internet to the user in a relevant form, the system must be able to manipulate content on a proto-semantic level. While current technology does not permit us to capture the full semantic richness of Internet-based content, we attempt to apply available processes in manipulating this content in intelligent ways, laying the foundation for a system that will one day take full advantage of the semantic web. Our presentation is based on the results obtained in the implementation of an agent-based travel support system operating on the Internet.

3 : Stale Data - Fresh Decisions. Thanos Papadimitriou, UCLA; Mamer, John W.

It is generally assumed that maintaining current data is the utmost priority of any computer application. This is certainly true for transaction systems where even minute discrepancies between reality and stored data can have an adverse effect. When

it comes to decision support applications, we challenge this assumption. We propose a stochastic model that tackles with the trade-off between aggregate-based decision quality and the cost of maintaining up-to-date data. We determine optimal date update times and we present SESAME, our middleware that enables the implementation of various delayed update policies on top of conventional database systems.

4 : Decision Making in Transmission System Design. Nikolai Guschinsky, National Academy of Sciences, Belarus; Levin, Genrikh.

Mathematical models and methods for optimizing basic design parameters of power transmission systems are considered. The systems can include a gear-box and chains of gears of various types. The proposed models and methods allow to determine general transmission ratios of the system; to distribute general transmission ratios to gears; to calculate basic parameters of elements (gears, shafts and bearings). The mass of the system is minimized taking into account basic operational, strength and design parameters as well as random behavior of strength characteristics of materials. Decomposition methods in combination with dynamic and nonlinear methods are used. Numerical examples are presented.

: TE27 Effects of Information Sharing in SCM

Contributed Session — Room: L11

Chair: Mehmet Barut
Wichita State University

1 : Analysis of Serial Inventory Systems Under Nonstationary Demand and Batch Orders. Fevzi Başkan, METU; Güllü, Refik; Erkip, Nesim.

In this study we consider a supplier-retailer supply chain with a nonstationary demand process. Both upstream and downstream stages operate with order up to policy, and orders of the downstream stage are batched. We derive order quantities and inventory equations for both stages analytically, and show that the demand process for the supplier is more variable than that for the retailer. We also consider different available information levels for the supplier and compare performances of these through simulation.

2 : Impact of Forecasting Policies on the Bullwhip Effect in Supply Chains. Erkan Bayraktar, Beykent University; Sarı, Kazım.

The bullwhip effect implied by information distortion along the supply chain members is one of the shortcomings of a successful supply chain management. In this study, we analyze the impact of forecasting techniques using moving averages and exponential smoothing on the bullwhip effect under linear demand assumption with seasonal swings. Different ordering policies interacting with forecasting techniques are studied to observe the impact on the bullwhip effect. A simulation model is employed to experiment the different scenarios and a detailed analysis is presented.

3 : Pricing & Ordering Policies for a Perishable Product in a Wholesaler-Retailer Supply Chain. Yushin Hong, POSTECH; Lee, Jeong Eun.

Pricing and ordering policies for a perishable product in a supply chain consisting of a wholesaler and a retailer are proposed. Two models, non-cooperative and cooperative models, are discussed. In the non-cooperative model, the wholesaler and the retailer determine the pricing and ordering policies without any cooperation between the two parties. In contrast to the non-cooperative model, the optimal pricing and ordering policies maximizing the joint profit are determined simultaneously in the cooperative model. The profit sharing in the cooperative model is proposed. A numerical experiment shows the cooperative model gives significant profit to both parties than the non-cooperative model.

4 : Global Map of Supply Chain Information Coupling. Mehmet Barut, Wichita State University.

This paper attempts to develop a framework at macro-level for mapping the relative position of companies within an industry, and industries within a country and across countries in terms of the degree of information coupling they utilize. This framework also helps to answer to what extent and intensity companies or countries share the information with the players in their supply chain, and provides a multi-dimension comparison of companies and industries. A measurement to serve as a surrogate for the degree of coupling is developed and concerns with regard to the practice of the framework are indicated.

: TE28 Theory of Search Games and Rendezvous

Invited Session — Room: L12

Chair: Shmuel Gal
University of Haifa

1 : Search Games: An Overview. Shmuel Gal, University of Haifa.

We will present a state of the art overview on Search Games. The talk will focus on the following topics: Searching for an immobile object in a graph. Searching for a mobile hider in a graph and in a two dimensional region. Searching for an infiltrator who tries to reach a sensitive zone. Developing a general tool for finding minimax search trajectories for unbounded search spaces, and using this tool for searching an object on the line and in the plane. We will also present several problems of a fairly elementary nature which are still open.

2 : Open Problems in Rendezvous Search. Steve Alpern, London School of Economics.

The rendezvous search problem was proposed by the speaker a quarter century ago but has received attention only in the past decade. It asks how two (or more) searchers who are randomly placed in a known dark region can move so as to minimize the expected time taken to meet. Although much progress has been made on this problem (see the speaker's book with the chairman, 'The Theory of Search Games and Rendezvous'), several apparently easy versions of the problem have thus far eluded solution.

: TE29 EWG Complex Societal Problems - III

Invited Session — Room: L13

Chair: Dorien De Tombe

1 : The Viable System Approach to Designing Organizations. Slavica P. Petrovic.

Approach (VSA), based on the Viable System Model (VSM), is the cybernetic approach to efficient and effective diagnosing and (re)designing organizations. The VSA-framework is founded on notions of a viable system, the variety balance, and recursion. Bringing together implementation, co-ordination, control, development and policy, the VSM can be used as part of a methodology for uncovering whether an organization obeys cybernetic laws or not. The procedure for using the VSM to diagnose a social system design is divided into system identification and system diagnosis. The VSA has employed creatively to make valid recommendations for increasing viability of organizations.

2 : Evaluating Projects in Large Cities. Dorien De Tombe.

Changing complex issues in large cities leaves the decision makers a problem of evaluating their projects. However the complexity of a city the causes are more intertwined and include more aspects than is taken into account. This can be realized by an integrated approach based on the Compram method. In order to determine the value of a city we use Bourdieu's distinction in capitals. The extended theory of Bourdieu makes it possible to evaluate the different elements in relation to each other and to see what is successful in the projects and what not.

3 : A Survey Research on the Issue of Forgiveness - The Case Study of Croatia. Elza Jurun, University of Split; Vuèkoviæ, Ante.

This paper deals with the theoretic-philosophical understanding of the notion of forgiveness as a means of liberating victims of hatred. The paper offers an answer to the question whether there is a significant connection between the basic human philosophy of life and the readiness to forgive. Therefore a research study has been done whether there is a significant statistic-mathematical difference between the theoretic-philosophical understanding on one hand, and the practical readiness to realize forgiveness in one's own life among the population which claim to be atheistic and those who claim to be theistic.

4 : A Field Survey of Key Components for the Applicability of Pay-As-You-Throw in Waste Management in the Municipality of Panorama. Anna Xirogiannopoulou, Aristotle University; Karagiannidis, Avraam; Moussiopoulos, Nicolas.

Presented here are results from a survey conducted in Municipality of Panorama in Greece, for investigating the applicability of "Pay-As-You-Throw" (PAYT). The main survey objectives were: (a) Study of the parameters influencing PAYT's implementation. (b) Accurate prediction of the outcome. (c) Recording of citizens' related behavior. (d) Anticipation of citizens' reaction (PAYT acceptability). (e) Assessment of environmental awareness, and (f) Determination of potential illegal-diversion rate. The survey included 257 (out of a total of 2570) households, whereas the impact mechanism of the households' characteristics on waste reduction, illegal dumping and, in general, on PAYT's acceptance were also studied.

: TE30 **Education and Distance Learning - C2**

Contributed Session Room: L14

Chair: Bopaya Bidanda
University of Pittsburgh

1 : Web based Knowledge Assessment. Sasa Bosnjak; Bosnjak, Zita; Pocajt, Viktor.

Web based learning and knowledge assessment cannot be viewed as a universal paradigm, because the very nature of some areas makes them inadequate for distance learning and knowledge assessment utilization. However, Web based knowledge acquisition and evaluation of the acquired knowledge in the domains of management and information systems development is a very useful approach. For the realization of processes described in the article, the software product COMPETTEST (from Competence Testing) was developed.

2 : Reengineering Learning: Don't Teach or Automate, Obliterate - Possibilities from Statistics and Decision Analysis. Michael Wood, University of Portsmouth.

Possibilities from Statistics and Decision Analysis The use of hard ideas is often difficult. Conventional solutions are to automate the process, or to teach users, or to teach them better using appropriate technology. In the medium to long term, these approaches are unsustainable: as far as possible we need to re-engineer hard ideas to make them easier. The possibilities will be illustrated (very briefly with back-up material on the web) by concepts and methods for statistical inference and decision analysis.

3 : Industrial Engineering Curricula: A Comparative Analysis of Programs in Israel, Turkey, Iran and the US. Bopaya Bidanda, University of Pittsburgh; Alagöz, Oğuzhan; Bayrak, Halil; Rubinovitz, Jacob; Motavalli, Saeid.

Industrial Engineering (IE) programs in Turkey, Iran and Israel are among the most popular choices of the students in engineering. This is not the case in the United States. In this paper, we attempt to establish the causal issues behind this popularity difference by comparing typical curricular requirements of industrial engineering programs in Iran, Israel, Turkey, and the United States within the ABET Criteria 2000 framework. Our analyses suggest that in foreign countries the focus of IE education is more on Operations Research and Stochastic Models classes whereas in the US the focus is more on Information Systems classes.

: TE31 **Queueing Systems - C3**

Contributed Session Room: M33

Chair: Djamil Aissani
University of Béjaïa

1 : Fluid Approach to Control of Multiclass Queueing Networks. Gideon Weiss, University of Haifa.

We consider systems where large numbers of discrete stochastic items share joint resources over time, eg manufacturing, vehicle traffic, communications networks, project scheduling, economic input output systems. Our fluid approach takes 5

steps: - Construct a Fluid Model of the system - Formulate a Fluid Optimization Problem - Solve Separated Continuous Linear Program (SCLP) - Present Fluid Visualization of Optimized System - Construct Discrete On-Line Control from the Optimal Fluid Solution. We discuss a new simplex algorithm to solve SCLP to do step 3, and we discuss queueing systems with virtual infinite buffers, to do step 5 with bounded loss.

2 : Modelisation and Simulation of the Movement of the Vehicles on the Level PIVT (Customs - Béjaïa Harbour). Djamil Aissani, University of Béjaïa; Adjabi, Smail.

The aim of this work is to make an analysis of flows entry/exit of the vehicles and passengers on the level of the PIVT (Principal Inspection of Visit to the Travellers) - Customs - Béjaïa Harbour. The current performances of this system are presented. Then we predict its characteristics after modification of some parameters. The movement of the vehicles on the level was modelled by a Jackson's queueing network. For this, we applied two methods: an analytical method and a method of simulation. A comparison of the results obtained and a sensitive analysis was carried out.

3 : Modelisation and Simulation of the Movement of the Vehicle on the Level PIVT (Customs - Béjaïa Harbour). Boukir Lynda, University of Béjaïa; Hocine, Brahiti; Aissani, Djamil; Adjabi, Smail.

The aims of this work is to make an analysis of flows of entry/exit of the vehicles and passengers on the level of the PIVT (Principal Inspection of Visit to the Travellers) - Customs - Béjaïa Harbour. The movement of the vehicles on the level of the PIVT was modelled by Jackson's Queueing network. For this, we apply two methods: an analytical method and a method of simulation. A comparison of the result obtained was carried out. A sensitive analysis made it possible to evaluate the performances of the system after perturbation of some parameters.

4 : Inequalities of Stability in the GI/M/1 Queueing Systems. Louisa Bouallouche, University of Béjaia; Aissani, Djamil.

In this paper, we determine the conditions and estimations of stability of chains describing the queue size (demands in service or waiting) in a M/M/1 Queueing systems after perturbation of the arrival stream. We find exact inequalities to approximate characteristics of the GI/M/1 queueing system by identical characteristics of the M/M/1 one. The results of the paper are proved by using the operator approach of the stability theory, whose concepts are introduced in [Aïssani D. and Kartashov N.V., Doklady AN USSR, Ser. A, 11, pp. 3 - 5, 1983].

: WA01 **Enabling Value Chain for E-Business**

Tutorial Room: MB I

Enabling Value Chain for E-Business. Mathias F. W. Kirchmer, IDS Scheer; Özatalay, Savaş.

This presentation will discuss the process of enabling the value-chain for e-Business in three stages. The first stage will examine the components, the structure, and the data requirements of an integrated value-chain. The second stage will show how the implementation of Enterprise Resource Planning (ERP) systems and Advanced Optimization and Planning (APO) tools will help to increase the efficiency of the value-chain. In the final stage, the process of moving the ERP and APO enhanced value-chain into an e-Business platform will be discussed. The presentation will conclude with the discussion of how the Business Process Improvement Tools, by using IDS Scheer's ARIS as an example, can help to expedite and improve this transformation process.

: WA02 **Adaptive Value Chain Optimization**

Tutorial Room: MB II

Adaptive Value Chain Optimization. Grace Lin, IBM TJ Watson Research and IBM Academy of Technology.

As companies look for ways to improve operation efficiency and customer values in the dynamic and challenging business environment, a new supply chain focus, models and technologies are emerging to create a competitive edge. In the last few years, Supply Chain Management (SCM) has evolved its focus from Enterprise Resource Planning (ERP) to Advanced Planning Systems (APS) to Collaborative Planning, Forecasting, and Replenishment (CPFR). Companies are starting to share risks and values to optimize their value chains. Additional capabilities such as dynamic pricing, e-auctions, and risk management are being developed and deployed to multiply the impact, efficiency and value of the supply chain process. In order to utilize these capabilities effectively, many companies are starting to shift from the rigid command and control business models to more adaptive models. In this talk, the pros and cons of the traditional Command and Control and a Sense and Respond business models will be examined and a new adaptive business model that dynamically exploits various business analytics will be presented. The criticality of business process management and the adaptive technologies required to support the adaptive business will also be discussed, as will a framework for adaptive value chain optimization to support adaptive business and cross-enterprise optimization.

: WA03 **Revenue Management**

Tutorial Room: MB III

Revenue Management. Peter Bell, The University of Western Ontario.

This tutorial will present revenue management (also known as "yield management") and the basic tools used by the revenue manager: optimum dynamic pricing, overselling, trading-up, discount allocation, and re-planing. The business rationale and the underlying OR models that guide decision-making for each will be discussed. Emphasis will be placed on research opportunities in this fast growing and important application area for OR.

: WA04 **Combinatorial Optimization in VLSI Design**

Invited Session Room: JB A

Chair: Sven Peyer
University of Bonn

1 : Advances in VLSI Placement. Ulrich Brenner, University of Bonn.

In VLSI placement, chip components have to be placed disjointly in a given area meeting several constraints (routability, timing constraints etc.). Most placement tools work in two phases: First, the components are spread out over the chip area ignoring disjointness (global placement). Then, the components are moved to their final positions such that all overlaps are removed (detailed placement).

2 : Balancing Slacks: Applications in VLSI-Design. Stephan Held, University of Bonn.

Slack in VLSI-Design is known as the difference between required and computed arrival times of signals. Slack balancing algorithms on digraphs can be used for several tasks concerning timing optimization. A powerful application is the optimization of clock schedules of VLSI-chips. Instead of clocking all register elements simultaneously, individual clocking times are computed for each register element, such that slacks are globally optimally distributed. This optimization results in impressive timing improvements. A further application is the computation of timing-driven net-length bounds that can be used in final placement and routing.

3 : Paths and Flows in Global Routing. Dirk Müller, University of Bonn.

Global routing is an important step in the VLSI design process and is used to estimate the routability of a given placement and to reduce the running time of the detailed routing step significantly. The capacities on the edges of the coarsened global routing grid must be estimated as precisely as possible. In this talk we present a new method for capacity estimation based on a very fast maximum flow heuristic which is applied after prewiring the local (i.e. short) nets. This method leads to more exact capacity values and significantly shorter running times of the detailed router.

4 : Delay-Related Objectives for Rectilinear Steiner Trees. Sven Peyer, University of Bonn.

Rectilinear Steiner minimum trees in the plane can today be computed quickly for realistic instances occurring in VLSI design. However, interconnect signal delays are becoming increasingly important in modern chip designs. It is very important to construct Steiner trees which minimizes a given delay function in time critical nets, rather than take the Steiner tree of shortest total length. For various delay functions, we give structural properties of delay-optimal Steiner trees. Exact and heuristic algorithms as well as computational results for industrial designs are presented.

: WA05 **Transport and Environment**

Invited Session Room: JB B

Chair: Maria Cristina Sinay
Instituto Militar de Engenharia

1 : Environmental Level of an Urban Net using Neuro-Fuzzy Method. Maria Cristina Sinay, Instituto Militar de Engenharia; Quadros, Saul.

In this paper, a concept of "environmental level" related to an urban transportation net that takes into account its atmospheric and noise pollution, its service level and its security and comfort standard is introduced. Since the defined concept is constituted by such a different components (the first two can be quantitatively measured while the last ones are felt in a quantitative way) it is proposed the association of the Fuzzy Logic with the Neural Hierarchies Net as a natural way to evaluate it. A process to do so is the purpose of this work.

2 : Environmental Programs for Roadway Duplication. Leticia Dexheimer, Instituto Militar de Engenharia.

A previous condition to obtain the license of any highway project is the inclusion of the environmental variables that would prevent and reduce negative impacts. This is also requested by external financial organisms before loans negotiations. To include environmental variables, detailed studies of particular situations that constitute Environmental Programs, are needed. These Programs are designed to improve the neighborhood life quality as well as to preserve natural resources. In this paper the Environment Programs related to the licensing process of roadway duplication are discussed.

3 : Environmental Management of Transportation System. Maria Cristina Sinay, Instituto Militar de Engenharia; Barcellos Gouvêa Campos, Vania; Dexheimer, Leticia.

In this paper it is proposed an environmental plan to manage Transportation Services. It can be adopted for the different modalities by taking into account respective peculiarities in order to achieve a continuous environmental performance improvement. The operation of transportation services without a correct environmental planning contributes to the traffic corridor degradation, creating environmental degradation areas and reducing the life quality of the affected population. As any management plan, it should include the definition of parameters that would constitute performance indicators, standards to be achieved, schedules to be followed to reach those standards, costs to be dispended and responsibilities.

4 : A Decision Support System to Evaluate Transportation Systems: A Tramway Case Study in Como (Italy). Alberto Colorni, Politecnico di Milano; Luè, Alessandro; Rossi, Damiano.

The study concerns the analysis and evaluation of different alternatives of tramway systems in Como (Italy). The objectives are the reduction of traffic congestion, the protection of the environment, and the improvement of mobility. Several alternatives, based on vehicle technology, network extensions toward different suburban directions, and service management, are analyzed, and their effects on mobility, environment, land use, economy are evaluated. To consider the points of view of different actors with conflicting objectives, the alternatives are compared using the multi-attribute utility theory, which is implemented within a decision support system framework.

: WA06 **Scheduling - C3**

Contributed Session Room: M30

Chair: T'kindt Vincent
Ecole d'Ingénieurs en Informatique pour l'Industrie

1 : A Branch and Bound Algorithm for Scheduling on Parallel Machines with Availability Constraints. Anis Gharbi, Ecole Polytechnique de Tunisie; Haouari, Mohamed.

We consider the strongly NP-hard problem of scheduling a set of jobs on identical parallel machines with respect to availability restrictions for both jobs and machines. Each job has a processing time, a release date, and a delivery time. Each machine has an availability time on which it becomes continuously ready for working. The objective is to minimize the makespan. We introduce an efficient Branch-and-Bound algorithm based on a new formulation of the problem and tight lower and upper bounding strategies. Large instances with up to 1500 jobs and 50 machines are solved in moderate CPU time.

2 : Heuristics for the Cumulative Scheduling Problem. Fabrice Tercinet, Université de Tours; Emmanuel, Neron.

This presentation deals with upper bounds for the P|ri,qi,sizei|Cmax scheduling problem. These heuristics are based on truncated Branch-and-bound methods that have proven their efficiency to compute exact solutions for small size instances. From these exact methods we derived first a recovering beam search: it can be used with several branching schemes. The second heuristic which is an adaptation of the Limited Discrepancy Search (Harvey and Ginsberbg 1995), is more adapted to binary trees as for instance the search tree generated using time-window reduction (Carlier 87). Computational results show the relative effectiveness of all these algorithms.

3 : Resolution of Two Parallel Machine Scheduling Problems with a Single Server and General Processing Times. Samuel Guirchoun, Ecole Polytechnique de l'Université de Tours; Martineau, Patrick; Guillaumin, Ludovic.

We consider a computer system composed by a single server and m identical parallel machines. We assume that the processing times on the server, called setup times, are all equals. Immediately after loading, each job must be performed by an available parallel machine. This problem could be modelled by a two-stage hybrid flow shop with a no-wait constraint between the two stages. The objective is to minimize the total completion time. We propose a polynomial algorithm that can solve optimally the problem with unary setup times and a heuristic for the problem with setup times greater than one.

4 : Energetic and Preemptive Feasibility Tests for Parallel Machine Scheduling. T'kindt Vincent, Ecole d'Ingénieurs en Informatique pour l'Industrie; Emmanuel, Neron.

In this paper we consider the preemptive and the energetic feasibility tests for parallel machine scheduling problems. We first provide a generalisation to the case of unrelated machines of the energetic feasibility test introduced for the case of identical machines by Baptiste, Le Pape and Nuijten (1999). We show different complexity result and structural properties of this extension. Besides we derive an improvement by introducing the notion of machine energy. Computational results conclude the paper and show the relative effectiveness of the preemptive and energetic feasibility tests for various machine configurations.

: WA07 **Topics in Yield and Price Management**

Invited Session Room: M31

Chair: Burak Kazaz
University of Miami

1 : Marketing and Collection Strategies for Remanufacturable Products. Seviye Yoruk, University of Florida; Akcali, Elif.

Scientific support to establishment and survival of enterprises, especially small enterprises, is a particularly important factor of development and creation of stimulating conditions in Croatian economy. Therefore this paper expounds, first theoretically and then practically, an approach to the procedure of the optimal investment project selection. Owing to a large number of criteria and their different characters, it was necessary to consider investment possibilities and rank the investment projects by simultaneously taking into account several criteria using the AHP. Investment projects were evaluated in terms of the market and the socio-economic aspect, as well as in terms of risk and uncertainty.

2 : Two-Echelon Assembly Systems with Random Yields and Rigid Demand. Abraham Grosfeld-Nir, Academic College of Tel-Aviv-Yaffo; Anily, Shoshana; Ben-Zvi, Tal.

We consider two-echelon systems where the first echelon consists of two-stages or more and the second echelon consists of a single "assembly" stage. Assumption: yield is random and demand needs to be satisfied in its entirety. Several production runs may be required until the number of final products is sufficient. Each possible configuration of intermediate inventories a production policy specifies at which stage to produce next and the number of units to be processed. Objective: minimize the expected total of setup and variable production costs. Our proof: that expected costs of any production policy can be calculated via solving a finite set of linear equations.

3 : Coordination of Reverse Supply Chains with Price Sensitive Supply and Demand. Hulya Emir-Farinas, University of Florida; Akcali, Elif.

We consider a product that can be collected from a final user market to recover some or all of its parts to be remanufactured for sale in a secondary market. Typically, both the supply of the used product in the final user market and the demand for the remanufactured parts in the secondary market are price-sensitive. In this study, we determine the optimal buy/take back prices for the used product and the sales prices for the remanufactured product or its parts simultaneously under centralized and decentralized channel structures. We also provide coordination mechanisms for the decentralized structure.

4 : Production Planning in the Turkish Olive Oil Industry: Yield and Demand Uncertainty with Yield-based Cost and Prices. Burak Kazaz, University of Miami.

I study production-planning decisions for olive oil producers when the olive yield is uncertain. Fluctuations in crop yield inversely influence the purchasing cost of olives and the sale price of olive oil. Oil producers lease farm space from farmers hoping to reduce their future olive purchasing costs. While the study determines the optimal amount of farm space-to-be-leased, it departs from traditional results of random yield in its insight on the influence of the yield variance.

: WA08 **Consistency in Multicriteria Group Decision Support Systems**

Invited Session Room: M32

Chair: José María Moreno-Jiménez
Universidad de Zaragoza

1 : A DSS for Consistent Component Utility and Weight Assessment with Multiple Decision-Makers. Antonio Jiménez, School of Computer Science. Technical University of Madrid; Ríos-Insua, Sixto; Mateos, Alfonso.

We introduce a decision support system based on an additive multiattribute utility model, aimed at making the component utility and weight assessment easier and more consistent for multiple decision-makers. This is possible thanks to the increased understanding of the assessment method, the imprecision in the DM's information and the consideration of consistency checks. Moreover, a sensitivity analysis tool is included for taking advantage of the imprecision concerning the inputs, including simulation techniques based on rank order weights, which are especially useful in the case of multiple decision-makers, and to compute non-dominated and potentially optimal alternatives.

2 : A Spreadsheet Module for Consistent AHP-Consensus Building. José María Moreno-Jiménez, Universidad de Zaragoza; Aguarón, Juan; Raluy, Agustín; Turón, Alberto.

A spreadsheet module produces the consensus pair wise comparison matrix for AHP-Group Decision Making within a local context, leading to acceptably consistent preference structures. Developed in Visual Basic linked with Excel, this friendly program has a detailed graphical visualisation, and is suitable as the initial step in negotiated decision making.

3 : Exploring Differences in Managers' Mental Models. Füsun Ülengin, İstanbul Technical University; Özen, Ümit.

A framework to guide corporations in policy making and strategic planning is proposed. Using a formal modeling approach, a shared map can be built and policies derived in real time. The objective is to reach a common understanding and commitment to action through a learning process.

: WA09 **Product Assortment Decisions**

Invited Session Room: L15

Chair: Michaela Draganska
Stanford University

1 : Specificity of a Product Assortment. Ulrich Doraszelski, Stanford University; Draganska, Michaela.

We analyze a competitive environment and ask how many products should a firm offer. Increasing the number of products has two effects: (1) if their favorite product is offered, consumers' utility increases because there is a better fit between product and consumers' preferences; (2) if their favorite product is not offered, consumer's utility decreases because they get a product that is not tailored to their needs. Previous work has not considered these two effects jointly: for some consumers utility increases due to higher general quality whereas for other consumers utility decreases due to higher specificity.

2 : Effects of Product Variety on Competitive Market Conduct and Profitability of Consumer Goods Manufacturer. Daniel Klapper, University of Kiel.

Decisions on product variety are a central part of the (strategic) marketing planning process of many consumer goods manufacturers. Though we have only limited information about the effects of changes in product variety on competition, competitive market conduct and profitability. We develop a structural model of demand and supply to investigate and quantify the changes in product variety on sales and profitability. The empirical analysis will provide the estimation results within consumer goods markets and derive the implications of product variety on competition and profitability of the brands in these markets.

3 : Retail Assortment and Demand Uncertainty: An Empirical Investigation. Karl Schmedders, Northwestern University; Huchzermeier, Arnd; Mohr, Stefan.

When making decisions about the retail assortment in a product category, a critical factor to consider is the level of demand uncertainty. With higher demand uncertainty a retailer would need to stock more merchandise or face the risk of stock-outs. We conduct an empirical study of 10 frequently purchased product categories to investigate the relationship between the assortment a retailer carries and the level of demand uncertainty. Our findings confirm that the number of SKUs in a category is a key driver of demand uncertainty in addition to the price level and similarity of items in the assortment.

4 : The Competitive Effects of Product Line Composition. Michaela Draganska, Stanford University; Mazzeo, Michael.

We study the use of variety and quality of a product line as strategic tools, specifically the link between quality and the composition of product assortments. We observe that individual stores offer assortments such that the same ice cream flavors from brands within the same quality tier do not appear on store shelves at the same time. This suggests that retailers may use flavor selection as a tool to reduce inter-brand competition within quality tiers. Using the ice cream category data, we analyze the assortments offered by stores and the effect of the assortments offered on prices, sales and competition.

: WA10 **Semi Infinite Programming and Extensions**

Invited Session Room: L19

Chair: Georg Still
University of Twente

1 : Applications and an Outer Approximation Method for General Semi-Infinite Programming. Oliver Stein, Aachen University.

Applications for general semi-infinite programming range from robust optimization and minimax problems to design centering, disjunctive optimization, data envelopment analysis and defect minimization for operator equations. This problem class has turned out to be surprisingly difficult to treat theoretically as well as computationally. Our recent results admit to solve a large subclass of these problems numerically. Although an interior point approach is used in the lower level problem, it turns out that one obtains an outer approximation of the feasible set for the semi-infinite problem. We give convergence properties for the method and illustrate it with several numerical examples.

2 : Distance to Ill-Posedness and Consistency Value of Lin-

ear Semi-Infinite Inequality Systems. Marco A. López-Cerdá, Alicante University; Cánovas, Maria Josefa; Parra, Juan; Toledo, Javier.

In the space of all the linear inequality systems, those systems in the boundary of the consistent systems subset are considered ill-posed since small perturbations yield both consistent and inconsistent systems. The distance from the nominal system to this boundary influences the complexity of certain algorithms. We introduce a generalized concept of ill-posedness in linear semi-infinite programming, providing explicit formulas for measuring the distance to this generalized ill-posedness which involve the so-called consistency value of a system. Some applications are also presented: Lipschitzian properties of the feasible set, complexity analysis of the ellipsoid algorithm, distance to insolvability, etc.

3 : Semi-Infinite, Bilevel and MPEC Problems: Structure and Genericity Analysis for the Linear Case. Georg Still, University of Twente.

We consider semi-infinite-, bilevel problems and mathematical programs with equilibrium constraints (MPEC). For the linear case similarities and differences between the structures of these three problems are studied. The main objective is to analyze the topological and generic structure of the feasible set. In particular, closedness, connectedness and convexity properties are examined. The knowledge about the precise generic structure of the feasible set leads to methods for finding local or global minimizers of the problems.

: WA11 **Extensions and Applications of DEA**

Invited Session Room: R20

Chair: Finn R. Førsund
University of Oslo

1 : Calculation of Scale Elasticities in DEA models. Lennart Hjalmarsson, University of Gothenburg; Førsund, Finn R; Krivonozhko, Vladimir.

Returns to scale is a very useful indicator. In DEA the qualitative characterisation of it has occupied many researchers since Banker, Charnes and Cooper (1984). By the method of Førsund and Hjalmarsson (2002) the numerical value of the scale elasticity for radial projections of inefficient points to the frontier can be calculated. Our paper provides a method for numerical evaluation of the scale elasticity at any point on the DEA surface, using the approach developed in Krivonozhko et al. (2002).

2 : Falldown Efficiency Tables. Dag Fjeld Edvardsen, Norwegian Building Research Institute.

The motivation is to find the sensitivity of the efficiency scores in DEA. The efficiency tables are calculated in the following way. For each inefficient DMU we measure what the DMU score would change to if we removed permanently the most influential peer. We continue removing peers with this "worst case" criterion until the unit reaches the frontier. We put the efficiency score calculated after each removal in the "Falldown efficiency table". Examining this table provides useful information about sensitivity. The method is tested on real world data, and it is shown how this is implemented in a computer program.

3 : Far out or Alone in the Crowd: Classifications of Self-Evaluators in DEA. Sverre A.C. Kittelsen, Frisch Centre; Edvardsen, Dag Fjeld; Førsund, Finn R.

The units found strongly efficient in DEA studies on efficiency can be divided into self-evaluators and active peers, depending on whether the peers are referencing any inefficient units or not. The paper subdivides the self-evaluators into interior and exterior ones. The exterior self-evaluators are efficient by default. These units should therefore be removed in a two-stage analysis of efficiency. A method for classifying self-evaluators based on the additive DEA model is developed. The application to municipal nursing- and home care services of Norway shows significant effects of removing exterior self-evaluators from the data when doing a two-stage analysis.

4 : The Tale of Two Research Communities:The Diffusion of Research on Productive Efficiency. Finn R Førsund, University of Oslo; Sarafoglou, Nikias.

The field of efficiency analysis is pursued both by economists and people from operational research and management science. Each group tends to cite a different paper as the seminal one. Recent availability of electronic databases of journal articles makes studies of the diffusion of papers through citations possible. The seminal papers followed quite different diffusion patterns for the first 20 and 10 years respectively. Research strands within economics inspired by the seminal paper are identified and followed by citation analysis. In recent years a trend toward convergence of the two camps into a common network for efficiency analyses is documented.

: WA12 **Graphs & Networks - C2**

Contributed Session Room: M39

Chair: Benmeziane Zineb
USTHB

1 : Basic Approximations to the Adaptive Stochastic Multi-Modal Resource Allocation Technique. Anabela Tereso, Minho's University; Araújo, Maria Madalena; Elmaghraby, Salah.

This paper presents three basic approximations developed to solve the Adaptive Stochastic Multimodal Resource Allocation Problem. Two of them are based on the DP model introduced in earlier papers. The other one uses NLP. The approximations developed consist in considering the Work Content of some/all the activities of the project as represented by their mean values. These approximations were applied to a set of examples, and results were obtained and commented. As expected, running times were reduced, compared to the original model, but the total cost was underestimated, due to the use of means instead of the complete distribution.

2 : On the Conjecture of Delorme, Favaron and Rautenbach about the Randiæ Index. Ljiljana Pavlovic.

Let G(k,n) be a connected graph without multiple edges and loops which has n vertices and the minimum degree of vertices is k. The Randiæ index is summation over all edges of (d(u)d(v)) raised to -1/2, where d(u) is the degree of vertex u. We proved the conjecture of Delorme, Favaron and Rautenbach about the graphs for which the Randiæ index attains its minimum value

when k = n/2 or k = (n-1)/2. The extremal graphs must have the number of vertices of degree k equal n-k and the number of vertices of degree n-1 equal k.

3 : A Fault Tolerant Routing Algorithm on Neighbor-Faulty Hypercube. Pınar Dündar, Ege University; Kılıç, Elgin.

It is important for an communication network to efficiently route data among nodes. Efficient routing can be achieved by using node-disjoint paths. The one-to-one routing that constructs the maximum number of node-disjoint paths in the network between two given nodes. Optimal algorithms have proven useful in designing efficient and fault tolerant routing algorithms on hypercube networks. In this paper firstly we discuss the concepts of neighborhood and neighbor-integrity in a graph which is model of a communication network. After, we give a fault tolerant routing algorithm for faulty hypercube that is proceed from neighbor notion and using cube algebra.

4 : New Classes of Graphs for which the MSP is Polynomially Solved. Benmeziane Zineb, USTHB.

The maximum stable set problem (MSP) is NP-hard. In this communication we give the recent results on MSP. We present new classes of graphs for which the MSP is polynomially solved and the different algorithms used to solve this problem. In the FA-free graphs, the V.O (Vertex Order) algorithm is proposed, in the class of F1-free graphs, the algorithm MIN is used, and in subclasses of banner-free and P5-free graphs , we use the concept of augmenting graph to solve the MSP.

: WA13 **Supply Chain Management - C1**

Contributed Session Room: R21

Chair: Beril Toktay
INSEAD

1 : Investing in Forecast Quality. Mumin Kurtulus, INSEAD; Toktay, Beril.

We consider a two stage supply chain consisting of a supplier and a retailer, the latter serving an uncertain market. By undertaking costly investment prior to their production and ordering decisions, firms can independently acquire private information regarding the market demand. We consider two information exchange scenarios: (1) One Way Communication exchange where only one of the parties invests in improving the forecast quality and shares the forecast with the other party and (2) Information Pooling where both invest in improving the forecast quality and share the forecasts with each other. We investigate the impact of supply chain information exchange structure on the investments in improving the forecast quality. We characterize under what conditions the investment into communication technology should support One Way Communication as opposed to the Information Pooling type of information exchange and show that this choice depends on the each party's forecasting capability, the level of information overlap in supplier's and retailer's information sets and how supply chain profits are shared.

2 : Two Models for Supply Chain Integrated Planning. Jean-Marie Bourjolly, Concordia University; Chen, Ming Yuan; Gupta, Devender Mohan.

We consider a production planning problem that integrates the following four stages: supply of raw material; production of product families; production of finished goods; and distribution to customers. Setups are incurred at the raw material processing plants for product families, and at the finishing plants for individual products. Two main models have been developed: (i) No provision is made for tracking back the products through the chain; and (ii) Product identity is maintained throughout the chain (important for the pharmaceutical industry). They have been implemented in two different real-life contexts. The models are discussed and numerical results are presented.

3 : Co-Ordination in a Single-Vendor Multi-Buyer Supply Chain by Synchronising Ordering and Production Cycles. Brian Kingsman, Lancaster University; Chan, Chi Kin.

A co-ordinated single-vendor multi-buyer supply chain model synchronising ordering and production cycles is presented. The buyers' ordering days are scheduled and co-ordinated with vendor's production cycle but buyers are free to choose their own lot sizes and order cycles. Our results show the synchronised cycles policy works better than independent optimisation or using a common buyers 'order cycle. Savings come both from synchronised scheduling of the order days as well as the co-ordination of the ordering intervals. There are circumstances where both the vendor and the buyers gain from such synchronisation without the need for price and quantity discount incentives.

4 : Strategic Network Design and Inventory Deployment. Koray Dogan, i2 Technologies; Raman, Ramesh.

Right place, right time, right amount ... same old story. This talk will focus on the effects of distribution strategies on the optimal inventory levels to maximize on time delivery metrics to customer orders. The methodology, already implemented at several semiconductor companies, include prescribing multi echelon manufacturing-distribution network design and inventory deployment solution and a discrete event supply chain simulation system for validation purposes.

: WA14 **Multi-Objective Combinatorial Optimization - II**

Invited Session Room: R22

Chair: Matthias Ehrgott
University of Auckland

1 : A Recursive Algorithm to Determine all Pareto-optimal Solutions of Multiobjective Combinatorial Optimization Problems with Q criteria. Dagmar Tenfelde-Podehl, Graz University of Technology.

Multiobjective Combinatorial Optimization (MOCO) Problems are in general considered being difficult to solve and, indeed, until now only a few algorithms are known. Most of them are highly problem dependent and exploit the special structure of a given combinatorial problem. Especially when dealing with problems occurring in applications, additional constraints often destroy the special structure, hence a multi-purpose algorithm is needed. Up to now these general methods are mostly restricted to the biobjective case. We present a recursive algorithm with which we are able to determine the complete set of efficient solutions for a problem with Q objectives.

2 : An Unweighted Bi-Criteria Knapsack Algorithm. Cameron

Walker, University of Auckland; O'Sullivan, Michael.

We present an algorithm for the unweighted bi-criteria knapsack algorithm that exploits the connectedness of the efficient solution space. At present the connectedness of this space is only conjectured, but the performance of our algorithm suggests that this is the case.

3 : A Multi-Objective Routing Problem Solved by Simulated Annealing. Jacques Teghem, Faculté Polytechnique de Mons; Tuyttens, Daniel; El-Sherbeny, N.A.

A particular routing problem is considered: a customer asks to load a quantity at one place and to transport it to another one. The aim is to determine the daily routes of a fleet of trucks satisfying the requests of a set of customers. Several constraints must be considered: maximal duration of the daily routes; time-windows at the loading points; request of a particular type of trucks. Several objectives are taken in account. A Multi-Objective Simulated Annealing approach is applied to generate an approximation of the set of efficient solutions.

4 : A Discussion of Scalarization Techniques for Multiobjective Combinatorial Optimization. Matthias Ehrgott, University of Auckland.

Multiobjective programming problems are generally solved using a scalarization. Most scalarization methods use an aggregation of the objectives or/and transform some of the objectives into constraints. Both techniques have drawbacks when applied to combinatorial problems: not all Pareto optimal solutions can be found or the scalarized problems are much harder to solve than the original (single objective) problems. We discuss these issues and point out how the difficulties can be overcome at least to some extent.

: WA15 **Parallel Algorithms & Implementation**

Invited Session Room: R23

Chair: İlkay Boduroğlu
Boğaziçi University

1 : A Generic Method that Ties the Starting Temperature of the Simulated Annealing Algorithm to the Problem Size. İlkay Boduroğlu, Boğaziçi University; Özgen, Serkan; Kimyonok, Alphan.

We propose a generic method for determining the starting temperature of the Simulated Annealing algorithm as a function of the problem size of any combinatorial optimization problem. We implemented the Parallel Simulated Annealing Algorithm of Aarts and Laarhoven on a PC Cluster. Traveling Salesman Problems of up to 2025 cities were used in our tests. Our experiments with the TSP show that our proposed starting temperature reduces run time without deteriorating solution quality.

2 : Parallel Computing in Option Pricing. Halis Sak, Boğazici University; Özekici, Süleyman; Boduroğlu, İlkay.

We discuss the use of parallel computing in option pricing and evaluate the efficiency of various algorithms. This requires finding the numerical solution of a partial differential equation by the finite-difference method. We consider both European-type options for which analytical solutions are available as well as "fixed-strike" and "backward-starting" Asian options. Evaluations are made by comparing the numerical results of explicit and mixed finite difference methods with respect to accuracy and CPU time.

3 : Solving Sparse Symmetric Path Problems on a Network of Computers. Robert Manger, University of Zagreb; Nogo, Goranka.

Path problems are a family of optimization and enumeration problems that reduce to generation of paths in graphs. Some examples are: checking path existence, finding shortest or most reliable paths, listing all paths, etc. In this paper we present an optimized version of a previously studied distributed algorithm for solving path problems. The new version is designed for sparse symmetric path problems, i.e. for graphs that are both sparse and undirected. We report on experiments where the new version has been implemented with the PVM package and evaluated on randomly generated problem instances.

4 : Solving Distributed and Dynamic Constraints using an Emotional Metaphor: Application to the Timetabling Problem. Pierre De Loor, ENIB; Pierre, Chevaillier.

This paper presents a method and its implementation for solving distributed and dynamic constraints satisfaction problem. In order to improve adaptability and performance, our algorithm is based on agents with autonomous behavior guided by metaphoric assumptions. Our approach can be distinguished by the following points: The metaphor turns on sociological and emotional criteria without negotiation and memorisation. It tries to imitate collective and affective human's behavior when groups make complex decision. The agent's model include the notions of affective power, intruder and public mood perception. We have applied this method successfully to the timetabling problem.

: WA16 **New Approaches for Solving the Resource-Constrained Scheduling Problem**

Invited Session Room: R27

Chair: Marc Uetz
Universiteit Maastricht

1 : Alternative Approaches to RCPSP: Critical Chain. Walter Rom, Cleveland State University; Tukel, Oya.

In this discussion we analyze and compare the quality of the schedules obtained by using Goldratt's Critical Chain idea and the Resource Constrained Project Scheduling Methods. Specifically, a detailed step by step comparison of the two methods is presented using Patterson's problem set.

2 : Towards a Theory of Peaks for the Resource Constraint Project Scheduling Problem. Sacramento Quintanilla, University of Valencia; Valls, Vicente; Ballestin, Francisco.

RCPSP peaks are defined as ordered lists of activities that, when sequenced in the established order, produce a high utilisation of resources. As minimising the length of a project is equivalent to maximising the average use of resources, it would be interesting to have a mechanism for combining the best peaks from various schedules. We analyse the difficulties involved in combining peaks from different solutions. Auxiliary direct graphs are used

to indicate acceptable ranges that may offer new solutions. We describe a procedure for generating all the maximal acceptable ranges and various methods for generating schedules from acceptable ranges.

3 : Justification Technique Generalisations. Sacramento Quintanilla, University of Valencia; Valls, Vicente; Ballestin, Francisco.

Justification is a simple and quick technique which when applied to an RCPSP schedule produces another schedule that is shorter - or of equal length. A recent paper has shown that incorporating this technique in heuristic algorithms can substantially improve results. This paper shows new techniques resulting from justification generalisation. Theoretical analysis of the originating schedule sets, and a computational analysis of the improvements obtained by applying justification show that the introduced generalisations are not redundant.

4 : Circuit Enumeration and Resource Constraints in Scheduling. Marc Uetz, Universiteit Maastricht; Stork, Frederik.

In resource constrained scheduling, it is sometimes important to know the inclusion-minimal subsets of jobs that must not be scheduled simultaneously. These so-called minimal forbidden sets are given implicitly by a linear inequality system, and can be interpreted in a more general context as the circuits of an independence system. We present several complexity results related to computation, enumeration, and counting of the circuits of an independence system. On this account, we analyze a backtracking algorithm that enumerates all minimal forbidden sets for resource constrained scheduling problems. Its practical performance is evaluated on instances from the project scheduling library PSPLIB.

: WA17 **Simulation - C4**

Contributed Session Room: R24

Chair: Wolfgang Hörmann
Boğaziçi University

1 : Simulation of the Choice of Bank Offices using a High-Level Petri Net. Gergely Mészáros-Komáromy, Budapest University of Technology and Economics.

This paper outlines an economic model implemented using a high level Petri Net (Knowledge Attributed Petri Net), modeling the decision of bank clients when choosing bank offices. Offices and clients' homes are connected by roads, building up a complex net. The decision is based on different factors: fixed parameters (the clients' own preferences), variables changing runtime (interest rate at the office) and experimental values (traveling time required to get to the bank office and the serving time at the office).

2 : Check-in Optimization by Simulation and LP in Combination. Erik van der Sluis, University of Amsterdam; van Dijk, Nico.

Check-in planning can be highly complex and concerns an operational problem for which: 1. A stochastic (waiting time and desk capacity calculations) and a deterministic (desk scheduling and minimization) OR-approach are necessarily required; 2. Queueing theoretic or analytical results are too limited, while standard LP formulations are not available; 3. Stochastic (simulation) and deterministic (LP) software tools will necessarily have to be combined. Dynamic simulation and LP in combination, is therefore proposed. Both the simulation and LP-formulation are of interest in themselves. Numerical support shows a triple win in · Waiting time performance · Number of desks · Desk hours.

3 : Automatic Non-Uniform Random Variate Generation. Wolfgang Hörmann, Boğaziçi University; Leydold, Josef.

In the last years universal methods have been developed to sample from large classes of continuous distributions. The set-up of such algorithms is rather complex whereas the sampling routine is often very simple. So we have developed an Automatic Code Generator. The output of this program is a C (or FORTRAN or JAVA) programming code that generates random variates from a distribution, selected by the user. The code generator allows a user to obtain tested random variate generation procedures for a large variety of distributions and different programming languages without installing any programming library.

4 : Randomized Quasi-Monte Carlo Simulation with Applications to Computational Finance. Giray Okten, Ball State University.

Today the quasi-Monte Carlo method is used successfully in a number of fields as an alternative to traditional Monte Carlo simulation. Although the estimates produced by quasi-Monte Carlo are in general more accurate than the estimates of Monte Carlo, there is one drawback: there is no practical way to assess the accuracy of quasi-Monte Carlo. To address this issue, several researchers introduced the so-called randomized quasi-Monte methods. These methods produce accurate estimates that are subject to statistical error analysis. This talk will review these methods and discuss their use in problems from computational finance.

: WA18 **Forestry Management - I**

Invited Session Room: R25

Chair: Peter Lohmander
SUAS

1 : Adaptive Stochastic Harvest Scheduling with Constraints at the Forest Property Level. Peter Lohmander, SUAS.

Multi period linear programming with integer and quadratic generalizations, have often been used to optimise forest level scheduling under constraints. Then, stochastic markets and environmental conditions have usually been neglected. Adaptive decisions and sequential information concerning changes of exogenous stochastic variables have sometimes been considered in stand analysis. Then, higher level constraints have not been considered. This paper contains definitions and preliminary analyses of typical adaptive real world harvest scheduling problems at forest properties with stochastic markets. Adaptive approaches from stochastic scenario optimisation and from stochastic dynamic programming are used and compared.

2 : Optimal Deterministic and Stochastic Continuous Cover Forestry. Peter Lohmander, SUAS.

It is shown that optimal continuous cover forestry generates a higher present value than rotation forestry in a large set of

problems. Economic and biological parameters influence optimal values and decision rules. Explicit analytical derivations of optimal values and decision rules based on deterministic assumptions are included. A possibly changing climate, wood market price changes and other "stochastic" events influence optimal decisions. Hence, optimal adaptive decision rules are determined via multi stage stochastic programming and stochastic dynamic programming in Markov chains. The expected present value changes caused by stochastic events are determined.

3 : Forest Production and Species Protection: A Comparison of Two Approaches. Jeff Arthur, Oregon State University; Nalle, Darek.

The efficacy of simultaneously advancing two distinct types of science-based designs for species protection is addressed. In the literature, numerous models from each general approach can be found, but rarely are comparisons made between approaches. We argue that this oversight can be counterproductive to conservation achievement and the evolving field of ecoinformatics. When applying a more integrated modeling framework to a case study in Oregon (USA), it was found that neither approach was universally superior in terms of financial value or degree of protection for two late-seral forest dependent species, and that more realistic modeling efforts might improve understanding.

4 : Demand based Tactical Planning of the Roundwood Supply Chain with respect to Stochastic Disturbances and Quadratic Storage Cost. Leif Olsson; Hultqvist, Daniel.

An adaptive mixed integer quadratic model with stochastic disturbances of critical parameter values is presented. It is applied to a demand based roundwood flow problem with discreet time periods on a tactical planning horizon. Policies that jointly optimise the whole roundwood chain, integrated with the process at both pulp and saw mills are calculated within distinct time limits, for a forest area. Optimal harvest, storage and transport decisions for each time period are reported.

: WA19 **Health Care - C2**

Contributed Session Room: R26

Chair: Kemal Gürsoy
Boğaziçi University

1 : Scheduling Trainees at a Hospital Department. Jeroen Belien, Katholieke Universiteit Leuven; Demeulemeester, Erik.

Each year, trainees (medical students) have to be scheduled to assist specialists in their activities (surgery, consultation, etc.). The trainees can specify their preferences for weeks-off in advance. Every week, each activity must be performed and the trainees need to perform each activity for a consecutive period (e.g. between six and nine weeks). A branch-and-price algorithm has been developed that solves the problem to optimality. Computational results on real-world data from the ophthalmology department of the University Hospital Gasthuisberg in Leuven (Belgium) will be presented. An indication will be given of the extensions that can be solved by the algorithm.

2 : Modelling Emergency Departments: Towards an Integrated Approach. Sally Brailsford, University of Southampton; Churilov, Leonid.

All over the world, hospital Emergency Departments are experiencing the problems of ever-increasing demand on limited resources and a lack of coordination with wider healthcare systems. We present a comparative analysis of the use of discrete event simulation and system dynamics in tackling these problems. We argue that the relative strengths and limitations of these two approaches are complementary, and that emergency care provides an ideal application area in which to attempt to develop an integrated approach. The argument is illustrated by case studies from the UK and Australia.

3 : Can Fuzzy Logic Help My Research Analysis?. Özlem Aydın, Başkent University; Ersoy, Korkut.

We aimed to evaluate the quality of services provided at Baskent University Students' Health Center. A survey is conducted to students, referred to Health Center within last 3 months. We reached 75 students and conducted a survey of 17 questions on the phone. As there would be a bias in evaluation, survey was conducted after one week of service provision. As total time spent in Health Center was short, the number students was few, the results of this survey, whose sensitivity and specificity was carried out, would be imprecise. Because of that, fuzzy logic approach is included in analyzing process, and the reliability of the results is obtained.

4 : Residuals for k-Step-Ahead Controlled Processes and Related Monitoring Problems. Edward Nugent, IBM Burlington; Baykal-Gürsoy, Melike; Gürsoy, Kemal.

A dynamical system controlled by k-step-ahead minimum variance controller is considered. Problems encountered in the application of the monitoring schemes are discussed, particularly with respect to detecting process upsets. Upsets may occur in any of three ways, for which expressions are derived. It is shown that the mechanism by which upsets occur influences the ability of the residuals to detect the upsets. It is also shown that the effect of the disturbance on the residuals is independent of the process time delay k. The ability of the residuals to detect a change in the process dispersion is discussed. It is shown that the disturbance dynamics do not alter this ability. This information is useful in obtaining accurate estimates of control chart performance and directing the SPC practitioner in modifying the control chart design.

: WA20 **Bayesian Queues**

Invited Session Room: M35

Chair: Carmen Armero
Universitat de València

1 : Bayesian Nonparametric Analysis of Single-Server Queues. Pier Luigi Conti, Università degli Studi di Roma "La Sapienza".

Bayesian analysis of queueing systems has recently received considerable attention. The present talk focuses on the Bayesian approach to general GI/G/1 queues. Since no parametric assumptions are made on inter-arrival and service times, one is forced to resort to a nonparametric approach. As priors for inter-arrival and service times distributions, mixtures of Dirichlet processes are considered. The main goal consists in making in-

ference on the (equilibrium) waiting time distribution. Although the posterior distribution of interest can be evaluated exactly, its expression is of poor utility. For this reason, the problem of its approximation is discussed in detail.

2 : Bayesian Inference and Prediction for the GI/M/c Queueing System with Applications to Optimal Design Problems. Michael Wiper, Universidad Carlos III de Madrid.

We consider Bayesian inference for the GI/M/c system with the objective of optimising the number of servers. We formulate a cost function which depends on performance measures such as the number of busy servers and waiting time in the queue. The interarrival time distribution is approximated by a model based on mixtures of Erlangs. Given arrival data, birth-death MCMC is used to fit the model. Given information about the service process, we calculate predictive distributions of measures such as the stationary systemsize and estimate the optimal number of servers. We provide a numerical example constructed from real data.

3 : Waiting for a Renal Transplant in Comunitat Valenciana (Spain). Carmen Armero, Universitat de València; Conesa, David; Abellan, Juan Jose; Pérez-Panadés, Jordi; Martínez-Beneito, Miguel Angel; García-Blasco, María José; Zurriaga, Oscar; Vanacloca, Herme.

Bulk queueing models, Bayesian statistics and simulation tools are considered in order to analyze the waiting list for a kidney transplant in the Spanish Comunitat Valenciana. The basic features characterizing the system are the arrival process of the patients to the list, the process of donations, and the number of kidneys provided by each donor. Simulation tools are used to predict the temporal evolution of the size of the waiting list. Special attention is paid to the effect of the number of donations in the size of waiting list. A first analysis about the queueing times is presented.

: WA21 **Production and Inventory Systems - C2**

Contributed Session Room: M36

Chair: John Moussourakis
Rider University

1 : Supply Chain Inventory Control: Lot-Sizing Regression Approximations. Jack Hayya, Penn State University; Kim, Jeon; Sun, Daewon; Kucukemiroglu, Orsay.

The Supply Chain Operations Reference Model (SCOR) rests on the following: plan, source, make, deliver, and return. Under 'source' are · Selecting suppliers · Scheduling deliveries · Assessment and data maintenance · Managing inventory We concentrate on regression heuristics for calculating order quantities and reorder points. We develop a simple solution to an Erlang lead time and deterministic demand model, which is robust to misspecification. It turns that our solution is as easy as the EOQ's, with an accuracy rate of 99.87% when prior information on the lead time distribution is available and 98.35-99.72% when only historical information is available.

2 : A Novel Model Formulation for Multi-Stage Simultaneous Lotsizing and Scheduling. Herbert Meyr, University of Augsburg; Techanitisawad, Anulark.

The paper presents a novel MIP formulation for the simultaneous lotsizing and scheduling of a multi-stage flow line system, where deterministic demand of several products has to be met (on possibly parallel production lines per stage) with respect to limited capacity and sequence-dependent setup times. The objective is to minimize production, inventory and sequence-dependent setup costs. By means of small examples the benefits and pitfalls of the formulation are illustrated. Because of its flexible time structure, the MIP formulation is a well-chosen starting point for the development of efficient heuristics to the above problem situation.

3 : A Genetic - Benders' Approach for Multistage, Simultaneous Lotsizing and Scheduling with Sequence Dependent Setup. Anulark Techanitisawad, Asian Institute of Technology; Do Ngoc Anh, Dung; Meyr, Herbert.

This study addresses the simultaneous lotsizing and scheduling problem in a multistage system with sequence dependent setup. Its objective is to minimize the total costs of setup, holding, and production. We propose a heuristic that combines Benders' decomposition with a genetic algorithm (GA). A mixed integer program is decomposed into two parts: a combinatorial sequencing (Master Problem) and a linear lotsizing and scheduling problem (LP). GA solves in each generation for best sequences each of which yields a Benders' cut after its corresponding LP has been solved. The proposed heuristic is finally evaluated for solution quality, runtime, and convergence.

4 : Economic Order Quantities in Multi-Product Inventory Systems with Discounts and Common Resource Constraints. John Moussourakis, Rider University; Haksever, Cengiz.

In this paper we examine a case where a number of products, for which price discounts are available, are to be ordered in quantities subject to some common constraints such as budget, space, etc. A flexible mixed integer programming model that considers both fixed and independent cycle solutions is proposed, and its feasibility is illustrated.

: WA22 **Modeling Agent and/or Customer Behavior in Service Delivery**

Invited Session Room: M37

Chair: Zeynep Akşin
Koç University

1 : Capacity Investment for Credence Goods. Laurens Debo, Carnegie-Mellon University; Toktay, Beril; Van Wassenhove, Luk.

We analyze the role that capacity plays when selling service of which the customer can never be sure, after the service has been performed, whether it was necessary or not. Services that have these characteristics referred to in the economics literature as 'credence goods.' In such a setting, the server may have an incentive to recommend more service than necessary, in order to increase his revenues. Rational customers process ex ante the server's incentives before deciding whether to purchase the service or not. We study how a server can use congestion to signal his incentive not to advise unnecessary service.

2 : Value Creation in Service Delivery: Relating Value Cre-

ation in Service Delivery: Relating Market Segmentation, Incentives and Operational Performance. Evrim Gunes, INSEAD; Akşin, Zeynep.

This paper studies service delivery design in settings where firms engage in value creation activities, that have the objective of generating additional revenue from customer interactions. The firm is modelled as a single server queue, in a principal-agent framework. The manager determines a market segmentation scheme given an overall customer value generation profile, which divides customers into two groups, as well as a service level for each segment. The optimal market segmentation decision, optimal service level choice and a set of optimal linear incentive contracts that enable their implementation are characterized. Possible reasons for incentive design failure are identified

3 : Rational Abandonment Models for Tele-Queues. Nahum Shimkin, Technion; Mandelbaum, Avishai.

Abandonments of waiting customers are an important factor in queueing systems, that affects both performance and customer satisfaction. The abandonment profile (or, equivalently, customer patience) is often taken to be pre-specified in queueing modeling practice. In this talk, we consider the modeling of customer patience and its inter-dependence on system performance. We focus on queues which are invisible to their occupants, or tele-queues, discuss several options for modeling this dependence, and describe a rational model for customer abandonments. The resulting equilibrium point is characterized in the context of an M/M/s queue.

4 : Adoption Challenge of Telecom E-Services. Esin Kiris, AT&T Labs.

As telecom service providers struggle under the financial pressures associated with the continuing sluggish economy, plans to trim operational expenses and grow margins have been fundamental parts of their business models. Key among these expense-cutting efforts has been the redirection of cost-intensive customer services communications significantly less-costly web site portal interactions. However, their use and adoption has been a lot lower than their targets in this year. Increasing use and adoption of eServices has been a challenge for them. This paper presents the techniques applied to design to ensure the high rate of efficiency, effectiveness and satisfaction of eServices.

: WA23 **Portfolio Optimization**

Invited Session Room: M38

Chair: Süleyman Özekici
Koç University

1 : A Bond Portfolio Model with Credit Derivatives. Rosella Giacometti, University of Bergamo; Castellano, Rosella.

In the last decade a great attention has been dedicated to quantitative models and instruments to measure and control the credit risk exposition of financial institutions. The aim of this work is to implement a bond portfolio model with credit derivatives in order to verify the risk reduction caused by the introduction of contingent claims on credit. In particular, using Monte Carlo techniques we want to simulate the empirical distribution of the portfolio returns and evaluate the credit risk exposure, utilizing different risk measures. Selected the appropriate risk measure, we determine the optimal portfolio considering covered and uncovered positions.

2 : Robust Multiperiod Portfolio Optimization. Dessislava Pachamanova, Babson College; Bertsimas, Dimitris.

Traditional approaches to multiperiod portfolio management become computationally intractable when market frictions, e.g. transaction costs and taxes, are considered. We propose robust optimization formulations of the problem that result in linear problems of relatively low dimension. We compare the computational performance of our approach to the performance of other portfolio management techniques, such as alternative robust portfolio optimization methods and single-period mean-variance optimization.

3 : Optimizing Tactical Investment Rules based on Stochastic Volatility. Batur Bicer, Princeton University; Mulvey, John.

We analyze the relationship between the implied volatility and daily returns for the SP500 and other equity indices over 1995 to 2002. Periods of high volatility offer strong potential investment rewards. However, volatility spikes are often coincident with drops in equity markets. A stochastic system of equations is constructed in order to carry out anticipatory planning and then to optimize the investment strategies. Empirical results show the benefits of keying off the implied volatility triggers.

4 : Optimal Mean-Variance Portfolios in Markovian Markets. Süleyman Özekici, Koç University; Çakmak, Ulaş.

We consider the portfolio selection problem in a multi-period setting where the prevailing market conditions form a Markov chain. There are a number of risky assets available for investment and a risk free asset. The mean vector and covariance matrix both depend on the state of the market during that period. The investor chooses a new portfolio at the beginning of each period in order to minimize the risk at some finite time provided that a required level of expected return is attained. The problem is analyzed using dynamic programming. Optimal mean-variance portfolios are obtained explicitly under reasonable assumptions.

: WA24 **Innovation**

Invited Session Room: L17

Chair: Maria Romanova
George Washington University

1 : Effects of Market Orientation on Firms' Innovative Capability in the Turkish Software Industry: An Empirical Examination. Gülşen Akman, Kocaeli University; Yılmaz, Cengiz; Karakoç, Çağın.

Innovation is a very important factor in the face of intensive competition and high environmental uncertainty. Market orientation is an important and necessary element of an corporate culture to be a high performer in an environment that changes rapidly. A market oriented culture facilitates innovations and provides a optimum environment to innovations. In this study, we examine the effects of market orientation on firms' in-

novative capability. Direct effects of components of market orientation (customer orientation, competitor orientation and inter-functional coordination), as well as the hypothesized moderating effects of environmental uncertainty, are tested in a sample of software industry in Turkey.

2 : The Effect of R&D Partnerships on Innovation. Zeynep Hansen, Washington University in St. Louis.

R&D partnerships are increasingly found in high technology industries. Yet, the empirical economics literature on R&D productivity has not carefully analyzed returns from these partnerships. I empirically investigate innovative returns, measured in terms of patent production, from collaborative R&D, internal R&D, and public knowledge spillovers using a knowledge production function. Two preliminary findings are of particular interest. First, the implied long-run elasticity of successful patent output with respect to active R&D alliances is lower than the elasticity estimate with respect to internal R&D investments. Second, the nature of R&D collaboration matters and returns from R&D alliances are shown to differ.

3 : Advanced Quantitative Schedule Risk Analysis. David Hulett, Hulett & Associates, LLC.

Project schedule risk analysis has become accepted because we know that preparing a good schedule will not provide even the most likely completion date. First we need a robust project schedule. Activity duration risk is presented using the three-point estimates. Risk along a simple schedule path is discussed and the Monte Carlo simulation method is introduced. Parallel paths that merge in the schedule create extra risk, the "merge bias." The concept of "risk criticality" is the probabilistic analog to the traditional critical path. Advanced topics of probabilistic branching, conditional branching and correlation are discussed with simple examples.

4 : Developing Competitive Organizations through Six Sigma, Innovation, and Project Management. Frank Anbari, George Washington University; Romanova, Maria.

Organizational interest in the Six Sigma management method has been exploding. Understanding this method provides leadership opportunities to operations research professionals in Six Sigma strategy deployment. This paper discusses the integration of Six Sigma and project management strategies to develop competitive, innovative organizations. It clarifies the roles of various participants in achieving technical, financial and market objectives of Six Sigma projects. The paper describes cultural and training issues that may encourage or hinder the successful implementation of this method. It presents examples of success and failure in the implementation of the Six Sigma method in North America and Europe.

: WA25 **Electricity Markets - I**

Invited Session Room: M34

Chair: Shmuel Oren
UC Berkeley

1 : Experimentation with a Two Stage Equilibrium Model of the European Regulation on Cross-Border Trade of Electricity. Olivier Daxhelet, Electrabel; Smeers, Yves.

Abstract not available.

2 : The Evolution of Firm Conduct in Restructured Electricity Markets: A Case. Ali Hortacsu, University of Chicago; Puller, Steven.

We study the bidding behavior of generators in ERCOT, the balancing auction market of the newly deregulated electricity market of Texas. Using detailed cost data, we investigate the time series behavior of deviations of observed bid functions from noncooperative staticequilibrium models of bidding. We investigate whether observed deviations are attributable to 1) learning and experimentation, 2) firm organizational structure and experience in other electricity auction markets, and 3) response to regulatory threat.

3 : Hedging Transmission Risk with Node-to-hub Swing Options and Flowgate. Shijie Deng, Georgia Institute of Technology; Oren, Shmuel.

We introduce a new transmission right called a node-to-hub transmission swing option for managing transmission risks in a zonal or nodal power market. It is a single instrument in the form of a call option on the zonal hub price with different strike prices. It can serve as an appropriate hedge for the congestion charge faced by a generator which is equal to the difference between the generator's incremental costs and the zonal price. We provide a framework for valuing such node-to-hub transmission swing options and illustrate the merits of the transmission swing options in transmission risk management.

4 : Why Did British Electricity Prices Fall After 1998. Richard Green, University of Hull; Evans, Joanne.

Electricity prices in England and Wales have fallen by approximately 40% since 1988. We use econometric analysis of monthly average prices since 1996 to examine the contributions of a larger number of companies, a greater margin of spare capacity, and a change in the market rules.

: WA26 **Environmental Management - I**

Invited Session Room: L10

Chair: Peter Letmathe
University of Siegen

1 : Modelling Material Flows in Closed Loops: A Hierarchical Approach within the Packaging Recycling System. Rainer Souren, Chair of Environmental Management and Industrial Controlling at Aachen.

Closed loop systems are becoming increasingly important. Therefore, Supply Chain Management (SCM) must be extended to Closed Loop Management (CLM). As a quantitative basis, a Material Flow Analysis helps to structure the complex network and to map several processes. Using the packaging recycling system as an example, the lecture describes a top-down/bottom-up procedure for modelling cyclic systems. It gradually refines a general closed loop framework into material flow sheets. Additionally, it offers components for building up transformation networks. These components are distinguished by transformation type and process flexibility and can be linked directly to optimising OR models.

2 : Reverse Logistics in Saturated Markets. Alexander Wutz, University of Siegen.

In saturated markets, product life-cycles (PLC) are getting shorter. Short PLC generally are considered as ecologically harmful, since more and more natural resources are used within each period. Replacing a one-way economy with both material cycles and longer PLC could be a solution. This contribution focuses on shortened PLC and their impact on planning used product flows in a reverse logistics context. It is shown that the ability to plan and control reverse product flows depend on past sales. In a simulation model, the consequences of shortening PLC for controlling and planning reverse product flows are examined.

3 : Emission Trading and Technical Progress from the Firm's Perspective. Peter Letmathe, University of Siegen.

In the European emission trading system, the affected firms will obtain yearly allowances to emit a given amount of CO2. The firms can trade these allowances and may invest in technical progress leading to fewer emissions. The presentation examines how companies can adjust to the trading system. The theoretical background builds Solow's hypothesis that technical progress is embodied in capital goods which leads to different production functions in each period. In combination with the putty-clay model, it is shown that technical progress rates, timing of investment and prices of allowances play an important role in coping with the trading system.

4 : Environment Oriented Reverse Logistics by using Vehicle Routing Planning. Frank Schultmann, University of Karlsruhe; Rentz, Otto.

In this contribution, the peculiarities of establishing a Closed Loop Supply Chain (CLSC) are presented, based on an example considering the end-of-life vehicle (ELV) treatment. Different design options for a CLSC are put up, concentrating on how reverse material flows can be integrated in supply chains. Reverse logistics aspects are modeled with vehicle routing planning. Introducing a problem-tailored algorithm, results of several closed loop supply chain scenarios are discussed which are based on real case data, depicting measures from German ELV stakeholders.

: WA27 **ESIGMA - I**

Invited Session Room: L11

Chair: Theodor Stewart
University of Cape Town

1 : Adding Transparency to MCDA Methods. K. Nadia Papamichail, University of Manchester; French, Simon.

This work describes a methodology for automatically generating explanations in MCDA applications. We have developed an expert system that justifies the advice of a decision support system for nuclear emergencies. This explanation system adds transparency to the ranking process by applying natural language generation techniques to produce two reports: first, a comparative report that contrasts two alternatives and second, a sensitivity analysis report that interprets the variation of outputs in response to changes in the inputs. A validation study indicates that the generation of explanations improves the performance of the users and facilitates their understanding of the decision process.

2 : A Case of Confrontation: Insights from MCDA and Conflict Analysis. Valerie Belton, University of Strathclyde; Losa, Fabio.

This paper explores the integrated use of MCDA and conflict analysis, in particular drama theory, to improve understanding of decision contexts characterized by conflicting objectives and complex, multi-party interactions. We aim to demonstrate the potential for synergy between the two approaches through one or more case studies. In particular we illustrate how a multi-criteria perspective can enhance understanding of the credibility of threats, promises and the ensuing dilemmas of rational choice, consequently highlighting possible ways in which these may be resolved.

3 : Aggregation of Preferences with Inconsistencies in a Pairwise Comparisons Scenario. Jacinto González-Pachón, Universidad Politécnica de Madrid; Romero, Carlos.

Let us consider n decision makers that have to rank m alternatives. The decision makers show their preferences through n pairwise comparison matrices that are not necessarily reciprocal and/or consistent. A proposed preference aggregation procedure is divided into two phases. First, from n pairwise comparison matrices an aggregate distance-consensus matrix is obtained. Second, this consensus matrix is minimally modified while simultaneously holding "as much as possible" the reciprocity and consistency properties. A balance between normative and descriptive aspects of the decision making process is thus established. In both phases, Goal Programming reveals as a powerful approach for dealing with the underlying optimisation problems.

4 : A Simple Common Framework/Interface for MCDM. Ignacy Kaliszewski, Systems Research Institute.

A rough taxonomy of interactive Multiple Criteria Decision Making methods distinguishes two major classes, namely the weight methods and reference point methods. All methods of these classes amount to a partial, decision maker guided search of the set of efficient decisions. The dichotomy is based on which elements are manipulated to capture DM's preferences. The purpose of this paper is to show that in some technical terms, reference point methods are equivalent to weight methods. With such an interpretation provided, it is possible to implement methods of these two classes in the same technical framework.

: WA28 **Geometric Search**

Invited Session Room: L12

Chair: Patrick Jaillet
Massachusetts Institute of Technology

1 : Parallel Online Search of Concurrent Lines. Patrick Jaillet, Massachusetts Institute of Technology; Stafford, Matthew.

We consider various problems where p searchers explore m>p half-lines, all joined at a common origin. We propose optimal deterministic on-line strategies for solving a version of the time-competitive problem, and compare with results obtained on other variants of time-competitive problems. We also discuss

results associated with distance-competitive ratio, and with the value of additional information.

2 : Geometric Search and Its Application to Limited Broadcasting in Peer-to-Peer Ad Hoc and Radio Networks. Mikael Hammar, University of Salerno; Gargano, Luisa; Östlin, Anna.

A new class of on-demand protocols for mobile ad hoc networks has been proposed for their low routing overhead. However, to find a destination node, these protocols flood the network, resulting in overuse of bandwidth. We analyze a method called limited broadcasting that terminates a broadcast as soon as the destination is found. The analysis uses techniques developed for geometric search problems. In particular, we use results for parallel searching on rays to obtain tight bounds for limited broadcasting in both ad hoc and radio networks.

3 : Application of Genetic Algorithms to Scheduling Problems. Ali Yurdun Orbak, Uludağ University; Erdiller, Aslı.

Genetic algorithms are mostly applied to problems that are difficult or impossible to solve with classical techniques in polynomial time. Scheduling problems are one of these NP-hard problems. In this paper, a modified new version of Simple Genetic Algorithm (SGA) is applied and illustrated to scheduling problem. The modifications include the subroutines for the construction of the objective functions, calculation of objective function values and fitness values. As objective functions makespan, number of tardy jobs, and total tardiness are chosen. With these modifications, active, non-delay and near-optimal schedules are obtained in a very short computation time.

4 : The Dynamic TSPTW on a Line: Do Preprocessing so that Insertion of a New Location into an Existing Route may be Done in Sublinear Time. Binay Bhattacharya, Simon Fraser University; Mitrovic-Minic, Snezana.

The Traveling Salesman Problem with Time Windows (TSPTW) deals with finding a shortest route in order to visit a set of locations each within a specified time window. When all locations are positioned on a straight line the problem is the TSPTW on a line. The dynamic TSPTW arises when not all locations are known in advance. This talk focuses on improving complexity of inserting a new location into an existing route by using a certain preprocessing. Straightforward linear-time algorithm explores all slots of a route. We would present a way to do insertion in sublinear time.

: WA29 **Dynamic Programming - I**

Invited Session Room: L13

Chair: Seiichi Iwamoto
Kyushu University

1 : A Primitive Dynamic Programming. Seiichi Iwamoto, Kyushu University.

What is dynamic programming? This presentation is concerned with the class of all dynamic programmings - with or without optimization. Where is an origin in the class? What is it? The talk is a travel which leads to the origin. We present a primitive form of dynamic programming. It is a non-deterministic dynamic programming, which generates stochastic dynamic programming, which in turn reduces to deterministic dynamic programming. Thus we propose the non-deterministic dynamic programming as a primitive dynamic programming.

2 : Maximizing Order Probabilities on Markov Chains. Seiichi Iwamoto, Kyushu University; Ueno, Takayuki.

It is natural to consider expectation criteria in stochastic decision problems. In particular, both discounted expected value of total reward and average value per stage are well studied criteria in Markov decision processes. However, in this paper we consider a probability criterion that the reward is nondecreasing in time- an order probability. We maximize the order probability on finite-horizon controlled Markov chains. We show that the policy class for maximization depends upon reward function's dependence on today's state, today's decision and tomorrow's state.

3 : On Splitting Problem. Seiichi Iwamoto, Kyushu University; Fujita, Toshiharu.

We consider an iterative splitting of a finite set of consecutive integers. Any split yields two consecutive parts with a splitting cost. Each of splitted-parts is also splitted into two parts. The splitting is repeated until each splitted-part contains only two consecutive integers. The two consecutive integers incur a terminal cost. The problem is to find a sequence of splittings which minimizes the total cost of all splitting costs and of all terminal costs. This problem is solved through a nondeterministic dynamic programming.

: WA30 **Finance & Banking - C1**

Contributed Session Room: L14

Chair: Zdravka Aljinovic
University of Split

1 : The Interdependence of the Accounting Variables and Market Measures of Risk: A GARCH Model of the Japanese Banking Institutions. Iqbal Mansur, Widener University; Elyasiani, Elyas.

This study attempts to establish whether equity prices of the Japanese banking institutions impound information contained in the balance sheet and income statement. A three-index model, the indices being the Market Index, Interest Rate Index and the Foreign Exchange Rate, within the GARCH framework is utilized. This paper extends the literature by investigating the determinants of market and exchange rate risks. To this end, the beta measures derived from the GARCH model are regressed against the corporate decision variables. The Japanese bank data provides an international comparison of the systematic risk and exchange rate risk sensitivities.

2 : Shadow Riskless Returns and Maximin Portfolios: A Robust Hedging Approach to Interest Rate Risk. Alfredo Ibáñez, ITAM; Balbas, Alejandro; Romera, Rosario.

This paper addresses the hedging of bond portfolios interest rate risk by drawing on the classical "one period no-arbitrage" approach of Financial Economics. Under realistic and weak assumptions on the instantaneous shifts (or shocks) on the yield curve, several "Shadow Riskless Assets" are introduced by means of linear semi-infinite mathematical programming problems and maximin portfolios. Our technique is general. Finally,

we solve a few examples and show that maximin strategies are not only worst-case scenario strategies, but namely, (a), they are robust ((b), they are very effective , and (c), they resemble maturity matching portfolios.

3 : Efficiency of Banks: Recent Evidence from The Transition Economies of Europe-1993-2000. Semih Yildirim, University of Tennessee; Philippatos, George.

This study examines the cost and profit efficiency in banking sectors of twelve Central and Eastern European countries, using stochastic frontier approach(SFA) and distribution-free approach(DFA). The managerial inefficiencies were found to be significant, with average cost efficiency level of 72 and 76 percent by DFA and SFA, respectively. According to the SFA, approximately one-third of banks' profits are lost to inefficiency, and almost one-half according to the DFA. The higher efficiency levels are associated with larger size, higher profitability and equity. The level of competition and GDP growth are found to increase efficiency while market concentration is negatively linked to efficiency.

4 : Immunization Strategies based on the Macaulay Duration Concept. Zdravka Aljinovic, University of Split.

This paper discusses immunization strategies which are closely related to the basic and simplest duration measure - Macaulay duration. Although there are serious objections to the strategies based on Macaulay duration, primarily to the assumption on interest rate trends in the investment period, in some empirical investigations it is found that the simple Macaulay duration works at least as well as any of the alternatives. The main issues in the paper are illustrated with numerical examples.

: WA31 **Queueing Systems - C4**

Contributed Session Room: M33

Chair: Smail Adjabi
Laboratory LAMOS

1 : Performance Evaluation of a Tandem Queueing Network. Smail Adjabi, Laboratory LAMOS; Lagha, Karima.

To evaluate the characteristics of a tandem queueing network, we proposed a study account of qualitative properties of the distributions. For that, we consider different bounds (lower and upper) for different classes of non parametric distributions. Theses bounds are calculated after to have applied QNA (Queueing Network Analyser) method. To verify if the proposed intervals surround the approximate values, we considered some of approximations such that KLB (Kramer-Langenbach-Benz) method and simulation. Two algorithms are elaborated for programming of the method according to that the interarrival distribution of customers to the network be parametric or non parametric.

2 : Performance Evaluation of Delta Communication Network. Karima Lagha, Laboratory LAMOS; Adjabi, Smail.

The purpose of this work is to use qualitative properties of distributions to evaluate MIN's communication network characteristics (bounds for mean sojourn time and for mean number of jobs in the network). Two procedures are discussed in this work in which we use qualitative properties of Erlang and hyper-exponential distributions in the internal flow. We consider parametric or non parametric distribution for arrival flow. These procedures were translated into a computer code in Delta network with three stages.

: WC01 **EWG DEAPM**

Invited Session Room: MB I

Chair: Emmanuel Thanassoulis
Aston University

1 : Tutorial on Data Envelopment Analysis. Rolf Färe, Oregon State University; Thanassoulis, Emmanuel.

Data Envelopment Analysis (DEA) is a linear-programming based method for deriving information to manage the performance of homogeneous operating units such as bank branches, hospitals, schools etc. The information can include e.g. measures of relative efficiency, benchmark units, performance targets, marginal rates of substitution, and measures of scale efficiency and productivity change over time. This session will review generic DEA models, and illustrate the theoretical aspects and the use of DEA in practice. E.g. by means of simple examples and diagrams, it will be shown that DEA has a natural foundation in axiomatic production theory. DEA software will be illustrated.

: WC04 **Discrete Optimization Problems in Circuit Layout Design**

Invited Session Room: JB A

Chair: Miguel Anjos
University of Southampton

1 : A New Mathematical Programming Framework for Facility Layout Design. Miguel Anjos, University of Southampton; Vannelli, Anthony.

We present new framework for efficiently finding competitive solutions for the facility layout problem. This framework is based on the combination of two new mathematical programming models. The first model is a convex relaxation of the layout problem and is intended to find good starting points for the iterative algorithm used to solve the second model The second model is an formulation of the facility layout problem as a non-convex mathematical program with equilibrium constraints (MPEC). Computational results show that the framework can be solved efficiently using widely available optimization software for problems with up to 33 departments.

2 : New Interior Point Models for Global Routing of Very Large Scale Integrated Circuits. Laleh Behjat, University of Calgary; Vannelli, Anthony; Rosehart, William.

Circuit layout is the design step of Integrated circuits in which a physical realization of a circuit is obtained. Global routing is one of the sub-problems of the circuit layout that involves finding an approximate path for the wires of a circuit. In this paper the global routing problem is formulated as an ILP problem. A linear relaxation of the model is solved using Interior Point algorithms. Computational efficiency is achieved by applying several numerical techniques to increase the speed of the interior point algorithm. Application of interior point algorithms and their numerical efficiency is discussed in this paper.

3 : Interior Point Models for Power System Stability Problems. William Rosehart, University of Calgary; Roman, Codruta; Behjat, Laleh.

In this paper, a detailed analysis of the use of optimization techniques in the study of voltage stability problems, leading to the incorporation of voltage stability criteria in traditional Optimal Power Flow (OPF) formulations. The relationship between the Lagrangian Multipliers of the OPF problem and the classification of the maximum loading point level of the system is given. Finally, the paper presents a sequential optimal power flow (OPF) technique to enhance voltage stability using reactive power and voltage rescheduling.

: WC05 **Fleet Scheduling and Management**

Contributed Session Room: JB B

Chair: Marta Mesquita
Instituto Superior de Agronomia

1 : Incorporating the Pricing Decisions into the Dynamic Fleet Management Problem. Huseyin Topaloglu, Cornell University.

In this talk we show a tractable method to include the pricing decisions in the dynamic fleet management problem whose scope normally involves only the vehicle allocation decisions. We propose a model that makes the vehicle allocation and pricing decisions together assuming that the price determines the number of demands through a nonincreasing function. The underlying idea of our model is to adjust the prices iteratively using the solution of the dynamic fleet management problem. We show that the proposed pricing approach yields high quality solutions and can be efficiently applied on large problems.

2 : Helicopter Scheduling Models in Crisis Management. Hüseyin Onur Mete, Boğaziçi University; Barbarosoğlu, Gülay.

This paper proposes different models for scheduling helicopters that are used for material transportation and human evacuation during crisis situations. The crisis situation is defined by specifying mission restrictions like weather and geographical conditions, air crew requirements, and refueling. The static and dynamic versions of this problem are first modeled as mixed integer programming problems. Then, heuristic algorithms are developed for solving this problem and their performance is compared by using real-life data.

3 : Heuristic and MILP-based Scheduling Methods for Dual-Load AGVs at Seaport Container Terminals. Hans-Otto Günther, Technische Universität Berlin; Grunow, Martin; Lehmann, Matthias.

In highly automated seaport container terminals the transport of containers from the berthing area to the storage yard is realized by AGVs, which can carry up to two 20ft containers or alternatively one 40 or 45ft container at a time. For the assignment of transportation orders to vehicles two alternative scheduling methods are proposed. The first one consists of a flexible priority rule based approach, which is suitable for real-time application. The second one employs an MILP model for scheduling the available vehicles over a given short-term horizon. The performance of both scheduling methods is compared in a numerical investigation.

4 : Valid Inequalities and Separation Procedures for Multi-Depot Vehicle Scheduling Problem. Marta Mesquita, Instituto Superior de Agronomia; Paixão, José.

The vehicle scheduling problem consists of optimally linking timetabled trips into vehicle blocks, so that trips in the same vehicle block form a feasible schedule for a vehicle. We address the NP-hard case where vehicles are located at two or more depots. We consider a multicommodity flow based formulation and derive new families of valid inequalities to strengthen the LP-relaxation. We show that some of these inequalities are facet-defining. Exact and heuristic separation routines are used in a branch-and-cut algorithm. To discuss the effectiveness of the cuts, computational experience is reported using data available on the web.

: WC06 **Scheduling - C4**

Contributed Session Room: M30

Chair: Umut Corbacioglu
Erasmus University Rotterdam

1 : Capacity Loss Management in Single Machine Scheduling Problems with Uncertainties. Nihat Kasap, University of Florida; Aytug, Haldun.

We analyze a one machine scheduling problem with breakdowns and preventive maintenances. The primary objective in this work is to minimize the capacity loss due to breakdowns and unnecessary preventive maintenance. We propose a model where the timeline is split into two alternating regions as risk free and risky regions by assuming that the machine does not breakdown for a fixed amount of time after the last maintenance. We show how to partition and schedule jobs into these regions to minimize the capacity loss. We report results on special cases.

2 : Tool Switching and Sequencing Problem on a Single Flexible Machine. İbrahim Karakayalı, METU; Azizoğlu, Meral.

In this study, we examine a tool switching and sequencing problem on a single flexible machine. We assume each job requires arbitrary number of tools and tool magazine capacity of machine is limited. Our aim is to find a job sequence and a tool switching sequence so as to minimize total flow time. We show that the problem is NP-hard, therefore we develop several heuristic procedures that find local optimal solutions. We test efficiencies of the procedures relative to each other and optimal solutions or lower bounds. We find that the procedures produce high quality sequences in reasonable solution times.

3 : Cyclic Loading of Identical Parts in a Flexible Manufacturing Cell. Umut Corbacioglu, Erasmus University Rotterdam; Kayalıgil, Sinan.

Identical parts cyclic scheduling problem in a flexible manufacturing cell is considered. All material handling activities are performed by a stacker (AGV) moving on a linear track. Parts must be fixtured for processing. An operator is responsible for fixturing/defixturing operations. Productivity of the cell depends on scheduling of the AGV, the operator and the fixtures. We developed two mathematical programming models to minimize the makespan of a batch of jobs. In the first model, we

assume instantaneous empty moves of the AGV. In the second model we lift that assumption. Finally, we propose a practical heuristic algorithm for the problem.

4 : A New Hybrid Heuristic Algorithm to Timetabling Problem - A Case Study. Zahra Najiazimi, Ferdowsi University of Mashhad.

In this paper at first we discuss about timetabling problems and then specialized the discussion to examination timetabling and introduce hard constraints and lots of soft constraints. We try to solve this problem with several famous metaheuristic methods. This methods are GA, SA, TS and ACO. Finally introducing a new hybrid heuristic algorithm and then comparing these algorithms with each other. The conclusion shows that the new method has more advantages in compare to mentioned method and in the case study this algorithm work strongly.

: WC07 Integrated Inventory and Transportation Models

Invited Session Room: M31

Chair: Sila Cetinkaya
Texas A&M University

1 : Procurement Decisions for Buyers of Third-Party Contract Manufacturing Services. Candace Yano, University of California, Berkeley.

The use of third-party contract manufacturers has grown dramatically and a wide variety of such suppliers now exist. Some provide only assembly services while others also take responsibility for procurement of component parts. We address the buyer's procurement decisions in this context, considering both costs and risks.

2 : Polynomial Time Algorithms for Some Multi-Level Lot-Sizing Problems with Production Capacities. Albert Wagelmans, Erasmus University Rotterdam; van Hoesel, Stan; Romeijn, Edwin; Morales, Dolores.

We consider a model for a serial supply chain in which production, inventory, and transportation decisions are integrated, in the presence of production capacities and for different transportation cost functions. The model we study is a generalization of the traditional single-item economic lot-sizing model, adding stationary production capacities at the manufacturer, as well as multiple intermediate storage levels including the retailer level), and transportation between these levels.

3 : A Two-Echelon Inventory Optimization Model with Demand Time Window Considerations. Wikrom Jaruphongsa, National University of Singapore; Cetinkaya, Sila; Lee, Chung-Yee.

This paper studies a two-echelon dynamic lot-sizing model with demand time windows and early and late delivery penalties. The problem is motivated by third party logistics and vendor managed inventory applications in the computer industry where delivery time windows are typically specified under a time definite delivery contract. Studying the optimality properties of the problem, the paper provides polynomial time algorithms that require O(T3) computational complexity if backlogging is not allowed and O(T5) computational complexity if backlogging is allowed.

4 : Transportation Contract Value Problems in Two-Echelon Settings - Single. Fatih Mutlu, Texas A&M University; Cetinkaya, Sila.

We study the coordination problem of a We study the coordination problem of a transporter in a simple buyer-vendor system. Given the dispatch quantity by the buyer/vendor, the transporter attempts to change this quantity in order to decrease her/his costs. Transporter's actual costs may include a per truck cost as well as a fixed cost associated with each dispatch. This cost structure provides some incentives to the transporter to change the dispatch quantity requested so that truck utilization is increased. We develop a procedure for estimating the value of the transportation contract under different pricing schemes adopted by the transporter.

: WC08 GDN Keynote Session - III

Invited Session Room: M32

Chair: Marc Kilgour
Wilfrid Laurier University

1 : Efficient Fair Division: Help the Worst Off or Avoid Envy? Steven J. Brams, New York University; King, Daniel.

Two or more players rank a set of indivisible items from best to worst. An efficient allocation of items is characterized. If this allocation helps the worst off by being maximin or Borda maximin, it may ensure envy. Other trade-offs are discussed, such as that the only envy-free allocation may be inefficient.

2 : Impasse Resolution in International Negotiation: Evaluating a Computer-Assisted Decision Aid. Daniel Druckman, George Mason University; Druckman, James; Arai, Tatsushi.

The impacts of a computer-assisted tool for resolving impasses in negotiation are evaluated by an experiment embedded in a simulation of a bilateral conflict between nations resembling Iraq and the US. Effects of the tool on number of agreements, position changes, time to settlement, and perceptions of the situation are discussed.

: WC09 Store Brands

Invited Session Room: L15

Chair: Koen Pauwels
Tuck School of Business at Dartmouth

1 : Determinants of Private Label Buyers. Andrew Ainslie, University of California at Los Angeles.

We use a variant of a hierarchical Probit model across multiple categories to analyse what drives similarities and dissimilarities in private label purchasing behavior across multiple categories, by decomposing the private labe intercept term across the different categories.

2 : Store Traffic and Cross-Selling - Does the Loss Leader Strategy Work? Andre Bonfrer, Singapore Management University; Padmanabhan, Paddy; Chiang, Jeongwen.

Retailers' advertised price discounts (feature advertising) could influence store profits and traffic in their loss leader role (Wal-

ters and McKenzie 1988), or via the ability to signal that the store is low price (Simester 1996). Our goal is to substantiate conclusions of Simester (1996) to suggest that stores' feature advertising may be useful to some customers to assess the overall price image of the store. We empirically decompose the additional store traffic and sales volume generated by retailers' advertised prices, into the above two components, and study the cross selling power of these promotions.

3 : Who Benefits from Store Brand Entry? Koen Pauwels, Tuck School of Business at Dartmouth; Srinivasan, Shuba.

In a large-scale econometric investigation, we assess the impact of store brand entry on (1) retailer (2) consumers and (3) national brand manufacturers. First, structural break unit-root tests uncover that store brand entry has a structural impact on the category. Second, VARX models estimate the pre- and post entry equilibrium. Across categories, we find that store brand entry consistently benefits the retailer by higher margins and consumers by higher product variety. Premium national brands experience lower price sensitivity and higher revenues. In contrast, second-tier national brands experience higher price sensitivity and lower revenues.

4 : How Category Characteristics Affect the Number of Store Brands Offered by the Retailer: Model and Empirical Analysis. Serdar Sayman, Koç University; Raju, Jagmohan S.

We examine how certain category characteristics affect the number of store brands offered by a retailer. Our analysis suggests that we are likely to observe two store brands in categories where the national brands are similar in strength, and the price sensitivity between the national brands is low. Our empirical findings support our model-based predictions. Key words: Store Brands, Retailing, Positioning, Game Theory.

: WC10 **Fuzzy Linear Programming**

Invited Session Room: L19

Chair: Enriqueta Vercher
Universitat de València

1 : On the Solution of Fuzzy Linear Programs by using Semi-Infinite Programming. Teresa Leon, Universitat de Valencia; Vercher, Enriqueta.

We consider a class of Fuzzy Linear Programming problems characterized by the fact that the coefficients in constraints are modeled as L-R fuzzy numbers with different shapes. Solving such problems is usually more complicated than the solution when all the fuzzy coefficients have the same shape. We propose a primal semi-infinite algorithm as a valuable tool for solving this class of fuzzy linear programs. The performance of the procedure is illustrated by means of several examples.

2 : Some Fuzzy Techniques for the P-median Problem. Vicente Liern, Universitat de Valencia; Canos, Maria J.; Ivorra, Carlos.

We propose a fuzzy version of the classical p-median problem which permits us to incorporate external data in the model. So we can obtain certain good solutions that would have been discarded by the crisp model. We analyze two situations: the first one is when not covering a part of the demand reduces significatively the transport costs and the second one is when the model presents pathologies. Besides, we propose an explicit enumeration algorithm (based on Hakimi's works) for solving small or medium sized instances, and an interchange heuristic procedure (with the Teitz-Bart heuristic structure) for larger problems.

3 : A Fuzzy Approach to the Efficiency Evaluation with DEA Models. Teresa Leon, Universitat de Valencia; Liern, Vicente; Ruiz, Jose L.; Sirvent, Inmaculada.

In many real applications, the data of production processes cannot be precisely measured. This is particularly worrying when assessing efficiency with DEA models, since they are very sensitive to data errors. For this reason, the possibility of having available a methodology that allows the analyst to deal with imprecise data becomes an issue of great interest in these contexts. To that end, we develop here several fuzzy versions of the classical DEA models. This approach can be seen as an extension of the DEA methodology that provides users and practitioners with models which represent some real-life processes more appropriately

4 : Some Fuzzy Models for Portfolio Selection. Enriqueta Vercher, Universitat de Valencia; Leon, Teresa; Liern, Vicente; Marco, Paulina; Segura, José Vicente.

We present some fuzzy Mathematical Programming techniques for different versions of the portfolio selection problem. We consider single and multi-objective programming models in which we take into account not only the risk and the expected returns but the diversification requirements of the investor. By using fuzzy methodology we can both incorporate the uncertainty related to data and include subjective aspects. It allows us to stablish different estimations of the expected risk and benefit.

: WC11 **Data Envelopment Analysis - C1**

Contributed Session Room: R20

Chair: Paola Zuddas
University of Cagliari

1 : Assessing Regional Attractiveness via Statistical and Data Envelopment Analysis Methods: The Case of the Greek Prefectures. Maria Dimopoulou, Athens University of Economics and Business; Kandilorou, Eleni.

Spatial distribution of population, residential mobility and socio-economic characteristics are important factors that are actively involved with issues of regional productivity and attractiveness of capital and human resources. These characteristics are of high importance to both governmental offices for policy decision-making and urban planning, as well as private companies for marketing research and retail network allocation. In this paper, a comparative evaluation of the spatial entities (like prefectures) is performed. The evaluation method utilized both statistical analysis and DEA as well as GIS map algebra techniques to display the results. The method was applied to assess the Greek prefectures.

2 : Large Scale DEA Implementation: Designing Quality and Performance Improvement in Large Service Organizations. Alexandra Medina-Borja, Virginia Tech; Pasupathy, Kalyan; Triantis, Konstantinos.

Service organizations face a challenge while designing and implementing performance management systems. Such a system needs to capture and interpret multi-dimensional indicators of intangible nature such as service quality and outcomes. We present a case study of a real-life implementation of a performance measurement system that uses DEA to evaluate hundreds of organizational units operating in different environments. An automated system that collects operational data from field offices, surveys over 150,000 customers and makes recommendations for improvement was developed. It demystifies the limitations for real-life implementation attributed to DEA. Pitfalls and protocols drawn from our experience are discussed.

3 : An Evaluation of the Family Cost in Greek Regions: A DEA Analysis. Eleni Kandilorou, Athens University of Economics and Business; Dimopoulou, Maria; Livada, Alexandra.

This paper examines the regional effect on the cost of family. It shows that the area of the household's residence differentiates significantly the cost of family. The estimates of the family cost are calculated based on the Engel's specification. Given that the equivalence scales are very often used for policy purposes and welfare comparisons, we believe we should take into account both the robustness and the regional diversity of the estimates. Using the non-parametric method of Data Envelopment Analysis model in particular years then uses these estimates for assessing geographical regions. The different greek areas are comparatively assessed.

4 : A New Cut Device to Solve Linear Programming Problems. Paola Zuddas, University of Cagliari; Fanni, Alessandra; Montisci, Augusto.

In this paper, a new approach is presented to solve a linear programming problem that reduces the computational complexity of the Simplex method. The proposed approach explores the constraints rather than the vertexes of the domain. The constraints are ordered on the basis of their directions, with respect to the gradient of the objective function. The smaller the angle between directions, the more the corresponding constraint is ahead of the other constraints. The optimal solution of a reduced domain is evaluated by single step of Dual Simplex.

: WC12 **Graphs & Networks - C3**

Contributed Session Room: M39

Chair: Thierry Mautor
Universite de Versailles

1 : Path Counting Problem and Its Applications. Tatsuo Oyama, National Graduate Institute for Policy Studies; Morohoshi, Hozumi.

Given the network path counting problem is defined to be the problem requiring to count the number of paths connecting any two nodes. Then we define the weight of paths for each edge in the network as the number of such paths contained. This problem can be applied to propose a quantitative method for evaluating the stable connectedness of the network-structured system. From the viewpoints of computational complexity we show the application of Monte Carlo method to evaluate the stable connectedness function. This method can be applied to measure the strength of connectedness of the lifeline network system.

2 : Data Diffusion in a Weighted Line Communication Model. Thierry Mautor, Universite de Versailles; Berthome, Pascal; Cohen, Johanne.

In the considered problem, a given node (the transmitter) has to broadcast a given and voluminous information to a group of the other nodes. A communication occurs from one node that has already received the information to one only other node according to the line communication model. Several communications can occur simultaneously, provided the corresponding communication paths are edge disjoint. The objective is to find the sequence of communication steps that minimize the global cost. Let us finally emphasize on the fact that different original principles govern the diffusion and the cost function and make the problem original.

3 : Routing Optimisation with Consideration of Quality-of-Service in Telecommunications Networks. Benedicte Vatinlen, Bouygues Telecom; Chauvet, Fabrice François Marie; Chauvier, Laurent; Chretienne, Philippe.

The current problem is to define an optimal routing plan for multicommodity flows in an IP network subject to multiple bounded quality-of-service constraints (delay, loss, jitter...). This problem is NP-hard. In this paper, we focus on the delay-constrained problem. We first compare a usual and linear approach (maximizing the minimal residual bandwidth) to a non-linear one (minimizing delay, which is inversely proportional to the residual bandwidth). These ones are unbounded. For a real telecom network, the second approach appears better than the first one, whatever the traffic volume. Then, we add complexity with bounded constraints.

4 : On Cyclic Regularity in Graphs. Abdelhafid Berrachedi; Kahoul, Nawel.

we consider graphs (noted [μ,n,g]-cycle regular graphs)in which each path of length μ belongs to exactly n g-cycles. Since the subgraph induced by the two central levels of hypercube of odd degree Hk, is of a maximum order, for a given degree, among the [3,1,6]-cycle regular graphs. In a similar way, we show that Hk is of maximum diameter, for a given degree, among these graphs.

: WC13 **OR in Sports - I**

Invited Session Room: R21

Chair: John Norman
University of Sheffield

1 : Tournament Scheduling by Integer and Constraint Programming Methods. Michael Trick, Carnegie Mellon University.

Real sports scheduling problems are difficult to solve due to the variety of different constraints that might be imposed. Over the last decade, through the work of a number of researchers, it has become easier to solve round robin tournament problems. These tournaments can then become building blocks for more complicated schedules. Integer programming and constraint programming methods each have their places in this approach, depending on the constraints and objective function.

2 : Decision Support for Setting a Second Innings Target in Test Cricket. Philip Scarf, University of Salford.

In test cricket, if the side batting third are in a strong position, the captain of the side would be expected to set a target for the opposition taking account of a number of criteria. These criteria would include: his team's chance of winning; his team's chance of losing; his current attitude towards risk. A model is developed in order to provide decision support in this context. Data on recent test matches is used for estimation and validation.

3 : Running Uphill: Energy Needs and Naismith's Rule. John Norman, University of Sheffield.

Results from treadmill experiments and the Catskill Mountain road relay race suggest that corresponding to Naismith's rule of 1 to 8 for running in mountainous country (one foot of ascent is equivalent to 8 feet on the level), the rule for running on a treadmill is 1 to 3 and for running on roads 1 to 4 or 5. These rules suggest that, if possible, runners should zigzag up slopes steeper than 1 to 8 on the fells and zigzag up slopes steeper than 1 to 4 or 5 on roads

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: WC14 **MODM - C1**

Contributed Session Room: R22

Chair: Mordecai Henig
Tel Aviv University

1 : Robust Portfolio Selection in Multiattribute Capital Budgeting. Pekka Mild, Helsinki University of Technology; Salo, Ahti.

We consider the selection of multiattribute project portfolios in the presence of incomplete information about attribute weights. In particular, we present an algorithm for the determination of potentially optimal and non-dominated portfolios. We also considers robustness measures for the identification of portfolios that exhibit satisfactory performance across the full range of possible attribute weights. Based on linear programming, the proposed approach is particularly suitable to problems where the number feasible portfolios is large and where multiple resources and project interdepencies need to be accounted for. We also give a numerical example and consider potential applications of the framework.

2 : Supplier Selection by using an Integrated Approach: Analytic Network Process and Linear Programming. Ezgi Aktar Demirtaş, Osmangazi University.

Supplier selection is a multicriteria problem which includes both tangible and intangible factors some of which may conflict. In this paper an integration of Analytic Network Process (ANP) and LP is proposed to consider both tangible and intangible factors in choosing the best suppliers and define the optimum quantities among selected suppliers to maximize the total value of purchasing. The supplier priorities are calculated by using ANP. Four different plastic injection firms are evaluated according to 18 criteria. The priorities are used as objective function parameters of LP so this model can be applied to supplier selection with capacity constraints.

3 : Proper Efficiency in Vector Optimization via Tradeoff Directions. Mordecai Henig, Tel Aviv University; Bednarczuk, Ewa.

Different types of Pareto efficiency in the outcome space were expressed, in the literature, via different domination cones. Tradeoff directions of efficient points indicate possible gains in some objectives relative to losses in others. These directions in Euclidean outcome spaces were shown to exist if and only if the outcome is proper efficient. We extend here this result to give a new characterization of proper efficient points in various outcome spaces.

4 : An Exact Algorithm for Solving a Multiple Objective Linear Integer Programming. Chergui Mohamed El-Amine, Université des Sciences et de la Technologie H.B.; Abbas, Moncef; Moulai, Mustapha.

A new exact algorithm for solving a multiple objective integer linear programming (MOILP)is presented in this paper. This algorithm is based on a Branch and Bound technique able to identify all integer efficient solutions of MOILP in a finite number of iterations. The cone concept is used to build up a multiple cutting planes method that, when it is applied on a feasible integer solution, isolates this solution and an inefficient feasible integer solutions set from the feasible integer solutions set. This method produces the algorithm we propose.

: WC15 **Parallel Algorithms - C1**

Contributed Session Room: R23

Chair: Catherine Roucairol
University of Versailles

1 : Solving Rectilinear Steiner Tree Problem in Parallel. Nahit Emanet, Boğaziçi University; Özturan, Can.

Parallel Rectilinear Steiner Tree (RST) is an NP-hard problem which arises in VLSI area. We present parallel branch-and-cut algorithms for solving the RST problem. Our algorithms are implemented in C++ using an object oriented framework and use MPI message passing libraries for communication. Parallelization is achieved using a master-slave task allocation scheme. Our implementation performs faster than GEOSteiner software by Winter, Zachariasen, and Warme in most SteinerLib tests. Moreover, our parallel implementation shows good speedups on our Beowulf cluster.

2 : Grid Computing and Parallel Branch-and-Bound Tree Searches. Catherine Roucairol, University of Versailles; Cung, Van-Dat; Hahn, Peter.

In this talk, we will present the hardware and software environments of Grid Computing and point out the parallel computing issues one could encountered while implementing a program over this kind of heterogeneous machines. We will show how to implement Branch-and-Bound algorithms according to some parallel algorithmic issues (e.g. granularity). In particular, we will explain how to implement parallel Branch-and-Bound with "work stealing" load balancing strategies in order to take advantage of the available computing power of grid. The results obtained on the Quadratic Assignment Problem with our parallel Branch-and-Bound library BOB++ will illustrate our purpose.

: WC16 New Models and Algorithms for Resource-Constrained Project Scheduling

Invited Session Room: R27

Chair: Ramon Alvarez-Valdes
University of Valencia

1 : Feeding Buffer Size Determination for Critical Chain Project Scheduling. Oya Tukel, Cleveland State University; Rom, Walter.

Feeding buffers are added to paths that merge with the critical chain in order to protect the chain from unexpected delays. In this paper we discuss possible ways of determining feeding buffer sizes and where to locate them. We compare the performance of existing methods with ours using simulation. Results are discussed.

2 : A Branch and Bound Algorithm for the Resource Constrained Project Scheduling Problem with Profit Reinvestment. Sergey Soukhikh, Omsk Branch of Sobolev Institute of Mathematics SB RAS.

The Resource Constrained Project Scheduling Problem with Profit Reinvestment is considered in this paper. Each activity of this problem has a stream of deterministic cash flows. The objective is to schedule the activities to maximize the Net Present Value of the project subject to the precedence and financial resource constraints. An important feature of this problem is that the financial resource may not be consumed but it also may be reproduced while processing the activities. This profit can be used for performance other activities. We propose a branch and bound algorithm for solving this problem.

3 : On the Morphological Structure of a Network. Luis Tavares, Instituto Superior Técnico; Vanhoucke, Mario; Coelho, José.

In this paper, we report on results for the morphological structure of a network. We introduce a number of morphological network indicators implemented in an existing network generator from the literature. In doing so, we are able to describe each network structure in a detailed way and to generate networks with a given, pre-specified structure. We show that a number of measures are related to each other and we compare a number of network generators with each other.

4 : New Heuristic Algorithms for Project Scheduling Under Partially Renewable Resources. Mª Fulgencia Villa, Florida Universitaria; Alvarez-Valdes, Ramon; Crespo, Enric; Tamarit, Jose.

Recently, in the field of project scheduling problems the concept of partially renewable resources has been introduced. Theoretically, it is a generalization of both renewable and non-renewable resources. From an applied point of view, partially renewable resources allow us to model a large variety of situations that do not fit in classical models, but that we have found in real problems in timetabling and labour scheduling. This paper explores several metaheuristic procedures for solving the problem, mainly based on Tabu Search, and presents computational results.

: WC17 Variance Reduction Methods

Invited Session Room: R24

Chair: Victor Nicola
University of Twente

1 : Importance Functions for Achieving Asymptotic Efficiency in RESTART Simulation. José Villén-Altamirano, Universidad Politécnica de Madrid.

The method RESTART is an efficient alternative for rare event simulation. It is sufficient for having an application of RESTART asymptotically efficient a) to choose an appropriate importance function to define the thresholds; b) to define enough thresholds to have the "distance" between two thresholds bounded; c) to perform an adequate number of retrials. Condition c) is not ever restrictive. Condition b) is restrictive in few models. In this paper we will present importance functions for some models that lead to asymptotically efficient applications of RESTART. Some numerical results that confirm the theoretical ones will be presented.

2 : Problems with Common Random Number Streams in Discrete Event Simulation. Ruth Davies, University of Southampton; Brooks, Roger.

The use of common random number streams is a method of variance reduction in which different but repeatable random number streams are allocated to difference distributions in a simulation. Multiplicative congruential generators with equally spaced seeds for the streams are commonly used. Correlations between streams cause problem in complex simulations. We show how this problem may be overcome.

3 : Modelling of an Intelligent Software Agent. Bernd Viehweger, University of Potsdam; Andresen, Katja.

Based on a research project conducted to bring together a Management Game (BeSim) cooperating with ISA technology we present our results along with areas of ISA technology for simulation processes. In this paper, we focus on practical and theoretical issues of intelligent software agents in a balanced way. The development/programming of intelligent agent systems requires a solid understanding of concepts and functionality. In the light of state-of-the-art technologies the authors reflect on decisions made to realize the ISA system. Finally, specifications activities for generic agent technologies are evaluated in terms of interoperability with other (agent-based) applications.

4 : Efficient Simulation of Buffer Overflow in Queueing Networks. Victor Nicola, University of Twente; Juneja, Sandeep.

Consider a continuous-time queueing network with probabilistic routing, including feedback. An effective change of measure is proposed to estimate the probability of buffer overflow in an arbitrary ('target') queue during its busy period. The change of measure is state-independent, obtained by exponentially twisting the original arrival and service processes as well as the routing probabilities. Under the change of measure, all queues (except the target queue) are either stable or critical. We determine the twisting parameters by solving a non-linear optimization problem subject to appropriate inequality constraints. Under some conditions, a large amount of variance reduction is guaranteed.

: WC18 **Forestry Management - C1**

Contributed Session Room: R25

Chair: Bojan Djuric
University of Ljubljana

1 : Optimal Harvesting Decisions in Mixed Species Stands with Stochastic Prices. Fadian Lu, Swedish University of Agricultural Science; Gong, Peichen.

In this study, the thinning decisions and the composition of different species at different ages are guided by feedback stocking-level control functions for each species. These controls are functions of stand age and market timber prices. The final harvesting is determined by a reservation price function, which is formulated with stand age and standing timber stock as independent variables. The Powell method is used to simultaneously optimise the coefficients of the functions for a sample mixed species stand of Scots pine (Pinus Sylvestris L.) and Norway spruce (Picea abies (L.) Karst.) located in northern Sweden.

2 : Economic Consequences of Environmental Concerns on Timber Production: A Study on the Swedish Mountain Region Forests. Wenchao Zhou, Department of Forest Economics; Gong, Peichen.

This study analyzes the economic effects of environmental concerns on timber production for the forests in the Swedish mountain region. The environmental concerns include deadwood, broad-leaved forest, and old-growth forest. Results show that if managing the forests fully achieves the average targets decided by the Swedish Environmental Protection Agency, the net present value of timber benefits would reduce as much as about 50%. The results also show that among the three items of environmental concerns, the demand for deadwood is most restrictive.

3 : Land Use Planning Model using Goal Programming: A Case Study of Cehennemdere Valley, Turkey. Ersin Yılmaz, Eastern Mediterranean Forestry Research Institute.

The objective of this study is to develop a land use planning model through linear goal programming model. This model consisted of three sectors (forestry, agriculture, range) and different factors (economic, environmental, physical, social factors). Three goals were optimized in the model under the constraints of land, water, and the demands for timber, agronomic crops and range. These goals were the soil erosion, the quality of wildlife habitats and costs. The model was run under different scenarios for both the years 2000 and 2010. The results of these analyses provided the best spatial allocation of different sectors.

4 : Public Relations in Forestry. Bojan Djuric, University of Ljubljana; Milosevic, Sladjana.

This paper deals with function of public relations in forestry. This is new and still not researched area in forestry theory and practice. Current situation is analyzed in some European countries and Serbia specially related to how to use public relations in conflict situations. In order to introduce public relations in forestry enterprises few case studies are presented from the world experience and suggestion is given how it should be used by forestry professionals in Serbia. This paper is small contribution to emphasize the importance of public relations in forestry for Serbia academic environment as well as forestry professionals.

: WC19 **Health Care - C3**

Contributed Session Room: R26

Chair: Erkan Türe
TÜSSİDE

1 : Patient Welfare Implications of Innovation in the U.S. Antidepressant Market. Paris Cleanthous, New York University.

The study quantifies patient welfare benefits from pharmaceutical innovation in the U.S. antidepressant market employing an original dataset that consists of annual observations on sales and drug characteristics for every antidepressant medication sold in the U.S. market from 1980 to 2001, and demographic data on the distribution of patient income and prescription insurance. While evaluating pharmaceutical innovation in antidepressants, I uncover and address the moral hazard caused by the existence of pharmaceutical insurance coverage. The study estimates large patient welfare gains from innovation and helps explain the detected divergence between social and private patient benefits by the presence of insurance.

2 : Model Development for Planning and Forecasting in Diagnostic and Treatment Systems. S. Bülent Eriş, Marmara University; Türe, Erkan.

This study attempts to show different modeling approaches for forecasting in health systems and to build a dynamic forecasting model for future health care service costs and utilizations in the short and mid terms. We will first develop and test validity of such a model together with the sensitivity analysis and pilot applications. Real data were used to describe a model with a number of variables so that reliable forecasts can be made. In parameter estimation modeling, testing phases, analytical approaches and simulation techniques were employed. We provide the actuarial approach and techniques from the actuarial literature.

3 : Waiting List Improvements for Hospitals by Queueing and Simulation in Combination. Nico van Dijk, University of Amsterdam; Heemskerk, Linda.

Waiting lists for hospitalisation are common throughout most countries. A variety of factors has been reported in the literature. So far, one factor has remained unlightened. This factor is based on insights from queueuing theory. Based on this factor alternative scenarios for hospital logistics and operational planning can be suggested in order to reduce waiting lists. A simulation program will be presented to study and evaluate these scenarios. Experimental results will show that this combination of queueing and simulation may lead to practical improvements.

: WC20 **Bayesian Inference in Stochastic Models**

Invited Session Room: M35

Chair: Simon Wilson
Universidad Carlos III

1 : Statistical Performance of a Production-Inventory Sys-

tem. David Conesa, Universitat de València; Armero, Carmen.

Manufacturing systems working on a produce-to-stock basis can improve the level of service of customers. Nevertheless, this policy usually implies the necessity of an inventory of items available to fill customer orders as they arrive. In this work, we present how to statistically analyze, from a Bayesian point of view, a single product type manufacturing system working under this policy. To do so, we use its relationship with a multiple Poisson bulk arrival queueing model. Our main interest is to evaluate its performance in terms of characteristics such as the finished product inventory.

2 : A Bayesian Analysis of Beta Testing. Simon Wilson, Universidad Carlos III; Wiper, Michael.

In this article, we define a model for fault detection during the beta testing phase of a software design project. Given sampled data, we illustrate how to estimate the failure rate and the number of faults in the software using Bayesian statistical methods with various different prior distributions. Given a suitable cost function, we also show how to optimize the duration of a further test period.

3 : Modeling Discrete Data with the nu-Poisson. Galit Shmueli, University of Maryland; Kadane, Joseph; Boatwright, Peter; Minka, Thomas; Borle, Sharad.

The nu-Poisson is a flexible two-parameter distribution that is useful for fitting count data. It generalizes several well-known discrete distributions and has several appealing characteristics that make it an attractive alternative for modeling discrete data. In this talk we introduce the nu-Poisson and its conjugate prior and posterior. We discuss its properties and compare it to other suggested distributions. Finally we illustrate its use by applying it to data from marketing and actuarial applications.

: WC21 **Production and Inventory Systems - C3**

Contributed Session Room: M36

Chair: Hyo-Seong Lee
Kyung Hee University

1 : Determining the Number of Kanbans in a Hybrid-Type Manufacturing System using Simulation Metamodeling and Multiobjective Fuzzy Mathematical Programming. Özlem Uzun, Dokuz Eylül University; Eski, Özgür; Araz, Ceyhun.

In this paper, a method to determine the number of kanbans in a hybrid-type manufacturing system by using simulation metamodeling is described. The method is demonstrated on a two-card kanban-controlled manufacturing system composed of push and pulls modes. Simulation results are generalized by regression metamodels for several objectives such as minimization of WIP and costs. Because of conflicting and fuzzy nature of some objectives, multi-objective fuzzy mathematical programming is used to determine the number of kanbans under some specified constraints.

2 : A Heuristic Scheduling Policy for the Stochastic Economic Lot Scheduling Problem. Erik Levén, Luleå University of Technology.

A heuristic scheduling policy is introduced for a multi-item, single-machine production facility facing stochastic demand. The scheduling policy uses order quantities derived from solving an Economic Lot Size Problem but modifies the quantities to obtain a feasible production schedule according to current inventory levels. The schedule uses a dynamic approach. On completion of a production batch, the policy makes decisions concerning which item to produce in which quantities, or if no production is needed, the appropriate idle time. The items are scheduled in continuous time. The scheduling policy also takes into account the stochastic behaviour of the demand.

3 : A Solution Method for the Joint Replenishment Problem with Minimum Order Quantities. Eric Porras, Erasmus University Rotterdam; Dekker, Rommert.

We study the joint replenishment problem for m items under deterministic demand, with the constraint of minimum order quantities for each item in the replenishment order. The traditional JRP literature does not consider this type of constraints that are common in real inventory environments. We study an iterative procedure that proves to be not efficient in this case. Further, we derive some bounds on the basis cycle time and propose an efficient enumerative procedure using a Lipschitz constant. Several numerical examples are discussed under different parameters and demand scenarios. A real life example is given as well.

4 : Performance Evaluation of a CONWIP System with Compound Poisson Demands. Hyo-Seong Lee, Kyung Hee University.

In this study we consider a CONWIP system in which the processing times at each station follow a Coxian distribution and the demands for the finished products arrive according to a compound Poisson process. The demands that are not satisfied instantaneously are assumed to be lost. For this system we develop an approximation method to obtain the performance measures such as steady state probabilities of the number of parts at each station, machine utilization, the proportion of lost demands.

: WC22 **Call Center Operations - II**

Invited Session Room: M37

Chair: Francis de Vericourt
Duke University

1 : An Aggregate Staffing Model to Optimize Call Center Planning. Fabrice François Marie Chauvet, Bouygues Telecom Research Labs; Chauvier, Laurent; Nait-Abdallah, Rabie; Renaud, Arnaud.

Bouygues Telecom's call center employs more than 2500 agents. In order to optimize customer service, it is crucial to have consistently enough operating agents in the call center. On the other hand, a number of scheduling constraints such as French work regulations must be satisfied for each agent. An aggregate staffing model has been developed as a mixed linear integer program. It is equivalent to schedule each agent individually. This formulation makes a solution fast to obtain by a branch and bound algorithm.

2 : Performance Comparison of Different Priority Schemes

Among Customers in Call Centers Management. Mohamed Salah Aguir, Ecole Centrale Paris; Karaesmen, Fikri; Akşin, Zeynep; Dallery, Yves.

We study the priorities among different classes of customers in a call center in order to satisfy a service objective in terms of customers' waiting times. We compare different priority schemes with the goal of minimizing the number of customer representatives required to achieve the service objective.

3 : Managing Response Time and Service Quality in a Call Allocation Problem. Francis de Vericourt, Duke University; Zhou, Yong-Pin.

We analyze a call allocation problem in which customer service representatives show different service speeds and quality levels. We model service quality as the probability that an unsatisfied customer after service reenters the system. The manager has then to decide to which agent an arriving call should be sent in order to minimize the total average waiting time, including the re-calls. We formulate the problem as a Markov Decision Process, and study the optimal allocation policy in this framework. We also derive insights on how to take both response time and service quality into account when operating the system.

: WC23 **Financial Engineering - C1**

Contributed Session Room: M38

Chair: Mahmut Karayel
Babcock & Brown

1 : Capital Budgeting Decisions under Uncertainty - Real Options Approach. Sevin Sozer, Auburn University; Park, Chan S.

Capital budgeting decisions under uncertainty have been challenging tasks to many businesses, as the value of project develops stochastically over time and the decision to invest into this project can be delayed until an opportune time. In this presentation, we will consider a multi-stage capital budgeting model based on "real options" values to account for both dynamic and flexible structure of the investment environment. The objective is to maximize the wealth accumulation at the horizon time.

2 : A Monte Carlo Simulation Approach for Valuing Real Options with Switching Costs. Mehmet Aktan, University of Wisconsin-Madison; Nembhard, Harriet Black; Shi, Leyuan.

We present a Monte Carlo simulation approach for valuing real options with multiple sources of uncertainty. The valuation model has multiple options, switching costs between those options, and multiple exercise points for the options. We present the application of the proposed approach on a global supply chain network problem with exchange rate uncertainty. We value the flexibility to switch between global manufacturing options for a firm that has operations in different countries, and maximizes its expected discounted profit through the exercise of the manufacturing options.

3 : A Multi-Factor Stochastic Model and Estimation Procedure for the Valuation and Hedging of Commodity Contingent Claims. Gonzalo Cortazar, Pontificia Universidad Catolica de Chile; Naranjo, Lorenzo.

In this paper we provide a new multi-factor stochastic model of commodity futures prices and propose a Kalman filter estimation procedure that may be applied to a panel data with missing observations. This model may be used to implement financial engineering applications which require the valuation or hedging of commodity-linked assets. We calibrate our model using daily oil futures prices and analyse its goodness-of-fit to observed prices and empirical volatilities.

4 : Experiments in Pricing Correlated Joint Defaults. Mahmut Karayel, Babcock & Brown.

Hedging correlated asset portfolios is of interest in the face of increasing uncertainty and event risk. We report the results of modeling and simulation of a bond portfolio topology that attempts to address event risk. We use matching algorithms to construct the portfolio. We report the simulation results and compare the results to an un-matched portfolio. We will also discuss possible application of these ideas to consortium borrowing in the emerging markets.

: WC24 **Financial Models**

Invited Session Room: L17

Chair: Ben Lev
University of Michigan - Dearborn

1 : A Decision Theoretic Approach to Manipulation of Capital Markets. Ozan Özcan, TÜSSİDE; Yalınkılıç, Faysal.

Distinguishing between legal and manipulated purchasing/selling transactions has vital importance in Capital Markets. Supply and demand for reliable information cannot be met effectively in a manipulated market. To determine manipulations in the market we will attempt to develop a realistic modeling of the decision environment to simulate transactions and test for manipulations. The paper aims to help achieve fair and reliable market conditions by proposing decision making models to understand, analyze and determine the weak links in the system that may cause manipulations. Statistical tools, decision making and analysis, and project management techniques will be used for modeling.

2 : Comparing Financial Investments by Their State-Dependent Returns: A Note on Logarithmic Utility. Gerhard Speckbacher, Vienna University of Economics.

We formalize and discuss an intuitive criterion for the binary comparison of financial investments. The criterion ranks each pair of investments by calculating the present value of one investment's payoffs using the state-dependent returns of the other considered investment as discount factors. For a standard single-period-model under risk a one-way expected log-utility representation of the induced preference is shown to exist and hence a new interpretation of expected log-utility based decision making is provided.

3 : Traders' Decisions in Financial Markets: The Uninformed Profiting from the Informed. Johnnie Johnson, University of Southampton; Jones, Owen.

It is widely believed that financial markets efficiently incorporate historical price information. However, we argue that the decisions of traders with access to priveleged information ('insiders') may be discerned and profitably employed by less

informed traders('outsiders') via analysis of price movements. A conditional logit model is constructed to parameterise the price (odds) movements in simple financial markets(betting markets). Coefficients of several variables associated with insiders' betting decisions are found to be significant. Betting strategies based on the model yield significant profits ;suggesting that outsiders' investment decisions may be profitably informed by inadvertent market signals prompted by insiders' decisions .

4 : Enhancing a Price-based Decision Model in a Market for State-Contingent Claims. Alistair Bruce, University of Nottingham; Johnson, Johnnie.

This paper investigates the effect of including market trading volume as an independent explanatory variable in a model designed to explain returns in a financial market. Recent work in the technical analysis area of the finance literature suggests that, whilst volume effects should be fully factored into prices, additional explanatory power may be associated with the separate inclusion of volume. Using data from UK horserace betting markets, volume is seen to add significant explanatory power in markets which are relatively informationally opaque, but adds no value to a pure price-based model in more informationally transparent settings.

: WC25 Energy Policy and Planning in Latin America

Invited Session — Room: M34

Chair: Jesús Velásquez
Universidad de la Sabana

1 : Risk Analysis and Pricing of Electricity Options using Stochastic Optimization. Jesús Velásquez, Universidad de la Sabana; Hidalgo, Cesar.

Effects of decision environment in risk analysis and pricing electricity options are studied using a stochastic optimization model for electricity trading. The factors studied are: demand level, demand uncertainty, generation level, load curve, contracts, alternative bids, integrated decisions and option structure. The study considers the effect of four objective functions: maximize the expected income, maximize the minimal income, maximum regret and expected income plus conditional value-at-risk constraints. The results demonstrate that methodologies of pricing options based only on the probabilistic characteristics of the future spot price ignore important aspects that affect the "optimal" price of the options.

2 : Measuring the Relative Efficiency of Electric Power Generating Agents in Colombia using Data Envelopment Analysis. Yezid Orlando Pérez, Pontificia Universidad Javeriana; García Cáceres, Rafael Guillermo.

Efficiency of electricity generation is one of the principles of the new competitive structure of the generation market in Colombia, since the restructuring of this sector. Data Envelopment Analysis is used in order to determine the relative efficiency of generating agents. A generating agent that reflects in its bids a cost above the system's marginal price runs the risk that its generation will not be included in the dispatching plan. The results obtained allow the agents to define their efficiency profile as a function of their competitors and suggest them some of the efficiency improvements that they should undertake.

4 : Microworlds for Investments in Generation Capacity in Latin America. Ricardo Smith, Universidad Nacional de Colombia; Guzman, Vicente; Pineda, Luz Stella; Rave, Claudia; Dyner, Isaac.

The restructuring of the electric sectors in several Latin American countries rises the necessity of developing analysis tools focused on the understanding of the new energy trading structures. Two microworlds are presents to describe electric energy markets in several Latin American countries. Both intend to facilitate learning processes of the complex mechanisms that characterize investments electricity markets. The main tool used was System Dynamics, and different sources of risk and uncertainty were considered in the model. The developed system can also be used to analyze possible specific investments in electricity capacity. Some applications are presented and results discussed.

: WC26 Environmental Management - II

Invited Session — Room: L10

Chair: Jutta Geldermann
University of Karlsruhe

1 : System Optimisation and Multiple Criteria Decision Making for Sustainable Development. Adisa Azapagic, University of Surrey; Clift, Roland; Mellor, Warren; Stevens, Gary; Wright, Elizabeth.

This paper illustrates how system optimisation and multiple criteria decision analysis can be used to support decision making for sustainable development. A software tool "CHAMP" has been developed for these applications. CHAMP enables modelling of material and energy flows at the micro-level (e.g. company) or macro-level (e.g. the whole economies) and supports environmental, economic and social assessments of different systems.

2 : Integrating Risk Communication and Risk Management. Simon French, University of Manchester; Papamichail, K. Nadia.

We are researching how to communicate risk to the public and other stakeholders in a manner that addresses their concerns. The findings are of relevance to all situations where authorities are required to determine when and what risk information to communicate to the public. Our study has a strong empirical strand; however, in this paper we focus on the implications of our work: namely that the risk communication strategy should be an integral part of the wider risk management strategy, rather than is often the case now that communications are only considered once the risk management strategy has been determined.

3 : A Three-Step Methodology for the Long Term Planning of Inter-Company Energy Supply Concepts. Wolf Fichtner, University of Karlsruhe; Frank, Michael; Rentz, Otto.

In order to assess the economic and ecological effects of intercompany energy supply concepts, an optimising model integrating investment and long-term production planning has been developed. This model has been complemented by a process simulation software to determine the necessary data and by game theoretic approaches to assign costs and benefits to the different partners of the cooperation. Finally, the application

of this three-step methodology to three industrial companies to analyse the economic and ecological implications resulting from investments in inter-company energy supply concepts will be presented.

4 : Integrated Technique Assessment based on the Pinch-Point Approach. Jutta Geldermann, University of Karlsruhe; Rentz, Otto.

Integrated Process Design aims at a holistic approach to process design, retrofitting, and operation. In a preliminary design, pinch technology allows cost and energy "targets" (i.e. the minimum possible values of these parameters) to be calculated, based on the pinch point as the enthalpy at which the hot and cold composite curves are separated by the minimum temperature difference in heat exchanger networks. This approach has been expanded to mass pinch analysis. Multi-objective functions must be chosen to consider a variety of economic and environmental process attributes, as a case study from VOC recovering/ recycling shows.

: WC27 **ESIGMA - II**

Invited Session Room: L11

Chair: Valerie Belton
University of Strathclyde

1 : Enhancing Performance Measurement Systems by Means of MCDA. Ralph Scheubrein, University of Hohenheim.

In recent years performance measurement systems like the Balanced Scorecard have become a widely accepted instrument to implement the company's strategy. Nevertheless strategic decisions are mainly concerned about the effectiveness of the organization, while operational decisions are mainly targeting the efficiency of the activities. In this context it is shown, how decision support systems based on MCDA can help making decisions at a tactical, medium-term level.

2 : An Integrated Approach to Student Performance Assessment Systems in Higher Education. Ali Rıza Kaylan, Boğaziçi University; Yazgaç, Tülin; Güvenç, Eda.

Analyzing and manipulating the existing data with respect to predefined goals brings a competitive advantage for higher education institutions in providing high quality, original, student-specific and student-centered education. This study proposes a new data-driven approach to evaluate and improve student performance, relationship management and course selection behavior using data mining tools. The records will be transformed into valuable information from which the decision-makers, such as students, advisors and administrators, can benefit. Based on a multi-criteria decision making framework, it is aimed to enhance student satisfaction. Thus, creating more efficient and effective student advising and preventing failures will be realized.

3 : Integration of MCDA and Scenario Planning. Theodor Stewart, University of Cape Town.

The development of multiple criteria decision analysis (MCDA) over the past 20 years has provided a powerful methodology for supporting decision makers facing multiple, conflicting objectives. In many applications of MCDA, however, uncertainties which are crucial to good decision making may often be ignored, or poorly treated. Scenario planning has been developed specifically as an aid to strategic decision making under uncertainty. Possible means of integrating scenario planning with MCDA are reviewed, and illustrated. We report on simulation studies in which consequences of some specific integrated approaches are evaluated, and which lead to recommendations for future decision-aiding practice.

4 : From Design to Decision: An Integrated Approach Linking Simulation, Evolutionary Multiobjective Optimization and MCDA. Gilberto Montibeller, University of Strathclyde; Hodgkin, Julie; Belton, Valerie.

This paper explores the potential to harness the power of discrete event simulation (DES), evolutionary multiobjective optimization (EMO) and multicriteria decision analysis (MCDA) to provide an integrated interactive decision support system in which DES provides the facility to explore alternative system designs, EMO is the means of identifying an efficient set of designs, and MCDA informs the choice of a preferred solution amongst these, or a desired strategy for improvement. The proposed process will be illustrated by analysis of a small scale problem, leading to discussion of the theoretical and practical challenges posed.

: WC28 **Searching Discrete Locations**

Invited Session Room: L12

Chair: Steve Alpern
London School of Economics

1 : Dynamic Search for a Moving Target. David Assaf, The Hebrew University; Sharlin-Bilitzky, Ariela; Zamir, Shmuel.

A target is hiding in one of several locations, each characterized by a search cost and overlook probability. A searcher must find the target with minimal expected total cost. Consider a moving target who may change his location at any time. In one model movements of the target are random, and we utilize a "dynamic search" procedure in which the searcher may continuously adjust his search intensities. A second model assumes an intelligent target who selects his moves strategically to maximize his expected survival time. The model in a non zero sum game, and we study equilibrium and minimax strategies.

2 : Rendezvous-Evasion Search in Two Boxes with Incomplete Information. John Howard, London School of Economics; Gal, Shmuel.

An agent (who may or may not want to be found) is located in one of two boxes. With probability p he wishes to be found, in which case he has been asked to stay in box B. With probability 1-p he tries to evade the searcher, in which case he may move between boxes A and B. The searcher looks into one of the boxes at times 1,2,3,... . Between each search the agent may change boxes if he wants. This paper finds a solution to this game and associated strategies for the searcher and each type of agent.

3 : The Quiet Accumulation Game on a Linear Graph: A Special Case. Kensaku Kikuta, Kobe University of Commerce; Ruckle, William.

In this accumulation game, at each time a hider places an ob-

ject at a node on a finite linear graph and a seeker examines a node, moving along edges. If the seeker discovers an object the seeker confiscates it. The goal of the hider is to accumulate a certain number of objects before a given time, and the goal of the seeker is to prevent this. In the quiet case the hider does not know where the seeker examines unless the seeker finds an object at that location. We give bounds for the value of this two-person zero-sum game.

4 : Weighted Search Games on a Lattice. Noemi Zoroa, University of Murcia; Fernández-Sáez, M.José; Zoroa, Procopio.

A spy works for n enterprises E1, ..., En and he has agreed to leak information a minimum number of times every month to each company, k1 times to E1, k2 to E2, etc. Contrariwise, the counterespionage service realizes h inspections each month in every company to try to avoid leaks. The spy must select the days in which he will leak information bearing in mind that the companies are of different importance, which is reflected in a specific weight associated to each Ei. We will study strategic situations similar to the one previously described.

: WC29 **Dynamic Programming - II**

Invited Session Room: L13

Chair: Thomas Archibald
University of Edinburgh

1 : A Discrete-Time Portfolio Model with Uncertainty of Stock Prices. Yuji Yoshida, The University of Kitakyushu; Yasuda, Masami; Nakagami, Jun-ichi; Kurano, Masami.

A mathematical dynamic portfolio model with uncertainty is discussed. In the uncertainty model, the randomness and fuzziness are evaluated simultaneously cooperating with both of probabilistic expectation and mean values with weighting functions. By dynamic programming approach, we derive an optimality equation for the optimal consumption and wealth problem in a fuzzy stochastic process, and then an optimal portfolio is given in the equation. It is shown that the optimal total expected utility is a solution of the optimality equation under a reasonable assumption.

2 : On the Optimal Allocation of Service to Impatient Tasks. Kevin Glazebrook, University of Edinburgh.

Service is often provided in contexts where tasks or customers are impatient or perishable in that they have a natural lifetime of availability for useful service. Hence telephone callers may hang up, emergency patients may die and mobile military targets may move out of range. Moreover, these lifetimes are usually unknown to the service provider. We consider the question of how service might be best allocated to the currently waiting tasks or customers in the context of a simple multi-class queueing system subject to such loss. A simple index heuristic is developed to guide service allocation in such contexts.

3 : Is Commonality Useful?: A Dynamic Stochastic Decision Approach to Maximise Survival Probability of Manufacturing Start-Up Companies. Edgar Possani, University of Southampton; Thomas, Lyn; Archibald, Thomas.

This paper deals with component commonality in start-up manufacturing firms. We present a two-product Markov decision model that examines the implications of the inventory and production strategies in the survival probability of the firm. The advantage of using component commonality is proven under different scenarios, and general properties are derived. We find the optimal policies for the firm to maximise the probability of survival in the long run. Although the model we analyse is a simple one its aim is to provide a framework and give insight about the relationship between inventory, production, and financial decision in a manufacturing environment.

4 : Modelling the Reset Decision for Segregated Fund Maturity Guarantees. Thomas Archibald, University of Edinburgh; Tapeinos, Socratis.

Segregated funds are fixed term investment products that include a form of life insurance and a maturity guarantee. The maturity guarantee ensures that when the value of the fund at maturity is less than a certain value, the investor is paid the difference. Often the investor has the option to "reset" the maturity date and the guaranteed value of the investment. Existing models generally restrict the reset strategy by using heuristics and limiting the number of reset opportunities. This paper analyses a Markov decision process model of segregated funds that imposes no such restrictions on the reset strategy.

: WC30 **Finance & Banking - C2**

Contributed Session Room: L14

Chair: Hitoshi Takehara
University of Tsukuba

1 : Ownership, Deregulation and Productivity Developments in Banking: The Case of Turkey. İhsan Işık, Rowan University; Yıldırım, Semih; Uysal, Doğan.

This paper examines productivity developments in public, private and foreign banks operating in Turkey over the initial post-liberalization period. Using the Dea-type Malmquist index approach, it also explores the contributions of technological change, efficiency change and scale change to productivity growth. The results show that productivity growth in the banking sector coincided with promotion of liberal policies. The major source of productivity gains is scale changes for public banks and efficiency changes for (domestic or foreign) private banks. In terms of productivity growth, foreign banks strongly dominate domestic banks and there are no observed advantages accruing to larger banks.

2 : Development and Characteristics of Single Stock Futures Markets. Sladjana Barjaktarovic, University of Belgrade.

Single stock futures are one of the most interesting products of financial derivatives. Reasons for this allegation are numerous. First and most important is huge trading potential for these instruments. Second is that single stock futures have not appeared on the most developed financial market in the world, in the US, until last year, after long time of preparation. Purpose of this paper is to show main characteristics of these instruments and influence they have for development of financial market. Moreover, in this paper will be given course of market evolution of these instruments and its advantages for emerging markets.

3 : Investment Banking in Emerging Markets. Stojan Dabic,

University of Belgrade; Barjaktarovic, Sladjana.

Investment banking is very important, dynamic and innovative segment of financial services on developed financial markets as well as on emerging markets. It enables efficient funds allocation, capital market development, creating new financial instruments, helping bringing together market's participants. This paper gives basic characteristics and points out the importance that investment banking has for emerging markets. Development of investment banking in emerging markets has great potential, but it demands both cognition of specific environment on these markets and potential risks that may occur.

4 : Characteristics versus Common Risk Factors: Identifying Equity Pricing Model for Japanese Firms. Hitoshi Takehara, University of Tsukuba; Kubota, Keiichi.

This paper investigates whether Fama and French's book-to-price ratio factor can span the risk-return space generated by the Tokyo Stock Exchange firm sample. Our null hypothesis is that the book-to-price ratio is a pricing factor, whereas an alternative hypothesis supports the claim that it is a characteristic by the usage of Daniel and Titman (1997), and not a risk factor. Our empirical test supports our initial contention. We conclude that the book-to-price ratio is a risk factor that prices equity values for Japanese firms.

: WC31 **Human Resources Management**

Invited Session Room: M33

Chair: Paul Swiercz
George Washington University

1 : Real Options Analysis of High-Tech Workforce Outsourcing Decisions for Semiconductor Equipment Manufacturer. Ying-Chyi Chou, Thughai University; Chang, Pao-Long.

Facing the changes in the number of engineers demand, the decision whether to take on temporary workers in lieu of hiring permanent employees is an important issue to the semiconductor equipment supplier. Due to the risk of whether the engineer can pass through the certification procedures, the real option approach is used to discuss the workforce outsourcing. In this paper, we will provide a method to evaluate the parameter of volatility, and the resulting call option can be used to satisfy the hedging purpose of the outsourcing company and the semiconductor equipment company.

2 : Scheduling Full and Part-Time Positions of a Single Shift under the Annualized Hour Arrangement. Carlos Salvador Azmat, University of Fribourg; Widmer, Marino.

Nowadays flexibility is a strategic concept for firms. Indeed the workload has to follow, as closely as possible, the evolution of demand along the year. However, due to legal and cost constraints, it is not always possible to adapt the human resources to the production requirement. Therefore, the workforce scheduling becomes a delicate task. In this paper, a heuristic method is used to solve the workforce schedule problem for a single-shift. The annualized hour scenario is considered and it is assumed that full and part-time employees are able to perform each task in the workshop.

3 : The Effects of Applicants' Characteristics on Employment Interview Satisfaction of Applicants. Fatma Kuşku, İstanbul Technical University; Çakmak, Ahmet; Ataman, Berk.

The purpose of this study is to explore the interview satisfaction level of job applicants by exploring the negative and positive experience of them during the process of employment interview. Additionally, if the demographic and personal characteristics (e.g., training; job knowledge, job experience, prior experiences with selection process and interview; purpose of interview, self-esteem) of applicants will effect the satisfaction level or not will be explored. The data is based on the real experiences of the job seekers, were gathered in 2 stages by using the "deterministic" (42 applicants replied) and "descriptive" (244 valued reply) research models.

4 : Management by Objectives in Human Resources Management. Eda Çetinkaya, TUSSIDE; Ünlü, Işıl; Çalışkan, Fethullah.

Implementing a "Human Resources Management System" in training and consulting organization is an essential and a challenging project. TÜSSİDE is Turkish Institute for Industrial Management providing customized training and consulting solutions for organizations. The Human Resources Management System has been designed with the aim of enhancing the overall performance of the existing human capital of TÜSSİDE. The paper will focus on the implementation of the "Performance Management System" which has been designed as a strategic management tool. The Performance System integrates the "Management by Objectives" approach with the competency framework thus providing a comprehensive and in-depth guide for performance development.

: WD01 **EURO Excellence in Practice Award (EPA)**

Award Session Room: MB I

Chair: Michael Pidd
Lancaster University

1 : ARMS: An Automated Resource Management System for British Telecommunications plc. Christos Voudouris, British Telecommunications plc; Owusu, Gilbert; Dorne, Raphael; Ladde, Cedric; Virginas, Botond.

Accurate demand forecasting combined with resource planning is critical to a company's performance and profitability. This paper describes ARMS (Automated Resource Management System), an integrated system developed for the customer service operations of British Telecommunications plc to help with the operational planning and deployment of the company's 20,000-strong field engineer workforce. ARMS integrates a forecasting tool with a resource planning tool providing an end-to-end automated resource management solution for the organisation. OR techniques are used throughout the system, including ARIMA for forecasting, Constraint Satisfaction for problem modelling, Heuristic Search for problem solving.

2 : Broadcast Scheduling for Mobile Advertising. Bert De Reyck, London Business School; Degraeve, Zeger.

We developed a broadcast scheduling system for a firm specialized in location-sensitive permission-based mobile advertising using SMS text messaging. Text messages containing advertisements and promotional offers were sent to customers when

shopping in shopping centres in London. The company's problem was deciding which ads to send out to which customers at what particular time, given a limited capacity of broadcast timeslots, while maximizing customer response and revenues from retailers. We solved the problem using integer programming with an interface in Microsoft Excel. The system significantly reduced the scheduling time, and resulted both in increased customer response and revenues.

3 : Laps Care - An Operational System for Staff Planning in Home Care. Mikael Rönnqvist, Linköping University; Eveborn, Patrik; Flisberg, Patrik.

The health care system in many other countries is facing increasing costs. We focus on a staff planning problem arising in Sweden where people receive home care from the local authorities. The planning is to find work routes to visit caretakers and at the same time consider a number of restrictions and soft objectives. We describe a decision support system Laps Care to aid the planners. It consists of several components including optimization routines. The system is currently in operation at a number of home care organizations. The savings are considerably in terms of saved planning time and quality.

: WD02 **Engineering Exuberance**

Semi-Plenary Room: MB II

Chair: Ali Rıza Kaylan
Boğaziçi University

Engineering Exuberance. Thomas L. Magnanti, Massachusetts Institute of Technology.

In the last hundred years, engineers conceived, designed, and implemented major scientific and technological developments that have transformed our lives. And, they will do so again in the next hundred years. But the context of engineering differs today from the past with innovations flourishing in such fields as bioengineering, engineering systems, tiny technologies, information, computation and communications, and new educational technologies. It is an exciting time for engineering, with almost unprecedented opportunities. This talk will summarize some emerging themes and ways the modern research university will remain at the forefront of engineering education, research, and practice.

: WD03 **Panel on University-Industry Relations in the Context of OR/MS**

Panel Room: MB III

Chair: Gündüz Ulusoy
Sabancı University

Panelists: August-Wilhelm Scheer
Universität des Saarlandes

Larry J. LeBlanc
Vanderbilt University

Andrés P. Weintraub
Universidad de Chile

İbrahim Kavrakoğlu
Kavrakoğlu Consulting

: WD04 **EURO Management Science Strategic Innovation Prize**

Award Session Room: JB A

Chair: Christof Weinhardt
University of Karlsruhe

EURO Management Science Strategic Innovation Prize.

The winning paper will be presented.

: WD05 **Transportation - C1**

Contributed Session Room: JB B

Chair: Vojin Tosic
University of Belgrade

1 : Some Theoretical Results on the Average Traveling Distance of a Radial-Circular Traffic Network. Li Mingzhe, Fukuoka University.

The investigations on the average distance traveled by people within an urban area are valuable since they provide one important measure of the traffic efficiency of an existing city or of a city design, also because they affect energy consumption of gasoline, air pollution caused by exhaust gas etc. during their trips. In this paper, based on an urban traffic model, we mathematically derive the average distance traveled by car commuters within a radial-circular traffic network. We also discuss the relationship between our model and the related studies, e.g., SPCP(Shortest Path Counting Problems) proposed by Oyama and Taguchi.

2 : Terminal Airspace Traffic Complexity Metric. Vojin Tosic, University of Belgrade; Netjasov, Fedja.

Air Traffic Complexity is discussed and a definition is proposed, as well as desirable properties of a complexity metric. Basic complexity metric structure is further proposed for a particular case of terminal airspace traffic. Two metric models, simple and somewhat more detailed are suggested for consideration. The model outputs are illustrated using a simple generic terminal airspace and traffic demand. Finally, further possible metric improvements are outlined.

: WD06 **Scheduling - C5**

Contributed Session Room: M30

Chair: Mohamed Haouari
Ecole Polytechnique de Tunisie

1 : Scheduling Resumable and Non-Resumable Operations. Philippe Mauguiere; Billaut, Jean-Charles; Jean-Louis, Bouquard.

In the scheduling literature that considers availability constraints, most of the problems involve single machine, parallel machines or flow shop environment. Few papers consider job

shop environment. Concerning the unavailability period, three cases are generally considered: the resumable case, the non-resumable case, and the semi-resumable case. We investigate a job shop problem, where in the same problem, some operations are resumable and other operations are not resumable. We propose a branch-and-bound algorithm to solve the single machine problem with heads and tails and another branch-and-bound algorithm for the job shop scheduling problem. Finally, some computational results are presented and discussed.

2 : Some Heuristics for Incorporating Flexibility into Job Shop Solutions. Carl Esswein, Université de Tours; Billaut, Jean-Charles.

The problematic that consists in providing flexible solution to scheduling problems so as to be able to react in real time to disturbances is now clearly identified. We decided to provide this flexibility by searching for a group-schedule instead of a single schedule in order to characterize a set of schedules among which the decision maker will be able to choose the one to process according to the disturbances occurred. This concept allows to add sequential flexibility to solutions. We present a few heuristics providing flexibility to job shop solutions and computational experiments emphasize the interest of the methods.

3 : A New Branch and Bound Algorithm for the Permutation Flowshop Problem. Talel Ladhari, Ecole Polytechnique de Tunisie; Haouari, Mohamed.

We design a new Branch and Bound algorithm for the permutation flow shop scheduling problem. This algorithm is based on new proposed adjustment procedures as well as new immediate selection rules. Also, a strong lower bound based on the two-machine flow shop with release dates, time lags, and delivery times is implemented. Computational experiments show that hard benchmark problems are solved in moderate CPU time.

4 : On the Two-Center Hybrid Flowshop Problem. Mohamed Haouari, Ecole Polytechnique de Tunisie; Hidri, Lotfi.

We address the two-center hybrid flow shop scheduling problem where a set of jobs must be processed in a shopfloor with two centers arranged in a serial way. The objective is to minimize the makespan. We investigate upper and lower bounding strategies and we present an exact branch and bound algorithm. Computational results on randomly generated instances are reported.

: WD08 Social Choice, Allocation, and Bargaining

Invited Session Room: M32

Chair: Remzi Sanver
Bilgi University

1 : Bargaining Power in Stationary Parallelogram Games. Özgür Kıbrıs, Sabancı University; Taub, Bart.

A stationary variant of the repeated Prisoners' Dilemma is analyzed by using the probabilistic cheap-talk concept. The equilibrium identified is then analyzed as a cooperative bargaining solution, and shown to satisfy some standard bargaining axioms within the class of parallelogram games. A characterization is provided in terms of these axioms.

2 : Consistency in Roommate Problems. İpek Özkal-Sanver, Bilgi University.

We study whether there exists a consistent extension of the core satisfying non-emptiness, anonymity, Pareto Optimality and Individual Rationality. We show that there exists no single-valued solution which is Pareto optimal and anonymous. Furthermore, there exists no well-defined solution which satisfies Pareto Optimality, Individual Rationality, Converse Consistency and Anonymity

3 : Dictatorial Domains in Choosing Committees. Remzi Sanver, Bilgi University.

We show that non-dictatorial social choice rules which pick a fixed size committee at each preference profile over committees are all manipulable, as long as we wish to relate preferences over committees to preferences over committee members in a "sensible" manner.

4 : Proportional Solution versus Egalitarian Equivalent Solution. Miguel Gines, Universitat Jaume I.

The Egalitarian Equivalent solution was characterized, in the case of one public good, by Moulin (1987). The paper proposes and compares a characterization of the proportional solution with a characterization of the egalitarian equivalent correspondence in the presence of several public goods.

: WD09 Managerial and Consumer Decision-Making - C1

Contributed Session Room: L15

Chair: Tolga Akcura
Purdue University

1 : To Innovate or Imitate? R&D Decisions and the Role of Market Research. Ozge Turut, Harvard Business School; Ofek, Elie.

A firm contemplating entry into a new market can either imitate or attempt to leapfrog the existing incumbent. We develop a game-theoretic model to examine firm behavior in such contexts and identify conditions for the entrant to prefer imitation to innovation. Furthermore, we show that threat of being imitated, rather than that of being leapfrogged, may spur more technological advance. We extend the model to include market demand uncertainties and allow firms to perform market research. We show that market research can serve as a strategic tool for the incumbent to influence the entrant's R&D decisions.

2 : Empirical Analysis of a Lanchester Model with Asymmetric Players. Ramla Jarrar, HEC Montréal; Breton, Michèle; Zaccour, Georges.

We study in this paper dynamic equilibrium advertising strategies in a duopoly, with asymmetric information structure in an infinite time horizon. The advertising model of Lanchester is used in a game where one of the player is leader and the other follower in a differential game à la Stackelberg. We adopt the feedback information structure and devise an algorithm to compute the resulting subgame perfect equilibrium. Numerical results based on data from the beer and cola industries are reported and analyzed.

3 : The Impact of Frequent Shopper Programs in Grocery Retailing. Rajiv Lal, Harvard Business School; Bell, David.

Frequent Shopper programs are becoming ubiquitous in retailing. Retailers seem unsure about whether these programs are leading to higher loyalty or higher profits. We analyze data from a supermarket chain that has used frequent shopper rewards to improve sales and profitability. We find, while these programs are profitable, this is only because substantial incremental sales to casual shoppers offset subsidies to loyal customers. Our findings are inconsistent with existing theories about how frequent shopper programs are supposed to work. We construct our own Hotelling-like model that explicitly models casual behavior and shows its predictions match the data quite closely.

4 : Private Labels and Retailer Strategies. Tolga Akcura, Purdue University; Bezawada, Ram; Kalra, Ajay.

We investigate the strategic role of private labels in limiting retail competition using an analytical model. Further, the results of an empirical analysis are in agreement with the analytical model. Our analysis shows that the overall private label shares of a store can deter entry and/or induce other non-competitive stores to exit the market. According to the model, competition makes it more likely for retailers to introduce private labels or increase private label market shares. Private label market shares may rise as national brand margins rise when stores use their private labels to limit competition.

: WD11 **Empirical Studies in SCM - C2**

Contributed Session Room: R20

Chair: Funda Sahin
The University of Tennessee

1 : The Impact of E-Replenishment Strategy on Make-to-Order Supply Chain Performance. Funda Sahin, The University of Tennessee; Robinson, Powell; Gao, Li-Lian.

We examine the impact of the electronic replenishment of direct materials on the operational performance of a two-stage make-to-order supply chain. Utilizing optimization-based rolling horizon procedures, we study manual, semi-automated, and fully automated e-procurement and e-fulfillment strategies in decentralized, centralized and vendor-managed inventory (VMI) structures. Experimental data is applied to investigate the relationships among e-replenishment strategy and supply chain costs at the system, channel member, and cost component level. The study also identifies environmental factors favoring the investment in e-replenishment technology and compares the impact of e-replenishment across decision-making structures.

2 : Analyzing Performance of Logistics Activities using Artificial Neural Networks. Şule Önsel Şahin, İstanbul Technical University; Ülengin, Füsun.

The objective of this study is to identify and analyze the performance of Turkish firms in terms of logistics activities. A survey is conducted with the top 500 firms of Istanbul Chamber of Commerce and an artificial neural network (ANN) is used. The basic idea behind using ANN in the selection of the best logistics activities; is to specify the activities that have the highest impact on the logistics performance level. All the logistic strategies are used as inputs and the logistics performance as the output of an ANN model that will be trained with back-propagation algorithm.

3 : Partial Least Squares-based Structural Equation Modeling: A Supply Chain Empirical Research Application. Canan Kocabasoglu, University of Kansas; Suresh, Nallan.

This study illustrates the use of partial least squares (PLS)-based structural equation modeling approach, which is yet to be adopted widely in operations management research. We demonstrate the use of these methods in a recently completed empirical study on strategic sourcing and its impact on supply chain performance. Strategic sourcing is treated as a second-order factor, based on strategic elevation of Purchasing, cross-functional integration of Purchasing with other internal processes, proactive involvement with key suppliers by provision of technical and financial assistance, and information sharing.

: WD12 **Maintenance Optimization**

Invited Session Room: M39

Chair: E. Kevin Doyle
Bruce Power

1 : A Model to Predict the Residual Life of Aircraft Engine based upon Oil Analysis Data. Wenbin Wang, University of Salford.

This paper reports on a study using the available oil monitoring information to predict the residual life of a set of aircraft engines. The relationship between oil data and the residual life is established using the concept of proportional residual. The principal component analysis (PCA) has been adopted to reduce the dimension of the original data set and to produce a new set of uncorrelated variables, which we shall use in the prediction model. The model is fitted to the actual SOAP data from the aircraft engines, and the goodness-of-fit test has been carried out.

2 : Stochastic Models for Repairable Systems Subject to Preventive Maintenance. David F. Percy, University of Salford.

Interpolating between renewals and minimal repairs of complex systems, we propose a parametric framework of stochastic point processes as mathematical models for reliability and imperfect maintenance. The underlying model for successive inter-failure times is assumed to be a nonhomogeneous Poisson process. We consider extensions to allow for preventive maintenance actions and to determine strategies for optimal scheduling of these actions. We refer to these as the additive (AIM) and geometric (GIM) intensities models. Subjective prior distributions are developed for dealing with unknown model parameters. Our theory is illustrated by application to valve maintenance data from a continuous process industry.

3 : Age-based Replacement with a Reliability Constraint. Philip Scarf, University of Salford; Dwight, Richard.

We consider the classic age-based replacement policy when reliability is also a decision criterion. We show that setting a value for the cost of failure and setting a reliability constraint are equivalent, and thus propose a simple method for checking the consistency of these measures when specified by system op-

erators and maintainers. Different measures of operational reliability are considered. A simple expression for the median time between operational failures for a socket subject to age-based replacement is obtained. The approach is illustrated using data from an actual case relating to train traction motors.

4 : Developments in the Application of Stochastic Models in Nuclear Power Plant Maintenance. E. Kevin Doyle, Bruce Power; Duchesne, Thierry; Cho, Danny I.

The current reality of global competition necessitates the pursuit of all financial optimizers. At present, statistical modeling isn't used in the convention maintenance decisions of the nuclear industry, an industry that represents hundreds of billions of dollars of industrial infrastructure. Significant progress has been achieved in demonstrating the financial incentives resulting from the application of stochastic maintenance models since the initiating study was published in the EJOR in 2002(submitted in Dec 2000). This paper describes a pilot study where component lifetime distributions obtained by expert elicitation techniques are used in simple statistical models to successfully reduce the cost of maintenance.

: WD14 **MODM - C2**

Contributed Session Room: R22

Chair: Mohammed Said Radjef
University of Béjaïa

1 : Application of MCDM Methods: ELECTRE and AHP using Expert Choice to Study of Railways Infrastructures. Jose M Anton, Universidad Politecnica de Madrid; Grau, Juan B.

The election of prior alternatives for the corridor Madrid-Valencia high-speed railway is considered in this paper using the outranking MCDM methods ELECTRE-I and AHP using Expert-Choice PC program. Starting from two reported cost-effectiveness studies for that link the feasibility may be assessed, but for the election of layout alternative a reduced but sufficient choice of criteria, variables and values was made, containing relevant long-term indirect benefits linked with Development and Organisation of Territory. In both cases the solution "North" was preferable, in coincidence with the official solution. Thus, such outranking methods are appropriated for such Decision-Making procedures.

2 : Energy Planning in Buildings under Uncertainty in Fuel Costs. George Mavrotas, National Technical University of Athens; Diakoulaki, Danae.

Hotel units are among the largest energy consumers in the building sector where energy planning may greatly facilitate investment decisions for efficiently meeting energy demand. The present study presents three Mixed Integer Programming models including both continuous and integer variables, which represent energy flows and discrete energy technologies, respectively. Emphasis is given on the modeling of the fuel cost coefficients as they are the greatest source of uncertainty in the problem. Three cases are examined: crisp, fuzzy and interval cost coefficients and the corresponding models (two multiple objective models and one single objective model) are developed.

3 : Optimizing Several Quadratic Fractional Objectives on a Non-Convex Polytope. Mustapha Moulai, UTHB.

Integer quadratic fractional programming problem with several objectives MIQFP is studied in the present paper in which each objective is to minimize a ratio of two quadratic functionals over a set of integer points contained in a convex polytope. A related integer linear fractional programming problem ILFP is formulated in order to obtain an optimal solution of the single objective integer quadratic fractional programming problem IQFP. A solution procedure is developed to find the set of all efficient solutions of MIQFP. The proposed procedure converges in a finite number of iterations.

4 : On Sufficiency Conditions of Optimality in Invex Multiobjective Problem. Mohammed Said Radjef, University of Béjaïa; Slimani, Hachem.

Using the concept of invexity and its extensions introduced by Hanson (1981), the existence sufficiency conditions for Slater and Geoffrion minimal decisions in a multiobjective problem have been subject to generalization under different forms: [Osuna-Gomez and al. 1999],[Aghezzaf and Hachimi 2000], [M.A. Hanson and al. 2001]. In this paper, we propose another form of the existence sufficiency conditions for Slater and Geoffrion decisions in a multiobjective problem. Some optimality conditions have been deduced for nonlinear programming.

: WD15 **E-Commerce Auctions**

Invited Session Room: R23

Chair: Gnana Anandalingam
University of Maryland

1 : Dynamic Airline Slot Exchange. Michael Ball, University of Maryland; Vossen, Thomas.

US air traffic management procedures for ground delay programs employ a resource allocation algorithm, called compression. We interpret compression and the associated operational procedures, as a mediated bartering process. Under this interpretation, airlines submit "offers" that can be viewed as proposed 1-for-1 trades. We define a generalization that uses 2-for-2 trades and formulate the mediator problem as an integer program that can be effectively solved through careful formulation. We show that the 2-for-2 trading system can achieve far greater system efficiency than the 1-for-1 trading system. The prospect of creating a true market by allowing side payments is also discussed.

2 : The Impact of Franchisor Web Sites on the Relationship between Franchisors and Franchisees. C. M. Sashi, Florida Atlantic University; O'Leary, Bay.

This study investigates how the advent of the Internet and electronic commerce has impacted the relationship between franchisors and franchisees. Many franchisors are establishing corporate Web sites to perform a variety of value-adding functions. Franchisees, however, may view the Web site as a beneficial tool designed to help them reach their individual and corporate goals or as an opportunistic self-serving act on the part of the franchisor. Hypotheses linking the relational norms of trust, commitment, and role integrity to franchisee reactions in terms of attitude, passive acceptance, constructive discus-

sion, venting, disengagement, and overall relationship quality are empirically investigated.

3 : On the Design of Time-Sensitive Auctions. Gnana Anandalingam, University of Maryland.

Time sensitive goods are goods (and services) that change in value to buyers or sellers or both. Examples include tickets to entertainment and sporting events, and seats in a particular airline flight. In order to address the nuances of such goods, new models have to be used, and also very fast algorithms to obtain equilibrium solutions. In this paper, we provide a set of models that can be used to analyze auctions for time-sensitive goods and services.

4 : An Efficient Algorithm for Winner Determination in Combinatorial Auctions. Roy Kwon, University of Toronto.

We present a mathematical programming approach to the winner determination problem for combinatorial auctions, and present a fast algorithm based on primal-dual theory to solve it. In markets where there is time sensitivity, it is important for the auctioneer to be able to determine the winner's in an auction very quickly. In this paper, we allow the auction to proceed through a number of rounds. However, in each round, the auctioneer can determine the winners very quickly, and can also stop the auction pre-maturely if time is running out, and end with a primal feasible solution.

: WD17 **Stochastic Model Applications**

Invited Session Room: R24

Chair: Jens Guessow
University of St. Gallen

1 : Forward Curve Modelling for Contract Evaluations in Stochastic Portfolio Optimization. Jens Guessow, University of St. Gallen; Kuhn, Daniel.

Due to changing market conditions, utilities in Europe have to handle limited and unstable price information in electricity markets. The presented approach overcomes some of these problems by using a quadratic program. It minimizes the discrepancy between the shape of spot curves and price information in futures markets and smoothes price jumps. Efficient numerical algorithms can be applied to solve the problem. A historic series of forward curves is generated, which in turn provides the input for a forecasting model. The results are used for the evaluation of contracts with user-defined load patterns in a stochastic portfolio optimization model.

2 : Stochastic Programming Models for Evaluation Competition Scenarios in Telecommunication Environment. Alexei Gaivoronski, Norwegian University of Science and Technology; Werner, Adrian.

We consider the problem of pricing of telecommunication services in the presence of competition. Competition is responsible for a part of uncertainty present in the environment, the other part is due to uncertain demand and limited information about other economic characteristics. We extend stochastic programming models for this situation, drawing on some ideas from the game theory.

3 : Valuation of Electricity Swing Options. Daniel Kuhn, University of St. Gallen; Frauendorfer, Karl; Guessow, Jens.

A swing option is an agreement to purchase electric energy at a predetermined price during a fixed period, and it provides some flexibility in the quantity to be delivered. Typically, a swing option appears along with limitations on power and cumulative energy. Sometimes, it contains complicating provisions like ratchets, i.e. maximum power changes in specified time intervals. Limitations on the integral or differential of the load curve introduce path dependence, allowing us to analyze swing options in a stochastic optimization framework. We develop a stochastic program to find the option's price and an optimal exercise strategy.

4 : Scenario Generation and Stochastic Programming Models for Natural Resource Management. Valentina Bosetti, Università Milano Bicocca; Messina, Vincenzina; Valente, Patrick; DiDomenica., Nico.

In this paper we compare scenario generation techniques for natural resource conversion models. We propose a multi-stage stochastic programming model for a land gradual conversion problem. The random variables represent possible outcomes for the value of the land in different states. Scenario trees are generated using both random sampling and methods based on moment-matching techniques. We compare the results obtained using these alternative scenario generation procedures by conducting rolling horizon simulations. Finally, conversion policies computed through the stochastic programming approach are compared to those obtained applying alternative techniques, as standard expected present value.

: WD19 **Combinatorial Optimization - C1**

Contributed Session Room: R26

Chair: Mustafa Pınar
Bilkent University

1 : Minimization of Total Setup Time in Cable System Manufacturing. Ekrem Duman, Doğus University; Özçelik, Hamdi; Ceranoğlu, Ahmet Nuri.

The cabling systems used in automotive, telecommunication and similar industries consist of large number of cables differing in length, color, diameter, and connectors attached to their ends. The production stage involving cutting, stripping, and crimping requires setup times on the machines due to variety in connectors to be crimped. Hence, the minimization of total machine setup time is a critical issue for high throughput rates. This problem surprisingly turns out to be a special and unexplored version of the well-known TSP. The description of a heuristic method which was developed and successfully implemented in a real production environment is presented.

2 : On Solving of the Dominating Subset with Minimal Weight Problem. Urfat Nuriyev, Ege University; Ordin, Burak.

In this work, we define a new combinatoric problem with Boolean variables under the name "Dominating Subset with Minimal Weight (DSMW)", problem that is equivalent to the Subproblem which appears as solving Global Optimization problems and DSMW problem can be expressed as of a kind of Assignment

problem. Then, mathematical model and economical interpretation of the problem are given and its properties are shown. After that, a method, which could be thought as a combination of algorithms with greedy type and its complexity is in polynomial time, is offered and a program is developed in C++.

3 : A Scatter Search Approach to the Time Slot Assignment Problem in SS/TDMA Systems. Fausto Pedro Garcia Marquez, Universidad de Castilla-La Mancha; Marti, Rafael; Laguna, Manuel; Conde Collado, Javier.

In this work we propose a Scatter Search (SS) procedure for the SS/TDMA problem. SS is an evolutionary method that has been successfully applied to hard optimization problems, which is mainly built on the following five methods: A Diversification Generation Method; An Improvement Method; A Reference Set Update Method; A Subset Generation Method; A Solution Combination Method. In order to measure the quality of the proposed method, we have compared the solutions obtained with the SS algorithm with those obtained by a recently proposed Reactive GRASP. The computational comparison favors our SS implementation.

4 : An Efficient Exact Algorithm for Capacitated p-Center Problem. Aykut Özsoy, Bilkent University; Pinar, Mustafa.

We develop a simple and yet very efficient exact algorithm for the problem of locating p facilities and assigning clients to them within capacity restrictions in order to minimize the maximum distance between a client and the facility to which it is assigned (capacitated p-center). The algorithm iteratively sets a maximum distance value within which it tries to assign all clients, and thus solves bin packing subproblems. An initial phase of the algorithm consists in solving linear programming subproblems, and is shown experimentally to give very tight lower bounds to the optimal value. Experiments on OR-Lib instances yield promising results.

: WD20 **Bayesian Reliability Modeling**

Invited Session Room: M35

Chair: Fabrizio Ruggeri
CNR - IMATI

1 : Bayesian Inference for a Nonparametric Software Reliability Model. Simon Wilson, Universidad Carlos III.

In this paper I pursue a fully non-parametric Bayesian approach to software reliability. I propose a bug counting model, with an unknown number of bugs in the software, each with a distribution for time to discovery that is described by a Dirichlet process prior. I show that data can be considered as observations from the distribution function with considerable right censoring, thus the posterior of the distribution function is described by a beta-Stacy process. This model is applied to some data and its performance is briefly discussed.

2 : On the Reliability of Repairable Systems: Methods and Applications. Fabrizio Ruggeri, CNR - IMATI; Pievatolo, Antonio.

We review the most common models for repairable systems and present our recent research and consulting activities on modelling failures in repairable systems, namely gas distribution networks and underground trains. We present and compare both parametric (nonhomogeneous Poisson processes) and nonparametric (gamma processes) models used to describe gas escapes. Failures of door opening systems of underground trains are modelled by a nonhomogeneous Poisson process with a periodic component and the relation between run kilometers and elapsed time is described by a gamma process.

3 : Bayesian Analysis of Markov Modulated Bernoulli Processes. Süleyman Özekici, Koç University; Soyer, Refik.

We consider Markov Modulated Bernoulli Processes (MMBP) where the success probability of a Bernoulli process evolves over time according to a Markov chain. The MMBP is applied in reliability modeling where systems and components function in a randomly changing environment. These applications include reliability assessment in power systems that are subject to fluctuating weather conditions over time and reliability growth processes that are subject to design changes over time. We develop a general setup for analysis of MMBPs with a focus on reliability modeling and present Bayesian analysis of failure data and illustrate how reliability predictions can be obtained.

4 : Bayesian Software Release Strategies using Monte Carlo Methods. Refik Soyer.

In this paper we address the problem of when to terminate the testing and release the software during the development phase. In so doing, we present a Bayesian decision theoretic approach and develop Monte Carlo based methodologies that replace the preposterior analysis by surface fitting methods. We illustrate our approach by considering single and two-period decision problems.

: WD21 **Demand/Inventory/Resource Pooling**

Invited Session Room: M36

Chair: Barış Tan
Koç University

1 : Analysis of Allocation Mechanisms for Cooperation of Manufacturers on Production Capacity. Barış Tan, Koç University.

We consider a number of independent producers with limited capacity. They form a partnership to compete in the market for large volume orders. We examine the mechanisms how an arriving order is to be distributed among the members depending on the volume and the due-date of the orders, capacities, the current loads, and the cost structures of the member producers. We also examine how the profit generated from the order should be distributed among the members. We present a centralized and a decentralized mechanism and evaluate the performances of these mechanisms in a dynamic stochastic setting.

2 : Demand Substitution on Single Stage Hybrid Systems with Pull-Type Control Polices. Aybek Korugan, Boğaziçi University; Gupta, Surendra M.

This study considers a production system that that performs remanufacturing as well as new product manufacturing activities on two discrete production lines. The output of either production line is capable of satisfying demand for remanufactured or newly manufactured products. However, when a product is used to satisfy a demand for another product type, a substitu-

tion cost is added. The problem is analyzed as a Markov process where interarrival times for demand occurrences and service completions are exponentially distributed i.i.d. variables. In order to control such systems single stage pull control mechanisms with kanban routing and substitution control are proposed.

: WD23 **Financial Engineering - C2**

Contributed Session Room: M38

Chair: Tatsiana Levina
Rutgers University

1 : Using the Aggregating Algorithm for Portfolio Selection. Tatsiana Levina, Rutgers University; Shafer, Glenn.

We present new strategies for selecting portfolios in the stock market. These strategies are inspired by two streams of previous work: (1) work on universalization of strategies for portfolio selection, which began with Cover's work on constant rebalanced portfolios, and (2) more general work on universalization of online algorithms, especially Vovk's work on his aggregating algorithm and recent work on Markov switching strategies. We plan to apply Vovk's Markov switching strategies to portfolio selection using some very simple stochastic models. We will explore the mathematical and empirical behavior of the resulting strategies, and report our numerical experience.

2 : Portfolio Selection Model for Holding Company. Mohammad Shahalizadeh, Islamic Azad University; Memariani, Azizollah.

The question is what goals and constraints best fit the holding company through construction and optimization of its professional portfolio including its under-control companies and/or under-influence companies. In this paper we propose some tailor-made financial ratios or indices for analytical purposes and define some statistical relations on the basis of additive relations between financial statements of daughter companies and consolidated financial statements of Mother Company. Goal programming approach is applied for model building. The model is applied on Tehran Stock Exchange Market.

3 : Multiperiod Portfolio Optimization in Safety-First Approach. Uğur Çelikyurt, Koç University; Özekici, Süleyman.

A multiperiod portfolio optimization problem is considered where investors aim to reduce the probability of a disaster corresponding to a certain undesired return at the end of the investment horizon. The market consists of several risky assets and a riskless asset whose rates of return depend on prevailing economic conditions that define the states of a Markov chain and are therefore correlated with each other. The objective is to minimize the downside risk of an investor by investing in portfolios that change periodically. An auxiliary problem solved with dynamic programming is used to find safety-first optimal portfolios.

4 : Effective Risk Measurement along the Tails for Global Portfolios. Giorgio Consigli, Università degli Studi di Catania.

Appropriate risk measurement in unstable markets calls for the introduction of new techniques explicitly focusing on returns far in the tails. Among these, Extreme Value Theory (EVT) approaches and parametric methods based on mixed probability distributions. In my talk, over an extended time-window and spanning markets with different liquidity and risk profile, I will present results from a development which allows the introduction of user-based risk measures with back-testing results coming from a variety of different parametric and non parametric approaches. Risk measures such as VaR, CVaR or spectral measures, alternative to the variance, are explicitly considered in the development.

: WD30 **Finance & Banking - C3**

Contributed Session Room: L14

Chair: Zeynep Önder
Bilkent University

1 : Predicting the Australian All Ordinaries using Neural Networks. Andrew Flitman, Monash University.

This paper describes the experimental approaches for the development of an artificial neural network for the purpose of modeling the Australian All-Ordinaries Index movement over a horizon of 1 year. Network parameters such as network architectures and input data sizing and periodicity are considered in the development process of the network. The input data is all readily available. A structured step-by-step method is used in the development process. The evaluation criterion for the neural network output is the R Square Statistic.

2 : What Gets the Emerging Markets Going, Politics or Economics? Evidence from Argentina and Turkey. Zeynep Önder, Bilkent University; Simga-Mugan, Can.

The aim of this study is two-fold: to investigate whether economic or political news have effect on the stock market indicators, and to explore whether domestic and world economic or political news carry value for the investors as reflected by the market indicators. Two emerging markets, Argentina and Turkey, are examined for the period between 1995 and 2001. Initial analysis suggests that political events significantly affect the stock markets. The results indicate that political risk and specific characteristics of the markets should be taken into consideration by international investors in making their investment decisions in emerging markets.

3 : Bank Efficiency and Liberalisation: A Case Study of Egyptian Commercial Banks. Malak Reda, Maastricht School of Management.

Financial institutions face today a fast-paced, dynamic, and competitive environment at a global scale. They are required to examine their performance as survival depends on their productive efficiencies. For the last 20 years, many countries liberalised their financial sector through deregulation aiming to improve performance efficiency. Egypt likewise has undergone a number of major important policy changes in bank deregulation. The study aims to compare the efficiency of Egyptian commercial banks pre and post liberalisation, and to identify the sources of inefficiencies using a non-parametric technique, namely, a two-stage data envelopment approach (DEA) for each year from 1988 to 2000.

: WD31 **Quality Management - C1**

Contributed Session Room: M33

Chair: Peter Tumbas
University of Subotica

1 : Improving Throughput and Quality through Integrated Use of QFD, TOC, FMEA and SPC. Benin Mertoğlu, METU; Köksal, Gülser.

In this study, a tool utilizing Quality Function Deployment, Theory of Constraints, Statistical Process Control and Failure Mode and Effects Analysis methodologies, is developed for determining priorities of quality improvement activities of manufacturing operations. The results of an example problem are compared with solutions of more popular, easy decision-making measures, and the optimal solutions obtained from a mathematical model. The analysis shows that the proposed tool performs well, and can easily be applied in a typical manufacturing setting. This study also demonstrates how various different methodologies can be integrated for the purposes of quality and throughput improvement in shorter times.

2 : Development and Analysis of Multivariate Q Charts for a Short Run Aircraft Part Production Process. Gülser Köksal, METU; Şahinsev, Gülay; Işık, Okay.

We develop and apply a quality control chart for monitoring an aircraft wing-tip part production process. Prior to the development of a suitable control chart for the process, we have developed a formulation for multivariate Q charts through simulation, and compared its performance to the one developed by Quesenberry (1997). We have also tested performance of two different estimators for the covariance matrix. Then, we have applied multivariate Q charts to the part characteristics utilizing the results of the former studies. The results obtained have led the company to detect important special causes and prevent possible failures.

3 : A Longitudinal Study of ISO 9000 Contribution towards Total Quality Management and Performance Improvement of Small-Medium Enterprises. Katerina Gotzamani, University of Macedonia; Theodorakioglou, Ypatia; Tsiotras, George.

The purpose of this paper is to evaluate the long-term value of the ISO 9000 standards and their contribution towards Total Quality Management (TQM) to the certified small and medium enterprises (SMEs). For this reason, two empirical surveys were curried out in the Greek certified companies within a three years period so as to evaluate: a) the motives that lead SMEs to ISO 9000 certification, b) the performance improvement that they achieve from ISO 9000 certification in important TQM areas, and c) the progress that they make after certification, by re-evaluating their performance improvement after a three years period.

4 : Software Quality Measurement under the Condition of Vaguaness and Uncertainty. Peter Tumbas, University of Subotica; Sedlak, Otilija; Jelica, Trninic.

Under the condition of uncertainty and risk, the number of the corresponding software quality factor is high. In the high percent of the cases there is no way of mathematical modeling. The context of software quality measurement is in the condition of vagueness and uncertainty. This paper is an attempt to show that the application of fuzzy sets gave an opportunity of description of events in economic situation which is vagueness. We present a new ordering method for multiple attribute decision making using fuzzy sets. If we can give the values of attributes as marks, the method can be applied.

: WE01 **Capacity Portfolio Investment and Hedging: Review and New Directions**

Tutorial Room: MB I

Capacity Portfolio Investment and Hedging: Review and New Directions. Jan A. Van Mieghem, Northwestern University.

This special session surveys the literature on stochastic capacity investment and presents new work on hedging the risk of the investment by purposely unbalancing the capacity portfolio. Capacity relates to upper bounds on the sustainable production quantities of a firm resulting from limitations in its processing network. While many factors can limit production quantities, the discussion here will focus on the prime economic factors of production: capital and labor resources. Investment is the change of the stock of capital and labor and includes expansion and contraction. A general stochastic capacity investment model and its major properties are reviewed together with a discussion of important issues in the formulation of capacity problems. Recent directions in stochastic capacity investment are discussed: investment in multiple resources, investment by multiple agents, and investment that incorporates risk considerations. We focus on optimal investment in a portfolio of capacity types or "real assets" and discuss and contrast hedging strategies involving financial versus operational means. We show that, in contrast to single resource capacity problems, the portfolio capacity problem cannot be transformed into an equivalent deterministic problem, which has repercussions on capacity planning in practice. New results on the efficient risk-return frontier and the optimal risk-hedging capacity adjustment path are presented. This suggests a measure for the value of operational hedging by purposely deviating from a balanced capacity configuration (or from the risk-neutral optimal configuration as prescribed by a newsvendor network solution).

: WE02 **Marketing Engineering: Marketing Decision Models for the Digital, Networked Economy**

Tutorial Room: MB II

Marketing Engineering: Marketing Decision Models for the Digital, Networked Economy. Gary L. Lilien, The Pennsylvania State University.

The digital networked economy is inducing significant structural changes in (a) how marketing models are developed and deployed, (b) who uses marketing models, and (c) what types of models are developed. In the first phase of our Marketing Engineering program (marketing decision support with OR inside) we developed over two dozen tools in an integrated, user-friendly environment, making those tools accessible to students and to practitioners. In the second stage of development, we are making the most widely used of these tools available in an application service provider (ASP) basis, requiring little or no software on the client computer. We will illustrate our ideas

with implementations of leading edge marketing models, including perceptual mapping, conjoint analysis, choice models and cluster analysis, operating over the internet. We will show what the impact of these developments have been for teaching and implementing marketing models in practice and will provide a perspective on the future developments of OR in marketing.

: WE03 **Vehicle Routing**

Tutorial Room: MB III

Vehicle Routing. Gilbert Laporte, HEC Montréal.

Vehicle routing problems lie at the heart of distribution management. These problems are NP-hard and, to this day, exact algorithm can only solve relatively small instances. In practice heuristics are the only sensible solution methodology. Over the past forty years several heuristic principles have been put forward and the best available methods are highly performing. Still, practitioners often use packages based on rather unsophisticated heuristics, dating sometimes from the 1960s. There can be several reasons for this state of affairs, but one of them is that most of the available methods simply lack the necessary attributes to make them appealing to practitioners. We argue that a good vehicle routing heuristic should be accurate, fast, simple and flexible. We examine several classical heuristics and some of the better performing metaheuristics proposed in recent years and we assess them with respect to these criteria.

: WE04 **Graphs and Hypergraphs**

Invited Session Room: JB A

Chair: Béla Vízvári
Eötvös Loránd University

1 : Orientation and Edge-Connectivity of Hypergraphs. Tamás Király, Eötvös Loránd University.

Two important and well-studied areas of graph connectivity problems are connectivity augmentation, which consists of augmenting a graph by adding new edges so as to reach a specified connectivity, and connectivity orientation, where the goal is to find an orientation of a graph that satisfies some specified edge-connection property. In this talk we present extensions of these problems to hypergraphs. For example, a characterization is given for hypergraphs that have a k-edge-connected orientation, and a formula is presented on the minimum number of uniform hyperedges whose addition can make a given hypergraph k-edge-connected.

2 : On Path/Cycle Families of Digraphs. Márton Makai, Eötvös Loránd University.

Greene's theorem in posets considers the maximum size of union of at most l disjoint chains. A natural extension in digraphs is to examine the maximum size vertex-set which can be partitioned into vertex-sets of at most l dipaths and some dicycles (l-path/cycle family). Antichains of posets also have a natural but not so obvious extension in digraphs which are called weightings. As above, this notion provides a generalization of the Green-Kleitman theorem. Min-max theorems for path/cycle families and weighting families are considered. Weighted versions are also obtained via polyhedral descriptions.

3 : Mapping Graphs or Hypergraphs onto Convex Polygons. Hiro Ito, Kyoto University.

We consider a projection of a vertex-labeled graph or a hypergraph with n vertices onto a vertex-labeled convex polygon with n vertices such that each vertex of the (hyper) graph is projected on a vertex of the polygon with the same label. We compare graphs (resp., hypergraphs) by the sum of the length of the edges (resp., the areas of the hyperedges) on the projection and show some necessary and sufficient conditions, which are based on cuts or (hyper) graph modifications, for that the measure of a (hyper)graph is always less than the measure of another (hyper)graph for any convex polygon.

4 : Global Optimization of Nonlinear Mixed-Integer Bilevel Programming Problems. Zeynep Gumus, Princeton University; Floudas, Chris.

A novel global optimization technique for solving mixed-integer, nonlinear bilevel programming problems is introduced. The outer level may involve general mixed-integer nonlinear functions. The inner level may involve functions that are mixed-integer nonlinear in outer variables, linear, polynomial or multilinear in inner integer variables, and linear in inner continuous variables. The technique is based on reformulating the mixed-integer inner problem as continuous via its convex hull representation, and solving the resulting nonlinear bilevel optimization problem by a novel deterministic global optimization framework. Epsilon global optimality in a finite number of iterations is theoretically guaranteed. Computational results will illustrate the approach.

: WE05 **Transportation - C2**

Contributed Session Room: JB B

Chair: Tonguç Ünlüyurt
Sabancı University

1 : VIOLA Platform for Collaborative Electronic Logistics. Sewon Oh, Electronics and Telecommunications Research Institute; Lee, Yongjoon.

This paper proposes a platform architecture for collaborative electronics logistics, which is based on the ebXML specifications. As the name of the platform, VIOLA, represents Visibility, Integration and Optimization for Logistics Applications, the platform has been designed and developed to help various business processes and services among logistics stakeholders.

2 : Methodology to Determine Hubs Location under Capacity Constrains. Victoria Rodríguez, MIK (Mondragón Ikerketa Kudeaketan); Barcos, Lucía; Alvarez, María Jesús.

The purpose is to find a possible solution to the problem of distribution costs reduction considering the reduction of traffic congestion of cargo in hub as the main element. Traditional models have received needed changes looking for fulfillment of delivery times. Over more, a methodology has been developed trying to find a solution of hubs localization. Methodology has two parts: the study of the hub as a queueing network and an heuristic algorithm that look for a solution for the problem under different constraints.

3 : Using Excess Shelf Space at Retail Outlets to Reduce Supply Chain Execution Costs. Rob Broekmeulen, TU Eindhoven; Fransoo, Jan C.; van Donselaar, Karel.

We observed that for 50% of the CPG assortment the shelves at retail outlets have space for more than three weeks sales, while this assortment is replenished on a daily basis. Based on this observation, we propose a joint replenishment strategy for this subset of the assortment to improve the load utilisation of the trucks, to reduce the total amount of handling and to reduce the peak workload at the distribution center. We discuss the effects of this strategy on inventory and customer service.

4 : A Hierarchical Model for Container Terminal Operations. H. Murat Özdemir, Sabancı University; Ünlüyurt, Tonguç.

A set of operational problems is investigated in port container terminals. Storage space allocation, location matching and vehicle scheduling problems are considered hierarchically so as to minimize the total turnaround time in a rolling horizon. In order to analyze the first two stages of the hierarchy, network flow models are constructed and solutions of arbitrarily generated test problems for a typical container terminal framework are provided. Computational results show that robust improvements are obtained when compared with random allocations. Extended models for the former problems and the vehicle dispatching in simultaneous discharging/uploading operations with precedence constraints are also proposed.

: WE06 **Scheduling - C6**

Contributed Session Room: M30

Chair: Yoshitomo Ikkai
Osaka University

1 : Models for Leveled-Mixed Production Scheduling with Setups and Variable Batch Sizes. Mesut Yavuz, University of Florida; Tüfekçi, Süleyman.

Majority of papers on mixed-model scheduling (Heijunka Schedules) used minimization of total deviation from the ideal schedule as final objective, some also used minimization of number of setups. All these papers assumed constant batch-sizes. This paper develops a new structure where setup/processing times and number of units are variable. Demands are met in batches, and each batch is processed within a fixed-length time-bucket, which itself is a decision variable. Four alternative models have been developed and compared via numerous experiments. Results show that the model using minimization of the total deviation from the ideal schedule as objective yields best results.

2 : Constraint Programming and Scheduling Problems. Ömer Benli, California State University, Long Beach.

Constraint programming is a relatively new approach for solving scheduling problems. This logic-based method is especially effective for solving large-scale scheduling problems with side-conditions. Hence, it seems to be particularly suitable for scheduling problems that arise from practical considerations. In this presentation, after comparing mathematical programming and constraint programming approaches to scheduling problems, examples will be given from timetabling, lot streaming, and other scheduling problems.

3 : A Conversational Rapid Scheduling Method by Analysing Job Flexibility in a Process Ordering Problem with Two Evaluation Functions. Yoshitomo Ikkai, Osaka University; Ishihara, Kyohei; Takii, Taiji; Komoda, Norihisa.

From order constraints between two jobs, optimal process orders of jobs are decided. Two kinds of jobs exist, initial jobs which should be included in a solution, and spare jobs which can be included. Each job has an attribute "size", and the job order from smaller to larger size is called "inversion." A number of initial jobs and inversions become evaluation functions. This paper proposes conversational style approach. Experts input a minimum number of initial jobs contained in a solution, and a solution with a minimum number of inversions is output by using flexibility of jobs and a branch-and-bound method.

4 : Petri Net based Scheduling: A Review and Analysis of the Literature. Gonca Tunçel, Dokuz Eylül University.

In recent years, the growth in the complexity of modern manufacturing systems causes the scheduling problems to become more difficult. Therefore, some of the existing scheduling techniques are improved, since they are lack in the formulation and/or the solution of the problems. Petri nets (PNs) are promising tools for modelling, analysing, and control of manufacturing systems. The modeling capabilities and formulating advantages makes PN based techniques appealing for solving scheduling problems. In this study, PN based scheduling techniques are discussed and a review of the current literature on PNs applications in scheduling is presented. A classification framework is provided.

: WE07 **Innovative Manufacturing and Capacity Management**

Invited Session Room: M31

Chair: Jayashankar Swaminathan
The University of North Carolina

1 : Nonlinear Capacity Models for Supply Chains. Jakob Asmundsson, Purdue University; Uzsoy, Reha; Rardin, Ronald.

A major difficulty in aggregate planning has been the inability of computationally tractable, scalable models to accurately represent the nonlinear dynamics caused by the relationships between load and lead times. We present a mathematical programming formulation for aggregate planning that uses nonlinear clearing functions to capture these dynamics in a computationally tractable manner. We provide computational experiments illustrating the performance of the proposed model.

2 : Sequential Capacity Procurement under Horizontal Competition. Feryal Erhun, Stanford University; Tayur, Sridhar.

Consider a model where a single supplier of limited capacity sells to two identical downstream manufacturers. The manufacturers compete not only for the limited capacity but also in the demand market. We study sequential capacity procurement to observe how each party - supplier, manufacturers and the end-consumers - is affected.

3 : Effect of Product Variety, Complexity and Technology on Manufacturing Performance: Evidence from the Semiconductor Industry. Murat Kristal, The University of North Carolina;

Roth, Aleda; Swaminathan, Jayashankar.

This paper subjects to empirical scrutiny the influence of structural factors (e.g., product variety, complexity and technology) on productivity and conformance quality in a sample of semiconductor plants. While, we empirically show the nonlinear effect of product variety on productivity, it is linear on quality. Complexity does not influence productivity, but it does decrease conformance quality. Process technology factors, especially technology generation and production volume, impact overall fab productivity. Unexpectedly, however, newer technologies did not impact conformance quality. Finally, we contrast our empirical results with those of a published automotive industry study that addressed similar issues.

: WE08 **Innovative Applications of Group Decision and Negotiation**

Invited Session Room: M32

Chair: Rodney B. Jarman
Curtin University of Technology

1 : Multiobjective Group Decision-Making in R&D Portfolio Selection. Karl Doerner, University of Vienna; Stummer, Christian.

Research and development (R&D) portfolio selection problems are difficult group decision problems because (i) they involve complex interdependencies between projects and (ii) feasibility of individual projects depends on resources allocated to group members. In the paper, we compare aspiration-based approaches for multiobjective group decision support by means of numerical experiments.

2 : Prospective Evaluation of a Cluster Program for Finnish Forestry and Forest Industries. Ahti Salo, Helsinki University of Technology.

We describe a prospective evaluation process for a major research program. Based on participatory workshops, this process benefited from a GSS which helped representatives from industry, research organizations and public administration assess socio-economic impacts and future research challenges. The preconditions, advantages and limitations of the participatory approach are also discussed.

3 : Development of an Executive Information System in South Africa: Some Exploratory Findings. Udo Richard Averweg, eThekwini Municipality; and; Petkov, Doncho; Cumming, Gregory.

Changing South African local government regulations force municipalities to be proactive in their strategic decision-making. During 2001 the eThekwini Municipality had to undertake complex 'what if' scenarios in preparing its annual financial budgets. An Executive Information System developed for this task addressed eight specific issues identified in the literature. Based on action research and case studies, the authors found support for five of these issues and noted various differences on the others. They consider whether these differences are unique to this metropolitan municipal environment, and suggest further in-depth research.

4 : Collaborative Risk Management. Jürgen van Grinsven, Delft University of Technology.

Currently, ill-structured Risk Management processes hamper collaboration between people, which leads to productivity losses. Productivity losses associated with RM indicates that organizations need to improve their RM processes. Because of the distributed nature of many organizational production processes, the RM processes associated with these processes are also increasingly carried out in a distributed fashion. In order to enable distributed collaboration in RM, a clear script is needed to limit the cognitive load of RM facilitators and participants and create patterns of collaboration in a predictable and repeatable way. Second, a tool is needed to support distributed collaboration in a RM process. Last but certainly not least, a specific configuration of the hard- and software is needed to realize and sustain the pattern of collaboration required for the problem at hand.

: WE09 **Customer Satisfaction - C2**

Contributed Session Room: L15

Chair: Toshio Ariu
CRIEPI

1 : Analyzing the Relationship between Customer Satisfaction and Customer Loyalty in Korean ADSL Service Market. Min-jeong Kim; Kim, Chan gyu; Song, Yoon Heon.

This paper investigates the relationship between customer satisfaction and customer loyalty in Korean ADSL service. Firstly, we define and analyze the causality with Factor Analysis and SEM, based on survey results from 737 ADSL subscribers. Secondly, we find major causal variables to affect customer loyalty. Finally, we suggest some implications to markets in telecommunications companies. conclusively, customer loyalty depends on the degree of customer satisfaction on network quality and service quality. Particularly, network quality affects customer loyalty relatively stronger than service quality. Thus we suggest marketers invest in improving network quality rather than service quality to enhance customer loyalty.

2 : Investigating the Relationship between Employee Satisfaction, Job Performance and Customer Satisfaction. Chan gyu Kim; Park, Youngjoon; Kim, Taeho; Cho, Dong Ock.

We investigate the relationships between employee satisfaction, organizational commitment, job performance and customer satisfaction. The subject of this study is call-center agent. The measures of job satisfaction, organizational commitment and job performance are collected by a survey. Service values, defined as indices of objective productivities, are collected with customer satisfaction. And then, we firstly explore the causal relationships between employee satisfaction, organizational commitment, job performance and customer satisfaction with SEM. Secondly, we extract which factor of employee satisfaction has a effect on customer satisfaction. Finally, we analyze how much the extracted factors affect service values and customer satisfaction.

3 : Longitudional Study of Vietnamese Branding Processes by Seven Large Multidimensional Corporations. Pandora Patton, University of the Nations; Patton, Charles.

This longitudinal study compares brand distribution in Vietnam for 7 worldwide Multinational corporations (MNC's) at three time periods: Spring 1994 - before the Clinton Administration "opened up" Vietnam Winter 1997 - when almost all imported goods were unavailable. Winter 2003 - after a few hypermarts opened. The findings were that each company [Colgate ,Kraft, Nestle, P&G, Quaker Oats, Reckitt and Unilever] saw a sharp decline in the number of their brands stocked in Vietnamese stores, on average an 88% drop since 1997.

4 : Evaluation of Electric Power Supplier by Japanese Large Customers: Analysis of Customer Choice based on Price, Power Reliability and Services. Toshio Ariu, CRIEPI.

Electric utilities in Japan are reshaping business strategy under the competitive market. We surveyed various customer needs for electric utilities. According to this, we confirmed that large customers were more eager to change their power supplier. It was recognized that customers placed significance on "power quality/reliability", "price", "financial stability/risk", and "customer service" in this order. We estimated that large customers would not be able to allow up to 13.5 minutes blackout increase even if they were offered half price, and 24% customers would change power suppliers if they gave a 5% price reduction.

: WE10 **Interior Point Methods**

Invited Session Room: L19

Chair: Tamas Terlaky
McMaster University

1 : Self-Regular Proximity based Infeasible IPMs. Tamas Terlaky, McMaster University; Salahi, Maziar; Zhang, Guoqing.

In this paper a self-regular proximity based Infeasible Interior Point Method is proposed. First we mention some interesting properties of a specific self-regular proximity function, studied recently by Peng and Terlaky, and use it to define infeasible neighborhoods. These properties of the proximity function indicate that in large neighborhoods of the central path large-update IIPMs are the only natural choice. We apply these results to design self-regularity based dynamic large-update IIPMs in large neighborhoods. The new dynamic IIPM takes large-updates and don't utilize any inner iteration to get centered. An O(n^2 L) worst-case iteration bound of the algorithm is established.

2 : Analytic Centers Cutting Plane Methods and MIP. Jean-Louis Goffin, McGill University; Elhedhli, Samir.

The most effective way to solve realistic MIPs (mixed integer programs) is branch and price, which is based on Lagrangean relaxation. Lagrangean relaxation provides better bounds than the traditional branch and bound method, which relax the integer requirement. We will sketch a full branch and price method that uses extensions of ACCPM, including Ryan and Foster branching and hot starts at the child nodes, using a dual Newton method. Numerical results will be presented in problems arising in supply chain optimization.

3 : The Minimum Enclosing Ball Problem in High Dimensions. E. Alper Yildirim, SUNY at Stony Brook; Kumar, Piyush; Mitchell, Joseph.

We study the minimum enclosing ball (MEB) problem for sets of points or balls in high dimensions. Using techniques of second-order cone programming and "core-sets", we develop (1+epsilon)-approximation algorithms that perform well in practice, especially for very high dimensions, in addition to having provable guarantees. We prove the existence of core-sets of size O(1/epsilon), improving the previously known bound, and we study empirically how the core-set size grows with dimension. We show that the implementation of our algorithm results in fast computation of nearly optimal solutions for point sets in much higher dimension than previously computable using exact techniques.

4 : OOF: Open Optimization Framework. Obinna Ezechukwu, Imperial College London; Maros, Istvan.

There is currently a plethora of formats for representing optimization models and instances. The varying degrees of support for these formats, coupled with their well-documented deficiencies complicate the task of integrating and developing optimization models and software. This has led to new initiatives to develop new forms of model representation, which address these deficiencies and exploit advances in software technology, particularly the Internet. This paper describes a framework, which not only comprehensively addresses the issue of model and instance representation but also provides in-built support for distributed optimization, particularly in the area of service delivery over the Internet.

: WE11 **Supply Chain Management - C3**

Contributed Session Room: R20

Chair: Katerina Gotzamani
University of Macedonia

1 : Supplier Selection through Logistic Regression. Sabriye Sibel Erkilic, Wichita State University; Or, İlhan.

The process of supplier selection into an interesting Supply Chain Management program in an Automotive Company is investigated. This program, named "Commodity Management Supplier (CMS) System", involves provision of more business volume, authority and responsibility to a carefully selected, small set of suppliers, which are also regarded as strategic business partners. In this study, factors influencing CMS designation decisions are identified, data on past decision are compiled and a statistical model is constructed to help company management in evaluating future CMS candidates; logistic regression is deployed in model construction. Data collection issues, model development and validation, results obtained are discussed.

2 : Buyer-Supplier Relationship Typologies in the Turkish Automotive Industry. Ayça Kuman, METU; Wasti, S. Nazlı; Kozan, M. Kamil.

Based on Bensaou's (1999) study, the typology of buyer-supplier relationships in the Turkish automotive industry were analyzed using data from 51 buyers in automakers and 72 suppliers. Three clusters (captive supplier, market exchange, and strategic partnership) were identified based on buyers' and suppliers' specific investments, with approximately equal frequencies in both samples.

3 : Optimal Production and Shipment Lot-Sizing in a Two-

Layer Supply Chain. Kadir Ertogral, King Fahd University of Petroleum and Minerals; Ben-Daya, Mohamed; Darwish, Mohammad.

Previous research on the joint vendor-buyer problem focused on the production shipment schedule in terms of number and the size of batches transferred between two parties. In this study, we analyze the vendor buyer lot-sizing problem under equal-size shipment policy. We introduce the complete solution of the problem in an explicit and extended manner that has not existed in the literature. We also consider the case where transportation cost is taken into account and develop optimal procedures. The structure of the transportation cost is assumed to be an all-unit-discounted format.

4 : Supplier Management Practices and Their Impact on Supplier and Buyer Performance: An Empirical Study in Greek Manufacturing Industry. Ypatia Theodorakioglou, University of Macedonia; Gotzamani, Katerina; Tsiotras, George.

In this paper the authors examine, via an empirical research conducted in the Greek manufacturing industry, the kind and degree of relationship between a) supplier management practices in the SCM context and b) supplier and buyer performance. Research results, which represent buyers' point of view, reveal a positive correlation between supplier management practices and supplier and buyer performance and highlight the main benefits of SCM implementation on supplier and buyer performance measures.

: WE12 **Stochastic Models and Orders in Reliability Theory**

Invited Session Room: M39

Chair: Moshe Shaked
University of Arizona

1 : Stochastic Comparisons of Discrete Time Minimal Repair Processes. Felix Belzunce, Universidad de Murcia; Ortega-Pastor, Eva-Maria; Ruiz, José-María.

Recently Pellerey, Shaked and Zinn (2000) introduce a discrete-time analog of the minimal repair process. In this paper we study conditions under which the epoch times and interepoch intervals of two of these processes, can be stochastically compared in various senses. These results are extended to a more general model.

2 : Multi-Component Cumulative Shock Models with Modified Block. Haijun Li, Washington State University; Xu, Susan.

Consider a system of components that are subjected to common random shocks. Components fail when their cumulative damages caused by shocks exceed the breaking thresholds. We equip this shock model with a maintenance policy that replaces failed components with new ones and performs block replacements at scheduled moments for the components whose damage levels cross certain maintenance thresholds. We make stochastic comparisons of the multivariate counting processes of component failures in two such shock models with different maintenance parameters, and also study the impact of correlated shock damages on the dependence nature of the numbers of failures at various components.

3 : The Stochastic Dispersion Order and the Notion of IFR Distribution: A Univariate and Multivariate Perspective. Alfonso Suarez Llorens, Universidad de Cadiz; Fernández Ponce, Jose María; Nuñez Barrera, Olga.

The univariate dispersion order based on quantiles more widely separated is well known in the literature. On the other hand, Pellerey and Shaked (1997) characterized the notion of Increasing Failure Rate (IFR) by means of the dispersion order, that is, a univariate random variable X is IFR if and only if their residual life distributions are ordered in dispersion. We provide a new multivariate dispersion order which has an interpretation based on multivariate quantiles. We show how this new order can be used to define a multivariate IFR notion and the relationship among some classical multivariate IFR definitions.

4 : Comparing Reliability Experiments with the Convolution Order. Moshe Shaked, University of Arizona; Suarez Llorens, Alfonso.

I will describe some results involving comparison of experiments in system reliability theory when the component lifetimes are independent and identically distributed random variables that have a common two-parameter exponential distribution with an unknown location parameter. For this purpose, a stochastic order, called the convolution order, is defined, and some basic properties of it are studied. Attention is focused on the family of distribution functions which are mixtures of distributions of partial sums of independent exponential random variables, and some results, which identify several conditions under which members of this family are ordered in the convolution stochastic order, are derived.

: WE13 **OR in Sports - II**

Invited Session Room: R21

Chair: Michael Trick
Carnegie Mellon University

1 : Handicapping in a Texas Scramble Golf Competition. Tony Lewis, Oxford Brookes University.

In a Texas Scramble golf competition the group of golfers playing together play as a team but choose the best of their shots from which to proceed. In deciding the winning group due allowance needs to made for playing ability through players' handicaps. Allowance also needs to be made for the relative advantage a group of four players has over smaller-sized groups. This paper uses simulation, probability theory and mathematical modelling to find the effect on scores of increasing sized groups of scratch golfers and to derive formulae to allow for varied handicaps within the various sized groups.

2 : Scheduling Fixtures for Basketball New Zealand. Mike Wright, Lancaster University.

The National Basketball League in New Zealand features ten teams playing over sixteen weekends. Each team plays against each other team at home and away. As well as the usual scheduling criteria therefore (balance of home and away fixtures, specific requests for dates, etc.), there are other considerations concerned with teams sometimes having to play twice within a weekend. Moreover, the availability of stadia frequently needs

to be negotiated once a draft schedule has been produced, which in turn may require many amendments to be made. This paper will discuss the multiple objectives associated with this problem and the way in which they were modelled. The solution procedure, which is a form of simulated annealing, will also be outlined and discussed, using the results from a long series of experimental runs.

3 : A Method for Analysing Characteristics of Football Teams. Nobuyoshi Hirotsu, Japan Institute of Sports Sciences; Wright, Mike.

A statistical model is proposed for analysing characteristics of football teams. The characteristics are evaluated by means of maximum likelihood estimators for factors such as home advantage, offensive and defensive strengths and their interactions, taking account of not only goals but also possession of the ball. The statistical model is built based on the real data of a football league and the characteristics of the teams are illustrated in ways which allow us to visualise offensive and defensive strength, preference for playing at home and preference for particular opposition teams.

: WE14 **E-Logistics/E-Banking**

Contributed Session Room: R22

Chair: Chulung Lee
National University of Singapore

1 : Performance Measures and Metrics in Logistics Management. Angappa Gunasekaran, University of Massachusetts Dartmouth; Kobu, Bulent.

Peformance measures and metrics are essential for effectively managing logistics operations, in particular in e-commerce environment. Traditional measures and metrics may not be suitable for the new environment wherein many activities are not easily identifiable. However, understanding the importance of non-financial measures and intangibles, an attempt has been made to develop a framework for measuring the performance in logistics management. This framework is based on a literature survey and some reported case experiences. Suggestions for future research directions are also indicated.

2 : Identifying Potential Decision Opportunities for Internet Banking. Emel Aktaş, İstanbul Technical University; Çevik, Sezi; Topçu, Y. İlker.

Internet based electronic banking is one of the newest and least researched delivery channel for retail banking services. The aim of this study is to identify the factors which consumers and executive and IT managers of banks consider influence the adoption of Internet Banking (IB) and to reveal the attitudes of the consumers toward the usefulness of and willingness to use IB. The perceptions of managers and the preferences of consumers for IB will be acquired through cognitive mapping approach. The Analytic Network Process will then be utilized to assess the relative importance of the related variables in the map.

3 : Extensible Business Reporting Language (XBRL) and Its Potential Impact on Corporate Reporting Supply Chain. Chaiho Kim, Santa Clara University.

There is a worldwide movement to adopt XBRL, a dialect of XML, as the standard format for corporate reporting supply-chain. This paper will examine the genesis of this movement, its current status, and potential impacts on entities likely to be affected by it including the government regulatory bodies, financial services, accounting firms, investors, and Internet. The presentation will include a discussion on XBRL syntax particularly relating to how it makes information contextually relevant. The paper will also discuss XBRL applications for non-financial domains as well as some roadblocks in making it a uniform standard format across national boundaries.

4 : An Inventory Model in the Presence of Electronic Marketplace. Chulung Lee, National University of Singapore; Lee, Loo Hay; Bao, Jie.

We build an inventory model in the presence of Electronic Marketplace (EM). The retailer can purchase and sell products in EM as well as order from a supplier. We develop the retailer's EM policy and proposed three ordering policies. The simulation results show that adding EM in the model substantially reduces the retailer's cost. One ordering policy we propose is both effective in reducing the retailer's cost and easy to use.

: WE15 **E-Commerce Applications**

Contributed Session Room: R23

Chair: Kemal Altınkemer
Purdue University

1 : Incentive Compatible Electronic Loyalty. Yasin Özçelik, Purdue University; Altınkemer, Kemal.

There are many loyalty programs on the Internet, most of which can be summarized as frequent-usage points. Since the rewards offered in most of these programs are not firm-specific, customers do not have an incentive to purchase from the same firm again. In this research, we first survey and categorize different e-loyalty programs, and then introduce an incentive compatible e-Commerce model in which firms offer customers their stocks for each purchase. We propose a two-period duopoly model and prove that firms realize higher profits and customers gain more surpluses in our model under certain conditions.

2 : Conversion from Brick-and-Mortar to Click-and-Mortar Business Model in Retailing. Deniz Aksen, Koç University; Altınkemer, Kemal.

We address the transition to online operations in retailing business. The retailer runs warehouses and chain stores. These are physical facilities designated as brick-and-mortar stores (BM) serving drive-in (walk-in) type customers. When the retailer initiates online transactions on its Web site, it may need to convert some BMs into click-and-mortar stores (CM), or open new stores to serve both current customers and newly acquired online customers. An optimization model is developed to solve this service logistics and distributions problem. We follow a composite Lagrangian relaxation approach to bracket the model's true optimal objective value between a lower and upper bound.

3 : Bundling and Pricing with Positive Marginal Cost. Kemal Altınkemer, Purdue University; Akçura, Tolga.

Deciding on the numbers of items in bundles and how to price these corresponding bundles is a challenging task. This paper

analyzes bundling and pricing problems when marginal/fixed costs are positive. We derive marginal costs from an optimal sourcing mechanism. When producing higher quality products have higher costs for the sourcing agents. The firm may find it beneficial to offer many bundles depending on the available quality levels. The proposed solution can be applied to many complex quantity and significant bundling situations such as the ones in telecommunication, banking, electronic journals, software, and music industries.

4 : Counter Intuition in Electronic Markets. Raymond Patterson, University of Alberta; Rolland, Erik.

There is a counter-intuition between what we expect to happen in electronic markets and what often seems to happen. This paper examines some of the apparent counter-intuitive aspects of E-Business. We highlight issues from practice and academic iterature and propose explanations to these phenomena.

: WE16 **Project Scheduling under Risk**

Invited Session Room: R27

Chair: Gündüz Ulusoy
Sabancı University

1 : Multiobjective GA Approaches to Project Scheduling under Risk. Gündüz Ulusoy, Sabancı University; Kılıç, Murat.

In this presentation, a 0-1 programming model representing project scheduling under risk is proposed. The activities have identified risks, which have states each with probabilities of occurrence and of impact. Expected activity durations are determined based on chosen states of risks. The objective to be minimized is the total cost and is defined to be the sum of the cost of measures to prevent risks from occurring, the labor cost, overhead cost, and a penalty cost. Different multiobjective GA approaches are tested to solve the problem. The solution thus obtained is further improved through an activity duration expansion heuristic developed.

2 : A Dynamic Project Management Approach to Output Quality Maximization under a Due Date Constraint. Hajime Mizuyama, Kyoto University; Yamashina, Hajime.

This paper addresses the problem of maximizing a project's output quality under a given due date constraint. The project consists of several activities with PERT-type precedence relationships and the completion time of each activity is an uncertain random variable. In order to satisfy the due date constraint, some activities may have to be truncated before completion and which will degrade the output quality of the project. The problem of setting a truncation time to each activity is formulated as a dynamic decision making process. Then, a heuristic algorithm is developed to this problem and some numerical examples are given.

3 : A Data based Design for Managing a Building Project. Abdelkamel Tari, University of Béjaïa; Bouallouche, Louisa.

In this paper, we have designed and implemented a data based for managing a building project at the University of Béjaïa. We modelized the problem as an integer program which considers both time and resource type of constraints. This kind of problem belongs to NP-COMPLET class. We used a hybrid method which combines the Earliest Start Algorithm to solve the resource conflicts and the Floyd Warshal method for the time scheduling. The data base is implemented using DELPHI environment. We also have illustrated graphically the obtained results and compared them to previous project ones.

4 : The Importance of Network Representation: Converting AON Networks to AOA Networks with Minimum Dummies. Yuval Cohen, Open University; Sadeh, Arik.

Many formulations of network problems are structured around a "from-to" matrix or node-arc matrix. While the structure of Activities on Arcs (AOA) networks conform with these matrices, Activities on Nodes (AON) representation does not posses this structure and cannot use the corresponding solution methods such as Linear Programming. Existing methods for AOA network generation could not minimize the number of dummy activities, as a result several different AOA networks could represent an AON network. The new algorithm minimizes the number of dummies and for each AON network there is one AOA network. The algorithm is explained through a detailed example.

: WE17 **Stochastic Models in Operations Management**

Invited Session Room: R24

Chair: Ülkü Gürler
Bilkent University

1 : Estimating Load-Sharing Properties in a Dynamic Reliability System. Paul Kvam, Georgia Tech.

An estimator for the load share parameters in an equal load-share model is derived based on observing k-component parallel systems of identical components that have distribution function F(x) and failure rate r(x). In an equal load share model, after the first of k components fails, failure rates for the remaining components change from r(t) to a*r(t), then to b*r(t)after the next failure, and so on. On the basis of observations on n iid systems, a nonparametric estimator of the component baseline cumulative hazard function R = -log(1-F) is presented, and its asymptotic limit process is established.

2 : Strategies for Worker Cross-Training in Service Environments. Eylem Tekin, University of North Carolina-Chapel Hill; Hopp, Wallace; Van Oyen, Mark.

We consider service systems where servers are initially grouped into departments based on their primary skills and each department serves a distinct customer type. While introducing flexibility to such systems by cross-training servers, a fundamental problem that a service manager faces is who to cross-train for which skill type. In this study, we address this question and present models to assess the benefits of cross-training under different strategies.

3 : Analysis of an Inventory System with Time Dependent Backordering and Stochastic Demand. Ülkü Gürler, Bilkent University; Berk, Emre; Haliloglu, Esra.

In this talk an inventory system is considered where the demand process is Poisson as long as there is on hand stock. When a stockout occurs time dependent backordering is assumed which amounts to a non-homogeneous Poisson arrival process. Under periodic review (s,S) and (nQ,r) policies are considered and

compared. Operating characteristics of both policies are derived and numerical results are presented.

: WE18 **Forestry Management - C2**

Contributed Session Room: R25

Chair: Hayri Önal
University of Illinois at UC

1 : Operational Research in Forest Harvesting and Transportation Planning. Mehmet Eker, Karadeniz Technical University; Acar, H. Hulusi.

In this paper, we outline a real life problem of operationally forest harvesting and transportation (FHT). A review of operations research techniques as optimization or simulation being applied to FHT problems is presented, and examined the adaptation possibilities to our case. Based on the review, the mathematical and heuristic/metaheuristic programming techniques can be assumed as a solution strategy and decision support mechanism. The programming techniques and model formulations are analyzed. We describe the problem statement encountered in Turkish Forestry and we show how a FHT problem formulation can be made to obtain a superior solution.

2 : A Fuzzy Multi-Objective Model for Forest Planning. Azamdokht Safi Samghabadi, Tarbiat Modares University; Memariani, Azizollah; Amani, Manoochehr; Johari Majd, Vahid.

In this paper a fuzzy multi-objective mathematical model is proposed for forest planning. The following criteria has been considered: a)Maximization of total carbon sequestration; b)Maximisation of net present value of profit; c)Maximisation of standing volume; d)Maximisation of employment generation; e)Minimisation of soil erosion. The parameters in the objective functions and also in the constraints are TFNs. The model has been applied to a real world problem in Caspian sea region.

3 : Incorporating Spatial Criteria in Selection of an Optimum Conservation Reserve. Hayri Önal, University of Illinois at UC.

Selecting efficient reserves to protect species from anthropogenic habitat loss is an important issue in biological conservation. Heuristic approaches dominated the literature presuming that formal optimization is difficult or impossible, especially when spatial considerations are involved. This paper presents linear integer programming formulations of various spatial problems and empirical applications.

: WE19 **Combinatorial Optimization - C2**

Contributed Session Room: R26

Chair: Takeo Yamada
National Defense Academy

1 : Optimizing the Use of Space and Layout of Goods in a Retail Store. Zeynep Orman, Marmara University; Taşlacıoğlu, Ergül; Canıbek, Havva; Türe, Erkan; Arıt, İbrahim.

This paper presents the results of a project conducted for a ready-wear retail store located in a large shopping mall. Data were collected over a long time period, interviews and observations were made. The project consists of four main parts: describing customer profile, finding the hourly and daily distribution of the number of customers, describing customer traffic patterns inside the various sections of the store, performing a basket analysis for the items purchased. The data analysis stage is currently proceeding. In the final stage the areas for improvement will be decided and alternative solutions will be evaluated.

2 : Finding All Efficient Solutions of a Bicriterion Steiner Tree Problem on Graph. Milan Stanojevic; Vujosevic, Mirko.

The paper considers bicriterion Steiner tree problem which is stated as a task of finding a Steiner tree with maximal capacity and minimal length. Using lexicographic approach, the bottleneck problem is solved first, and after that the classical minisum Steiner tree problem is solved under the constraint on capacity of the tree. Using the relaxation of the constraint on capacity, it is possible to find all efficient solutions of the initial bicriterion problem. Some numerical experiances are presented.

3 : A Polynomial Algorithm to Solve the Shorthest Path Problem with One Resource. Nassirou Lo, Université Laval; Guitouni, Adel.

Consider a directed graph G=(N,A) where N is the set of nodes and A the set of arcs. The Shortest Path Problem(SPPWR) is to find the minimum cost path from an origin o to a destination d that satisfy some additional constraint on one resource. We will show in this paper that we can find the SPPWR by a polynomial algorithm when we have one constraint and the coefficients of the resources constraints are all positives. Note that this problem is known as a NP-Complete Problem.

4 : An Exact Algorithm for the Knapsack Sharing Problem with Common Items. Takeo Yamada, National Defense Academy; Fujimoto, Masako.

We are concerned with a variation of the knapsack problem as well as of the knapsack sharing problem, where we are given a set of items and a knapsack of a fixed capacity. As usual, the problem is to determine the subset of items to be packed into the knapsack. However, in the problem there are more than one players and the items are classified into groups belonging to each player as well as common items. We formulate and solve this problem to optimality. Also, the performance of the developed algorithm are computationally evaluated.

: WE20 **Information Theoretic Methods**

Invited Session Room: M35

Chair: Ehsan Soofi
University of Wisconsin-Milwaukee

1 : Robust and Misspecification Resistant Model Selection with Information Complexity and Genetic Algorithms. Hamparsum Bozdogan, University of Tennessee.

In this paper we introduce and develop a new unified theory of model selection which is robust and at the same time misspecification resistant based on Bozdogan's information-theoretic measure of complexity (ICOMP) criterion. With ICOMP, we take into account several important issues in robust regression with the genetic algorithm (GA) to select the optimal subset of

variables. The genetic algorithm enables the rapid computation of models that would otherwise be impossible in a reasonable amount of time. As a result, it is now feasible to automatically and dynamically develop best fitting models with many different combinations of variables.

2 : Information Ordering of Order Statistics and Spacing. Nader Ebrahimi, Northern Illinois University; Soofi, Ehsan; Zahedi, Hassan.

Order statistics and spacing play important roles in various statistical analyses,including reliability. In this talk,we explore information orderings of order statistics as well as spacing through entropy and discrimination information functions. We find interesting results for information orderings among order statistics as well as results for information ordering of some well-known distributions.

3 : Information Importance of Explanatory Variables. Ehsan Soofi, University of Wisconsin-Milwaukee; Retzer, Joeseph.

The importance of an explanatory variable is the extent to which its use reduces uncertainty about predicting the outcome of the dependent variable, namely its information content. Information importance measures are applicable to qualitative and quantitative variables. For the case of normal variables, the information measures are functions of the correlations that are known in the relative importance literature. A distinguishing feature of the information measure for continuous random variables is invariance under transformations. Illustrative examples using synthetic data and data on organizational turnaround, choice of long distance provider, and adoption of new technology will be presented.

: WE21 **Production and Inventory Systems - C4**

Contributed Session Room: M36

Chair: Ahmad Reza Sarfaraz
California State University, Northridge

1 : The Selection Rule of the Place and Quantity of the Production in the Case of a Global Company. Roland Deme, Eötvös Loránd University; Vízvári, Béla.

If a company has factories in several countries then this firm can select the place and the quantity of production according to the global demand and the exchange rate of the currencies. The optimal decision for this problem is modelled by linear programming method in case of products which can be substitute one another. The structures of the possible optimal solutions are analyzed in this talk.

2 : A Systemic Approach and Mathematical Modeling in Aggregate Planning. Omerbegovic-Bijelovic Jasmina, University of Belgrade.

Although aggregate planning has been in use more than fifty years, its conceptual presentation and mathematical modeling are still developing. A simultaneous encompassing of all the time horizons is expressed as a multi-level loop of the decision-making activity, at the center of which are: decisions about the operative activities to transform the resources into products/services of greater value and putting into action (operationalising) the decisions on an operation level - operational plans. Mathematical models which optimize specific resources are here integrated into a single model; the integration method depends on: the purpose - needs, model power, available resources...

3 : An LP-based Decision Support System for Production Planning at a Steel-Cord Manufacturing Plant. Burcu Mercankaya, Sabancı University; Ertek, Gürdal; Tokalp, Alper; Özmen, Berkin.

We present an industrial application of forecasting and linear programming at a steel-cord manufacturer. The forecasting module implements methods such as Winter's method, ratio to moving averages, reflecting seasonalities. The optimization module reads the forecasted demand and calculated safety stock levels from spreadsheets generated by the forecasting module. The model incorporates the multistage character of the production system. The production system is modeled hierarchically with each stage having its own objective function and the solution for each production stage being used as input to the model for its upperstream stage.

4 : An Optimal Policy for Production Lot Size Proportional to Storage Cost. Ahmad Reza Sarfaraz, California State University, Northridge.

Whatever the form of inventory is, it often represents a significant cost to a business firm. The purpose of this paper is to develop a deterministic production quantity model so that the sum of the inventory-related costs is minimized. It is assumed that the inventory carrying costs are made up of two parts: an investment charge proportional to the average dollar investment in inventory, and a storage cost proportional to the maximum inventory. The model will be applicable to business firms where they rent space to inventorying their finished products.

: WE22 **Health Care Service Operations**

Invited Session Room: M37

Chair: Stephen Chick
INSEAD

1 : Balancing Patient and Payer Preferences: An Efficient Frontier for Breast Cancer Detection and Treatment. Julie Ivy, University of Michigan.

Mammography screening allows earlier treatment and the more favorable prognosis associated with early-stage cancers. However, a number of controversies and uncertainties surround mammography screening. Using the theory of POMDPs, we develop efficient frontiers for balancing patient and payer preferences for breast cancer screening and treatment as a function of patient age, perceived condition, monitoring and treatment costs. Our model incorporates the uncertainty associated with the partial observability of the disease process by the decision maker, and the uncertainty associated with the outcome of the treatment in determining the effectiveness of screening for a given patient.

2 : Breast Cancer Screening: Trade-Offs in Planning and Provision of the Service. Evrim Gunes, INSEAD; Chick, Stephen.

In this study we propose a stochastic model for breast cancer screening. Different health states and waiting lines in the service system for screening and diagnostic mammograms are mod-

eled explicitly. This is the first model that relates the accuracy of screening and average reading volume of doctors, as well as service facility distribution. Using simulations, trade-offs in service capacity, quality and the degree of centralization are demonstrated.

3 : Factors that Influence Efficiency in Performing Routine ENT Cases: A Qualitative and Quantitative Analysis. Fatma Pakdil, Wake Forest University, School of Medicine; Harwood, Timothy N.

The aim of this study was to assess procedures with high turnover time to procedure time ratios, estimate the effect of productivity changes on case efficiency, and determine causative factors. We specifically focused on suspension direct microlaryngoscopy (SDL) cases because significantly greater productivity was possible for these cases in terms of ratios. After determining process times, we developed economic models that employed time-reductions then assessed involved staff opinions using brainstorming and cause-effect methods. Improving all process times by 30% achieved up to a 50% improvement in revenue and the return on investment in additional scope equipment occurred within two months.

4 : Health Care Systems and Regulation of the Pharmaceutical Market. Pascale Crama, London Business School; Scholtes, Stefan.

Health Care Systems (HCS) attempt to contain their costs by imposing price ceilings on drugs and/or promoting prescription of generics after patent expiry. However, HCS are also concerned with social welfare issues and want to balance both objectives. Our theoretical model represents the interaction of the HCS, innovators, and generics producers and relies on a two-stage equilibrium approach. This contribution explicitly models the impact of regulation on R&D investments in the pharmaceutical industry. We discover that R&D outlays are relatively insensitive to market regulation and that price caps can actually increase social welfare.

: WE23 **Financial Engineering - C3**

Contributed Session Room: M38

Chair: Walid Khoufi
Sfax Graduate Business School

1 : Modeling Credit Risk with Partial Information. Yildiray Yildirim, Syracuse University.

This paper provides an alternative approach to Duffie and Lando for obtaining a reduced form credit risk model from a structural model. Duffie and Lando obtain a reduced form model by constructing an economy where the market sees the manager's information set plus noise. The noise makes default a surprise to the market. In contrast, we obtain a reduced form where the market sees a reduction of the manager's information set. The reduced information makes default a surprise to the market. We provide an explicit formula for the default intensity based on an Azema martingale.

2 : The Valuation of Bilateral Options. Katsushige Sawaki, Nanzan University; Seko, Susumu; Suzuki, Atsuo.

In this paper we consider the valuation of bilateral options which allows bath the buyer(holder) and seller(issuer) to exercise their rights. Kifer calls them game options. Callable convertible bonds among the existing financial commodities are examples of such bilateral options. We derive an functional equation that the price of the bilateral option must satisfy, and show that the price can be resolved to the sum of the American option price and the callable discount value. Analytical properties of the price of the bilateral option are also explored, as well as some numerical examples.

3 : Stock-Options and Computer Firms Performance, Myth and Fact: The Tunisian Case. Walid Khoufi, Sfax Graduate Business School; Feki, Rochdi.

Computer engineering and communication techniques constitute an innovation sector characterized by a big mobility of the staff. In management sciences, there exist many motivation techniques towards the innovation and the sense of belonging for the staff such as stock-options recently introduced in Tunisia. Our research is concerned about this new product and its characteristics, as well as its perspectives of success in mentioned sector.

: WE24 **Mathematical Programming**

Contributed Session Room: L17

Chair: Selin Malkoc
University of North Carolina at Chapel Hill

1 : Solving a Multiobjective Programming Problem through Compromise Programming. Rodriguez Uria Maria Victoria, University; Blanca, Perez Gladish; Mar, Arenas Parra; Amelia, Bilbao Terol.

In this paper we propose a solving method for a Possibilistic Multiobjective Programming problem. In order to find the ideal fuzzy solution we shall apply a method relied on the alfa-cuts of the fuzzy solution of each objective function to generate its possibility distribution. Then, we shall define a Compromise Programming problem based on expected intervals of the fuzzy numbers. To this end a definition of discrepancy between intervals is introduced. From this definition the problem of the relation "approximately equal to" between intervals can be transformed into one of minimising the discrepancy between them.

2 : A Decision Analysis Model for MCDM and Performance Measurement. Celik Parkan, Long Island University.

A linear programming (LP) based decision analysis (DA) model is introduced, which can be used for decision-making under partial probability information, multi-criteria decision-making (MCDM), and performance measurement. The model is formulated to determine the strategies that are efficient. Viewing the strategies as alternatives/entities and the events as effectiveness criteria/activity categories with cost/revenue implications, the LP is formulated in various configurations for MCDM and performance measurement.

3 : A Characterization of MinSum, MaxSum and Other Mixed Value Functions. Marc Pirlot, Faculté Polytechnique de Mons; Bouyssou, Denis; Greco, Salvatore; Matarazzo, Benedetto; Slowinski, Roman.

In some situations, the value of an alternative increases if it

improves, say, on criteria c1 and c2 OR on criterion c3. The value function is then the minimum of the sum of "partial utilities" related to criteria c1 and c3, and to criteria c2 and c3. The question of the axiomatic characterization of such models has been raised by Sounderpandian (1991) and left unsolved. Building upon a new characterization of value functions of ordinal type (Max or Min), we propose axioms for MinSum and MaxSum and more general combinations of Max, Min and Sum.

4 : Expediting versus Deferring Utility: The Effect of Temporal Perspective on Sensitivity to Prospective Duration. Selin Malkoc, University of North Carolina at Chapel Hill; Zauberman, Gal.

Recent research has shown that framing options as either deferral or expedite would lead to differential discounting of options (Loewenstein, 1988). We examine individuals' timing preferences when experiencing events, specifically, their sensitivity to time horizon (prospective duration) and temporal framing (deferring or expediting). Most importantly, we find that sensitivity to time horizon depends on temporal frame: greater decline in discount rates when deferring than expediting. Results are robust to elaboration manipulation, making time horizon less salient, and using monetary and non-monetary outcomes. Moreover, differential time horizon sensitivity is independent of changes in utility and depends only on the temporal perspective.

5 : A New Approach for Finding Wining Combinations in Dichotomic Data. Arik Sadeh, Holon Academic Institute of Technology; Cohen, Yuval.

When data items in a record can get only one of two possible values and the record could be classified either as wining or losing, there is a special interest in classifying the rules of wining or losing. For example, Dichotomic characteristic of people asking for a loan are the data items, and whether they got approval for the loan or not, determines if they win or lose. This research describes a new approach for finding these rules, based on statistical rules and modifications to an algorithm from the realm of digital design by Quine and Mclusky.

: WE25 Energy Policy and Planning in Latin America

Invited Session Room: M34

Chair: Gloria Patricia Jaramillo
Universidad Nacional de Colombia

1 : Agent-based Computational Electricity Markets using Large Scale Optimization Techniques. Gloria Patricia Jaramillo, Universidad Nacional de Colombia; Velásquez, Jesús; Jimenez, Ana María.

The Agent-Based Computational Economics is a new approach to explore the behavior of markets involving agents that are far of fully rationality all the time. This work presents a new approach for ACE that uses the optimality conditions derived from the large scale optimization theories (like Benders and Lagrangean Relaxation) to build agents with imperfect individual behavior and imperfect communication rules between the agents (limited rationality) in order to represent a more realistic market. The concepts are applied to an electricity market composed by a spot market and a long term market, in those which act multiple types of agents

2 : Optimal Hedging in Electricity Markets with Nodal Prices. Jorge Karacsonyi, Mercados Energéticos.

Economic theory shows that when prices are reflective of marginal transmission constrains and losses, social welfare is maximized. The nodal prices introduce risk to market participants when they have to trade energy through different nodes. Transmission Congestion Contracts (TCC) are an effective tool for hedging such risk. Difference of prices between two nodes is estimated with formulas that are similar to those used to compute the return of portfolios of financial assets. Therefore is possible to use some of the tools suited to optimize financial portfolios to TCCs. In this paper, alternatives for optimization of portfolios of TCCs are analyzed.

3 : Cost-Benefit Modeling of Climate Change with a Linear Programming Model. Maryse Labriet, GERAD; Loulou, Richard.

In order to study both cooperative and non-cooperative solutions to climate change issue, we combine the analysis of non-linear non-convex damage costs due to climate change (taken from the literature) with the computation of greenhouse gas reduction costs by the new multi-region MARKAL Global Model (technical-economic linear programming framework). A simplified approach to compute cooperative and non-cooperative equilibria is proposed, based on the (empirically tested) assumption that the only relevant variables are the cumulative emissions in each country and that a linear relationship links regional damages and cumulative global emissions. Preliminary results are presented.

4 : Non-Convex Power Plant Modelling in Energy Optimization. Simo Makkonen, Process Vision Oy; Lahdelma, Risto.

On the liberated market, power generation should be optimized considering the volatile spot price. Furthermore, non-convex optimization models are required due to novel production technologies, such as gas turbines, combined steam and gas cycles, and combined heat and power generation.The decision-problem can be represented as a large MIP-model. To make the model more manageable we form the model hierarchically from modular components. To speed up the optimization procedure considerably, we apply a decomposition technique and solve the different sub-problems using dedicated algorithms embedded to the overall system. The non-convex models are solved using an efficient tailored branch-and-bound algorithm.

: WE26 Environmental Management - III

Invited Session Room: L10

Chair: Hans-Dietrich Haasis
ISL, University of Bremen

1 : Market Segmentation and Product Technology Selection for Remanufacturable Products. Laurens Debo, Carnegie-Mellon University; Toktay, Beril; Van Wassenhove, Luk.

Remanufacturing is a production strategy whose goal is to recover the residual value of used products. Used products can be remanufactured at a lower cost than their initial production cost, but remanufactured products are valued less than new products by consumers. The choice of production technology

influences the value that can be recovered from a used product. We solve the joint pricing and production technology selection problem faced by a manufacturer who considers introducing a remanufacturable product in a market that consists of heterogeneous consumers. Our analysis identifies some phenomena of managerial importance that are typical of a remanufacturing environment.

2 : Integration of Environmental Objectives into the Balanced Scorecard as a Matter of MCDM. Heinz Ahn, RWTH Aachen.

The Balanced Scorecard concept claims to help companies integrate non-financial objectives within their strategic management process. In this regard, the concept is destined for taking environmental objectives into adequate consideration. However, empirical findings reveal that there is a gap between theory and praxis. In order to overcome this problem, it is explicated how the Balanced Scorecard concept can be methodically improved by using an approach well known in decision theory: the distinction between fundamental objectives and instrumental objectives, and their hierarchical connection.

3 : Environmental Management in Logistics Centres. Hans-Dietrich Haasis, ISL, University of Bremen.

In this paper decision problems related to environmental management in logistics centres are identified and described. Both operational and strategic problems are outlined. For selected problems, solving algorithms are assigned. The problems are motivated by case studies.

: WE27 **ESIGMA - III**

Invited Session Room: L11

Chair: Ahti Salo
Helsinki University of Technology

1 : Multi-Criteria Group Decision Support for Integrated Technique Assessment. Jutta Geldermann, University of Karlsruhe; Zhang, Kejing.

The determination of Best Available Techniques (BAT) plays an essential role in the realisation of the European IPPC-Directive 96/61/EC (concerning integrated pollution prevention and control) and influences industrial investment decisions. From a methodological point of view, this forms a multi criteria decision situation. This paper presents an integrated Multi-criteria Group Decision Support System (MGDSS) for integrated technique assessment, in combination with process simulation models. In the system, three multi-criteria approaches PROMETHEE, AHP MAUT are integrated to deal with different multi-criteria evaluation problems. The system provides corresponding sensitivity analysis tools. A case study about surface treatment illustrates the implemented MGDSS.

2 : A Multi-Attribute Model for Evaluation of Civil Servants. Luis Tavares, Instituto Superior Técnico.

The evaluation of civil servants is a major issue in most public administration as it is a key condition for the development of a dynamic of change improving performances and allowing better management of human resources. However, the extension of the system and the diversity of cultures and criteria of the evaluators are major difficulties to be overcome by the adopted methodology. In this paper, a multi-attribute model sufficiently flexible but also reasonably stable is proposed combining different MCDM approaches. This model is being applied to the Portuguese public administration.

3 : Multicriteria Methods for the Shaping of Research Priorities - A Case Study for Finnish Forestry and Forest Industries. Ahti Salo, Helsinki University of Technology; Liesio, Juuso.

Priority-setting in research has attracted increasing attention as pressures to align science and technology policies with industrial and societal needs have grown. Even though multi-criteria methods hold promise in this context, few reported applications have been presented in the literature. In this paper, we describe a case study in which recently developed multi-criteria methods and decision support tools were employed to assist leading industrialists, researchers and administrators in the shaping of priorities for a major research programme for Finnish forestry and forest industries.

4 : Application of the Multicriteria Decision Making Methodology for Outranking the Ballast Water Management Options - Example and Proposal for Application. Carlos Francisco Simoes Gomes, CASNAV.

The MCDM has been developed in order to support and guide decision-makers in the evaluation and selection of alternatives/ solutions. In this case, it can be used to evaluate and select ballast water exchange and treatment methods. The system proposed by Brazilian Delegation to IMO is based on the algorithm THOR, which has been the subject of a presentation given at the IFORS-2002. We submit here in a methodology for the outranking of the ballast water treatment options. As a result of the application of this methodology it will be possible to indicate, consensually, the best treatment systems.

: WE28 **Economic Modeling - C1**

Contributed Session Room: L12

Chair: Vaclava Pankova
University of Economics, Prague

1 : Monetary and Fiscal Management Problems and Their Conjugation. Vardan Petrosyan, Yerevan State University.

Financial market development in transition economies allows the authorities to focus more on public debt management in fiscal area, and increases Central Banks' role in providing price stability in monetary area. Problems solved in mentioned areas are multicriterion management problems interrelated both directly and through financial markets. Thus, the problem of policy coordination at operational level is accentuated. A system of models is developed to conjugate the problems for the example of Armenia. Decisions and environment of fiscal and monetary policy implementation process are considered in the models, as well as requirements and regulation rules on policy parameters and performance.

2 : Monetary Base Management Problem. Vasak Toroyan, Yerevan State University; Petrosyan, Vardan; Petrosyan, Lilit.

As the most generalized liquidity agregate based on Central Bank balance sheet, monetary base serves as common opera-

tional target for monetary policy in many transition countries. Separate interrelated functions are conjugated within policy implementation process: comercial banks reserve formation and holding, clearing and settlement, foreign reserve management, as well as functions of lender of last resort and government financial agent. A model of monetary base management problem was developed which allows to conjugate above-mentioned functions under the efficiency criteria of smoothening the "proper activity noise". Model adequacy is substantiated for the case of transition economy on the example of Armenia.

3 : Real Options Approach for Valuation of Manufacturing Flexibility in Flexible Manufacturing System Investments. E. Ertuğrul Karsak, Galatasaray University; Özoğul, Okan.

The traditional discounted cash flow techniques are reported to be inadequate in evaluating advanced manufacturing system investments since they disregard the flexibility to revise the original strategy if future events prove to be different from the ones originally predicted at the outset. In this paper, a real options approach is presented to incorporate option premium of flexibility to defer the investment, expansion flexibility and product flexibility while evaluating a flexible manufacturing system investment. The proposed valuation approach is based on binomial trees and risk-neutral analysis. A comprehensive numerical example is presented to illustrate the approach, and sensitivity analyses are performed.

4 : Economic Analysis of Small Sample Data - Export of The Czech Republic. Vaclava Pankova, University of Economics, Prague.

Analysis of short time-series is proposed to be done by the technique of seemingly unrelated regression equations. Single equations are summarised into a compact one-equation model comprising all variables, with the data of the length equal to the sum of all individual numbers of observations. Disposable data enable to perform the necessary optimisation of sum of squares of residuals by the generalised OLS method. By a certain similarity among disturbances of original equations, a gain in efficiency of estimators can occur. The method is applied to the export analysis of The Czech Republic in context of GA CR 402/01/0161.

: WE29 Dynamic Programming - III

Invited Session Room: L13

Chair: David Smith
University of Exeter

1 : Iterative Dynamic Programming and the End of Some Board Games. David Smith, University of Exeter.

A large class of board games of the backgammon family has an endgame in which the players have a small number of pieces on the board. Moves in the game involve making decisions about which piece(s) to move. This options open to a player may be modeled using dynamic programming. We shall consider the problems of creating and solving such models, and discuss some examples.

2 : Optimal Premium Pricing in General Insurance. Celia Glass, City University; Gerrard, Russell.

In this paper we demonstrate the potential of dynamic programming in a novel application. An important and unsolved problem in actuarial science is how to determine an insurance premium for a company that is operating in a dynamic and competitive market. In this article we provide a pricing model, which takes account of risk assessment of customers of general insurance over their life-time with the company. Models of customer behaviour and market dynamics are combined with those of a company's own costings and objectives. We show how dynamic programming can be used to construct optimal pricing strategies.

3 : Recreational DP. Moshe Sniedovich.

Dynamic programming (DP) offers a very powerful and versatile environment for the modelling, analysis and solution of games and puzzles. DP is also subjected to the Curse of Dimensionality. In this presentation we shall discuss a number of issues related to the use of DP as practical tool for solving games and puzzles. We also demonstrate how such a treatment can provide educationally rich material for both graduate and undergraduate level OR/MS subjects.

4 : An Explicit Formula for the Optimal Gain in the Full-Information Problem of Owning a Relatively-Best Object. Mitsushi Tamaki, Aichi University; Mazalov, Vladimir.

A version of the secretary problem, called the full-information duration problem is considered both in sampling without recall and with recall. n objects appear sequentially and the value associated with each object is observed. The values are i.i.d. random variables from a known continuous distribution. An object is relatively-best if it possesses the largest value observed so far. We want to choose a relatively-best object with the view of maximizing the duration it stays relatively-best. It can be shown that the optimal limiting proportional durations are 0.435 and 0.449 in the sampling without recall and with recall respectively.

: WE30 Warehouse Design, Planning, and Control

Invited Session Room: L14

Chair: René de Koster
Erasmus University Rotterdam

1 : A Mathematical Model for Warehouse Design and Product Allocation. Sunderesh Heragu, Rensselaer Polytechnic Institute; Huang, Chih-Shah; Schuur, Peter; Mantel, Ronald.

Primary warehouse functions include, temporary storage and protection of goods, and value added services such as fulfillment of individual customer orders, packaging of goods, after sales services, repairs, testing, inspection, and assembly. The warehouse is divided into several functional areas: reserve storage area, forward area, and cross-docking. We present a mathematical model that jointly determines product allocation to the functional areas in the warehouse as well as the size of each area using data readily available to a warehouse manager. The model can be solved optimally for medium scale problems. An efficient heuristic is presented for even larger problems.

2 : Hybrid On-Line Dispatching Rules for Vehicle-based Internal Transport Systems. Tuan Le Anh, Erasmus University Rotter-

dam; de Koster, René.

This research focuses on on-line vehicle dispatching rules to control vehicles within facilities such as warehouses. Most of dispatching rules in literature are single-attribute dispatching rules that dispatch vehicles based on only one parameter. In this research, we propose two new hybrid dispatching rules. The first one is a multi-attribute dispatching rule and the second one is a multi-attribute dispatching rule with vehicle reassignment. We evaluate the performance of these hybrid dispatching rules and several single- and multi-attribute dispatching rules in a real-life case, using simulation. Results show that the new hybrid dispatching rules are better and more stable.

3 : Storage Zone Optimization in Warehouses. Tho Le Duc, Erasmus University, Rotterdam; de Koster, René.

We can improve the order picking process by using a relevant storage policy. One of the most common policies used in practice is the class-based storage policy (i.e. products are divided into a number of classes and each class is then located on a dedicated area in the warehouse). The most critical issue concerning this storage policy is determining the optimal storage space used for a certain class in each pick aisle. In this paper, we propose a formulation and a heuristic approach for the problem. Numerical examples we conducted show that the heuristic performs very well.

: WE31 **Quality Management - C2**

Contributed Session Room: M33

Chair: Erkan Bayraktar
Beykent University

1 : Customer Satisfaction and Excellence in Education. Fethullah Çalışkan, TÜSSİDE; Türe, Erkan.

Implementing a Customer Focused Quality Management System in educational organizations is as a challenging practice as it is essential. In Antalya College, a private school that provides primary and high-school education for more than 1500 students, Parents and Students Satisfaction Surveys are applied regularly, and the results are integrated to the Performance Management System and Quality Improvement activities. This paper will primarily focus on Student Satisfaction Surveys, including the design and application of questionnaires, and analysis of the resulting data to provide useful information which in turn can be used for the quality improvement studies.

2 : Control Charts for Detecting Specific Shape Changes Across a Web Profile. Nasser Ruhhal, King Fahd University of Petroleum and Minerals.

A special control chart is proposed for detecting changes in the shape or profile of a web. Improved monitoring is established by utilizing prior statistical modeling of historical process data for the normal and the out-of-control conditions. The historical data model is used for determining pertinent contrasts and principal components for monitoring in a special control chart. The proposed chart has less false alarm rate, and faster response to out-of-control situations than traditional charts, it also simplifies the diagnosis process and the corrective action plan. A simulation example is given which shows the improved performance of the proposed control chart.

3 : Integrating Preventive Maintenance and Statistical Process Control. Sophia Panagiotidou, Aristoteles University of Thessaloniki; Tagaras, George.

Statistical process control and preventive maintenance are two research areas that have been studied extensively over the last years. Although these two areas are strongly interrelated only few attempts have been made to integrate them. We present a review of the existing integrated models and we investigate the behavior of a production process, where both a shift in the process quality and an equipment failure can occur. Our model assumes that when the process shifts to an out-of-control state, the failure rate increases. We derive the appropriate cost function and discuss the determination of the optimal time for preventive maintenance.

4 : Evaluation of Total Quality Management Practices in Turkish Higher Educational Institutes. Kazım Sarı, Beykent University; Bayraktar, Erkan.

In the search of better and good quality educational programs, Total Quality Management (TQM) is one of the indispensable tools for educational institutes such as universities. In fact, many institutions among Turkish universities has developed or attempted to develop such programs. In this study, we discuss TQM practices at Turkish universities in terms of the tools used, perception of quality by the stakeholders, implementation policies using a survey technique. A comprehensive statistical analysis is conducted on the survey data.

: RA01 **The Subversive Spreadsheet**

Tutorial Room: MB I

The Subversive Spreadsheet. David Chadwick, University of Greenwich; Croll, Grenville.

This talk will be in two phases: phase one will give an overview of the problem of spreadsheet errors, phase two will look at a detailed approach to spreadsheet audit. Phase one will cover common the problem of spreadsheet errors - what they are, how they are caused, the risks they pose and what can be done about them. A taxonomy of errors will be discussed and examples of common errors shown. The aspects of causation such as human error and non-awareness will be covered in overview with suggestions on how to prevent or minimise. Audit aspects such as audit tools, methods and strategies will be briefly covered. Phase two will be looking at a tried and tested audit methodology composed of ten steps. Each of the steps incorporates a number of checking and risk management procedures resulting in an assessment of a level of confidence that may be placed in the integrity of the reviewed spreadsheet model.

: RA02 **Modelling of Telecommunications and Electronic Commerce**

Tutorial Room: MB II

Modelling of Telecommunications and Electronic Commerce. Bezalel Gavish, Southern Methodist University.

Telecommunication systems, the Internet and Electronic com-

merce are having an enormous impact on industrial organizations, economic activities of nations, governmental activities and services offered and executed by individuals. The tutorial will present some of the innovative applications and services that stem from the widespread availability of the Internet, the opportunities and limitations of growth imposed on them by economic and physical considerations. The tutorial will also present some new problems in this area and will develop mathematical and economic models; they will be used as a basis for developing solution procedures. Their use will be demonstrated through numerical examples.

: RA03 **A New Look at Convexity, Duality, and Optimization**

Tutorial Room: MB III

A New Look at Convexity, Duality, and Optimization. Dimitri P. Bertsekas, Massachusetts Institute of Technology.

We provide a unified framework for minimax theory and constrained optimization duality as special cases of duality between two simple geometrical problems. Within this framework, the fundamental constraint qualifications needed for strong duality and existence of saddle points are quite apparent, and admit straightforward proofs. Some new tools from convex analysis, needed to fully exploit this framework, will be discussed. This analysis is central to the new textbook Convex Analysis and Optimization by D. Bertsekas, A. Nedic, and A. Özdağlar.

: RA04 **Combinatorial Optimization - C3**

Contributed Session Room: JB A

Chair: Jian-Bo Yang
UMIST

1 : Lot-Sizing Scheduling with Batch Setup Times. Bo Chen, University of Warwick; Ye, Yinyu; Zhang, Jiawei.

This paper is concerned with scheduling independent jobs on parallel machines in such a way that the makespan is minimized. Each job j is allowed to split arbitrarily into several parts, which can be individually processed on any machines at any time. However, a setup for uninterrupted s_j time units is required before any split part of job j can be processed on any machine. The problem is strongly NP-hard if the number of machines is variable and weakly NP-hard otherwise. We give a polynomial-time $5/3$-approximation algorithm for the former case and a fully polynomial-time approximation scheme for the latter.

2 : Low Cost Simulation Tools for Packing Line Performance Improvement. Paul Brunn, UMIST.

The paper describes an efficient, low cost, generic simulation modelling technique applicable to flow processes, such as food packing, that has been developed in conjunction with and used by a major international manufacturer of cake and biscuit products. These models assist in the effective management of resources by allowing all concerned to experiment with the main processes in the business. By carrying out "what-if" queries and comparing production volumes and costs it is possible to identify key areas requiring change and those that can safely be left until more suitable resources become available.

3 : A Multiobjective Decision Making Model. Xianjia Wang, Wuhan University.

In this paper, a multiobjective decision making model for time-resources harmonious combination is proposed and a solution algorithm embedded in the compromise Lagrangian relaxation approach based on three-phase structure strategy. Objective functions are defined as adaptive and adjustable. A satisfied feasible solution can be obtained in our solution procedure by compromising and adjusting relationship. A numerical example is presented. In addition, project duration and the total consumed-resources cost in the Lagrangian relaxation form associated with resource constraints are interpreted as a two-player game.

4 : Evidential Reasoning based Reference Ranking using Mixed 0-1 Programming. Jian-Bo Yang, UMIST; Wang, Ying-Ming; Xu, Dong-Ling.

In this paper, an evidential reasoning (ER) model is constructed to represent a ranking problem having several options initially ranked on individual criteria by a group of decision makers. The ER algorithm is employed to combine individual assessments to arrive at a final assessment, represented by a distribution matrix where degrees to which each option is assessed to every rank is recorded. A mixed 0-1 programming problem is then constructed to find a final ranking order maximising the total degree to which each option is assessed to an appropriate rank. Several numerical examples are examined to demonstrate the proposed approach.

: RA05 **Transportation - C3**

Contributed Session Room: JB B

Chair: Khaled Abbas
King Faisal University

1 : Analysis of Train Dispatching Process with Artificial Neural Networks. İsmail Şahin, Yıldız Technical University; Dündar, Selim.

We have analyzed decisions of train dispatchers, using artificial neural networks. We extracted the necessary data from planned and actual train schedules; the latter of which consists of decisions concerning meeting conflicts considered in this study. Having established the historical data set regarding the previous conflict resolutions and the numerical values of the associated criteria, we used a part of it to train a multilayer neural network, using backpropagation algorithm. The test results showed that trained neural network was able to reproduce previous decisions taken by train dispatchers with over a 90% success rate.

2 : Circulation of Railway Rolling Stock: A Branch-and-Price Approach. Marc Peeters, Centrum voor Wiskunde en Informatica.

We describe a branch-and-price approach to determine an efficient railway rolling stock circulation on a single line. Given the timetable and passengers' seat demand, we develop an algorithm that results in an allocation of rolling stock material to the daily trips. In order to efficiently utilize the train units

on this line, they can be added to or removed from the train at some station along the line. This change in train composition is subject to several constraints. The algorithm is tested on real-life instances from NS Reizigers, the main Dutch operator of passengers trains.

3 : Finding a Line Plan with Minimal Transfers. Susanne Scholl, Universität Kaiserslautern; Schoebel, Anita.

An important strategic element in the planning process of public transportation is the development of a line plan, i.e. to find a set of paths and frequencies for operating lines on these paths. So far, the models in the literature have considered minimal cost or maximal number of direct travelers as objective function. In this paper we present a new approach minimizing the changing activities over all customers. This approach maximizes the comfort of the passengers and will make the resulting timetable more reliable. To tackle our problem we present integer programming models and suggest different solution approaches.

4 : Budgeting Bus Operation using Route based Simulation Model. Khaled Abbas, King Faisal University.

The purpose of this research is to construct and demonstrate applicability of a model that simulates interactions within a bus transit system. It is meant to estimate route based bus operation parameters and assist in budgeting bus activities. It consists of bus maintenance, operation, procurement, fare determination and cost accounting modules representing supply and demand analysis module. Components and interactions captured within the model are portrayed. Applicability of the model as a tool that can support planning and budgeting decisions of bus managers is demonstrated using real data and information related to bus route 48 operated by Cairo Transport Authority.

: RA06 **Scheduling - C7**

Contributed Session Room: M30

Chair: George D. Stamoulis
Athens University of Economics and Business

1 : Decision-making Model for Pairwise Comparision in Job-shop Scheduling. Zohar Laslo, Negev Academic College of Engineering; Golenko-Ginzburg, Dimitri.

A newly developed decision-making model for controlling a flexible job-shop manufacturing cell with cost objectives by means of pairwise comparison is presented. Decision-making is based on analyzing long-term forecasting results with modified average values of tested total cost expenses within the job-shop makespan. The modified heuristic for choosing jobs for the machines has been implemented into a generalized simulation model including a broad variety of cost expenses.

2 : A New Due Date based Dispatching Rule for Minimising MAL and MSL in a Job Shop. Şerafettin Alpay, Osmangazi University; Yüzügüllü, Nihat.

In this paper we present a new due date based dispatching rule for minimising mean absolute lateness (MAL) and mean squared lateness (MSL) in a job shop. This rule is closely related to the modified operation due date (MOD) rule and combination of critical ratio rule (CR) and operation slack time rule (OPNSLK). It does also not require any parameter estimation for its implementation. Simulation results show that the performance of the new rule is better than that of other rules that have been reported their good performance on MAL and MSL.

3 : Distributed Scheduling of Recording Tasks for Networked Servers. George D. Stamoulis, Athens University of Economics and Business; Soursos, Sergios; Bozios, Theodoros.

We consider a system with multiple interconnected video servers storing TV programs received through satellite antennas. Users are equipped with set-top boxes, and submit requests for programs. The distributed scheduling algorithm selects the programs to be recorded and the servers to store them, so that a high total value is generated to the users' population. The recording decisions are based on the programs' broadcasting information, the users' preferences, the constraints regarding the capabilities of simultaneous recordings, and the system's topology. This work has been carried out as a part of the project IST-1999-20751 UP-TV, funded by the European Union.

4 : Lot Sizing Problem with Equipment Replacement as a Bilevel Programming Problem. Kristina Soric; Lukac, Zrinka; Vojvodic Rosenzweig, Visnja.

The object of a Production Lot Sizing Problem is to minimize the sum of the costs of production, storage and set up. On the other hand, an Equipment Replacement Problem concerns a machine which deteriorates with age. The object is to decide when to replace the machine in order to maximize the utility of operating it. We introduce the hierarchy into the problem and model the problem as the new bilevel mixed 0-1 integer programming problem. We develop and compare heuristics based on simulated annealing and tabu search for solving the problem.

: RA07 **Retail Supply Chains**

Invited Session Room: M31

Chair: Zeynep Ton
Harvard Business School

1 : Efficient Discounting. Garret van Ryzin, Columbia University.

Given a collection of possible discounts and promotions, which combinations should a firm offer and under what conditions? We analyze this question using a notion of "discount efficiency," which is based on constructing an efficient frontier between the expected revenue and probability of purchase. We discuss the implications of efficiency for decision making and illustrate it using applications from discounted air fares and retail markdowns and promotions.

2 : Optimal Commodity Procurement. Ali Güzel, Kırıkkale University; Schmidt, Charles; Miller, David.

Forward Buying is the acquisition of materials well in advance of the time when the material is actually needed. The literature on forward buying generally assumes first order Markovian prices. The prices in our approach are allowed to take any discrete-time continuous-space stochastic form. We develop the optimal procurement strategy and show that the computation time exponentially increases in the number of future periods. An operational policy is developed based on computationally efficient bounds of the optimal procurement model. A case study

shows that the operational policy saves more than 20% of the maximum potential savings.

3 : Retail Supplier Relations. Noel Watson, Harvard University.

We examine in a supply chain dyad with independent supplier and retailer, the effect of information sharing, the retailer's replenishment strategies, and supplier inventory management strategies. We place emphasis on echelon inventory management examining its stabilizing potential for system performance given the retailer's replenishment strategies.

4 : Retail Assortment and Inventory Management. Zeynep Ton, Harvard Business School; Raman, Ananth.

When products at retail stores are misplaced in areas when customers cannot find them, customers experience "phantom stockouts." That is, they experience stockouts even when the product they want to purchase is physically available at the store. From an empirical study of 242 stores of a large retailer, we study the effect of product variety and inventory levels on misplaced SKUs. We show that higher levels of product variety and inventory levels are associated with increased misplaced SKUs. Our findings have implications for research in retail inventory management and assortment choice.

: RA08 **GDN - C1**

Contributed Session Room: M32

Chair: Dengfeng Li
UMIST

1 : A Bayesian Belief Net for a Dynamic Inflation Analysis: Case of Turkey. Füsun Ülengin, İstanbul Technical University; Önsel Şahin, Şule; Ülengin, Burç.

Case of Turkey This paper proposes to use Bayesian Belief Nets (BBNs) in order to analyze the complex structure of inflation in Turkey. In this study, initially a model of inflation is structured using cognitive mapping technique. Then, the dependent probabilities of the concepts are calculated based on detailed analysis of the past data. Finally, BBN is used to analyze the complex structure of inflation in Turkey. As a result, it will be possible to see dynamic structure of the inflation model and to understand the basic consequences of any strategic change that may occur in the system.

2 : A Decision Support Procedure for Financing of the Public Non-Divisible Goods. Andrzej Jakubowski, Systems Research Institute, Polish Academy of Sciences.

One main task of collective decision making is considered. This is connected with the choice of quantity and financing of the public non-divisible good. It is assumed that the collective members differ in their opinions on the amount of this public good to be produced as well as on the share of total cost. The negotiation procedures used to solve these problems can be considered as realizations of N-person games. So, different types of equilibrium for such games are discussed. The examples, illustrating the so-called free-rider (manipulation) - versus the so-called Lindahl - behaviour of the collective members are presented.

3 : MCDA Support to Negotiation: A Conflict Analysis Applied to the Environmental Impact Assessment of a Transportation System. Alessandro Luè, Politecnico di Milano; Colorni, Alberto; Montanini, Marco.

The environmental impact assessment procedure is used for the choice of the transportation system in a small Italian town with problems of traffic congestion. Alternative multimodal transportation systems, including innovative systems and measures of travel demand management, are compared using the multi-attribute utility theory. Since the interested actors have conflicting viewpoints and different decision powers, an aggregated viewpoint is generated to reach a compromise solution. A conflict analysis, conducted on the actor viewpoints and on the alternative performances, is carried out to analyze the level of agreement associated with the compromise solution and to support the negotiation between the actors.

4 : Fuzzy Linear Programming Technique for Multidimensional Analysis of Preferences in Multiattribute Group Decision Making under Fuzzy Environments. Dengfeng Li, UMIST; Yang, Jian-Bo.

This paper is aimed to extend a LP technique for multidimensional analysis of preferences in group decision making under fuzzy environments, where linguistic variables may be used to assess alternatives. In this paper, firstly we define group consistency indices based on the preferences between alternatives and generate results from a decision model based on a distance measure. Then we generate a fuzzy ideal solution and the weights of attributes using a new LP model based on the group consistency indices. Finally, the distance of each alternative to the fuzzy ideal solution is calculated to determine the ranking of all alternatives.

: RA09 **Consumer Behavior - C3**

Contributed Session Room: L15

Chair: Demetrios Vakratsas
McGill University

1 : Business Gifts as a Promotion Tool: An Investigation of Factors Influencing Gift Evaluation and Reactions to Gift Receipt. Onur Bodur, Concordia University; Grohmann, Bianca.

In this paper, we focus on effectiveness of business gifts as a promotional tool. First, we propose that customer-firm relationships differ from interpersonal relationships in nature and that relationship type will influence reactions to gift receipt. Secondly, we propose that the value of the gift will have an impact on reactions to gift receipt. Next, we propose that a number of other factors, such as implicit vs. explicit requests made by the gift giver, influence recipients' evaluation of a business gift and their likelihood to reciprocate. Finally, we discuss the implications of our empirical findings for business gifts giving.

2 : Ambient Scents & Service Encounters. Sanjay Mishra, University of Kansas; Lee, Sanghoon; Singh, Surendra.

Anecdotal evidence suggests that scents may affect consumer behavior, but very little empirical research has addressed that possibility. A study is conducted to explore the role of ambient scents in service encounters. On the basis of empirical evidence from physiology and psychology, a contingency olfaction model

is developed. The model is examined in a 2 (types of ambiance: pleasant scent and no scent)*f*, 3 (levels of service complexity: high, moderate, and low) design. The results suggest that pleasant scents are mood enhancers affecting attitudes and behavioral intentions. The effect of ambient scent is moderated by the stimuli and individual characteristics.

3 : News on Product Tampering: A Requiem or A Marketing Opportunity. Paul Sergius Koku, Florida Atlantic University.

We collected data on news of product tampering from 1990 through 1999, and analyzed the stock market's reaction to the firms when the news became public. Because such news scare consumers away from buying the product, it is intuitive to expect the stock market to react negatively. However, we hypothesize that the stock market will not react negatively per se, rather, the markets reaction will be determined by steps taken by the firm when the news becomes public. Our results show that the market reacts marginally positively. However, analysis of the individual firms produced mixed results.

4 : Bricks and Clicks versus Pure On-liners:Success Factors, Brand Perceptions and First-Mover Advantages. Emine Sarigollu, McGill University; Jo, Myung-Soo; Vakratsas, Demetrios.

Pioneer Internet brands (e.g. e-Bay) face increasing competition from conventional brands that offer online services in addition to their existing offline services (e.g., Fidelity Investments). This growing trend prompts questions regarding the existence of pure Internet brands' first-moving (pioneering) advantages, the sources of such advantages, and their sustainability in the event of entry by conventional "household" brands. This research explores the existence and defensibility of first-mover pure Internet brand advantages through a series of research questions that concern consumer perceptions and valuations of brands, consumer preferences and transferability of an established brand's equity from the conventional to the Internet landscape.

: RA10 Modeling Languages and Systems for Optimization

Invited Session — Room: L19

Chair: Josef Kallrath
BASF-AG

1 : The Importance of Modeling Languages for Solving Real-World Optimization Problems. Josef Kallrath, BASF-AG.

Modeling languages play a very important role when it comes to solving real world optimization problems. They help to speed-up the modeling process itself and the process of coding the model, they may increase the efficiency of the solution process, and they may extend the shelf life of a model.

2 : Strategies for Interacting with Algebraic Modelling Languages. Mustapha Sadki, Brunel University; Valente, Patrick; Mitra, Gautam; Fourer, Robert.

We present in our work a component based approach which represents recent trends in modelling interaction. Using AMPL as the modelling language, we illustrate GUI support for users and scope of creating embedded applications using components (COM) objects. The stochastic programming modelling constructs of Stochastic AMPL (SAMPL) will be also introduced as a natural extension of this interactive modelling paradigm.

3 : Solving Semi-Infinite Programming Problems with SIPAMPL and MATLAB. A. Ismael F. Vaz, Minho University; Fernandes, Edite.

The SIPAMPL software was developed two years ago to allow the codification, in the AMPL modeling language, of semi-infinite programming (SIP) problems. MATLAB in its optimization toolbox provides a solver for SIP problems. This solver applies a quasi-Newton SQP algorithm to the finite problem, obtained by using an interpolation of the maxima in the discretized infinite constraints. The SIPAMPL interface routines can be used to provide the problem data to the MATLAB solver. The aim of this presentation is to illustrate how one can use MATLAB to solve the SIPAMPL SIP problems and to present some numerical results.

4 : Scheduling Jobs on Multi-Port Dyeing Machines: An Application. Cem Saydam, UNC Charlotte; Cooper, Doug.

In this paper we report the development and implementation of a job scheduling system for a major textile firm with annual sales of more than $2.5 billion. For the first phase of the problem, we developed a linear programming model to generate optimal machine loads. For the second phase, we designed a heuristic to minimize the delays that occur during the subsequent fabric roll selection and sequencing operations. Our system completely replaced tedious manual calculations with optimal machine loads and greatly improved the overall quality of their products.

: RA11 Integration Models in SCM - C4

Contributed Session — Room: R20

Chair: Burcu Balçık
METU

1 : A Multi-Item Integrated Location-Inventory Problem. Burcu Balçık, METU; Meral, Sedef.

We consider a distribution network consisting of supplier(s), distribution centers and retailers. Several products (or product groups) flow through the distribution network. Demand occurs at the retailers only, and it is uncertain. A subset of retailers that also function as distribution centers orders products from the supplier(s) jointly and distributes them to the retailers. We address the problem of determining the number and location of the distribution centers by considering transportation costs, inventory and joint ordering costs, and fixed cost of facility location, while the location of supplier(s) and retailers is fixed.

2 : Multi-Company Collaborative SCM: Strategic Analysis with MILP Models. Cihan Oruç, Koç University; Türkay, Metin.

Integrated analysis of different companies can provide valuable insight and identify improvements in the financial and environmental performance of industrial supply chain systems. A systematic approach to identify the synergy among different companies at the strategic level has been developed. The approach includes detailed MILP models for each company to realize collaboration in a multi-period horizon. The approach is illustrated with an example that is a simplified version of a real problem and tested on an industrial problem. It is shown that important improvements in the cost and release of environmen-

tally harmful emissions can be accomplished by integration of companies.

3 : An Integrated Two-Echelon Supply Chain Model for Improving System Performance. Güzay Paşaoğlu, İstanbul Kültür University; Yazgaç, Tülin.

This study focuses on a two-echelon supply chain system. The developed mathematical model addresses production, purchase and capacity decisions of a main supplier company, his buyers and suppliers simultaneously within a single integrated model. The main company is the supplier to many domestic and export automotive manufacturers, whereas, his suppliers provide critical and non-critical components for the selected product. Deviations of delivery quantities from the planned purchase requisitions of all three parties are penalized, and reflected in the quota allocation at the end of the performance evaluation period. Different objective functions displaying centralized and decentralized approaches are utilized, and compared.

: RA12 **Reliability Testing**

Invited Session Room: M39

Chair: İ. Kuban Altınel
Boğaziçi University

1 : Optimum Reliability Test Plans for Phased Mission Systems. Orhan Feyzioğlu, Galatasaray University; Altınel, İ. Kuban; Özekici, Süleyman.

Most reliability techniques and tools assume that the systems being analyzed perform a single phased mission. However, many of the modern systems perform a mission with different phases. As a typical example, an aircraft has different flight-phases where the engines and various instruments have different roles during take-off, cruise and landing. In this work, we are concerned in finding out the component test plans which demonstrate a specified system reliability level at minimum possible cost while seeking to minimize the associated producer and the customer risks. We analyze various system configurations: series, passive redundant, active redundant and k-out-of-n systems.

2 : Reliability Assessment Methodology for One-Shot Systems. Sheo Misra, Misra Associates.

This paper describes some of the challenges of one-shot device analysis. An existing one-shot system reliability analysis approach for nuclear weapons will be discussed. Some of the other important characteristics that influence the approach are also highlighted. Although illustrated in the context of nuclear weapon systems, many of the aspects of the discussed approach are relevant to other applications.

3 : Joint Reliability Importance for All-Terminal Reliability in a Network System. Takeshi Koide, University of Marketing and Distribution Sciences; Shinmori, Shuichi; Ishii, Hiroaki.

Joint reliability importance (JRI) of two edges in a network system measures the interaction in the system reliability with respect to their reliabilities and it is significant information to design network systems. When all-terminal reliability, famous as one of the most important network reliabilities, is selected as the system reliability, it is NP-complete to compute JRI in general. We propose an efficient algorithm to compute JRI for all-terminal reliability. Axioms on network reductions for all-terminal reliability are proved and utilized in the proposed algorithm to reduce computational time. Numerical experiments result the efficiency of the algorithm.

4 : Reliability and Maintenance. Oumhani Belmokhtar, Ecole Nationale Polytechnique d'Alger; Tewfiq, Lamraoui.

This paper addresses the relationships between reliability and maintenance. With using characteristics: MTBF, failure rate, reliability function,..., we investigate how reliability can be viewed as a decision making tool in the different aspects of the maintenance ; Secondly, we suppose: N identical equipments are into function, in the same conditions at a time t=0. The number of functioning equipments is constantly maintained equal to N, during the time range (0,t). We know the reliability functions. How many equipments to stock in (0,t) ? To answer to this question we use the notion dealing with a renewal stochastic process.

: RA13 **Issues in Flexible Manufacturing - I**

Invited Session Room: R21

Chair: Andrea Pacifici
Università di Roma Tor Vergata

1 : Setting WIP Levels in a High-Variety, Low-Volume Environment. Mandyam Srinivasan, The University of Tennessee.

We present a methodology for setting WIP levels in a high-variety, low-volume, manufacturing plant. The methodology iteratively determines WIP levels for different products to meet required throughputs, using a spreadsheet-based closed queueing network model. The spreadsheet implementation allows plant supervisors to rapidly analyze alternate scenarios.

2 : Heuristics for PCB Assembly Operations using a Collect-and-Place Machine. Ihsan Onur Yilmaz, Technische Universität Berlin; Grunow, Martin; Günther, Hans-Otto; Schleusener, Martin.

We focus on a so-called collect-and-place type machine, which uses a revolver-type placement head in order to collect components from the magazine and to place them at their predefined positions on the printed circuit board (PCB). There are two main problems in optimizing operations of such a machine: the feeder assignment and the component insertion sequence. We present a hierarchical heuristic solution approach to solve these problems. In the first step, the feeders are assigned by using a greedy algorithm. The component insertion sequence is determined in the second step by using different adaptations of savings heuristics.

3 : Batch Scheduling of Printed Wiring Boards in Surface Mount Technology Lines. Tadeusz Sawik, University of Mining & Metallurgy.

Mixed integer programming approach is presented for scheduling batches of printed wiring boards in surface mount technology lines. A surface mount technology line is a flexible flow line with parallel machines and finite in-process buffers. The problem objective is to determine shortest assembly schedule for a mix of boards, where the boards of a given type are scheduled consecutively. The formulation includes new cutting constraints

identified for typical SMT line configurations and a batch scheduling mode. Results of some computational experiments with CPLEX solver are reported.

: RA14 **E-Crime/E-Government**

Contributed Session Room: R22

Chair: Seda Özmutlu
Uludağ University

1 : E-Commerce and Organized Crime. Mirjana Drakulic; Drakulic, Ratimir.

Achieved profit in digital economy has been great challenge for organized crime. Traditional crime groups have also discovered that the Internet is able to provide new opportunities for crime in various ways. Interaction and cooperation of organized criminal groups from different countries with globalization of financial and economic markets enable theirs enter into licit e-commerce. On the other hand, new environment is good for appearance of new form of white-collar crime - cyber crime. This phenomenon keeps growing daily. In the paper will be present a connection between e-commerce and the expansion of organized cyber crime in transition countries.

2 : Internet Voting. Guido Schryen, RWTH Aachen.

Voting via the internet is part of electronic government and electronic democracy. However, there are many obstacles to be overcome, especially legal restrictions have to be transformed into technical and security solutions. The article discussed advantages and disadvantages of internet elections, shows different application fields and presents important international pilot schemes (political and business ones). Due to democratic basic principles, general security aspects are worked out and dedicated cryptographic elements are demonstrated. Because of the complex requirements of internet voting systems a techncial structure model is presented that helps matching different requirements with technical solutions.

3 : Cybercrime in Turkey: Definitions and Discussion of Solution Strategies . H. Cenk Özmutlu, Uludağ University; Özmutlu, Seda; Emel, Erdal; Çavdur, Fatih.

The fast development of information technology has created many opportunities for cybercrime, making cybercrime an increasing concern for security forces in Turkey and other countries around the world. This study summarizes results of the initial steps of a joint project with the Turkish Police Department. The first emphasis of this paper is defining, identifying and classifying cybercrime, especially those in Turkey. Fighting cybercrime is only possible through creative solutions stemming from information technology. Consequently, the second focus of the paper is to discuss potential solution alternatives to overcome cybercrime, as well as the problems in applying such solution alternatives.

4 : A Study on Question Format Web Queries from the Fast Search Engine. Amanda Spink, Pennsylvania State University; Özmutlu, Seda; Özmutlu, H. Cenk.

Search engines are one of the most important tools in e-commerce. This study is a part of the general research trend analyzing Web search engine user behavior. For Web users, a common form of submitting queries on Web search engines is accomplished by asking questions. This study reports findings on the characteristics of question format Web queries submitted to the FAST search engine. The question queries in a dataset of over one million queries were analyzed. Results include: (1) sessions including question queries are shorter than general search sessions, (2) question queries are longer than general search queries.

: RA15 **Data Mining and Finance**

Invited Session Room: R23

Chair: Fidan Boylu
University of Florida

1 : How Robust are the Profits from Assuming Risks Internal to Turkey's Securities Markets?. Kurt Dew, Işık University.

Using a bootstrap test, we found that the performance of trading profits from an earlier study was not robust. We conclude that although the volatility of markets in Turkey is an important part of the evolution of Turkish common stock returns series, expecting to generate above average returns based on price information from our model is a risky enterprise. Unlike the apparent behavior of the long run market risk premium in the United States, it appears that the unique risks of Turkey's securities markets do not decline in the long run.

2 : Value Versus Growth Portfolio Performances: A Data Mining Approach on Turkish Stocks. Halit Gönenç, Hacettepe University; Koyuncu, Onur.

This study obtains a descriptive model to define the stock market movements and accuracy of certain stock performances based on Book-to-Market ratio and size effects. We plan to modify the Fama and French approach (1995) that forms and measures the returns of size and book-to-market portfolios. Thus, we combine the Fama and French approach with a simple data mining model consisting of prespecified association rules based on trade volume along with book-to-market ratio and size. We will use the Istanbul Stock Exchange as a laboratory.

3 : Knowledge-based Supply Chain Configuration: Demand and Supply Side Dynamics. Selwyn Piramuthu, University of FLorida; Boylu, Fidan.

Most current work on supply chain management assume a given (fixed) supply chain configuration. Given recent advances in Information Technology, this limitation can be alleviated to allow for dynamic reconfiguration of the supply chain as per the dictates of demand and supply levels. We propose a knowledge-based framework to study the demand and supply chain dynamics of automated supply chain configuration. We also illustrate the proposed framework using examples.

4 : Intelligent Knowledge Discovery from Military Health Systems. Dursun Delen, Oklahoma State University; Ramachandran, Satheesh.

Herein we present the up-to-now results of a federally funded research project that aims to develop a hybrid knowledge discovery framework that would support the excavation of valuable information from military health systems data repositories in order to deliver useful knowledge to patients, medical prac-

titioners and policy planners. So far, we established the foundation for a knowledge discovery framework that has potential to overcome many of the challenges commonly found in data rich, knowledge poor decision environments; developed a set of deployable data mining components and implemented an integrated toolkit that maps those components into the proposed framework.

: RA16 **Project Management - C1**

Contributed Session Room: R27

Chair: Erik Demeulemeester
Katholieke Universiteit Leuven

1 : Experiences from a Development Planning Project for the City of Düzce. Funda Sivrikaya Şerifoğlu, Abant İzzet Baysal University.

Düzce was severely damaged by the 1999 Earthquakes and is now subject to a pioneering governmental project in Turkey: strategic development planning at the city level. The project is executed by the local university with the cooperation of local governmental offices and non-governmental organizations. It is comprised of nine subprojects, which encompass all aspects related to city development: demographical, social, economical, infrastructural and environmental. The aim is to develop a vision and development strategies for the city, comprising a time span from 2003 to 2023. In this presentation, experiences from the project management point of view will be shared.

2 : Strategies for Solving 0-1 Stochastic-Mixture with Branch and Fix Coordinated. Celeste Pizarro, Universidad Rey Juan Carlos; Alonso Ayuso, Antonio; Escudero, Laureano Fernando; Ortuño, M. Teresa.

We present a framework for solving 0-1 stochastic-mixture problems with full recourse, particularly, the Multiperiod Single-Source Problems (MPSSP), a problem of assigning retailers to facilities with a lot of periods and single sources under uncertainty in the demand and the production/distribution cost of the product from the retailers along the time horizon. We use the so called Branch-and-Fix Coordinated algorithmic for exploring selectively the active nodes of the Branch-and-Fix tree. We propose some strategies for partitioning the scenarios in clusters, for obtaining (hopefully) good solutions for this model.

3 : A Priority Rule Heuristic for Resource Constrained Scheduling of R&D Projects. Prem Viswanathan, National University of Singapore; Karimi, I. A.

Resource constrained scheduling of research projects involving the option of outsourcing and penalty for delayed completion has been considered. A marked feature of scientific R&D projects is the possibility of failure of individual activities thereby leading to the abandonment of the project itself. When an activity fails, the costs incurred till that point of time are wasted. The objective of the problem is to maximize the expected NPV of the discounted cash flows. Complexity of the problem ensures that large scale problems cannot be solved exactly within realistic computational time. A backtracking heuristic which progressively improves the solution is proposed.

4 : A Real Option Approach to Project Scheduling. Robert Boute, Katholieke Universiteit Leuven; Demeulemeester, Erik.

When scheduling an uncertain project, you may wait for more (future) information in order to reschedule your project according to this new information. This flexibility enhances the project's value by improving its upside potential while limiting downside losses relative to the initial expectations. Using traditional techniques such as net present value or decision tree analysis may lead to false results. Instead, a real option analysis should be used. We discuss the potentials of a real option approach to project scheduling with an example and highlight future research directions.

: RA17 **Stochastic Models in Semiconductor Manufacturing**

Invited Session Room: R24

Chair: Kaan Katircioglu
IBM Corporation

1 : Sense and Respond Supply Chain Management. Markus Ettl, IBM Corporation; Buckley, Steve; Lin, Grace.

We describe a sense and respond supply chain management system applicable to a variety of enterprise supply chains. The system provides event monitoring, situation management, proactive analysis of global supply chain information and the ability to assess the risk and reward of proposed responses for best supply chain performance. We discuss performance prediction, and risk assessment models that provide real-time decision support at key points in the supply chain and a software architecture for implementing an innovative event driven solution management system developed at IBM.

2 : Capacity Reservation in Semiconductor Manufacturing. David Wu, Lehigh University; Erkoc, Murat.

We study capacity reservation contracts in a semiconductor manufacturing environment. We consider contracts that allow the manufacturer (the supplier) to share the risk of capacity expansion with her OEM customers (the buyer). The supplier would expand her capacity in any case, but reservation may encourage her to expand more aggressively. To reserve capacity, the buyer pays a fee upfront while (a pre-specified portion of) the fee is deductible from the order payment. We propose a number of channel coordination contracts, and discuss the relationship of these idealized contracts to common practice in the industry.

3 : Test Wafer Inventory Management in the Semiconductor Industry. Ertunga Ozelkan, The University of Texas at Dallas; Cakanyildirim, Metin; Foster, Bryce.

Test wafers (TWs) are used for tool qualification purposes in semiconductor production. For a typical semiconductor Fab, the yearly TW demand is in the order of thousands, which sums up to millions of dollars. A TW is downgraded into a lower grade TW after being used a number of times on the same qualification type. When the TW cannot be downgraded to another type of wafer, the TW is scrapped. The typical decisions are the quantity of TWs to purchase and to downgrade. We use mixed integer programming to formulate the problem and study several special cases.

4 : A Semiconductor Inventory Model with Service Constraints. Kaan Katircioglu, IBM Corporation; Ramachandran,

Bala; Gallego, Guillermo.

We will present a multi-echelon inventory model for semiconductor manufacturing. The model captures fabrication, wafer test, substrate manufacturing, and module assembly operations. Each operation has a random yield and a random cycle time. Demand is stochastic and non-stationary. The objective is to minimize inventory costs subject to customer service constraints. We will show a model that uses echelon inventory positions to manage inventory in the system. We will also show approximations that can be used to calculate key performance measures such as expected inventory, backlog, and service.

: RA18 **Forestry Management - C3**

Contributed Session Room: R25

Chair: Isabel Martins
Instituto Superior de Agronomia

1 : Optimization of Timber and Water Production in Karanlıkdere Forest using Parametric Linear Programming. Sedat Keleş, Karadeniz Technical University; Karahalil, Uzay; Başkent, Emin Zeki; Köse, Selahattin; Altun, Lokman.

Forests present various values to the public such as timber production, erosion control, water production and recreation. This study tackles the integration of timber and water production values in Karanlıkdere planning unit. In addition to an already developed growth and yield matrix, water production was functionally linked to forest structure with a water production matrix developed in this study. Two forest management objectives, maximize timber and water production, were simultaneously integrated into an LP model and solved by an LP solver. Finally, the results were presented emphasizing on the opportunities and limitations of using LP in multiple-use forest management planning approach.

2 : Integration of Soil Conservation Value to Forest Management Plans using Linear Programming in Karanlıkdere. Uzay Karahalil, Karadeniz Technical University; Keleş, Sedat; Köse, Selahattin; Başkent, Emin Zeki; Bakkaloğlu, Murat.

Forest management focuses on the control of forest ecosystems based on the sustainable use of forest values without damaging ecological integrity. This study aims to minimize the contradiction between timber production and soil conservation in Karanlıkdere planning unit, Gümüşhane. First of all, soil protection values were associated with forest structure using a regression model to built a soil loss matrix. Then, soil protection integrated forest management model was developed and linear programming was used to maximize timber production under restriction of soil loss. The developed forest management model was solved with a commercial LP solver and the results were presented.

3 : Alternative Models for Integrating Conservation of Biodiversity in Forest Management. Emina Krcmar, University of British Columbia; Vertinsky, Ilan.

We model a problem of ecosystem management at a landscape scale. A mixed-integer programming model is developed to maximize the net present value of returns from timber production while meeting targets of biodiversity conservation. We provide a comparative evaluation of the outcomes of three management frameworks for conserving biodiversity: (i) achieving a specific representation of ecological types, (ii) maintaining or increasing areas of late seral forest conditions (mature and old-growth forests), and (iii) managing for both ecological representation and old-growth maintenance. The consequences of alternative model formulations are examined in the context of a British Columbia case study.

4 : Optimal Packing of Connected Subgraphs in a Graph: An Application to Forest Management. Isabel Martins, Instituto Superior de Agronomia; Constantino, Miguel; Borges, Jose.

We present an integer program for a non-temporal forest harvest problem with constraints on the clearcut size. In the terminology of graphs, the problem may be described as the connected subgraph packing problem which is to find a subgraph of maximum weight whose connected components have at most K nodes. The solution set of the formulation is a (K+1)-regular independence system. For K=1, the problem corresponds to the node packing problem. To solve the formulation, we use branch-and-cut. We define three families of valid inequalities. Some of those inequalities define facets. Computational results for test instances are reported.

: RA19 **Combinatorial Optimization - C4**

Contributed Session Room: R26

Chair: Lemba Nyirenda
University of Zambia

1 : Approximation Preserving Reductions Among Set Covering and Vertex Covering Hierarchies via Differential Approximation Ratio. Tınaz Ekim, Ecole Polytechnique Federale de Lausanne; Paschos, Vangelis Th.

The notion of approximability preserving reductions deserves special attention in the approximability theory because it allows us to convert polynomially some known "good" approximation algorithms for some NP-hard problems to ones for some other NP-hard problems. In this context, we consider reductions among instances of set covering hierarchy and also among instances of vertex covering hierarchy. The particularity of this paper is the adoption of the differential approximation ratio instead of the classical one in the conception of such reductions. This paper offers new results in the approximability theory based on the differential ratio and addresses some future research areas.

2 : On the Heuristic Algorithms for the Hub Location Problem. Mercedes Landete, University Miguel Hernández of Elche; Canovas, Lazaro; Garcia Quiles, Sergio; Marín, Alfredo.

In this paper, a different heuristic will be developed using better formulation of the hub location problem. This heuristic is based in a dual-ascent method. This heuristic will be compared with the other known heuristics by computational experience. Also, some extension of the heuristic for different version of hub location problem will be shown.

3 : A Population Training Approach to Permutation Problems. Luiz A. N. Lorena, INPE - Brazilian Space Research Institute; Oliveira, Alexandre C. M.

This paper describes the general guidelines of a new way to

employ specific-problem heuristics to improve evolutionary algorithms. The individual and its best neighborhood are conserved in the population for a number of generations inversely proportional to their evaluation. The population is then ranked by a coefficient that contemplates the double evaluation of individuals, in order that, the best individuals by this rank have greater probability to be selected from population for recombination and mutation operations. Applications are examined for permutation problems, such as the gate matrix layout and the minimization of open stacks, employing a 2-Opt-like heuristic.

4 : Traveling Salesman Problem Linear Path Spanning Tree Simplex Algorithm. Lemba Nyirenda, University of Zambia; Schinzinger, Roland.

The paper presents the linear path spanning tree simplex algorithm for solving the traveling salesman problem. The nodal distance matrix is transformed into the Dedekind-cut row-simplex matroid consisting of n well-ordered factor groups. The D1-Cut minimum-value link-set is transformed into the base set of linear path spanning tree simplex tableaus from which the linear spanning cycle solutions are obtained. At each iteration the current base solution is transformed into an improved spanning cycle maximizing the inclusion of D1 and D2 cut links until optimality is reached. The minimum-value spanning cycle set is obtained from the base minimum-value spanning cycle solutions.

: RA20 Mathematical Programming - C1

Contributed Session Room: M35

Chair: Alkis Vazacopoulos
Dash Optimization

1 : The Extended Parametric Decomposition. Genrikh Levin, United Institute of Informatics Problems.

We present a new method of the extended parametric decomposition for mathematical programming problems. This method allows combining efficiently the parametric decomposition approach and the extension of obtained subproblems. A main attention is focused on (i) a general scheme of the extended parametric decomposition, (ii) sufficient conditions of its applicability for an exact or e-approximate solution of an initial problem, (iii) some properties of such decompositions, (iv) development of techniques for extended parametric decomposition schemes for the mathematical programming problems. Several applications of the method will be discussed.

2 : Implicit Enumeration Method Used in Resolution of Decomposition Problems. Elder M. Macambira, Universidade Federal do Rio de Janeiro; Goulart, Shane; Maculan Filho, Nelson; Valiati, Douglas.

In this work, we considered a Benders' master problem, where the great difficulty is the fact of all solutions are feasible. If we wanted to compute all the solutions, we´d have a new situation, that is the infeasibility of time, mainly to problems with a high number of variables. Then, we applied the implicit enumeration method, that gets the best solution without the computation of all of them. Computational experiments based on this method are presented. We compare our results with these appearing in the literature.

3 : Sensitivity Analysis and Parameter Study of the Generalized Transportation Problem. Dalia Gil, University of Central Florida.

Parametric analysis has been shown to be useful for determining how the optimal solution of a model will change if some of the parameters are modified. This paper describes an algorithm that performs a sensitivity analysis and a parameter study of the optimal solution of a typical machine-assignment problem. The model structure has the form of the classical generalized transportation problem. Several problems can be solved by this means. The algorithm developed was applied to a load transportation-balancing problem. A version of this algorithm adapted to standard transportation problem was also developed. The prototype software was programmed in C language.

4 : Developing Solution Algorithms in Xpress-Mosel & Xpress-IVE: Combining Different Solvers and Techniques. Alkis Vazacopoulos, Dash Optimization.

Mosel is a new environment for modeling and solving problems. It includes a language that is both a modeling and a programming language. Since there is no separation between a modeling statement and solution algorithm, one can program complex solution algorithms by interlacing modeling and solving statements; typical examples are branch-and-cut, column generation, recursion, and different types of heuristics. Mosel provides a dynamic interface to external solvers, allowing them to directly extend the vocabulary and capabilities of the language through plug-in modules.

: RA21 Medical Applications - I

Invited Session Room: M36

Chair: Horst Hamacher
University of Kaiserslautern

1 : The Statistical Method Substituted for MONANOVA in Conjoint Analysis. Hiroshi Noguchi, University of Marketing and Distribution Sciences.

MONANOVA has recently been applied in developing a new product, because even data obtained only at the ordinal level of measurement can be analysed. However, the obtained scores from MONANOVA are not necessarily unique and cannot be dealt with statistical test, since MONANOVA is based upon the criterion called Stress. Therefore, in this paper, we show that it is possible to apply the scores in statistics by using both of least squares type as a criterion and an order preserving transformation and also show that the results of our new method corresponds well to those of MONANOVA.

2 : A Two-Phase Solution Approach for the Hospital Resident Scheduling Problem using Constraint and Mixed-Integer Programming. Seyda Topaloğlu, Dokuz Eylül University; Özkarahan, İrem.

Residents' long duty hours have been raising serious concerns recently due to its adverse effects on quality of patient care, resident education, and resident physical and emotional well-being. In this study, we developed a mixed-integer program for scheduling residents' duty hours considering the on-call night, days-off, rest period, and total work-hour regulations as well as

the requirements of the residency program and then proposed a two-phase solution approach that uses constraint and mixed-integer programming sequentially. The flexibility of the proposed approach makes it possible to obtain optimal monthly schedules for residents in different scheduling environments using very short computing times.

3 : Utility Theory and Organizational Performance Measurement in Health Services. Güldal Büyükdamgacı, Marmara University.

Strategic Management necessitates organizational performance measuring. Measuring customer and employee satisfaction, financial and non-financial results is not a major challenge. The exception to that is measuring the quality of health outcome - the raison d'etre of health organizations-across an organization. Widely utilized clinical performance measures are mostly either disease-specific, or department-specific, or age-specific. Those that transcend these barriers construct a profile of health not a health quality score. Moreover, preferences of parties involved are not modeled into any of these measures. We explore the use of preference based models in relation to measuring clinical performance of a hospital.

4 : A Data Mining Implementation to Reduce False Positives for Pre-Biopsy Patients with Moderate Chance of Prostate Cancer. Ali Tekin, Haydarpaşa Numune Hospital; Boduroğlu, İlkay; Danış, Selmin; Andırınlı, Barış; Yücebaş, Ergin; Şengör, Feridun.

A decision tree algorithm is employed to detect prostate cancer among men who belong to what we call the pre-biopsy "diagnostic dark gray zone" defined as being over the age of 49, having a normal Digital Rectal Examination result and a total Prostate Specific Antigen level between 4 and 20 ng/ml. Our goal is to reduce unnecessary biopsies in this zone without missing any cancer patients. 145 patients are included in the study. As input variables, we use well-known variables plus a novel variable called the "short-term coefficient of variance of total PSA." We report promising computational results.

: RA22 **Military OR - I**

Invited Session Room: M37

Chair: Diederik J.D. Wijnmalen
TNO-FEL

1 : Strategic Scenario Analysis: Preparing for Future Challenges to the Dutch Armed Forces. Rene Willems, TNO-FEL; Wijnmalen, Diederik J.D.

The presentation focuses on a scenario analysis study carried out in 2002 to support the Dutch Chief Defence Staff in developing his Strategic Vision. The study aims to investigate strengths and weaknesses of the armed forces and to formulate these through themes for planning purposes. A group of military experts analysed the generic functional capabilities for a coalition force (with Dutch participation) through illustrative and challenging conflict scenarios and specific critical moments of intervention therein. The analysis was performed in a workshop setting. The presentation addresses the methodology and touch upon the missions analysed and on themes identified.

2 : Optimising Logistic Support to the Royal Navy. David Lowe, Defence Science and Technology Laboratory; Lawrence, Alan.

DSTL (Defence Science and Technology Laboratory) was tasked with identifying the optimum mix of future Afloat Support platforms to support the Royal Navy on enduring operations. This unclassified talk will briefly address the changing role of the Royal Navy, review the current Afloat Support platforms that are due to leave service and will give an overview of the OR methods employed. These methods included spreadsheet-based integer programming and softer, subjective techniques in the concept phases followed by more detailed discrete event simulations in the initial stages of procurement.

3 : OR of Battlefield Engineering Situations. Alasdair Hood, Defence Science and Technology Laboratory.

The presentation shows, with examples, the course of a 'standard' study in the area of battlefield engineering. Engineering questions are cover a wide variety of systems and tasks, they also tend to have an indirect impact of battle outcome which makes quantifying the value of engineering equipment challenging. The importance of 'gaming' (ranging from map studies to computer wargaming) in identifying issues, testing tactics and creating scenarios is highlighted. The gaming is followed by the selection or design of a simulation to provide quantitative results and further study the problem.

4 : Timely Availability and Sustainability Simulations for Fighter Aircraft. Ottar Graasvoll, Norwegian Defence Research Establishment.

Planning and operating fighter squadrons is a tough challenge with many contributing factors that influence the sortie generation. In order to get a better understanding of how these different factors influence the combat readiness of the air force, a computer simulation model has been developed at the Norwegian Defence Research Establishment (FFI). This model is explained in this paper together with simulation results demonstrating how the deployment of a number of aircraft reduces the combat readiness.

: RA23 **Financial Engineering - C4**

Contributed Session Room: M38

Chair: Cristian Pelizzari
University of Brescia

1 : Bankruptcy Prediction of Electric Power Industry. Toshiyuki Sueyoshi, New Mexico Tech; Inal, Mehmet.

This study applies several different classification methods to predict corporate bankruptcy of American electric power companies. Discriminant analysis is compared with logit and probit models in terms of classification rates. Our estimation proposes a simultaneous use of accounting and financial data. In addition, a methodological examination among several different approaches is discussed from a perspective of developing an important corporate strategy.

2 : Mean-Variance Portfolio Optimization Models with Transaction Costs and Initial Holdings. Marius Radulescu, The Romanian Academy; Radulescu, Constanta Zoie; Radulescu, Sorin.

In this paper we extend Markowitz's portfolio selection model to include transaction costs in the presence of initial holdings for the investor. We present a risk minimization model, a return maximization model and a model which takes into account the risk aversion of the investor. Our approach is new. The portfolio selection models for the case of transaction costs are solved by computer simulation. We built a portfolio optimization module (PORTOPT) which computes the optimal portfolio during the horizon period by solving a quadratic programming problem with linear and complementarity restrictions.

3 : Real Options in a Duopoly Market with General Volatility Structure. Masaaki Kijima, Kyoto University; Shibata, Takashi.

This paper considers strategic entry decisions in a duopoly market when the underlying state variable follows a diffusion with volatility that depends on the current state variable. It is shown that, even in the extended model, three types of equilibria exist in the case of strategic substitution, as for the geometric Brownian case, when the revenue functions are linear. Also, the presence of strategic interactions may push a firm with cost advantage to invest earlier, and the firm value as well as the optimal threshold for the investment decision increases as the market uncertainty increases.

4 : Clustering Technical Trading Rules. Cristian Pelizzari, University of Brescia; Falbo, Paolo.

To classify technical trading rules according to their style of 'market timing' requires a classification framework completely different from what is currently available. In particular, it is necessary to identify a classification criterion based on buying/selling pattern similarity, rather than on analytical similarity. To this end, we have tested a sufficiently wide set of technical trading rules on different financial indexes series. A distance measure is analysed based on the correlation between the signals generated by a pair of rules and a classification is produced based on a cluster analysis. We finally verify out-of-sample stability of the clusters thus formed.

: RA24 **Decision Analysis Applications**

Contributed Session Room: L17

Chair: Luba Sapir
Ben-Gurion University

1 : Decision Analysis at the Racetrack: A Case Study in The Jockey Club of Rio de Janeiro. Eduardo Vieira, IBMEC Business School; Autran M. Gomes, Luiz F.; Sant'Anna, Annibal P.

This paper presents a decision-making framework for the analysis of the value of information utilized in the launching of strategies for bets in horse races. It is shown how the value of information changes according to the physical elements of the problem and to the financial restrictions of the bettor. Results obtained from applying the framework to a series of more than 250 horse races in the Jockey Club of Rio de Janeiro, Brazil are utilized in order to identify the most useful information-gathering strategies in a given setting.

2 : The Predictive Power of Preferences Calibration in a Competitive Environment. Manel Baucells, IESE Business School and Fuqua School of Business; Villacis, Antonio.

This paper studies the effect of a decision pattern, such as the one described by prospect theory, in a financial market. A two-stage experiment is proposed. In the first stage, individual preferences are calibrated. In the second stage, agents have to trade a risky asset in a double auction. Then, individual decisions are traced to analyze the predictive power of the preference calibration in the final allocation of resources and the market price of the risky assets.

3 : An Extended Stochastic Dominance Notion in the Context of Cumulative Prospect Theory. Franz Heukamp, IESE Business School; Baucells, Manel.

Based on recent empirical results about the significance of Cumulative Prospect Theory (CPT) an extended notion of stochastic dominance called Cumulative Prospect Stochastic Dominance (CPSD) is developed. CPSD includes the probability weighting function into current definitions of stochastic dominance. Based on lotteries designed with CPSD, empirical evidence for the importance of weighting functions in the choice under uncertainty is given.

4 : Is the Aaugmentation of the Decision-Making Body Always an Advantage? Daniel Berend, Ben-Gurion University; Sapir, Luba.

We consider Condorcet's dichotomous choice model. A committee faces two alternatives, of which only one is correct, and decides utilizing the simple majority rule. Condorcet believed that the group is likely to choose correctly as its size n becomes large. This claim has been proved under various assumptions, but is not generally true. Our main result is that, if a committee operates by selecting a random subcommittee of odd size k and letting it decide, then the probability of choosing correctly always increases with k. This generalizes a result of Ben-Yashar and Paroush (2000).

: RA25 **Energy Policy and Planning - C1**

Contributed Session Room: M34

Chair: Gürkan Kumbaroğlu
Boğaziçi University

1 : A Multi-Agent Modelling Framework for Simulating Industrial Energy Efficiency Improvement. Gürkan Kumbaroğlu, Boğaziçi University; Jochem, Eberhard; Konersmann, Lars.

This research introduces multi-agent modelling as a new approach for simulating industrial energy use at the branch level. Firms of an industrial branch are clustered in three groups according to traditional distinction in innovation research. The clusters have distinct behavioural rules that induce different reactions to changing boundary and contextual conditions. This features to simulate different kinds of investment and organisational behaviour in response to economic energy-efficiency potentials. It also improves the transparency of ex-ante evaluations of energy efficiency policies, and provides prospects for a better simulation of outsourcing activities of energy conversion technologies by contracting.

2 : Capacity Investment Planning in the Electricity Supply Industry: A Real Options Application for Turkey. Reinhard Madlener, ETH Zurich; Kumbaroğlu, Gürkan.

Electricity market liberalisation renders traditional investment planning models less useful because of the many uncertainties induced, and project values evolve dynamically over time. Real option theory (Dixit/Pindyck 1994) provides an attractive theoretical framework for studying the irreversibility, uncertainty, and timing of investments. Here, we focus on a stochastic dynamic technology adoption model that is firmly rooted in economic theory and takes major investment determinants under uncertainty into account. Electricity supply data for Turkey are used for model calibration. The results provide insights about the optimality of (historical) investment decisions, the evolution of the plant stock, and related fuel consumption patterns.

3 : A Regional Electricity Demand Projection Study to the Year 2020 for Turkey. Arzu R. Sunam, Boğaziçi University; Or, İlhan.

Forecasting of regional electricity demand is analyzed; this is a key factor in the privatization of electricity distribution on a regional basis, which is a current issue in Turkey. The recently established 13 distribution regions are considered and four sectoral projections are obtained for each, through statistical regression. In each region and sector, various combinations of possible influencing factors are investigated; differences are highlighted and discussed. Medium term demand forecasts are obtained under different growth scenarios. Results are compared with the forecasts and models of other researchers.

: RA26 **DSS - C2**

Contributed Session Room: L10

Chair: Konstantinos Katsikopoulos
Max Planck Institute for Human Development

1 : Distinctive Features of Designing School Business Intelligence Portal. Dragana Becejski-Vujaklija, University of Belgrade.

The paper deals with the concrete solution of the college Decision Support System and key functions for each of its subsystems. Its global structure is presented - source of data, decision models, and software for using and managing the system. The system can be applied in all kinds of colleges and schools. Business intelligence portal enables decision support on top-down basis (starting with strategic level, towards tactical and operational). It encompasses its own database for decision support which is connected with the relational OLTP database.

2 : Some Analyses of Simple Trees for Classification. Konstantinos Katsikopoulos, Max Planck Institute for Human Development; Martignon, Laura.

Humans often need to classify objects into categories. Many methods have been developed that theoretically increase classification accuracy, but there is empirical evidence, from behavioral medicine and systematic biology, that they appear complex to human users and they are avoided. We consider a family of simple classification trees, motivated by recent psychological research: these trees allow for the possibility of making a classification at each level. We discuss results of analyses and simulations that illustrate some properties of these simple trees, and show that they compare well with more complex models in terms of computational demands and accuracy.

3 : Transportation Management System for Sustainable Development. Andras Bako, Szechenyi University.

The road network is one the most important element of the infrastructure system. The available budget for the rehabilitation and maintenance usually not enough for holding the system in a certain condition level its whole lifetime. The paper briefly discusses some elements (monitoring of trial sections, asset value calculation) and several models (urban and motorway PMS, network level, multi-stage highway PMS, BMS). The mathematical model of a combined PMS-BMS system is also presented where Markovian type deterioration process is supported and can be solved by Linear Programming

4 : A Rule-based Simulation Model for Cadaveric Organ Transplantation System. Emin Gündoğar, Sakarya University; Evirgen, Hayrettin; Güney, Baha; Şimşir, Fuat.

Cadaveric Organ allocation is a very difficult process to make the best decision because of the different parameters affecting it. Changing the importance level of the parameters over time or adding parameters, a new transplant policy could be offered. In this study, structure and operation of a simulation model which includes waiting periods, the transplant and the post-transplant events is presented using simulation software specially designed for this purpose. This model enables to make desired policy changes by means of a rule base and provides evaluation of the effects of the policy on the allocation results.

: RA27 **ESIGMA - IV**

Invited Session Room: L11

Chair: Gustavo Daniel Roig-Sannemann
Itaipu Binacional

1 : SCOPE - An Integrated Framework for Multi-Attribute Decision Making. Steen Leleur, Technical University of Denmark.

We propose an integrated framework for multi-attribute decision making named SCOPE for System for Combined Planning and Evaluation. The framework comprises scanning as well as assessment issues that are supported by methodology of both a systemic and a systematic type. Specifically, we look at boundary setting systems analysis, scenario technique, stakeholder analysis and multi-attribute decision making. The latter concerns a composite method, COSIMA that makes it possible to deal with mixed criteria sets. After treatment of SCOPE elements and an example, the paper gives some conclusions and a research perspective.

2 : Combining MCDM and SSM with GIS. Doncho Petkov, Eastern Connecticut State University; Jadoo, Rishaal; Tucker, Kim.

A project integrating existing GIS with a MCDA component was completed recently to address environmental decisions at local government level in South Africa. The methodology involved a combination of MCDA, SSM and GIS. The experienced problems related to real life environmental decision making, software development practice and project management are discussed.

3 : A Systemic View on MCDA: Exploring Interrelationship Criteria for Evaluating and Improving Organizational Performance. Gustavo Daniel Roig-Sannemann, Itaipu Binacional; Ensslin, Leonardo.

This work presents a proposal to identify the perceived interrelations between the main elements of a given context and use this knowledge to improve the overall system performance. It proposes using an MCDA methodology, following a constructivist view, as a tool for the development of representative models. In the models thus created, it is possible to identify opportunities for improving the performance. With this approach, the identification, measurement and exploitation of the synergic aspects (interrelationship criteria) of the system provide an advantage that may allow a broader vision of the organizational performance problem. A case study illustrates the proposal.

4 : New Guidelines for Forming Criteria Trees. Cathal Brugha, University College Dublin.

We introduce new guidelines to guide the construction and usage of criteria trees that fit into a structure, and are steps in a process. We suggest that the process of revealing a decision-maker's set of criteria, and the alternatives that they serve to evaluate, and then shaping the criteria and associating scores with the alternatives in order to help a decision-maker make a preference is itself a multiple-criteria decision. We propose that the challenge to do this well is an information management problem whose solution involves satisfying the following criteria: accessibility, differentiability, abstractability, understandability, verifiability, measurability, refinability, and usability.

: RA28 **Economic Modeling - C2**

Contributed Session Room: L12

Chair: Maximo Bosch
Universidad de Chile

1 : Parallel Replacement under Multifactor Productivity. Maximo Bosch, Universidad de Chile; Varas, Samuel.

Replacing equipment in the mining industry is a major strategic decision because it determines its operation level, maintenance requirements and, ultimately, the production capacity of the whole operation. This type of decision depends on a cost benefit analysis of various alternatives. However, interactions between different equipment result in large indirect costs and/or benefits which are hard to measure. This paper addresses this problem by developing a Dynamic Programming model which includes a productivity function that is estimated as a metamodel of a simulation model of the complete mine operation. This approach was implemented at a Chilean copper mine.

2 : Self-Organizing Economic Maps of Serbian Municipalities. Jasna Soldic-Aleksic, University of Belgrade.

The main effort in this study was concentrate on the application of the Self-organizing mapping algorithm for the purpose of making global picture of regional economic development of Republic of Serbia. In particular, our interest was aimed at comparing two images of economic development of the country: two maps relating to years, which are considered to be main pre-crisis and post-crisis focal time points. Different economic indicators were considered as component variables. As the final result we have had a very informative general maps, as well as pictures of component planes for each chosen economic variable.

3 : Modeling the Development of the Serbian Agriculture in Transition. Tibor Kis; Cileg, Marija.

A dynamic econometric model of Serbian agriculture, by including internal and external factors influencing growth and by tracking its development, enables analyses of changes and long-term characteristic tendencies of this economic sector, as well as revealing cycles and structural brakes that cause changes in the levels of development.

4 : Interpretation of the Dual Model and Dual Prices of Hyperbolic Programming Models. Marija Cileg; Kis, Tibor.

In the paper, the possibilities of economic interpretation of hyperbolic programming models are studied. To each of the constraints of the primal model two dual prices are connected. The influence of the fluctuations of a right-hand side of the value on the value of the criterion function can be determined based on the signs, the ratio of the values of the two dual prices and the initial value of the function. The suggested procedure enables determination of the interval of validity of dual prices and provides economic indicators about the resources preferred to be enlarged.

: RA29 **Auctions / Competitive Bidding**

Invited Session Room: L13

Chair: Taner Bilgiç
Boğaziçi University

1 : High-Tech SME Participation in Future Telecommunication Markets. Daniel Kilper, Dresden University of Technology; Pohler, Matthias.

Up to now, small entrepreneurial firms play a minor role in the provision of telecommunication services. Compared to other industries, market entrance is basically prevented through today's monolithic telecommunication structures. Given SMEs' ability to encourage competitive market structures, and the generation of knowledge, innovation, and technical progress, it should be the interest of telecommunication stakeholders to foster SME participation. We propose a new brokerage-driven market model in order to obtain an independent and SME-integrating resource trading scheme. Based on actual European market figures, we derive a valuation model assessing the SME participation assuming the proposed novel brokerage approach is used.

2 : TELE-AUCTION: An Advanced E-Procurement Tool. Cornel Resteanu, National Institute for R&D in Informatics, Bucharest.

In the paper, an e-procurement software is presented. TELE-AUCTION is meant to equip the web sites of companies who intend to organize electronic auctions in order to purchase, usually for investments, goods and services of great values. The entities subject to the auction process are described by their attributes, expressed in cardinal/Boolean/fuzzy manner. A mathematical model, belonging to the Multi-Attribute Decision Making (MADM) class, generates competitors' ranking problems that are automatically solved upon any significant state transaction in the system. Facilities to make human corrections in the final ranking are presented. Once decided, every auction benefits from automatic orders launching.

3 : Iterative Combinatorial Auctions: A Mathematical Programming Approach. Umut Sevin, Boğaziçi University; Bilgiç,

Taner.

The aim of the paper is to design and implement an iterative combinatorial auction mechanism, which allows an auctioneer to distribute bundles of items in an iterative manner to self interested agents with independent preferences. The auctioneer announces ask prices for every requested bundle of items in each round and the agents bid with those prices according to their value function and price determination rules. After getting the bids, the auctioneer solves a winner determination problem to allocate bundles to agents that maximizes its revenue. The ask prices are updated and auction continues until stopping conditions are met.

4 : Dynamic Mechanism Design for Online Commerce. Jeremie Gallien, Massachusetts Institute of Technology.

Most of the research to date on mechanism design has ignored the timing of transactions and bidder arrivals; I consider the problem of maximizing expected time-discounted revenue when selling multiple identical items to a stream of time-sensitive, self-interested buyers. Using Dynamic Programming and Auction Theory, I derive the optimal dynamic mechanism in this framework, and conduct numerical simulations to compare it with electronic catalogues and online auctions.

: RA30 Warehouse Design, Planning, and Control - C1

Contributed Session Room: L14

Chair: Marc Goetschalckx
Georgia Institute of Technology

1 : Flexibly-Spaced Cross-Aisles in Warehouse Planning. Bilge Küçük, Sabancı University; Ertek, Gürdal.

We aim at identifying the impacts of adding cross-aisles in a warehouse with aisle structure. We extend earlier research on the topic by introducing flexibly-spaced cross-aisles and analyzing the benefits brought by performing extensive experiments. In flexibly-spaced cross-aisles, cross-aisle locations are not necessarily evenly distributed. We consider the average travel time as the performance measure and present our findings on space and travel time savings.

2 : Development of a Science-based Design Methodology for Warehousing Systems. Marc Goetschalckx, Georgia Institute of Technology; McGinnis, Leon; Sharp, Gunter; Bodner, Douglas; Govindaraj, T.; Tian, Lei.

We will present the results of our effort to develop a science-based design methodology for warehousing systems. We will briefly reviews design methodologies published in the literature or currently employed to design warehousing systems as well as a general design methodology for any type of physical system. Characteristics, advantages, and disadvantages of each methodology are identified. We will then present a hierarchical optimization model and solution algorithm for selection and configuration of warehousing technologies under resource constraints. Computational results of the application of the sub-model for bin shelving and modular storage drawers will also be shared.

: RA31 Technology Management

Contributed Session Room: M33

Chair: Martin Cele
Realcore

1 : Network Analysis of Intersectoral Innovation Flows: An Alternative Approach. Pao-Long Chang, Feng Chia University; Shih, Hsin-Yu.

The network of intersectoral innovation flows can be constructed by using the data on input-output tables and sectoral R&D expenditure. Leoncini used the method of network analysis to compare among the intersectoral innovation flows of industries based on a relative value approach. However, it can only provide a comparative base among constituent sectors within a certain column/row. To overcome this problem, this paper proposes a new approach to reduce the scale effects resulting from the different size of industries. The evidence shows that our approach is more capable to reflect the real phenomena of intersectoral innovation flows.

2 : Data Envelopment Analysis for Effective Technology Commercialization. Tae Hee Moon, Yonsei University.

The main purpose of this study is to provide some effective commercialization scenarios at the stage of R&D of a new technology. The commercialization process is associated with many inputs as well as various output factors. In this paper, DEA is applied in order to evaluate the relative efficiency of various technology scenarios based on the survey data conducted by Korean Information Technology Transfer Center in 1998. It is expected that the results can be used as guidance for selecting ideal scenarios for commercialization under budget constraint.

3 : The Technology Innovation Audit of a Small IT Company - A First Stage of the Strategy Formulation Process. Martin Cele, Realcore; Petkov, Doncho.

The paper explores the stage of technology innovation audit at a small information technology (IT) company. It is needed as a first stage in a company strategy formulation process. It highlights five categories of variables that influence the innovation strategies of a business regarding new products and services: timing to market entry; technological leadership; scope of innovativeness; and rate of innovativeness. The actual outcome and the experience of the authors with the implementation of the audit in a real IT business environment are discussed.

: RB01 Half a Century of Combinatorial Optimization

Semi-Plenary Room: MB I

Chair: Silvano Martello
University of Bologna

Half a Century of Combinatorial Optimization. Jan Karel Lenstra, Georgia Institute of Technology.

In the past fifty years combinatorial optimization has grown to become one of the strongest branches of operations research. In this presentation I will discuss some of the highlights of its development. I will focus on the progress that has been made in our understanding of the complexity of combinatorial optimization problems and in our ability to solve them exactly or to a

reasonable degree of approximation. As a vehicle I will use two hard problem instances, a routing problem and a scheduling problem, that served as a contest among high school students in the Netherlands.

: RB02 **OR Education: Spreadsheets as a Powerful Platform for OR/MS Education**

Semi-Plenary Room: MB II

Chair: Erhan Erkut
University of Alberta

OR Education: Spreadsheets as a Powerful Platform for OR/MS Education. Armann Ingolfsson, University of Alberta; Grossman, Thomas.

Teaching of OR/MS has changed dramatically at many universities during the last decade, driven by three forces: 1) powerful new spreadsheet add-in software for OR/MS, 2) threats of elimination of management science from business school curricula, and 3) a growing awareness of the importance of educating business students to be effective end-user modelers. We discuss the surprising benefits of using spreadsheets for OR/MS, as well as their limitations. To fully harness the benefits of spreadsheets it is important to align course content with the aptitudes and interests of the students, and teach foundation modeling and analytical skills. We provide a guide to resources for OR/MS educators with pointers to teaching materials such as textbooks, cases and teaching notes, software suitable for education, new ideas, and discussion.

: RB03 **Disruption Management: Airline and Other Applications**

Semi-Plenary Room: MB III

Chair: Murat Tarımcılar
George Washington University

Disruption Management: Airline and Other Applications. Gang Yu, The University of Texas at Austin.

The September 11th terrorist attack has drastically changed the world. It also pushed the disruption management to the front stage of the operations research/management arena. In fact, the disruption management concept has been successfully applied in the airline industry. This is exemplified by our Franz Edelman Prize-winning application, Crew Recovery System, at Continental Airlines. It has brought significant benefit and impact to the airline operations including the remarkable recovery from the 9-11 event. In Year 2001, the system has saved Continental a total of over $60 million. In this talk, I will present a general framework, optimization models, and solution techniques for disruption management with emphasis on airline applications. I will also illustrate the methodologies via applications in other areas including supply chain management and scheduling; drawing parallels with airline operations recovery.

: RB04 **Closed-Loop Supply Chains and a Simple Method for Balancing Supply and Demand**

Semi-Plenary Room: JB A

Chair: Gerhard Wäscher
Otto-von-Guericke-Universität

Closed-Loop Supply Chains and a Simple Method for Balancing Supply and Demand. V. Daniel R. Guide, Jr.,The Pennsylvania State University; Van Wassenhove, Luk N.

There are common processes required by a closed-loop supply chain for reverse supply chain activities: product acquisition, reverse logistics, inspection, testing and disposition, remanufacturing, and selling and distribution. However, the management activities and focus in these common processes are not the same among all closed-loop supply chains. We document a number of diverse products that are presently being remanufactured and describe their supply chains. After each case, we summarize and discuss the distinguishing features of the supply chains. We discuss the crucial differences in the management of each of the different supply chain systems and research needs. A framework for analyzing the profitability of reuse activities is developed, and we show how the management of product returns influences operational requirements. We show that the acquisition of used products may be used as the control lever for the management and profitability of reuse activities. Finally, a simple model is developed for determining the optimal prices to stimulate product returns, and determining the corresponding overall profitability.

: RC04 **Combinatorial Optimization - C5**

Contributed Session Room: JB A

Chair: Oktay Günlük
IBM Research

1 : Throughput Maximization of Real-Time Scheduling with Batching. Baruch Schieber, IBM Research; Bar-Noy, Amotz; Guha, Sudipto; Katz, Yoav; Naor, Seffi; Shachnai, Hadas.

We consider a scheduling that has many applications. The input consists of jobs with release time, deadline, weight, and family. Each family is associated with a processing time. Jobs that belong to the same family can be batched and executed together. The processing time of each batch is the associated processing time of the family of its jobs. The goal is to find a non-preemptive schedule on parallel machines that maximizes the weight of jobs that meet their respective deadlines. We give approximation algorithms for two variants of the problem, and show exact algorithms for several special cases.

2 : Scheduling A DAG on Two Machines with Release Times to Minimize Total Completion Time. Philippe Baptiste, University of Technology of Compiegne; Timkovsky, Vadim.

We consider the scheduling situation where a set of unit execution time jobs have to be scheduled on two machines. Jobs have release dates and there are some precedence constraints between them. The objective is to minimize the total completion time. When the graph of precedence constraints is an out-tree, the problem is known to be solvable in polynomial time. In this talk, we show that this result can be extended for any directed

acyclic graph. Our algorithm is based on a dynamic programming formulation of the problem combined with Garey and Johnson's algorithm for the maximum completion time criterion.

3 : Min-up/Min-down Polytopes. Jon Lee, IBM TJ Watson Research Center; Leung, Janny; Margot, Francois.

Motivated by the so-called "unit commitment problem" associated with scheduling power generators, we develop integer programming cutting-plane techniques to address constraints on minimum up and down times for machines.

4 : Scheduling Drivers for Limousine Service. Oktay Günlük, IBM Research.

We describe a routing/scheduling problem where a collection of rides with given start and service times are distributed to drivers with certain shift requirements. We present a column generation based integer programming approach which solves large-scale real-world instances to near optimality. We discuss algorithmic issues and present computational results.

: RC05 **Transportation - C4**

Contributed Session Room: JB B

Chair: Kaan Özbay
Rutgers University

1 : A GA based Meta-Heuristic for Capacitated Vehicle Routing Problem with Simultaneous Pick-up and Delivery. Arif Volkan Vural, Sabancı University; Çatay, Bülent.

In this paper, we focus on the theoretical framework of a decision model for a real world problem. The problem reveals itself as simultaneous distribution of commodities and recollection of empty packages the same size as the initial state with a single depot and a fleet of uniform vehicles with limited capacities. Resembling instances pile a profound literature under the category of 'pick-up and delivery problem with backhauls' and 'rural postman problem'. To solve the arousing NP-hard problem we use GA approach. Computational efficiency and a good solution performance are sought.

2 : A Vehicle Routing for LTL Daily Line haul Operations. Woo-Je Kim, Daejin University; Murty, Katta; Lee, Sangwook; Lim, Sungmook; Park, Soondal.

A vehicle routing for LTL daily line haul operations is to determine the least cost way to move the daily customer shipments from originating terminal to destination terminal with the maximum driving time constraint for each vehicle. First, we developed a heuristic method for roundtrips of vehicles. Second, we developed a heuristic method for kick and pick activities which involve a vehicle leaving a terminal with freight for several other terminals and another vehicle picking up freight and moving it to its destination terminal. Finally for remaining shipment we developed a genetic algorithm using a hub and spoke system.

3 : Optimal Algorithms for Special Reductions of the Inventory Routing Problem. Marta Cabo, University of Southampton; Potts, Chris.

In this paper we present optimal algorithms solvable in polynomial time, for inventory routing problems (IRP) in which the distance between customers is negligible. The IRP deals with customers spatially dispersed that need to be replenished at certain intervals during a predetermined planning horizon. Customers can store inventory and do not need deliveries every day. The objective is to minimise the total number of services, the fleet size and the travelling costs. The variation that we consider here, assumes that customers are placed in a location where the distance is negligible and can be ignored from the problem definition.

4 : Modeling and Simulation based Evaluation of New Local Freeway Ramp Metering Strategy that Takes into Account Ramp Queues. Kaan Özbay, Rutgers University.

A "feedback" based ramp metering strategy that not only regulates the ramp input into the freeway but also regulates ramp queues by explicitly modeling them as part of the feedback based ramp metering strategy is presented. This mixed ramp metering strategy is tested using Paramics, a microscopic traffic simulation package on a test network located in Hayward, California. In addition to the "mixed ramp control strategy", two other control strategies, namely, ALINEA (Papageorgiou, 1991), New Control (Kachroo and Özbay - "Feedback Ramp Metering in Intelligent Transportation Systems" To Be Published by Kluwer Academics, 2003) are also implemented.

: RC06 **Scheduling in Automated Manufacturing**

Invited Session Room: M30

Chair: M. Selim Aktürk
Bilkent University

1 : Reactive Scheduling with Controllable Processing Times. Ayten Türkcan, Bilkent University; Aktürk, M. Selim; Storer, Robert H.

The controllable processing times can be used in reactive scheduling, in order to cope with unexpected events. The processing times can be decreased by increasing cutting speed or feed rate. Although compressing the processing times incurs additional tooling cost and increases the total weighted earliness, the total weighted tardiness and the deviation from the initial schedule in terms of completion times decrease. We consider the problem of determining processing times of jobs and scheduling the jobs on nonidentical parallel machines. We formulate the problem as a time-indexed IP model and solve the problem with an efficient Lagrangian relaxation based method.

2 : Robotic Cell Scheduling with Tooling Constraints. Hakan Gültekin, Bilkent University; Aktürk, M. Selim; Ekin-Karasan, Oya.

Robotic cell scheduling problem with two machines and identical parts is considered. We assume that some tasks can only be processed on the first machine while some others can only be processed on the second machine due to tooling constraints. Remaining tasks can be processed on both machines. The problem is to find the allocation of the remaining tasks to the machines and the optimal robot move cycle that jointly minimize the cycle time. We prove that the optimal solution is either a 1-unit or a 2-unit robot move cycle and we present the regions of optimality.

3 : Machining Conditions based Scheduling with Preventive Maintenance Considerations. Sinan Gürel, Bilkent University; Aktürk, M. Selim.

We consider total completion time of jobs on a single CNC machine with a machine availability constraint. We show that there is a nonlinear relationship between the preventive maintenance (PM) need of the machine and the processing times of the jobs. For a given sequence of jobs, decreasing processing times decreases processing time effect on completion times whereas it may increase the number of PM visits. We provide optimality properties and propose a search algorithm to determine processing times for the jobs and their schedule on a single CNC machine simultaneously while considering their impact on the PM schedule.

4 : A New Bounding Mechanism for the CNC Machine Scheduling Problems with Controllable Processing Times. Rabia Kayan; Aktürk, M. Selim.

We have attempted to determine the upper and lower bounds for the processing time of each job under controllable machining conditions, and to find an efficient frontier for a bi-criteria scheduling problem on a single CNC machine. We have two objectives; minimizing the manufacturing cost and a regular scheduling measure. The technological restrictions along with the job specific parameters affect the machining conditions; such as cutting speed and feedrate, which specify the machining times and tool lives. Since scheduling problems are sensitive to processing time data, it seems that by selecting processing times appropriately, resources can be utilized more efficiently.

: RC07 **Topics in Supply Chain Research**

Invited Session Room: M31

Chair: Selçuk Karabati
Koç University

1 : Two-Stage Supply Chain Coordination with Limited Information Sharing. Selçuk Karabati, Koç University; Kouvelis, Panos.

In this paper we address the coordination problem in a deterministic two-stage supply chain under the assumption that the supplier and the buyer share demand rate information only. The supply chain experiences economies of scale in both stages. We show that the supplier can actually moderate a cost-minimizing buyer to order in quantities different than his individual optimal order quantity. We present a quantity discount scheme that achieves this, and analyze the coordination efficiency of the new order quantity and resulting allocation of its supply chain benefits.

2 : Supply Chain Contracts vs Market Competition: Assessing the Effect of Market Leverage. Elizabeth Junqueira, Washington University-St. Louis; Durango-Cohen, Pablo.

We consider a supplier who can either enter into a contractual agreement with a customer or sell its goods in the open market. We study the effect of capacity on the supplier's decision under different market structures. We discuss properties of the optimal solution and related managerial insights.

3 : Dynamic Pricing via Customer Discounts for Multi-Class Customer Demand Fulfillment Optimization. Panos Kouvelis, Washington University-St. Louis; Ding, Qing; Millner, Joseph.

We consider the problem of allocating inventory over a horizon to demand from several classes of customers when partial backlogging of unfilled demand is possible. We present a solution approach to the problem of determining the inventory allocation, the customer discounts, and the prioritization of demand over time. We show that a class order policy is optimal with waiting customers being served subsequent to new demand in any period. We show how to find the inventory allocation for each class at any point in time, and show that these limits are monotonic in the time and inventory remaining.

: RC08 **GDN Panel**

Invited Session Room: M32

Chair: Melvin Shakun
New York University

Group Support vs. Group Decision Support vs. Negotiation Support: What are Our Objectives?

: RC09 **Marketing Research - C4**

Contributed Session Room: L15

Chair: Fatma Selcen Kilinc
Auburn University

1 : Estimating the Magnitude of the Number-of-Levels Effect in Metric Conjoint Analysis under Various Conditions. Kemal Buyukkurt, Concordia University, John Molson School of Business.

The "number-of-levels effect" in conjoint analysis refers to a systematic increase in the estimated relative importance of an attribute as a function of the number of levels used to define it. Previous research has shown that if metric conjoint judgments are ordinal-like in nature, the maximum and minimum relative importance weights can be determined using some formulae assuming full factorial designs and error free judgments. This Monte Carlo experiment relaxes these two assumptions and examines the impact of six conjoint conditions on the magnitude of the number-of-levels effect. The findings and their implications will be presented.

2 : Some OR Problems in Media Audience Survey Research. Dan Mallett, Daniel Mallett Associates; Collins, James.

Several problems in building and using audience survey research databases can be described in classical OR terms. Only recently, however, have these problems been approached from an OR perspective. Three such problems are described, along with discussion of how formal OR treatment has and has not changed commercial practice. One problem is imputing missing values, which can be treated as a weighting matching problem. A second is integrating two databases, which can be treated as a transportation assignment problem. The third is selecting multi-media advertising schedules in an environment of integral advertising choices and non-linear objectives and costs.

3 : Multicriteria Analysis Application Possibilities in Market-

ing. Omer Kurtanoviæ; Pasagiæ, Jasmina.

This paper shows the multicriteria analysis application possibilities in marketing by discussing the aspects of mix product promotion, for the further forming of multicriteria programming model for the company development plan, from the aspect of investments in the capacities for the production of some goods or articles, by observing the annual plan or a longer period of time, which includes also corresponding econometric models for the products which were present on the market in the past. An illustrative example is shown on the mix promotion model , its solving by the application of Expert Choice software for the AHP Method.

4 : A New Approach of Human Comfort Analysis in Industrial Applications. Fatma Selcen Kilinc, Auburn University; Elmogahzy, Yehia; Hassan, Mounir.

Understanding and meeting consumer's needs and expectations towards products have become essential for the long-term survival of any enterprise in competitive markets. Human comfort has been one of the major concerns particularly under severe environmental and physical conditions. This paper provides a new approach to the analysis of human comfort particularly in relation to clothing and fabric contact areas (e.g. car seats, upholstery, etc.). The approach is based on a structural model of the relationship between the "True Contact Area" of objects with human skin or human body and comfort-related factors such as neurophysiological, thermophysiological and psychological.

: RC10 **Internet Delivery of OR Services**

Invited Session Room: L19

Chair: Robert Fourer
Northwestern University

1 : Optimisation and the Internet: From Optimisation Web-based Applications to Optimisation Web Services. Patrick Valente, Brunel University; Mitra, Gautam; Kyriakis, Triphonas.

In the OSP (Optimisation Service Provider) EU project, we developed a platform which provides practitioners, researchers and students with remote (internet) access to algebraic modelling systems, solvers, and optimisation based decision support systems. We are now extending the scope of the OSP project by designing and implementing distributed optimisation components in the form of web services. By this approach, remotely invoked optimisation engines are embedded into distributed applications.

2 : Optimization Modeling in Distributed Applications: How New Technologies such as XML and SOAP Allow OR to Provide Web-based Services. Bjarni Kristjansson, Maximal Software, Inc.

Through new Web-based standards, an environment is now created where distributed applications based on components are relatively easy to implement. In this presentation we will explore how innovative new technologies, such as XML and SOAP, are creating new opportunities for solving optimization problems within distributed applications. We will demonstrate how optimization and modeling services can be packaged into component libraries based on industry standards such as ActiveX/Com and JavaBeans. This allows seamless integration of optimization into easily maintainable applications.

3 : Analyzing and Benchmarking Submissions to the NEOS Server. Robert Fourer, Northwestern University; Dolan, Elizabeth; More, Jorge; Munson, Todd; Orban, Dominique.

The NEOS Server has made optimization methods widely available over the Internet, but it remains reliant on individual users to select solvers appropriate to their problems. We describe new utilities that can assist in solver selection, by analyzing a submitted problem prior to optimization. A problem analyzer checks properties ranging from size and sparsity to linearity and convexity, then compares the results to a database of solver characteristics to produce a list of recommended solvers. A benchmarker runs one submission on a variety of solvers (on the same computer), verifies the correctness of the solutions returned, and summarizes the results.

4 : A Multi-Criteria Decision Support Model for Industry based Learning Placement Allocation. Dineli Mather, Monash University; Churilov, Leonid.

The Bachelor of Business Systems degree at Monash University offers an industry based learning program. The assignment of students to these placements involves two consecutive allocations and must be done in a way that it maximises the sponsor preferences and student exposure. This study investigated mathematical programming and constraint programming approaches to this problem and compared these with the heuristic method that is currently used. The models were tested on recent data and their performance evaluated against the criteria of solution quality and computational resources. The best results were obtained with the single variable linear assignment model.

: RC11 **Modeling Applications in SCM - C5**

Contributed Session Room: R20

Chair: Mahmut Ali Gökçe
North Carolina State University

1 : Dynamic Optimization and Model Predictive Control (MPC) of Supply Chain Systems. Esen Mestan, Koç University; Türkay, Metin; Arkun, Yaman.

The object is to present an integrated supply chain modeling framework and allow the evaluation and comparison of the performance of MPC approaches in single and multi product (hybrid) supply chains. For a single product, the supply chain is modeled into a dynamic continuous system and optimized. The open loop optimal control strategy is next compared with MPC at different control and measurement update intervals. In case of a multi-product supply chain consisting of both continuous and discrete dynamics, the supply chain is modeled and optimized through Mixed Logical Dynamical system, while the MPC scheme is formulated as a MILP.

2 : A Combined Mixed Integer Programming and Constraint Programming Approach to Planning and Scheduling in a Paint Company. Miguel Constantino, University of Lisbon.

We consider the integrated planning and scheduling of production lots in a paint company. While the production plan

establishes the production lots for a horizon of 1 to 2 weeks, the scheduling of the lots on the machines is done daily. The approach considered uses a Mixed Integer Programming model to obtain solutions for the planning problem, and Constraint Programming to check for the existence of daily feasible schedules. In case such a schedule does not exist, this information is incorporated in the MIP model, and the procedure is iterated. We present results with real data from the paint company.

3 : Constrained Supply Chain Optimization using Genetic Algorithms with Complex Evaluations. Mahmut Ali Gökçe, North Carolina State University; King, Russell.

A constrained genetic algorithm with complex evaluations is used to solve the supply chain replenishment problem of both seasonal and basic items. First, we introduce proposed methodology and demonstrate it for seasonal item scenario. Then, the methodology is used to solve a case study, which is the problem of the inventory management and replenishment of a basic good for a manufacturer of workpants to a US national discount-retailer chain. Solutions that satisfy the customers' constraints and improve the performance of the manufacturer are found. Finally, simple yet effective inventory system is presented based on the results of the optimization.

4 : Integrated Production and Distribution Planning in Supply Chain: A Fuzzy Multi-Objective Approach. Hasan Selim, Dokuz Eylül University; Araz, Ceyhun; Özkarahan, İrem.

Today, increasing competitive pressures is forcing firms to develop supply chains (SC) that may reduce operating costs and quickly respond to customer needs. In this research, an integrated multi-period, multi-product, multi-shop production and distribution model for SC is developed. Each partner in the SC has its own objectives and constraints. Furthermore, it is assumed that the SC operates in somehow uncertain environment. In order to solve the multi-objective model dealing with uncertainties, fuzzy goal programming approach is used. Implementation results show that fuzzy multi-objective approach may provide a satisfactory solution at an acceptable achievement level.

: RC12 **Reliability - C1**

Contributed Session Room: M39

Chair: Burak Birgören
Kırıkkale University

1 : Reliability in Management-Application to Human Resources. Ouabdesselam Abdelaziz, Ecole Nationale Polytechnique d'Alger; Belmokhtar, Oumhani.

Firstly, this paper addresses the relationships between reliability and management. We mean to show how reliability can play a great part in solving various management problems. We investigate how reliability can be viewed as a decision making tool in the following domains: investment; production; quality, maintenance; marketing, human resources... Secondly, this article is devoted to a human resources case study which is dealt with by analogy with reliability-based renewal of equipment. More precisely, we carry out the modelling of a staff hiring system in a firm that requires an almost constant manpower in normal operation.

2 : Neuro-Fuzzy Reliability: Application in Mechanical Components. Abbas Toloie, I.A.U. Science & Research Campus; Khanmohammadi, Sohrab; Aryanezhad, Mirbahador Gholi.

In classic survey of reliability engineering, reliability function is base on time failures, that is estimated and identified by Boolean logic. In this way, hazard, density, reliability and distribution functions of failure of components are observed in binary situation. This paper presents a linguistic variable methodology to estimate reliability related functions based on fuzzy logic. Where the nonlinear reliability function are modeled by learning an appropriate neural network architecture.

3 : Estimating Confidence Lower Bounds for Weibull Quantiles. Burak Birgören, Kırıkkale University.

In reliability analysis, estimating lower quantiles of the Weibull distribution has been a major concern, because the estimates can be quite unreliable for small sample sizes. For instance, sample sizes of 5-10 are common in modeling fracture strength of composite materials. Recent studies focused on constructing confidence lower bounds on the lower quantiles; several variations of maximum likelihood and least-squares methods were proposed for calculating exact confidence bounds. In this work, these methods are compared by Monte-Carlo simulation using the measure of false coverage probabilities. The maximum likelihood method is found to be the best method among the alternatives.

: RC13 **Issues in Flexible Manufacturing - II**

Invited Session Room: R21

Chair: Kathryn E. Stecke
UT Dallas

1 : Virtual Factory Simulator for FMS Education. Byoung Kyu Choi, Korea Advanced Institute of Science and Technology.

Presented in the paper is a virtual factory simulator for the design and analysis of FMS. When developing a FMS simulator, the following requirements are taken into account: 1) ease of 3D layout design, 2) ease of control logic modeling, 3) realistic simulation with 3D animation, and 4) ease of performance evaluation. In order to support these requirements, an object-oriented modeling framework, the JR-net modeling framework is employed. With the developed system, we have been successfully teaching the topics of FMS design, planning, and operation in the modeling & simulation and other manufacturing courses.

2 : A Real-Time Methodology for Minimizing Mean Flowtime in FMSS with Routing Flexibility: Threshold-based Alternate Routing. Seda Özmutlu, Uludağ University; Harmonosky, Catherine.

This paper presents an efficient continuous real-time routing strategy, Threshold-based Alternate Routing (TAR), to minimize mean flowtime of parts in a FMS with routing flexibility. TAR routes parts to alternate instead of primary machines when the benefit in waiting-time exceeds a threshold value. The threshold concept and performance of TAR in minimizing mean flowtime are tested with intricate experimental design and simulation. TAR provides very significant improvements in system performance measures compared to other real-time rerouting

methods and shows that the threshold value is unique and system-dependent. The relationship between the threshold value and system parameters has also been determined.

3 : Minimizing Makespan in Two Machine Flow Shop with a Single Robot. Grzegorz Pawlak, Poznan University of Technology; Blazewicz, Jacek.

Flexible manufacturing system with a single robot is considered. The production system is represented by two stages of dedicated machines with independent buffers. The flow shop system is considered. The linear routing of robot with distance dependent transportation time has been considered. The special case of the system with additional cooperative stage between first and second machine has been demonstrated. The simultaneous schedule of tasks on machines and robot has been presented and minimizing the makespan objective function considered. The heuristics and branch & bound algorithms has been constructed for above systems. The computational and simulation experiments has been performed.

4 : Hybrid Genetic Approach for Solving Large-Scale Capacitated Cell Formation Problem with Multiple Routings. Aaron Luntala Nsakanda, Carleton University; Diaby, Moustapha; Price, Wilson.

We present a comprehensive model for designing a cellular manufacturing system (CMS). The model bridges the cell formation problem, the machine allocation problem, and the part routing problem. Multiple process plans for each part and multiple routing alternatives for each of those process plans are considered. The problem is to assign a finite number of machines to manufacturing cells so that total intercellular material movement and intracellular control costs are minimized, subject to satisfying demand requirements for the parts, limits on the machines capacities and the number and sizes of the manufacturing cells. Computational results will be reported.

: RC14 **Online Shopping**

Contributed Session Room: R22

Chair: Cenk Kocas
Michigan State University

1 : Student Online Purchasing Behavior: A Comparison of American and Turkish College Student Samples. Fahri Unsal, Ithaca College; Ruzgar, Nursel Selver.

Business-to-consumer electronic commerce is very promising in the college student market given this segment's superior Internet skills and relatively large purchasing power. This study was conducted to better understand the online buying behavior of college students. An online survey was conducted focusing on the reasons for buying online, frequency of purchases, total value of purchases, type of products purchased, and methods of payment. The sample was drawn from two universities, one in the United States and one in Turkey. The results indicate that there are significant differences between the two groups suggesting different marketing strategies in the two markets.

2 : E-Transformation Initiatives of IT Firms in Turkey. Gülçin Büyüközkan, Galatasaray University.

The Internet offers many opportunities for companies to implement new business models, briefly called e-business, and to make them more competitive in the market. Becoming an e-business typically follows an evolution from initial experimentations with Internet related technologies to a transformation of the company into an enterprise supported all "operations management work" much more productive, cost reductive and flexible, utilizing the full power of the Internet. In this study we present an e-transformation benchmarking study realized during October-December 2002 on 6 International IT firms located in Turkey. Based on the results, we propose some strategic guidelines for successful e-transformation.

3 : A Cross-Cultural Comparison of On-Line Shopping Behavior of Turkish and American Young Populations. Ant Ozok, University of Maryland at Baltimore County.

With internationalization of commerce and business and with increased use of e-business and e-commerce, it is important to ensure that these systems can be effectively utilized across cultural boundaries. To increase effectiveness, appropriate changes and modifications in the systems may be required. With this in mind, a survey of 300 Turkish university students was undertaken to assess their on-line shopping and behavior preferences, and these were compared with the results derived from 64 US university students. The results provide guidelines for specific design of features for the Turkish population that may not be necessary for the US population.

4 : Price Competition in Asymmetric Oligopolies. Cenk Kocas, Michigan State University.

Effective pricing strategies are crucial to a company's long-term survival. Especially in markets where numerous firms compete mainly on price to sell homogenous products, like the on-line markets for books, DVDs and CDs, the competition can be fierce and unforgiving. We model and analyze a market with many firms, each with a loyal customer segment of various sizes, selling a homogenous good. The asymmetric loyal segment sizes and the existence of many distinct firms enable us to examine the pricing strategies of firms with varying market positions. We use a game theoretical approach to analyze this market.

: RC15 **Kernel Methods in Data Mining and Applications**

Invited Session Room: R23

Chair: Theodore Trafalis
University of Oklahoma

1 : Fixed-Size LS-SVMs for Large Scale Problems. Johan Suykens, Katholieke Universiteit Leuven.

One of the central issues in Support Vector Machine methods are the primal-dual optimization problem formulations. In least-squares SVMs (LS-SVMs), which are closely related to Gaussian processes, regularization networks and kernel Fisher discriminant analysis, one aims at exploiting the primal-dual insights. LS-SVM methodology can be extended to methods of kernel PCA, PLS, CCA, recurrent networks and control. We discuss methods of fixed-size LS-SVMs where estimations are done in the primal space via Nystrom sampling with active selection of support vectors. These fixed-size LS-SVM versions are also very suitable for adaptive processing and transductive inference. (book reference, publications, software: www.esat.kuleuven.ac.be/sista/

lssvmlab/)

2 : Support Vector and Kernel Methods for Pattern Analysis. Nello Cristianini, UC Davis.

Kernel-based learning methods are a class of algorithms for pattern analysis, whose best known element is the Support Vector Machine, based on the idea of replacing inner products by Mercer Kernels. This substitution enables them to operate in high-dimensional spaces, implementing the following simple idea: first embed the data into some vector space, and then detect linear relations in such a space. If the kernel is suitably chosen, points that are 'similar' for the task at hand, will be mapped to nearby positions, and 'different' points will be far apart. We review recent developments in this field. 2538 Cross Decomposition: Mechanism, Applications, and Problems Cross decomposition seems to have tremendous potential in mixed integer and nonlinear programming. It combines the advantages of Lagrangean and Benders decomposition methods in one approach. However, the algorithm has advantages and disadvantages. We discuss some of these issues in the context of a coordinated replenishment lot sizing application.

3 : Support Vector Regression in Option Pricing. Huseyin Ince, University of Oklahoma; Trafalis, Theodore; Mishina, Tsutomu.

In this paper, we apply the Support Vector Regression (SVR) methodology in option pricing. Specifically, we consider flexible functional forms based on support vector regression (SVR) with the main objective to come up with the price of an option. We simulate the Black-Sholes equations through Monte-Carlo simulation and compare with support vector regression (SVR) and radial basis function networks. Preliminary computational results are provided. They show that SVR has minimum mean square error.

4 : Approximate Functional Optimization in Kernel Methods. Marcello Sanguineti, University of Genoa; Kurkova, Vera.

The Representer Theorem(RT) shows that the function minimizing the regularized empirical error functional in learning from data has the form of a one-hidden-layer network. The number of computational units in such network is equal to the number of data, which might be too large for feasible implementation. We present an approximate version of RT and estimate rates of convergence of minima and argminima achievable by networks with n computational units, to the minima and argminima guaranteed by RT. The results are not merely asymptotic and can be applied to kernel methods using networks with less computational units than data.

: RC16 **Project Management - C2**

Contributed Session Room: R27

Chair: José Coelho
Instituto Superior Técnico

1 : Complexity Paradigm and Project Management. Alper Camci, University of Central Florida; Kotnour, Tim.

The dominant paradigm scientific world has been the Newtonian paradigm. According to Newtonian paradigm in order understand the whole one must study the parts of it. But in today's world, the Newtonian paradigm cannot capture the dynamic, complex nature of project-based organizations, where main goal is to produce series of successful projects. Complexity paradigm has been emerging as an answer to the limitations of Newtonian paradigm. The purpose of this paper is to link the complexity paradigm to project management domain. We will identify a project management framework using principles of the complexity paradigm.

2 : Evolutionary Tabu Search for the Resource Constrained Project Scheduling Problem. Artem Stolyar, Sobolev Institute of Mathematics; Kochetov, Yuri.

We propose a hybrid approach combining the tabu search algorithm and the path relinking strategy for the resource constrained project scheduling problem. According to the strategy we construct a path in the neighborhood graph between two solutions of population. We study different rules of the pair selection and the path construction. Local search uses two kinds of randomized neighborhoods based on the critical paths and a new concept of the block. Computational results for the PSPLib data set and future research directions are discussed.

3 : AVALGES - A Methodology for Project Evaluation and Management. Gabriela Fernandes, Universidade do Minho; Araújo, Maria Madalena; Correia, Fernando.

Management is a well developed and accepted science. Numerous methods and techniques have been developed. However, many projects exceed their budgets, suffer delays and fail to attain their objectives. We believe that there is some lagging between the development of the techniques and their application. To overcome this difficulty we developed a methodology (AVALGES) that integrates all project's processes, incorporating ten phases. We based our approach on PRINCE2 and PMBoK. The framework is computerised, to store and produce the project's inputs and outputs. It will allow real time interaction. We expect to have produced a general methodology.

4 : Efficient Transformations to RCPSP. José Coelho, Instituto Superior Técnico; Tavares, Luis; Vanhoucke, Mario.

In this paper, transformations to RCPSP from Job-shop, Flow-shop, Bin-packing and Graph-colouring are presented. The concept of efficient transformations is proposed, that could explain why some transformations can be used in practice, and others not. Benchmarks of these problems are transformed to RCPSP and results of solving the transformed instances with priority rules and meta-heuristics are shown.

: RC17 **Stochastic Models - C1**

Contributed Session Room: R24

Chair: Solon Carvalho
Brazilian Institute for Space Research

1 : Analysing Admission Rules to a Service System with Two Job Classes and Mandatory Preemption. Christian Larsen, The Aarhus School of Business.

Consider a queueing system consisting of S identical servers and two classes of jobs. Class 1 jobs must always be serviced as soon as possible. Therefore, the administrator must, if neccesary, preempt a class 2 job and allocate the server to an arriving class 1 job. However, the preemptive action will cause a time delay

before the server can start servicing. Therefore, he might in some instances deny a class 2 job access to an idle server and instead hold it back in queue. We develop a semiMarkov decision model for this problem analysing the optimal admission rule.

2 : Properties of Total Positivity with an Application to a Job Search Problem under Uncertainty. Toru Nakai, Kyushu University.

This paper concerns the total positivity of order two to investigate the learning procedure for a partially observable Markov process. A job search in a dynamic economy is considered as an example. Especially, the probabilities to make a transition into each state after some additional transitions by employing the optimal policy are observed. All information are summarized by probability distributions on the state space, and we employ the Bayes' theorem as a learning procedure. Relationships among the optimal policy, the probabilities to make a transition into each state, prior and posterior information are considered.

3 : A Stochastic Programming Approach to the Generalized Assignment Problem with Forecasted Resource Capacities. Berkin Toktas, University of Washington; Yen, Joyce; Zabinsky, Zelda B.

In this study, we introduce the Collectively Capacity Multi-Resource Generalized Assignment Problem (CCP) as an extension to the Generalized Assignment Problem (GAP). The CCP finds a minimum-cost assignment of a set of tasks to a set of agents that collectively use capacitated resources. We address the CCP with uncertain resource capacities, where the resource capacities have an unknown distribution that can be sampled. We propose three stochastic programming-based formulations that can be used to solve this problem, and provide solution techniques for the resulting models. We also present numerical results for a variety of test cases.

4 : Control of Work-in-Process Inventory between Two Serial Machines with Processing and Repair Times following Phase-Type Distributions. Solon Carvalho, Brazilian Institute for Space Research; Rodrigues, Rita.

We consider the optimization of the in-process inventory in a serial production system consisting of two machines subject to failure. The processing time and the repair time of each machine are considered to follow phase-type distributions. The inventory is controlled by a policy that determines dynamically whether to activate the first machine or not. We consider starvation costs, inventory holding costs, and restarting costs. By hypothesis the current phase of processing and repair times are not observed, so the system is modeled as a Markov Decision Model with Partial Information in order to minimize the system's long run average cost.

: RC18 **Location - C1**

Contributed Session Room: R25

Chair: Osman Oğuz
Bilkent University

1 : Decision Tree and MAUT for Global Facility Location Selection. Yavuz Canbolat, Wayne State University; Garg, Nitin; Chelst, Kenneth.

The paper presents a multi-phase approach for analyzing the placement of a global manufacturing facility. An influence diagram is used to frame the decision. A decision tree analyzes uncertainties regarding cost and generates a risk profile. The risk profile is incorporated as one of the measures in an MAUT model that incorporates a wide range of factors. The integrated approach is demonstrated with an example involving an auto supplier locating a new plant in one of five widely dispersed countries. The paper identifies, clearly defines, and incorporates a variety of measures for which national data are readily available.

2 : Solving the P-Median Problem with Pos/Neg Weights by Variable Neighborhood Search and Some Results for Special Cases. Hossein Taghizadeh Kakhki, Ferdowsi University of Mashhad; Fathali, Jafar.

We consider the 1-median problem with pos/neg weights on a tree and explore some of its properties for special cases. We also use a variation of the 'variable neigborhood' search procedure of Hansen and Mladenovic (1998)['Variable neigborhood search for the p-median', Location Science 5(4) 207-226] to solve the p-median problem with positive and negative weights for general networks.

3 : Location Selection of Wood Industry Units (Plywood & Veneer) by Fuzzy. Majid Azizi, University of Tehran; Memariani, Azizollah.

Location of plywood & veneer units has not been selected based on scientific programming and due to no development in the industry we have not had enough production. Effective criteria in location of the Industry were divided to five major Groups. After hierarchy planning of the criteria, calculation their weighting value, amounts of the criteria with regard to Alternatives were obtained from the Factories and governmental organizations. Priorities of candidate cities calculated By Fuzzy TOPSIS method. The results showed the Alternatives of Kordestan, Azarbayjan, and Gilan provinces are the highest priorities for location selection of Plywood & Veneer units.

4 : Facility Location under Vehicle Routing Considerations. Osman Oğuz, Bilkent University; Selçuk, Barış.

The concept of integrated logistics system has emerged as a new management philosophy that aims to increase distribution efficiency. It recognizes the interdependence among the location of facilities, the allocation of suppliers and customers to facilities and vehicle route structures around depots. We build a model for the integration of location and routing decisions, emphasizing these interdependencies.

: RC19 **Facilities Planning and Design - C1**

Contributed Session Room: R26

Chair: Brigitte Werners
Ruhr-University Bochum

1 : Layout Optimization Considering Demand Uncertainty and Expansion Flexibility. Sadan Kulturel-Konak, Penn State-Berks; Smith, Alice E.; Norman, Bryan A.

When facility layout and design is considered under uncertainty, expansion flexibility, which is the necessity of increasing capac-

ity and capability in response to system changes, is required. We propose a methodology to solve the problem that minimizes the combined costs of relayout and subsequent ongoing operation, and demonstrate its effectiveness on test problems.

2 : Identifying the Ideal Channel Coefficients in Multi-Channel Manufacturing: An Analytic Network Process Approach. Feriştah Özçelik.

Multi-Channel Manufacturing (MCM) enhances the advantages of cellular manufacturing by expanding the capabilities of the cells to handle multiple products. Thus, MCM provides multiple channels for each manufactured product. The number of channels capable to manufacture a product (channel coefficients) is aimed to be kept proportional with the importance of that product. Investment should be decreased while the channel coefficients are increased. These two conflicted goals must be compromised in determining the channel coefficients. MCM design techniques need the ideal channel coefficients as input. This study develops an ANP model to identify these ideal coefficients for a manufacturing system.

3 : A Hybrid GT Clustering Method based on Genetic Algorithm. Tijen Ertay, İstanbul Techcical University; Doğan, İbrahim; Durmuşoğlu, M. Bülent.

Nowadays, cellular manufacturing takes increasingly attention from the researchers and practitioners. The most important step for cellular manufacturing is to form part families and machine groups. At last two decade a huge number of clustering techniques were developed for this issue. Among these techniques, genetic algorithm offers an opportunity to overcome some difficulties in GT. In this study, a hybrid GT clustering method based on genetic algorithm is developed. An experimental design set for comparison of the hybrid method and the other algorithms is built. Consequently, the effectiveness of the hybrid method compared to the other algorithms is discussed.

4 : Decision Support to Schedule Ambulance Fleet Servicing. Brigitte Werners, Ruhr-University Bochum.

Ambulances are located at different fire stations and hospitals to immediately respond to emergencies. At least once a week every ambulance has to be carefully checked and restored. A probabilistic MILP model is suggested to schedule fleet servicing in view of the time-dependent demands and the capacity of each station. The result of its application to a German city is a high coverage rate even if additional constraints with respect to agreeable working hours are considered.

: RC20 **Mathematical Programming - C2**

Contributed Session Room: M35

Chair: Susana Scheimberg
Universidade Federal do Rio de Janeiro

1 : Development of an Object-Oriented and Visual Mathematical Modeling and Optimization Environment. Ilgaz Sungur, Boğaziçi University; Taşkın, Z.Caner; Ünal, Ali Tamer; Altınel, İ. Kuban.

In this paper, we propose an object-oriented and visual optimization environment. The environment includes object-oriented data modeling and visual algorithm development facilities, where users can visually generate and solve mathematical models within the algorithmic framework. In the paper we explain the underlying object-oriented mathematical modeling language, and its integration with the data structure and the algorithms. Through examples, we also show how algorithmic structures can be organized as optimization model templates, and how the system supports the clone based modeling paradigm, where a role based (as OR specialists, expert users, etc.) decomposition of modeling / optimization process is managed.

2 : 0-1 Integer Approach for Multi-Criteria Flow Shop Production System. Ahmet Yekta Kayman, Kocaeli University; Aydın, Gülşen; Yılmaz, Didem; Aladağ, Zerrin.

In this paper; a flow shop production system of a lighting firm is considered and determined that problems are caused by work-in-process, idle time, production level. To prevent negative effects of imbalance; an integer programming model is suggested. Although a flow shop production system is based on product oriented layout, segments; where process is interrupted, taken as a cell so whole production process consist of four cells. WIP, idle time, production level etc. between these cells are main criterion in formation process of the cells. So developed 0-1 integer model is evaluated according to results gathered from parametric variation.

3 : A Perturbed Projection Method for General Variational Inequalities. Susana Scheimberg, Universidade Federal do Rio de Janeiro; Santos, Paulo Sergio.

We consider the problem of General Variational Inequalities, (GVI), in a Hilbert space, introduced by M. A. Noor in 1988. We propose a method to solve (GVI), at each iteration is considered only one projection on an easy approximation of the constraint set, important from a practical viewpoint. We analyze the convergence of the algorithm under the assumptions that the solution set is nonempty and a usual cocoercitivity condition, using variational metric of sets. Preliminary computational experience is also reported and a comparative analysis with algorithms given in Noor M.A. et al. and in He B.

: RC21 **Medical Applications - II**

Invited Session Room: M36

Chair: Horst Hamacher
University of Kaiserslautern

1 : A Trim Loss Case Study in Coronary Stent Manufacturing. Tülin Yazgaç, İstanbul Kültür University; Özdemir, Rifat Gürcan.

This study proposes a two-stage procedure for pattern generation and cutting plan determination of the one-dimensional cutting stock problem. In Stage-1, cutting patterns are generated through a heuristic approach which forms patterns one at a time, using an integer linear programming (ILP) model with the objective of waste minimization at each iteration. These patterns are then fed into Stage-2, which employs another ILP model to form a cutting plan satisfying demands, due-date, and aiming to minimize the system's total cost. The developed methodology is implemented in a coronary stent manufacturer and its performance is tested using different data sets.

2 : A Decision Theoretic Approach to Optimal Timing of Liv-

ing-Donor Liver Transplants. Oguzhan Alagoz, University of Pittsburgh; Maillart, Lisa M.; Schaefer, Andrew J.; Roberts, Mark S.

We consider the problem of optimally timing liver transplantation with a living donor in order to maximize patient life expectancy. We formulate a Markov decision process in which the state of the process is described by patient health and organ quality. We explicitly model the patient health and use real clinical data to solve the problem. Our computational experiments show that in most cases, the optimal policy is of control-limit type.

3 : A Discrete-Event Simulation Model of the National Liver Allocation System. Steven M. Shechter, University of Pittsburgh; Alagoz, Oguzhan; Kreke, Jennifer E.; Bryce, Cindy; Schaefer, Andrew J.; Angus, Derek C.; Roberts, Mark S.

We describe a discrete event simulation model of the liver allocation system in the US. The simulation model differs from the previous simulation models in that it models the biology of the disease independent of the allocation scheme. We provide the structure of the model that consists of several modules. We compare the outputs of the model such as number of wasted organs and number of people on the waiting list with the actual figures and our results suggest that this simulation model provides a valid tool for testing different allocation schemes.

: RC22 **Military OR - II**

Invited Session Room: M37

Chair: Carlos Francisco Simoes Gomes
CASNAV

1 : Operations Research in Brazilian Navy. Carlos Francisco Simoes Gomes, CASNAV.

OR was born as a science field during WW II, initially to solve military problems. While OR tools are nowadays heavily used in areas as industry, transportation, public administration, and others, it is even more employed in the armed forces. In the CASNAV, established with the mission of contributing to the improvement of the Navy's readiness, has large experience in the application of Military OR, making extensively use of the OR tools in fields like logistics, tactics development, decision process, training etc. We will describe some past, and present, work developed at CASNAV.

2 : Information and Communication Technology: Support or Barrier in Good Functioning of the Military? Irene van der Kloet, Royal Netherlands Military Academy; van Dijk, Hans.

ICT is meant to improve organisational policy. This suggests that ICT provides support for communication within the Royal Netherlands Army (RNLA). Information has also become more confusing because the use of both digital and paper documents makes information hard to find. As such, ICT is a barrier for good functioning of the RNLA. Contextual leadership and trust are widely spread among commanders at various levels. These policy tools are not impeded by ICT, but could be improved by better implementation of ICT. Knowledge management can improve organisational policy, with in its slipstream improvement in contextual leadership and trust in leadership.

3 : Decision Conferencing Within a Multimethodological Framework: Developing a Performance Appraisal Model for the Portuguese Army Officers. Joao Thomaz, Military Academy Research Centre & Centre of Management Studies; Bana e Costa, Carlos.

Portuguese Army's officers have been evaluated annually by their commanders, with a model which includes 16 attributes and a specific 5-level descriptive scale. This paper describes the intervention process in which Decision Conferencing, Process Consultation and Multicriteria Decision Analysis were used in a multimethodological framework aiming at conceiving a new model, not only for the appraisal of officers' performances, but also to evaluate each officer's individual potential in terms of functional specialization.

: RC23 **Financial Engineering - C5**

Contributed Session Room: M38

Chair: Javier de Frutos
Universidad de Valladolid

1 : Modelling the Information Contents of Financial Time Series. Andrzej M.J. Skulimowski, Academy of Mining & Metallurgy.

Outperforming existing forecasting methods needs new quantitative modelling methods, considering previously neglected phenomena. Following an earlier paper of the author, we will provide analytic properties of so-called n-th-rank runs and bounds, and binary-tree-valued time series derived therefrom. The entropy-like function associated to the sequence of trees so arisen, which serves as its information contents measure, is investigated in more detail. We provide theoretical background for its correlation with the volatility of the underlying series, considered previously as an empirical phenomenon. The above methods should allow to implement a DSS improving considerably the performance of intraday Forex trade.

2 : Decentralized Risk Management for Energy Companies. Hafize Erkan, Princeton University; Mulvey, John.

Recent US legislation provides for the merger of disparate financial organizations: banks, insurance companies, and security firms. Optimizing the overall company requires a method for allocating capital and aligning the goals of the divisions with headquarters. Decentralized optimization is an ideal approach for solving the capital allocation problem. This approached can also be extended to risk management in energy companies via utilizing the state prices associated to each scenario. These state prices will passed to the divisions which can in turn optimize themselves accordingly.

3 : Pricing Installment Options with an Application to ASX Installment Warrants. Michèle Breton, HEC Montréal; Ben Ameur, Hatem; François, Pascal.

Installment options are Bermudan-style options where the holder periodically decides whether to exercise or not and then to keep the option alive or not (by paying the installment). We develop a dynamic programming procedure to price installment option and derive the range of installments within which the installment option is not redundant with the European contract. Our approach is applied to installment warrants, which are

actively traded on the Australian Stock Exchange. Numerical investigation shows the various capital dilution effects resulting from different designs.

4 : Linearly Implicit Runge-Kutta Methods for Financial Derivatives Princing Models. Javier de Frutos, Universidad de Valladolid.

In this paper additive Runge-Kutta methods of linearly implicit type are investigated for application to the spatially discretized partial differential equations arising in the valuation of some derivative securities. Both European and American type contracts are considered. In this second case the additional early exercise is enforced by using a penalty source term. Several ways to treat the fully discrete equations are investigated. Depending on the particular spatial discretization a fully implicit treatment of the nonlinear penalty term is some times an efficient way to solve the discrete equations. Numerical experiments are presented.

: RC24 **Game Theory**

Contributed Session Room: L17

Chair: Sihem Taboubi
HEC Montréal

1 : Playing Strategies in the Game of Blackjack: An Overall Approach through Mathematical Analysis and Simulation. Vassilis Kostoglou, TEI of Thessaloniki; Koliousis, Alexandros; Vitsas, Vassilis.

This paper develops an algorithm that calculates the optimal player's decisions in the game of Blackjack. The resulting zero-memory strategy is based on strict statistical analysis assuming card sampling without replacement. Altering playing decisions and/or the magnitude of the wager according to the "quality" of the remaining deck is beneficial to the player. The proposed algorithm is enhanced to examine several card counting strategies and Kelly's betting system. A computer simulation programme is developed implementing the proposed playing strategies. The results obtained verify that the calculated decisions from the proposed mathematical model are advantageous to players.

2 : On Cost Allocation in Hub-like Networks. Darko Skorin-Kapov, Adelphi University; Skorin-Kapov, Jadranka.

We study network design in which each pair of nodes can communicate via a direct link and the communication flow can be delivered through any path in the network. The cost of flow through each link is discounted if and only if the amount of flow exceeds certain threshold. The cost of services delivered through such a network is distributed among its users who may be individuals or organizations with possibly conflicting interests. Consequently, there is a need to find a fair distribution of the service cost among network users. We analyze the associated cost allocation problem.

3 : Slowing Deforestation Pace through Subsidies: A Differential Game. Karima Fredj, HEC Montréal; Martin-Herran, Guiomar; Zaccour, Georges.

This paper deals with the issue of deforestation. We consider two players, North and South, having different utilities for forest conservation. The North wants to maximize the size of tropical forest at a certain time. The South's revenue function involves forest exploitation and agricultural activities. We study two scenarios. The first is a "laisser-faire" policy, where the South solves an optimal control problem. Revenue and optimal forest exploitation represent a benchmark for the second scenario, where the North offers subsidies to the South to reduce the deforestation rate. The two scenarios are compared in terms of outcomes and forest conservation.

4 : Incentives for Retailer Promotion in a Marketing Channel. Sihem Taboubi, HEC Montréal.

We analyze a differential game in a two-member marketing channel. The manufacturer invests in national advertising and her retailer makes local promotions. The manufacturer has the option of affecting retailer's efforts by offering to support local promotions. The manufacturer is the channel leader that announces her strategy first and commits to playing it. He wishes to induce the retailer to implement a certain outcome. We study two specific instances of channel coordination: How can the manufacturer induce the retailer to implement an outcome that (i) is favored by the all channel members, (ii) is favored by the manufacturer only?

: RC25 **Energy Policy and Planning - C2**

Contributed Session Room: M34

Chair: Berna Haktanırlar
Osmangazi University

1 : The Dynamic MCDM Model of Power Supply. Michael Yesayan, State Engineering University of Armenia.

This paper is devoted to the development of the dynamic MCDM model of power supply. The model is based on the system of differential equations representing the equilibrium between Demand and supply. These equations provide a description of the equilibrium in the market of power and reflect our model of price and quantity determination during the planned period. An equilibrium price is funding by the solution of dynamic MCDM problem with objective function representing the minimum of the distance between current equilibrium point and the point in the end of planned period.

2 : An Electricity Market Game between Consumers, Retailers and Network Operators. Erling Pettersen, Norwegian University of Science and Technology; Wallace, Stein W.; Philpott, Andrew B.

To enhance short-term flexibility in the demand side of the Nordic electricity market, network owners and retailers may provide consumers with incentives to curtail peak loads. The incentive given by the retailer will affect the optimal incentive for the network owner, and vice versa. This strategic interaction between the retailer and the network owner is analyzed using a game-theoretical model. The market outcomes from collusion are compared with those from the equilibrium of a non-cooperative game, and we solve the game model for both two and three load periods. For three load periods the results are numerical.

3 : Which Energy Source to Use?: A Case Study for Turkey. Berna Haktanırlar, Osmangazi University; Özdemir, Müjgan.

Energy is an inevitable necessity especially for human beings.

But as the population of a country increase, consumption for energy increases consequently. On the other hand people want to use the energy sources that are renewable, clean and have less cost. There are several alternative energy sources available. Therefore the selection of the appropriate energy source arises as a decision problem. In this study, first a basic structure to determine the criteria for the selection of the energy sources is formed by ANP. Then the criteria are used to determine the most appropriate energy source for Turkey.

: RC26 **Nonlinear Programming**

Contributed Session Room: L10

Chair: İ. Kuban Altınel
Boğaziçi University

1 : Fitting a Table to a Page using Non-Linear Optimisation. Nicholas Beaumont, Monash University.

It is sometimes difficult to fit a large table comprising several rows and columns onto a page. The usual tactic is to manually adjust column widths, abbreviate some text and/or change some cells' font sizes until the table fits onto a page. We show that it is possible to express the problem of adjusting column widths to minimize the height of a table as an optimization problem with non-linear constraints. Five test problems were routinely solved using a free software package. It would be possible to incorporate the calculations in word processing and typesetting packages such as Word and TeX.

2 : Continuity Properties of Some Set-Valued Maps. Maxim Todorov, Universidad de las Americas.

We consider set-valued maps whose images are convex hull of their boundary. Some connections of the continuity properties of these maps and the maps putting into correspondence to each point the boundary of the image have been established. An application to the linear semi-infinite optimization has been given, as well.

3 : Optimum Tests for the Software with an Operational Profile. Nalan Kadıoğlu, Koç Allianz Hayat ve Emeklilik A.Ş; Altınel, İ. Kuban; Özekici, Süleyman.

One of the important concepts in software testing is the operational profile, which is the set of all operations that a software is designed to perform and the occurrence probabilities of these operations. Recently, an interesting new model to determine the testing durations in all of these operations has been proposed and the resulting nonlinear programming problem has been solved under unrealistic convexity assumptions. In this work, we extend the model by removing most of these assumptions and propose solution approaches which use the current state of the art in nonconvex optimization.

4 : Stochastic Optimization with Linear Constraints by Monte-Carlo Estimators. Leonidas Sakalauskas, The Lithuanian State Research Institute of Mathematics and Informatics.

Stochastic nonlinear optimization problem with linear constraints is considered. We develop the stochastic method of gradient projection using series of Monte-Carlo estimators. Our approach has two peculiarities: optimality and stopping conditions are tested in a statistical manner and the Monte-Carlo sample size is adjusted so, that the total amount of Monte-Carlo trials to decrease and the solving of optimization problem with a required accuracy to guarantee. Under some general conditions we prove by martingale approach that proposed methods converge a.s. to the stationary point of the problem solved. Application of developed approach to investment portfolio problems are considered, too.

: RC27 **ESIGMA - V**

Invited Session Room: L11

Chair: Michael Doumpos
Technical University of Crete

1 : A Web-based Multicriteria Classification PROAFTN Methodology for Medical Diagnosis. Nabil Belacel, NRC-Institute for Information Technology-e-Business.

The need for effective and efficient exchange of clinical knowledge is increasing. In this context, we will integrate the multicriteria classification method PROAFTN and develop a web-based clinical database system using standard JSP, JavaBean, and XML technologies. The developed system will help to make online diagnosis and to compare its performances with human practitioners. By using the proposed system, the physicians will be able to exchange the information with the biologist-hematologists. This will aid them in making more informed and objective life decisions in real time. In the future, we will extend this system to other types of pathologies.

2 : Cardiac Beat Classification through a GA Tuned Multicriteria Method. Yorgos Goletsis, University of Ioannina; Papaloukas, Costas; Fotiadis, Dimitrios; Likas, Aristeidis; Michalis, Lampros.

A multicriteria sorting method is applied for classifying cardiac beats to ischaemic or not. The applied multicriteria method deals with assigning objects (beats) into predefined, not ordered categories (nominal sorting problematic). Through supervised learning each beat is compared to already assigned category prototypes under five criteria. The required parameters (thresholds and weight values) are calculated automatically with the use of a genetic algorithm applied in a training set. The method was tested with 50,053 beats from the ESC ST-T database. The obtained results are high (91% sensitivity and specificity) indicating that this technique can be used for automated ischaemia diagnosis.

3 : A Partition-based Interactive Method to Solve Discrete Multicriteria Choice Problems. Subhash Narula, Virginia Commonwealth University; Vassilev, Vassil; Genova, Krassimira; Vassileva, Mariana.

We propose a learning-oriented interactive method to solve discrete multicriteria choice problems with a large number of discrete alternatives and a few quantitative criteria. The proposed method is inspired by the partition-based methods designed to solve multiple objective mathematical programming problems. At each iteration, the DM may choose the next current preferred alternative from one or two ranked sets of alternatives. The first ranked subset of alternatives is obtained by solving a discrete optimization scalarizing problem. The second ranked set is obtained using AHP or outranking procedures. We illustrate the procedure with an example.

lems based on Pairwise Comparisons. Michael Doumpos, Technical University of Crete; Zopounidis, Constantin.

Classification refers to the assignment of a set of alternatives into predefined homogenous classes. Most of the existing classification methodologies are based on absolute comparisons among the alternatives and some reference profiles (cut-off points) that discriminate the classes. This paper proposes a new approach that involves pairwise comparisons based on the multicriteria decision aid (MCDA) paradigm. The basis of the methodology is a preference relation that is used to perform pairwise comparisons among the alternatives. The criteria weights used to construct the preference relation are specified using a reference set of alternatives on the basis of linear programming techniques.

: RC28 **Issues in Flexible Manufacturing - C1**

Contributed Session Room: L12

Chair: Fatma Tiryaki
Yıldız Technical University

1 : Confluence and Termination of Fuzzy Relations. Vilem Vychodil, Palacky University, Olomouc; Belohlavek, Radim.

Confluence and termination are basic properties connected to rewriting and substituting. Our aim is to investigate confluence and termination from the point of view of fuzzy logic leaving the ordinary notions a particular case of two-valued logic. The main motivation is the fact that there are natural examples where substitutability is inherently fuzzy. We introduce the notions of a degree of confluence, termination, well-foundedness, and that of an inductive property. We show basic connections to Church-Rosser property, and show the equivalence between termination, well-foundedness and universality of inductive properties, and show that confluent and terminatin fuzzy relations have normal forms.

2 : Fuzzy Concept Lattices and Invariance to Scaling. Radim Belohlavek, Palacky University, Olomouc.

The paper contributes to formal concept analysis of fuzzy data. Fuzzy concept lattices-hierarchically ordered clusters found in the data-are fundamental structures of formal concept analysis. We focus on the dependence of concept lattices on scaling of input data. Scaling (assigning degrees from [0,1]) is performed by the expert/user and so it is crucial to know to what extent differently scaled data lead to different concept lattices. After formalizing we show that in general, concept lattice depends on scaling. We show that if minimum-based fuzzy conjunction is used then natural scaling-independence results can be obtained. Some further properties are established.

3 : The Application of Fuzzy Modeling in Health Insurance. Bahadtin Rüzgar, Marmara University.

This paper represents an application of fuzzy sets to the assurance risk of health insurance. As a new approach, fuzzy logic is used to evaluate the health conditions of insured during the assurance period instead of certain probabilities. To do this, linguistic terms are converted to fuzzy equivalents and premiums of health insurance policy are determined whether they meet to supply the assurance.

4 : A New Ranking and Weighting Algorithm Proposal for Fuzzy Multiple Criteria Group Decision Making and an Application to ISE (İstanbul Stock Exchange). Fatma Tiryaki, Yıldız Technical University; Ahlatçıoğlu, Mehmet.

In this study, it's shown two methods from literature regarding fuzzy MCDM can be used stocks selection on ISE. The rating of each stock and the weight of each criterion are described by linguistic terms expressed in triangular fuzzy numbers. Both methods inform the investor about the ranking of stocks. Whereas, it's evident DM would like to know not only the ranking order of stocks, but also with which proportion he would invest in a particular stock. So, we present a new model includes information about both ranking and weighting, also the proportion with which chosen stocks will be bought.

: RC29 **Forecasting - C1**

Contributed Session Room: L13

Chair: José Vicente Segura
Universidad Miguel Hernández

1 : Forecasting the Auto Regressive Moving Average Stochastic Demand Pattern. Stephen Disney, Cardiff University; Farasyn, Ingrid; Lambrecht, Marc; Towill, Denis; Van de Velde, Wim.

We study the exponential smoothing forecasting mechanism when predicting the Auto Regressive Moving Average (ARMA) demand pattern. We develop closed form expressions for the; · variance of the ARMA demand, · variance of the forecast of the ARMA demand, · optimal smoothing constant (Ta) in the exponential smoothing forecasting mechanism that minimises the n periods ahead forecasting error, · autocovariance function of the forecast · forecasts' spectral density function. To do this we use a methodology exploiting z-transforms and discrete linear control theory that has its roots in the 1950's and 60's and is easily implemented in modern software systems.

2 : A Hierarchical Framework for Modeling and Forecasting of Web Server Workload. Ta-Hsin Li, IBM T. J. Watson Research Center.

Efficient management of computational utilities requires accurate prediction of the demand of different services in order to allocate adequate resources on demand. A time series of web server demand (workload) comprises both short-term random fluctuations and prominent long-term periodic patterns that evolve randomly from one period to another. A hierarchical framework with multiple time scales is proposed to model such time series. It employs a filter bank approach to handle the random periodic patterns and leads to an adaptive procedure that provides predictions of web server demand for both long-term (e.g., in days) and short-term (e.g., in minutes) horizons.

3 : A Confidence Interval for an Order One Autoregressive Process Parameter. Abdelnacer Dahmani, University of Béjaïa; Tari, Megdouda.

In this paper, we establish exponential inequalities of Bernstein Frechet type that allow us to construct a confidence interval for a real parameter of an order one autoregressive process.

4 : A Mathematical Programming Software to Find Optimal

4 : A Mathematical Programming Software to Find Optimal Predictions with the Holt-Winters Method. José Vicente Segura, Universidad Miguel Hernández; Torres, Diego; Vercher, Enriqueta.

This paper deals with the calculation of optimal forecasts for the Holt-Winters method with damped trend by using mathematical programming techniques. We treat the starting values of the local components of level, trend and seasonality as decision variables of the non-linear optimization problem associated with this forecasting procedure. To estimate the parameters of the model our scheme works in parallel with various functions of the forecast errors of historical data. The paper describes an Excel-based decision support system to find automatic predictions. Comparisons between this approach and existing methods in previous studies are reported for examples taken from the M-competition.

: RC30 **Work Flow Management Systems**

Invited Session Room: L14

Chair: Gabriele Kotsis
Johannes Kepler Universität Linz

1 : Fuzzy Workflows - Enhancing Workflow Management with Vagueness. Otmar Adam, Institute for Information Systems (IWi); Klein, Ralf; Thomas, Oliver.

Workflow Management Systems have proven their positive effects in well-structured procedures. In practice business processes depend on implicit knowledge and require decisions based on unclear objectives. This vagueness of real-world problems isn't appropriately supported by modeling methods and workflow systems so far. Today the fuzzy set theory is used successfully in systems that provide sophisticated control mechanisms with a small set of simple rules. This concept hasn't been adopted yet within the services sector. In this paper a holistic and integrated advance for the integration of the fuzzy set theory into BPM from modeling methods to workflow automation is proposed.

2 : A New Look at the Dimensions of Flexibility in Workflow Management. Roger Tagg, University of South Australia.

Early successful applications of workflow were in high-volume repetitive production business processes. However in other environments similar benefits were difficult to achieve, because the business processes involved were more volatile, and workflow software was not flexible enough. Research has been stronger on theory than on analysis of success and failure patterns in practice. Recent attempts to introduce workflow into university teaching management have led to a reappraisal of the dimensions of flexibility needed before users - in this case lecturers and course managers - will use a workflow system. These dimensions include "process evolution" and "optionality of workflow control".

3 : Optimization of Workflows by Sampling and Stochastic Branch and Bound. Christine Strauss, University of Vienna; Doerner, Karl; Gutjahr, Walter; Klein, Daniela; Kotsis, Gabriele; Polaschek, Martin.

Penalties and fines within competitive markets make the evaluation of time-critical processes an essential feature for commercial applications. The probability of completing complex activities on time can be raised by measures reducing the execution time of sub-processes (e.g., training of employees). Assuming constrained extra-resources, the allocation process follows different optimization criteria as examples to show the benefits of our new approach (i.e., minimization of both the risk of overrun and the idle time associated with extra-resources).Methodologically, we use Petri Nets for modeling, and stochastic branch-and-bound as a technique to combine efficiently optimization and simulation for evaluating the processes.

4 : Mobile Agent-based Integrated Workflow Management Framework. Ghazi Alkhatib, Qatar College of Technology; Maamar, Zakaria.

The objective of the paper is to develop a framework for managing the workflow of e-commerce activities in an integrated manner using mobile software agent technology. Using the Internet as a unified platform and portal middleware software, the organization and their customers and suppliers can be connected seamlessly throughout the value chain. Mobile software agents are used to keep track of all the activities and decisions associated with e-commerce transactions. Three strategies for agent deployment are suggested: distributed agents, serial agents, and a combination of centralized/distributed agents. Each of these deployment strategies has advantages and disadvantages and their application domains.

: RC31 **Trust in Technology**

Invited Session Room: M33

Chair: Susan Lippert
Drexel University

1 : Trust in Technology: The Impact of Trust on HRIS Implementation, Change Management, Technology Adoption, and Use of Technology. Paul Swiercz, George Washington University; Lippert, Susan; Forman, Howard; Davis, Miles.

This panel will investigate the role of various types of trust across several organizational contexts including: the relationship between "technology trust" (Lippert, 2002) and the success of systems implementations particularly HRIS applications; the connection between "interpersonal trust", "technology trust", "organizational trust", and adoption of technology; the absence of all forms of trust from all commonly cited change models; and the integration of all types of trust within these contexts. A discussion pertaining to these issues will be undertaken. Intellectual exchange stimulated through an environment of open discussion is proposed for this panel presentation.

2 : New Methods in Human Resource Accounting. Michaela Schaffhauser-Linzatti, University of Vienna.

Human Resource Accounting (HRA) partially explains the increasing gap between share prices and book values. It further helps evaluate the financial contribution of employees to their enterprises. Hereby, the so-called practitioners' approach that develops individual scoring models is gaining acceptance. However, this approach tries to identify the most useful information for different stakeholders by trial-and-error. Hence, researchers are challenged to develop theory-based HRA-approaches. Exist-

ing concepts comprise accounting theories and mathematically-oriented solutions. An adaptation of the real-options theory is presented as one possible evaluation method. Easily implemented with already known instruments, it effectively and efficiently generates comparable results.

: RD01 **Verification and Validation of Computer-based Models**

Tutorial Room: MB I

Verification and Validation of Computer-based Models. Robert G. Sargent, Syracuse University.

In this presentation we discuss the verification and validation of computer-based models. The different approaches to deciding model validity are presented; how model verification and validation relate to the model development process are discussed with the use of pictorial diagrams to show different relationships; various validation techniques are defined; conceptual model validation, model verification, operational validity, and data validity are described; ways to document results are given; and a recommended procedure is presented.

: RD02 **Creative Operations Research Modeling using Excel and Add-ins**

Tutorial Room: MB II

Creative Operations Research Modeling using Excel and Add-ins. Hervé Thiriez, Groupe HEC.

In this session, many examples will be shown of professional models developed with Excel and, in some cases, an Excel add-in. In the first part of this session, we will see an expert system for the diagnosis of pipes in a nuclear plant, a general-purpose toll booth simulation model, a traffic simulation model for the simulation of car traffic around an airport zone (between the highways and the protected airport area), a model for the optimization of satellite launches, a model for supervising the operations in a steel factory. Each of these models was developed much faster and cheaper with Excel than what competitive bids offered. In the second part of this session, we will see what techniques (known only by very few Excel users) were used in order to develop models which most people are totally convinced are far above Excel's capabilities. Some examples: graphs with pull-down menus, graphs with adaptive titles, flexible graphs, even movies. There is a major interest in developing OR models with a spreadsheet: not only do you save significant amounts of time and money, but you also benefit from an interactivity which most large dedicated modelling packages simply cannot offer.

: RD04 **Combinatorial Optimization - II**

Invited Session Room: JB A

Chair: Shmuel Onn
Technion

1 : Multi Way Tables. Shmuel Onn, Technion; De Loera, Jesus.

Motivated by problems of confidentiality-protection in statistical data disclosure by public agencies, we study spaces of multi-way-tables with specified margins. We provide comprehensive complexity-classification of several algorithmic problems for such tables; e.g., we prove that these problems are intractable for "slim" (3,m,n)-tables with given 2-margins, improving on earlier results for (k,n,m)-tables by Irving-Jerrum. On the way we show how to embed 1-margined entry-bounded 3-tables in 2-margined entry-free 3-tables; in particular, we automatically obtain the smallest known example, due to Vlach in the context of transportation polytopes, of 2-margins for (3,4,6)-tables admitting a (single) real solution but no (integer) table.

2 : Solving Lexicographic Multiobjective MIPs with Branch-Cut-Price. Laszlo Ladanyi, IBM Research; Jensen, David; Eso, Marta.

In this talk we will first describe an application, the FCC Auction #31, and its two formulation: one with a compact representation solvable via branch-and-cut, and one with column generation using branch-and-price. Then we will show how to utilize Dantzig-Wolfe decomposition to perform branch-cut-price on general MIPs and illustrate how this applies to the column generation version of our application. Finally, we extend the applicability of linear complementarity to integer programming to solve problems with multiple (lexicographic) objectives.

3 : Two Edge-Connected Hop-Constrained Paths and Polyhedra. Ali Ridha Mahjoub, LIMOS, Université Blaise Pascal; Huygens, David; Pesneau, Pierre.

Given a graph with two terminals, edge weights, and an integer L, the Two edge-disjoint Hop-constrained Paths problem is to find a minimum weight subgraph such that between the terminals there exist at least two edge-disjoint paths of length at most L. In this paper, we give an integer programming formulation for this problem and show that the linear relaxation is integral when L is no greater than 3. As a consequence, we obtain a polynomial time cutting plane algorithm for the problem in this case.

4 : An LP-based Local Search to the Pattern Restricted One Dimensional Cutting Stock Problem. Shunji Umetani, Kyoto University; Yagiura, Mutsunori; Ibaraki, Toshihide.

One dimensional cutting stock problem (1D-CSP) has been studied since 1960s because of its wide applicability to material industries. Given a sufficient number of stock rolls and several products of given lengths and demands, this problem asks a cutting plan to minimize the number of used stock rolls while satisfying all demands. Since setup cost has become more dominant than material cost in recent industries, we propose an extension of 1D-CSP, called pattern restricted problem of 1D-CSP (1D-PRP), which introduces a number of setups as an input parameter, and we develop a local search algorithm based on linear programming techniques.

: RD05 **Transportation - C5**

Contributed Session Room: JB B

Chair: Federica Ricca
Università degli Studi di Roma "La Sapienza"

1 : The General Traffic Assignment Problem: A Proximal Point

Method for Equilibrium Computation with Applications to the Demand Adjustment Problem. Lídia Montero, Universitat Politècnica de Catalunya; Codina, Esteve.

An adaptation of the proximal algorithm for the traffic assignment problem for an asymmetric traffic network is presented following the recently published results of Pennanen regarding convergence under non monotonicity. As it is well known the problem can be formulated as a variational inequality and the algorithmic solutions developed up to date converge only under too restrictive conditions which are difficult to appear in practice. In this paper it is also discussed the possibility of including the algorithm on a demand adjustment problem formulated as a bilevel program with lower level traffic equilibrium constraints expressed as a variational inequality.

2 : Comparison Between the Reactive and the Predictive Dynamic User Equilibrium Assignment Approaches. Caroline Lemoine, Laboratoire Central des Ponts et Chaussées; Haj Salem, Habib; Mangeas, Morgan.

This paper compares the results for these two dynamic traffic assignment (DTA) approaches. The former uses "instantaneous" travel times and can be solved using the optimal control discrete-time theory or by heuristic methods. The latter can be expressed in terms of "experience" travel and is solved by heuristic methods as the method of successive averages. Results of these different methods are presented for a southern part of the Paris highway network using a second order macroscopic traffic model. Interactions between links and queue spillback are taken into account.

3 : Minimal Revenue Network Tolling: System Optimisation under Stochastic Assignment. Kathryn Stewart, Napier University; Maher, Mike.

The minimal revenue toll problem has, in the case of deterministic assignment, been solved such that the System Optimal solution is obtained, by various methods: Linear Programming (Bergendorff et al, 1997), reduction to multi-commodity max-flow problem (Dial, 2000). The proposed paper examines the effect of tolling under Stochastic Assignment. The desired flow pattern to be achieved is considered; whether the true System Optimum where Total Network Travel Cost (TNTC) is minimised can be achieved, or whether it is more appropriate to seek a Stochastic System Optimum where instead perceived TNTC is minimised. Numerical results will be given for toy networks.

4 : Testing Aggregation of Survey Data for the Estimation of O/D Matrices. Federica Ricca, Università degli Studi di Roma "La Sapienza"; Scozzari, Andrea.

We consider the problem of testing aggregation of survey data for the estimation of traffic flows in O/D models. Referring to the city of Rome we generate a 'real' O/D matrix through a Logit model by using suitable values for the parameters. Then two large sets of dense and sparse surveyed matrices are generated. We apply the standard Logit estimation procedure both to aggregated sparse matrices and to dense ones. The reliability of the travel demand estimates is evaluated by comparing them with the corresponding 'real' values. The mean square error is adopted as a synthetic measure of the error.

: RD06 **Scheduling - C8**

Contributed Session Room: M30

Chair: Pakize Erdogmus
Social Sciences

1 : Interval Scheduling with Uniform Parallel Machines. Özgün Barış Bekki, METU; Azizoğlu, Meral.

This study addresses interval scheduling problem on parallel machines having different speed factors. We aim to find a subset of jobs that maximizes total weight. We show that the problem is NP-hard even when there are two uniform machines and the weights are identical. For the general problem, we develop some upper bounding mechanisms and test their efficiencies relative to the lower bounding procedures that produce local optimal solutions. Our experiments reveal that the gap between upper and lower bounds are quite small, therefore the bounds can be used for producing near-optimal solutions for large-sized practical problems.

2 : Three-Stage Scheduling of Customer Orders. Uttarayan Bagchi, The University of Texas at Austin.

The processing environment considered in this paper has a fabrication stage for subassemblies followed by an assembly stage followed by a testing stage. A customer order may require processing on up to m parallel, non-identical machines in the fabrication stage. After fabrication, a customer order may require assembly, and following assembly, may require testing. There are n immediately available customer orders to be scheduled. The scheduling objective is to minimize makespan. We characterize the optimal schedule and present worst-case performance guarantees for heuristics.

3 : A Lagrangean Relaxation Approach for Mixed-Model Line Sequencing Problem with Makespan Minimization. Deniz Türsel Eliiyi, METU; Özlen, Melih.

In this study, a mixed-model line sequencing problem with makespan minimization objective is considered. Mixed-model line (MML) is known to be a special case of production lines where products are transported on conveyor belt, and different models of the same product are inter-mixed to be assembled on the same line. We have focused on product-fixed, rate-synchronous lines with variable launching. An approximation algorithm based on Lagrangean relaxation and subgradient optimization is developed especially for large-size instances of the problem, and tested in terms of solution quality and computational efficiency.

4 : An Implementation of Course Timetabling Algorithm for Turkish Universities. Pakize Erdoğmuş, METU; Kaçtıoğlu, Sibkat.

In our study, we intend to develop an applicable program in real-life. With this aim, first we developed a course scheduling algorithm. We try to find an optimal solution in view of management. We accept some soft constraints as hard constraints. And we developed a program with Visual Basic 6.0 using this algorithm solving Course-Scheduling problems for Turkish Universities.

: RD07 **OR Methodologies**

Contributed Session Room: M31

Chair: Esma Gel
Arizona State University

1 : Optimizing a Linear Function over the Integer Efficient Set. Djamal Chaabane, USTHB; Abbas, Moncef.

In this communication a method for optimizing a linear function over the integer pareto-optimal set without having to determine all integer efficient solutions is presented. A linear objective function is to be optimized over the integer efficient set. The method is mainly based on a simple selection technique that improves the linear objective value at each iteration. The optimal solution is reached without having to enumerate all the efficient solutions using simple simplex procedure

2 : Benders and Lagrangean Relaxation Decomposition to Solve a Hydrothermal Coordination Problem with Binary Variables. Santiago Cerisola, Universidad Pontificia Comillas; Ramos, Andres.

Stochastic models resolutions usually rely on the application of a decomposition method that makes the underlying problem suitable to be solved via the application of a L-Shaped type algorithm. Convexity of the recourse function is an important assumption to guarantee algorithm well behaviour. When binary variables are introduced within the model, this convexity property is lost and nonlinear duality is applied with the purpose of convexifying the recourse function. On the paper it is presented recent experiments about the combination of the Benders decomposition algorithm and Lagrangean relaxation to solve the deterministic equivalent of a stochastic medium term hydrothermal model.

3 : Reliability Analysis of MEMS Switches for High Power Applications. Esma Gel, Arizona State University; Hubele, Norma; Heydt, Gerald; Karady, George.

We perform the failure analysis of a matrix configuration of switches in series and parallel using a Markov Chain. The concept is to use lower voltage and current-rating MEMS switches in series and parallel to attain the higher ratings needed in power engineering applications. In particular, we consider switch failure probabilities that depend on the voltage and current, and are interested in questions such as the expected lifetime of a given configuration and maintenance options. Representative results are illustrated and applications for urban and military ship power distribution systems are suggested.

4 : Resource Investment Problem with Discounted Cash Flows. Amir Abbas Najafi, Sharif University of Technology; Akhavan Niaki, Seyed Taghi.

The vast majority of the project scheduling methodologies in literature has been developed with the objective of minimizing the project duration. In doing so, the financial aspects of project management are largely ignored. In this paper, we focused on project scheduling with the objective of maximizing the net present value. At first, we review the literature of this filed, then we introduce a new problem, named Resourse Investment Problem with Discounted Cash Flows (RIPDCF). The mathematical formulation is presented, and proved that the problem is NP-hard. Then we offer a heuristic procedure to solve RIPDCF. Finally, the procedure is tested.

: RD09 **Supply Chain Management - C6**

Contributed Session Room: L15

Chair: Sanghyeok Seo
Korea University

1 : A Framework for Modeling Coordination Mechanisms in Complex Supply Chains. Pankaj Chandra, Indian Institute of Management Ahmedabad; Tirupati, Devanath.

We develop models to analyze some coordination mechanisms used in industry. The motivation for this work comes from practices of AMUL for managing the supply chain of the dairy industry in India. The chain linking thousands of producers of milk and millions of consumers is large and complex and a variety of coordinating mechanisms are used for coordination. These include price driven mechanisms, coordination of product allocations and production plans, and managing inventory in the chain. The objective of this research is to develop a framework for analyzing alternate coordination mechanisms to obtain insights for management of such supply chains.

2 : An Empirical Study on the Effect of Supply Chain Structure and Direction to Business Performance. Chang Juck Suh, Sogang University; Kim, Heetak; Kim, Jae Hwan; Kwon, Yeong Hoon.

This research addresses the effective policy designing the SC(supply chain) to enhance the business performance. The research model includes SC structure, identified by the type of SC and the level of locational dispersion of SC, and direction. This paper studies the effect of SC structure and direction to business performance empirically. The data set was obtained from 129 venture manufacturing firms which had the characteristics of both supplier and purchaser. The results showed that the SC pursuing a higher externality had higher financial performances. And it was found that the firms well aligned with environment and strategy had high performances.

3 : Negotiation Mechanism for Information Revealing in Supply Chain with Asymmetric Information. Sanghyeok Seo, Korea University; Kim, Sung-Shick; Kang, Yong-Ha.

For supply chains, a negotiation mechanism that induces revealing of the others' private information is investigated. The purpose of developing such mechanism is to make a contract that satisfies each node in supply chains. In supply chains, it is common that one node lacks some important information that at least one of the other nodes possesses. Activities such as accepting or rejecting of a contract and making or canceling a proposal could make your private information more public. Each node learns something whenever the others do something. Under the mechanism all nodes keep improving their own strategies as time advances.

: RD10 **Supply Chain Management - C7**

Contributed Session Room: L19

Chair: Müjde Erol Genevois
Galatasaray University

1 : Simulation of Supply-Side Information and Product Flows. Larry LeBlanc, Vanderbilt University; Hill, James; Dilts, David.

While extensive research has been completed in demand-side supply chain management, much less has been done for supply-side supply chains. The goals of this paper are to describe how to model efficiently the effects of sharing information in multi-level supply-side supply chains, describe difficulties encountered when developing such simulations, and highlight the results of an example of one such chain that extends from an OEM to vendors to sub-vendors. Using a detailed simulation example we find the surprising result that there are circumstances where information sharing is harmful to members of the supply chain and to the total chain.

2 : Adjusment of Social Accounting Matrices using Multiobjective Optimization Methods. Dolores Rosa Santos Peñate, ULPGC; Peñate, Manrique de Lara.

We propose an adjustment procedure which involves multiobjective optimization techniques. Taking into account the initial social accounting matrix (SAM) and some other information, we formulate a biobjective optimization problem which is solved using compromise programming. Different adjustment functions are considered and the corresponding results are compared. Some applications are presented.

3 : Taming Bullwhip whilst Watching Customer Service. Wim Van de Velde, Procter and Gamble; Towill, Denis; Farasyn, Ingrid; Lambrecht, Marc; Disney, Stephen.

We study a generalised order-up-to policy that has highly desirable properties in terms of order and inventory variance and customer service. For a weakly stationary Auto Regressive Moving Average stochastic demand pattern, we quantify exactly the order variance amplification, i.e. the bullwhip effect, and the resulting variance of inventory levels over time. We demonstrate that high customer service as measured by fill rate, and smooth replenishments can be simultaneously achieved. In some instances of the ARMA demand pattern this comes at the expense of a relatively small increase in safety stock, in other instances inventory levels can actually be reduced.

4 : (r,Q) Policy in Supply Chain with Fuzzy Demand. Ali Pirayesh, Sharif University of Technology; Modarres, Mohammad.

In this paper, we develop a two levels supply chain system in which the final demand is assumed to be fuzzy with triangular membership function. In this system, replenishment is on the basis of (r,Q) policy and demand can be back-ordered. The objective is to minimize the total cost of the system consisting order cost, inventory cost and shortage cost.

5 : An Hierarchical Production Planning Model for Supply Chain. Müjde Erol Genevois, Galatasaray University; İçen, Yeşim.

In today's competitive world, an increased attention is placed on Supply Chain Management due to its cost-reductive nature. Planning phase inherent in construction of all Supply Chain systems is regarded as one of the most important aspects to capture the advantages of such system. We advocate that hierarchical planning is a convenient technique to structure the interconnections between supply, production and distribution elements of a Chain. Thus,we propose a multiobjective HPP model with flexibility, cost, quality and/or service level optimisation based both on time and production quantity aggregation for the relations between suppliers both in cooperation and competition.

: RD11 **Planning Issues in SCM - C8**

Contributed Session Room: R20

Chair: Ying Xie
School of Mathematical and Information Science

1 : Positioning Inventory in a Single-Period Serial Supply Chain with Alternate Optimization Objectives. James Flynn, Cleveland State University; Chung, Chia-Shin; Stalinski, Piotr.

We study the inventory placement problem in a serial supply chain facing a stochastic demand for one period. All customer demand is served from stage 1, which contains the finished product. The upstream stages store the product in finished form or as raw materials or sub-assemblies. The goal is select the stock placements for two different objectives: (i) maximize the expected profit; (ii) maximize the probability of achieving a budgeted profit level B. For both objectives, we prove an optimal stock vector exists, characterize its properties, and provide an algorithm for its computation.

2 : Determining Optimal Decoupling Point in a Supply Chain. Mehdi Sharif Yazdi, Sharif University of Technology; Modarres, Mohammad.

By "Decoupling point" in a supply chain, we mean the stage that separates make-to-order and make-to-stock stages. In this paper, we introduce the concept of optimal decoupling point and develop a method to determine it such that the total cost of the chain is minimized. The cost includes fixed and variable production, inventory holding, fixed transportation and fixed ordering costs. We assume demand, transportation times and transfer times of order data are determinate, production rates are at least as high as demand rate, and shortage is not permitted. The optimal solution is obtained by a dynamic programming model.

3 : Replenishment and Allocation Policies for Supply Chains with Cross-Docking. Mustafa Cagri Gurbuz, University of Washington, Business School; Moinzadeh, Kamran.

We consider a centralized distribution system consisting of N identical retailers (close in proximity) facing Poisson demand and a warehouse employing cross docking. We assume full information exchange (retailers share their private information). We propose the following policy: Whenever the inventory position at any retailer drops to "s", an order is placed at the outside supplier by the warehouse to increase the inventory position of all the retailers to the order-up-to level "S". This policy is compared to two other policies: a more traditional echelon stock policy and another policy where the replenishment decisions are given in a periodic fashion.

4 : Coordinated Two-Level Stocking Control in Distribution Inventory Systems in the Presence of Uncertainty. Ying Xie, School of Mathematical and Information Science; Petrovic, Dobrila; Burnham, Keith.

This paper presents a new two-level decision making approach to determine the inventory policies for distribution inventory systems, which consists of one warehouse and several spatially distributed retailers. Each inventory is controlled by a fixed

period, order-up-to level review policy. The distribution system operates in the presence of uncertainty in customer demands, which are modelled by fuzzy sets. The parameters of review policies for all the inventories are determined using a two-level decision hierarchy: a follower level and a leader level. The decision-making processes at the two levels are repeated iteratively until the cost of the whole system becomes acceptable.

: RD12 **Reliability - C2**

Contributed Session Room: M39

Chair: Nevin Karaarslan
Sakarya University

1 : Application of Domination Theory to Reliability Evaluation for a Consecutive (k,k)-out-of-(n,n): F System. Tetsushi Yuge, National Defense Academy Japan; Yamamoto, Hisashi; Yanagi, Shigeru.

Reliability evaluation using domination theory is effective for a 1-dimensional consecutive k-out-of-n:F system. However, it has not been applied to the two dimensional version. We apply the domination theory to a consecutive (k,k)-out-of-(n,n):F system with a restriction in the number of failed components. The system fails if all components in a (k,k) sub matrix fails or the total number of failed components is more than M which is given beforehand. The reliability is obtained by calculating the probabilities of cut sets which are enumerated by domination theory. The exact reliability is obtained quickly for large n by using the method.

2 : A Fuzzy Petri Net based Reasoning System for Maintenance Planning. Mirko Vujosevic; Strak, Miodrag; Makajic-Nikolic, Dragana.

This paper describes a reasoning system which is aimed to help the maintenance manager in deciding whether to perform maintenance action or not, and in predicting necessary resources. The fleet consisting of different buses that operate on different lines is considered. Daily requirements for maintenance resources vary depending on stochastic factors, which are out of control of maintenance manager. He makes decisions on the assessment about overall bus condition. This is drawn from incomplete and vague information about the bus and its exploitation in the previous period. The reasoning process is modeled using fuzzy Petri net and Design/CPN software.

3 : Reliability Analysis of Sakarya University Computer Network. Nevin Karaarslan, Sakarya University; Yılmaz, Ayten; Topal, Bayram; Evirgen, Hayrettin.

Reliability of network systems such as logistics, telecommunication and computer systems that are used in daily life is an important consideration. Computer network reliability has gained ground day by day. Network reliability can be defined briefly as the effect of failure events occurring in one or more components of a network system, on the continuity of communication provided by the system. Exact measurement of network reliability is difficult. This is why network reliability is estimated by using methods such as simulation, GA and ANN.In this study we tried to measure the reliability of the Sakarya University LAN using simulation.

: RD13 **Flexible Manufacturing - C2**

Contributed Session Room: R21

Chair: Beumchul Park
KAIST

1 : A Simulation Approach for Concurrent Designing Plant Layout and Material Flow Management. Andrea Pacifici, Università degli Studi di Roma "Tor Vergata"; Confessore, Giuseppe; Furlan, Andrea; Liotta, Giacomo.

Group Technology consists of grouping part types into families and designing suitable machines cells. Typical indicators are based on the minimization of material inter-cell flow. We present a simulation based framework for solving such problem when additional criteria, namely robustness with respect to production-mix and throughput minimization, are taken into account.

2 : Production Scheduling in a Steelmaking-Continuous Casting Plant. Dario Pacciarelli, Università Roma Tre; Pranzo, Marco.

We describe a beam search procedure for a scheduling problem arising in a steelmaking-continuous casting plant. Our formulation generalizes the disjunctive graph of Roy and Sussman. Comparisons with a lower bound of the optimal solution and with previous performance of the plant show the effectiveness of this approach.

3 : Time Synchronization Mechanisms for the Federation of Distributed, Heterogeneous, Manufacturing Simulation Federates. Young-Jun Son, The University of Arizona; Misra, Sidhar; Venkateswaran, Jayendran.

Manufacturing Simulation Federates In forming a federation of distributed simulation federates, local simulation clocks must be synchronized to ensure that events in each simulation federate will be executed in a correct manner, resulting in correct simulation results. In this paper, we will first discuss the development of the requirements for three time synchronization methods: 1) conservative, 2) optimistic, and 3) real-time turbo. Then, we will present the results of an experiment conducted to compare performances of three methods for a distributed supply chain. We will finally present the framework of a neural network based time synchronization method and critical variables to be considered.

4 : 3D Emulation Framework for FMS Prototyping. Hoyeol Ryu, Korea Advanced Institute of Science and Technology; Choi, Byoung Kyu; Park, Beumchul.

Since FMS is a complex system requiring a heavy capital investment, it has to be carefully analyzed, especially, in the layout planning stage. 3D emulation framework is proposed in this paper. In the 3D emulation framework, the concept of virtual resource is employed to model physical resources in a unified manner, and a systematic command modeling scheme has been developed to describe detailed operations. Also included in the 3D emulator is a collision check module for interference detection between moving resources. The proposed 3D emulation framework has been applied to layout planning of a Mazak-type FMS and an educational FMS.

: RD14 **Knowledge Management**

Invited Session Room: R22

Chair: Michael Stankosky
George Washington University

1 : Strategies to Enhance Productivity of Knowledge Workers. A.D. Amar, Seton Hall University.

Going over knowledge job requirements from observations in the industry and the personality traits of successful workers in knowledge assignments, this paper provides management strategies that can be employed to gain higher productivity from knowledge workers. These strategies cover job design, reward and motivation, and morale. Some are modifications or adaptations of management strategies used in traditional organizations, whereas others are new, applicable uniquely to workers in the knowledge environment. Although suggested specifically for knowledge organizations, these strategies can find some use in all organizations. The work also provides results from some comparative studies on traditional and knowledge works.

2 : Mapping Process Knowledge in Manufacturing Enterprises - A Case Study. Norlida Buniyamin, University of Manchester, Institute of Science and Technology; Barber, Kevin.

Knowledge Management has been recognised as a key contributor to success and competitiveness of an organisation. This paper will give an overview of knowledge mapping and its link with Knowledge Management Systems (KMS). A discussion of how manufacturing enterprises could be supported by efficient re-utilisation and generation of knowledge via knowledge maps embedded with best practices and standard procedures will be presented. Further this paper presents the need for classification, codification and mapping of manufacturing knowledge to maintain a KMS designed specifically for a manufacturing environment. A fundamental classification of manufacturing knowledge and a case study will be included.

4 : Knowledge Development Frameworks in National Economies and International Organizations. Kemal Cakici, George Washington University; Passerini, Katia; Aslam, Aiza.

This research presents and contrasts established approaches adopted by international development institutions and multinational organizations to assess knowledge maturity at the macroeconomic level of a nation. It evaluates the advantages of specific measurement methodologies, but also draws a distinction between the efficiency and effectiveness of measurement models and holistic approaches to a knowledge development program. A comprehensive assessment framework that integrates scorecards models with in-country workshops and culture nurturing is proposed. Examples of implementation at the country level are presented. Additional analysis draws comparisons between the assessment methodologies and selected knowledge development initiatives in specific industries and multinational organizations.

5 : Learning Lessons from Experience for Error Prevention. Joji Tsumura, Central Research Institute of Electric Power Industry; Hirotsu, Yuko.

CRIEPI has been conducting detailed and structured analyses of human error incidents at nuclear power plants using proprietary J-HPES. In this study, the extraction method of common problems of human factor error incidents and checkpoints for preventing similar errors was standardized. This method was applied to eleven error types, and the results were summarized in booklets intended for supervisors to check the potential hazards when they do activities such as procedure preparation, and briefing. By applying this method to in-house human error data at each plant, an effective error management is expectable.

: RD15 **Data Mining for Knowledge Management**

Contributed Session Room: R23

Chair: Jehyun Woo
Yonsei University

1 : Searching Customer Patterns of Mobile Service using Quantitative Association Rule. Jehyun Woo, Yonsei University.

This study presents the usage patterns of various additional services which are currently provided to the customers of mobile telecommunication market. First, the customers are classified into eight groups by k-means clustering algorithm based on the factors of individual characteristics. Next, quantitative association algorithm is used to find the service adoption patterns in each group. It is expected that our study results can provide effective guidelines when launching new services or restructuring present services of mobile telecommunication.

3 : Analysis of the Reduction in Fatal Car Accidents in Israel between 1998-1999. Mali Sher, Israel Police; Schneider, Moti.

After years of increasing number of car accidents and injuries in Israel, in 1999 there was a 14% decrease in fatal accidents compared to 1998. This research project analyzed the factors associated with this significant decrease, based on the police accidents database and the police activities. We used the knowledge discovery and data mining algorithms as well as consultation with road safety experts to understand the significant decrease. The results of this research are important, as previously, due to the vast amount of input data, it was difficult to reach conclusions about the factors influencing the road accidents.

4 : Information Resource Discovery with Data Mining in Dynamic P2P Environment. Hiroyuki Kawano, Kyoto University.

By using peer to peer resource discovery systems with simple query functions, it is difficult to search appropriate resources and to guarantee practical response time. Furthermore, we have other problems of search performance which are caused by the network bandwidth and the instability of P2P networks. In order to resolve these problems, we try to modify our proposed search mechanism and realize good advanced functions with content-based search, which are based on heuristic functions with characteristic parameters for contents. We also consider the performance of our proposed methods and discuss related technologies, such as web mining and distributed query processing.

: RD16 **Disaster Management - II**

Invited Session Room: R27

Chair: Ayse Onculer
INSEAD

1 : Experimental Investigation of Inconsistent Perceptions toward Extreme Hazards. Özlem Özdemir, Yeditepe University.

The goal of the study is to investigate the effect of inconsistent risk perceptions on willingness-to-pay for risk reduction. The experiment detects why people respond differently to possible monetary loss at various probability levels in a controlled environment, testing previous research findings that while some people perceive the risk as if no hazard exists, others rate a low-probability risk equal to more frequent risk exposure. In addition, the influence of risk attitudes and socioeconomic variables on decision making for protection will be detected. Relative degree of risk aversion and socioeconomic variables are predetermined before the experiment by a preliminary questionnaire.

2 : Risk Mitigation for Low Probability High Consequence Events. Ayse Onculer, INSEAD.

We report a study on how individuals make mitigation decisions concerning low probability-high consequence events. Two separate studies were conducted. The first one is a large-scale survey distributed in Istanbul on earthquake risk. The second one is a controlled lab experiment with scenarios on earthquake and virus spread (SARS). The results demonstrate that mitigation decisions are based on a set of attributed, such as risk perception, affect, others' decisions and time horizon.

3 : Process Analysis in Crises Management. Hande Türçak, Boğaziçi University; Barbarosoğlu, Gülay.

In this study, we examine the main functions and the processes before, during and after a disaster from the perspective of crisis management. The objective of this work is to present an integrated framework for developing information and management system to be used by local administration of a metropolitan city. The related organizational units, functions and data requirements are determined to model the process chain diagrams needed in engineering the crisis management functions.

4 : Management of BH Steel Company in a War Turmoil Region. Faik Uzunovic, Cyprus International University; Ghafoor, Abdul; Ersöz, Burcu.

"Zenica" Steel Works was established in 1892 and by 1976 reached to an integrated iron and steel works with a capacity of two million t/y. Due to the regional war-turmoil period from 1992 to the present, "Zenica" was closed. However, it continued production at small scale. The rehabilitation process of "Zenica", now called BH Steel Company, is in progress but facing various problems. The objective of this paper are; to provide an insight into disaster and crisis management policies, to identify optimum technological upgrading levels of this industrial complex and to contribute to development and stabilization of the region.

: RD17 **Stochastic Models - C2**

Contributed Session Room: R24

Chair: Victor Albornoz
Universidad Tecnica Federico Santa Maria

1 : Replacement Processes - A Review. Ioannis Gerontidis, Technological Institute of Kavala.

This paper surveys results obtained by the author since 1992, together with earlier results on replacement processes, modelled by a Markov or semi-Markov process. The topics covered include the limiting distribution under different types of environmental behaviour, the distribution of the time to replacement, the asymptotic replacement rate and reversibility issues. The results contribute to the control theory of Markov and semi-Markov processes and extend in a natural manner a wide variety of applied probability models.

2 : Markets with Inert Investors. Erhan Bayraktar, Princeton University; Poor, Harold.

By an asymptotically efficient wavelet-based estimator we observed that high-frequency the Hurst parameter of S&P 500 index data (1989-2000) is above the efficient markets value, but it started to approach that level from 1997 onwards. We conjectured that this behavior of the market might be related to the increase in Internet trading, which increased the frequency of trading activity. We validate this conjecture by studying the effect of investor inertia on stock price fluctuations with a market microstructure model comprising many small investors who are inactive most of the time.

3 : Optimization of Real-Time System with Shortage of Maintenance Teams. Joseph Kreimer, Ben-Gurion University of the Negev; Ianovsky, Eduard.

We present optimality conditions for real-time multiserver system with large number of servers (e.g. unmanned air vehicles, machine controllers, overhearing devices, etc.) and several nonidentical channels (e.g. surveillance regions, assembly lines, etc.) working under maximum load regime (worst case analysis) with limited maintenance facilities. Optimization of these systems is a very important task. We calculate limiting values of system availability and its loss penalty function and show how to obtain optimal assignment probabilities which optimize (maximize and minimize respectively) these performance measures. Acknowledgement: This research was supported by Paul Ivanier Center for Robotics Research and Production Management at Ben-Gurion University.

4 : Management of the Prawn Fishery using a Nonlinear Stochastic Optimization Model. Victor Albornoz, Universidad Tecnica Federico Santa Maria; Canales, Cristian.

The annual quota for a fishery resource is calculated, formulating and solving a nonlinear stochastic program with recourse. The proposed model includes two uncertain parameters related to the intrinsic rate of growth and the carrying capacity, whose distribution is obtained using a sampling technique. The algebraic modeling language AMPL is used, with MINOS as solver. The methodology used was useful for modeling the stochastic nature of the system and provided a good approach for computing an annual quota of the renewable resource studied.

: RD18 **Location - C2**

Contributed Session Room: R25

Chair: Luiz A. N. Lorena
INPE - Brazilian Space Research Institute

1 : Multi Facility Location and Relocation Problem with Time Dependent Weights and Discrete Planning Horizon. Reza Zanjirani Farahani, Amirkabir University; Asgari, Nasrin.

We investigate a multi-facility location problem with multi-relocation opportunities. The weight of each demand point is a known function in time. The distance between the new facilities and a demand point is either rectilinear, squared Euclidean, or Euclidean. Relocations can take place only at predetermined times. The objective function is to minimize the total location and relocation costs. An algorithm which finds the optimal locations, relocation times and the total cost, for three types of distance measurements and various weight functions, is developed. Locations are found using constant weights, and relocations times are the solution to Binary Integer Programming model.

2 : A Fuzzy Multi-Objective Covering-based Vehicle Location Model for Emergency Service. Ceyhun Araz, Dokuz Eylül University; Selim, Hasan.

This paper presents a multi-objective vehicle location model for emergency services. Several objectives such as maximization of the population covered by one vehicle, maximization of the population covered by two vehicles at least, and increasing the level of service by minimizing the average travel distance to the uncovered zone are considered in the model. Covering-based emergency vehicle models developed so far either ignored uncertainty or consider it approximately through the use of probability concepts. In this paper uncertainties are presented by fuzzy sets and the proposed model was implemented by using fuzzy linear programming (FLP) approach.

3 : Location and Design of a New Facility under Partially Binary Preferences. Blas Pelegrin, Universidad de Murcia; Fernandez, Jose; Plastria, Frank; Tóth, Boglárka.

We consider n demand points in a region of the plane, where there already exist p+c facilities with known attractiveness, c of those facilities belong to a given chain. This chain wants to locate a new facility in the market to compete with the other existing facilities. We study the problem of determining both the location and attractiveness of the new facility, so as to maximise the profit obtained by the chain. It is assumed that demand is essential and customers´ preferences are partially binary. We present a competitive facility location model, study its properties and propose different optimisation methods.

4 : A Survey on Location - Routing Problems. Damla Ahipaşaoğlu, Bilkent University; Erdoğan, Güneş.

The Location-Routing Problem is a combination of Location/Allocation and Vehicle Routing Problems where location and routing decisions are taken simultaneously. In this paper, we present an improved taxonomy based on Min, Jayaraman, and Srivastava (1998) and give a critical survey of studies on location-routing problems. An overview of computational aspects, research prospects and a list of overlooked problem variants are included. This is the first survey in the literature, which includes a complete review of all problem variants.

5 : A Branch-and-Price Approach to P-Median Location Problems. Edson Senne, UNESP; Lorena, Luiz A. N.

This paper describes a branch-and-price algorithm for the p-median location problem. The objective is to locate p facilities (medians) such as the sum of the distances from each demand point to its nearest facility is minimized. The traditional column generation process is compared with a stabilized approach that combines the column generation and Lagrangean/surrogate relaxation. The Lagrangean/surrogate multiplier modifies the reduced cost criterion, providing the selection of new productive columns at the search tree. Computational experiments are conducted considering especially difficult instances to the traditional column generation and also with some large-scale instances.

: RD19 **Facilities Planning and Design - C2**

Contributed Session Room: R26

Chair: Erdal Erel
Bilkent University

1 : Effects of Product Variety in Technology Selection Decision for Cellular Manufacturing System Design. Hesna Müge Yayla, Bilkent University; Aktürk, M. Selim.

In this study, we solved the cellular manufacturing system design problem and the technology selection problem simultaneously. Modification of a well known similarity measure and the technology selection decisions are based on the individual properties of parts, namely production volume, variability of the demand, and design stability of the part. Integration of the product variety at the design stage leads us to the use of flexible machining systems in high volume production areas in contrary to the conventional wisdom. In the paper, a multi-objective MIP model is constructed and a filtered-beam based algorithm is presented to solve the problem efficiently.

2 : A Parallel Genetic Algorithm "PAGENA" for Facility Layout Problems. Orhan Türkbey, Gazi University; Kulluk, Sinem.

Facility Layout Problems (FLPs) deal with assigning m facilities to n locations, in such a way that the sum of the fixed investments and associated material handling costs are minimised. FLPs can be formulated as Quadratic Assignment Problem (QAP) when equal area facilities are considered. The importance of QAP applications coupled with the fact that the QAP is NP-hard, has caused the development of heuristics. Because of this, in this study, we describe a new parallel genetic algorithm "PAGENA" for the QAP. Comparison is made with solutions of several standard test problems taken from QAP Library.

3 : A Heuristic Procedure for the Dynamic Layout Problem. Erdal Erel, Bilkent University; Ghosh, Jay; Simon, John.

The dynamic layout problem considers the situation where the traffic among the various units within a facility changes over time. The objective is to determine a layout for each period such that the total of the flow and the relocation costs is minimized. The problem is computationally difficult and has begun to receive attention only recently. In this paper, we present a new heuristic scheme based on the concept of viable layouts. This scheme can be reasonably fast and can yield results that are competitive with those from other available solution methods.

: RD20 **Mathematical Programming - C3**

Contributed Session Room: M35

Chair: Stelios Rozakis
UMR Economie Publique, INRA

1 : SGDDP: Stochastic Generalized Dual Dynamic Programming Theory. Jesús Velásquez, Universidad de la Sabana.

This work presents theoretical considerations about the solution of stochastic dynamic optimization problems integrating the Benders Theory, the Dynamic Programming approach, the concepts of Control Theory and the non-anticipative Stochastic Programming. The work is an extension of the Generalized Dual Dynamic Programming Theory (GDDP) developed by Velasquez (2002). The GDDP can be considered as an extension of two previous approaches known as Dual Dynamic Programming (DDP): The first is the work developed by Pereira and Pinto (1991) which was revised by Velásquez et. al (1999); The second is the work developed by Read and others (1987, 1990).

2 : Custom Utility Functions and Interval Linear Programming for the Evaluation of Agricultural Policy. Stelios Rozakis, UMR Economie Publique, INRA; Kazakci, Akin; Vanderpooten, Daniel.

The mid-term reform of the Common Agricultural Policy in progress, implies significant mutations in the economic environment of European farms. In order to evaluate the effects to the French arable cropping system, LP models have been constructed to reproduce farmer's behavior. Two alternative paths are selected to model farmers' reasoning: The first one assumes that farmers wish to maximize benefits, hence ordinary LP models can be used with gross margin as objective function. The second one was to insert intervals as coefficients to the objective function level to take into account uncertainties implied in yields and in price variations.

: RD21 **Network Design**

Invited Session Room: M36

Chair: Hervé Rivano
INRIA

1 : The Generalized Subgraph Problem: Complexity, Approximability and Polyhedra. Corinne Feremans, Universiteit Maastricht; Labbé, Martine; Letchford, Adam; Salazar González, Juan José.

This paper is concerned with a problem on networks which we call the Generalized Sub graph Problem (GSP). The GSP is defined on an undirected graph where the vertex set is partitioned into clusters. The task is to find a sub graph which touches at most one vertex in each cluster so as to maximize the sum of vertex and edge weights. We examine the GSP from a theoretical viewpoint. We show that the GSP is strongly NP-hard, but solvable in polynomial time in several special cases. We also give several approximation results. We derive new classes of valid and facet-inducing inequalities.

2 : Approximating the Multicommodity Flow Problem with Applications to WDM Networks Design. Hervé Rivano, INRIA.

The design of WDM optical networks is an issue for telecom operators since the spreading of this technology will not occur unless enough performance guaranties are provided. Motivated by the seek for efficient algorithms for the Routing and Wavelength Assignment problem (RWA), we address approximations of the fractional multicommodity flow problem which is the central part of a complex randomized rounding algorithm for the integral problem. Through the use of dynamic shortest paths computations and other combinatorial approach, we improve on the best known algorithms. We also provide directions for further improvements.

3 : Design of Resilient Networks. Abdullah Konak, Penn State Berks.

Network resilience refers to the ability of a network to continue services in case of component failures. This research focuses on several issues in the economical design of resilient networks with components subject to failure, including network resilience measures, evaluating network resilience, and optimization approaches. In addition, computational results are represented for an evolutionary approach, and topological features leading to high resilience are discussed.

4 : Hub-Spoke Network Design Problem with Hop-Count Constraint for Air-Cargo Systems. Moon-Gil Yoon, Hankuk Aviation University; Yoon, Duk Young.

In this paper, we address a hub-spoke network design problem for air-cargo systems. To build such a network, three kinds of network costs should be considered: fixed cost for establishing a hub, fixed cost for operating air-cargo on each route and variable cost occurring on each route. With these kinds of costs, we develop an optimization model for design a hub-spoke network in air-cargo systems including the hop-count constraint being used effectively to deliver freights. we suggest a dual based heuristic algorithm to solve our problem and compare some results with the optimal solutions solved by CPLEX program.

: RD22 **Military OR - III**

Invited Session Room: M37

Chair: Peter Lohmander
SUAS

1 : Optimal Decentralized Tactical Decisions of Isolated Blue Units behind Red Lines. Peter Lohmander, SUAS.

The tactical decision problems of isolated blue units (IBU) with limited supplies behind enemy (Red) lines is analysed with mixed strategy game theory. Red has a limited number of mobile units for randomised protection and defence of potential Red targets. The Nash equilibrium mixed attack and defence strategies are determined. The sensitivity of the Nash equilibrium to possible parameter changes is determined in general form. The optimal Blue response to non-optimal Red strategies is described. The dynamics of adaptive strategy frequency changes is analysed. Easily used INTERNET software has been developed for simple decentralized optimisation of the mixed strategies.

2 : A Search Allocation Game with False Contacts. Ryusuke Hohzaki, Japan National Defense Academy.

This report deals with a two-person zero-sum game, called

"search allocation game", of a searcher and an evader, where false contacts are taken account of. The searcher distributes his searching effort in a search space in order to detect the evader. On the other hand, the evader is moving to avoid the searcher. A payoff of the game is the total amount of the searching effort weighted by the evader's probability. There have been few researches dealing with the search game including the false detection. We formulate it as a mathematical programming problem and obtain its equilibrium solution.

3 : An Optimal Two-Stage Search Plan Taking Account of Errors in Investigation Process. Toru Komiya, Japan National Defense Academy; Iida, Koji; Hohzaki, Ryusuke.

We consider a two-stage search operation which consists of broad search and investigation. In the broad search, a searcher gets many contacts which may be caused by a true target, false objects or noise. He could not tell the true one from them so he must investigate a contact immediately after he gets it. When he judges the contact, he would make two kinds of errors. We obtain an optimal investigation plan to maximize the detecting probability of the target taking account of those errors until the end of the operational time.

: RD23 **Research & Development**

Contributed Session Room: M38

Chair: Richard Reis
Stanford University

1 : Overcoming Barriers to Interdisciplinary Research. Richard Reis, Stanford University.

Many contemporary business and engineering problems lie at the intersection of disciplinary boundaries and for this reason today's researchers, need to be both disciplinary and interdisciplinary; to have the breadth to see problems, and the depth to solve them. Nevertheless, the challenges such interdisciplinary collaborations present are formidable. Lack of a common language, differing standards of performance and publication, varying modes of collaboration, and conflicting goals are just some of the difficult issues that must be addressed.

2 : Cognitive and Physical Utilization in Controller-Pilot Communications. Tatjana Bolic, UC Berkeley; Rakas, Jasenka; Hansen, Mark.

We introduce a new metric (cognitive utilization), trying to capture the percentage of time controller has to "think" about certain aircraft. Cognitive utilization sums all the intervals during which a specific communication "transaction" is underway. Communication messages and related traffic data are analyzed in order to determine whether cognitive utilization affects sector capacity. We investigate the relation between physical utilization and sector capacity, and whether there is an independent cognitive effect. Cognitive and physical utilization are closely correlated, but there are instances in which the cognitive vastly exceeds physical. Then, pilots' capacity to conduct voice communications is substantially reduced.

3 : An Integrated Design Method by Enhancing the Effectiveness of Six-Sigma through Axiomatic Design. Birgi Martin, Bocconi University, Milan; Martin, Ergi.

In this work, we present the incorporation of Six Sigma with Axiomatic Design to provide an integrated approach that increases the quality, productivity and profitability of a product or process. Invented by Nam Suh of MIT, Axiomatic Design is a methodology for creating new designs by the use of design domains and a set of axioms to ensure tight relationships between intended functions and means by which they are achieved. Associating functional requirements, design parameters, and process variables with critical to quality, satisfaction and process factors, we provide a systematic mapping and decomposition method for developing innovative designs or solutions.

: RD24 **OR in Development**

Invited Session Room: L17

Chair: Hans W. Ittmann
CSIR

1 : Is OR in Development Different? - A South African Perspective. Hans W. Ittmann, CSIR.

OR has been practiced in most countries of the world since its inception. During the 80's and 90's there was a move to look at OR, as practiced in countries classified as 'developing countries', differently. The question is whether OR as practiced in first world countries are indeed different to what is practiced in so called 'developing countries'? In addition if there are differences what are these? The paper will give a South African perspective on this topic. Having operated in both these "sectors" the author will endeavour to share his perspectives, draw some comparisons and draw some conclusions.

2 : OR and Sustainable Development in Developing Countries. Nazar Hassan, University of Massachusetts Amherst; Manwell, James.

Sustainable development problems are a genre of multi-objective wicked problems. Resources scarcity in developing countries adds to the convolution of these problems, which is rooted within many disciplines. The essence of a successful strategy is to find the dynamic strategic fit (DSF) between these systems' external factors (opportunities and challenges) and their internal factors (resources and capabilities). This article presents an algorithm that utilizes the DSF concept to improve on sub-optimal solutions represented by economically feasible developmental projects. The algorithm applications illustrate its ability to reduce the behavioral makeup of decision-makers and politics effects, which are discerned with MADM models.

3 : OR in Developing Countries: Different Viewpoint. Goutam Dutta, I.I.M, Ahmedabad, India; Taket, Ann.

OR in developing countries is often assumed to be of a rather different nature to that in developed countries. This paper subjects this view to examination, demonstrates that a less simplistic view is required. In order to demonstrate this, a number of different avenues of inquiry are pursued. Firstly, selections from the published literature in OR are examined. Secondly, experiences in applying similar mathematical models in two steel companies, one in a developing country and another in a developed country, are contrasted. The paper concludes by discussing avenues for strengthening the practice of OR in developing countries.

: RD25 **Bioinformatics**

Invited Session Room: M34

Chair: Metin Türkay
Koç University

1 : Mathematical Programming for Predicting Secondary and Super-Secondary Structures. Metin Türkay, Koç University; Yılmaz, Özlem; Savaş, Selçuk.

Proteins are responsible from realizing majority of chemical and biochemical activities in cells alone or by interacting with other proteins. The objective of this paper is to describe a novel two-stage method based on mathematical programming to predict the location of secondary structure elements in a protein using the primary structure data. In the first stage, super-secondary structure of a protein is determined using generalized disjunctive programming. The second phase of the method utilizes all of the data available in the Protein Data Bank and determines the possible location of secondary structure elements in a probabilistic branch and bound algorithm.

2 : A Probabilistic Branch and Bound Algorithm to Predict Protein Secondary Structures. Özlem Yılmaz, Koç University; Türkay, Metin; Savaş, Selçuk.

The functions of a protein are highly correlated with its native structure. The protein structure is examined in four levels with increasing complexity: the primary structure gives the linear amino acid sequence; the secondary structure gives locations of the structural elements such as alpha-helices and beta-sheets; the tertiary structure gives the coordinates of the atoms; and the quaternary structure gives the positions of proteins in a protein complex. The proposed method utilizes all of the data available in the Protein Data Bank and determines the possible location of secondary structure elements in a probabilistic branch and bound algorithm.

3 : Sequencing DNA Hybridization Data. Mufit Ozden, Miami University.

A challenging problem in Bioinformatics is to sequence the nucleotides in a DNA fragment. The sequencing-by-hybridization technology can determine the strings of nucleotides in a DNA fragment without indicating their sequence with some errors in readings. The problem is to determine the sequence of the strings forming the shortest DNA fragment excluding the errors. The problem is equivalent to the Traveling-Salesman problem and therefore NP-Complete. But we show that a LP-model may be used for this problem to find the sequence with a high degree of success rate because of the special "cost" structure of the problem.

4 : Continuous Optimization to Analyze Stability of Gene-Expression Patterns. Gerhard-Wilhelm Weber, METU.

Many problems in computational biology consist of the analysis of gene-expression data. The application of approximation, dynamical systems, algorithms and utilization of combinatorial structures lead here to a better understanding. We extend an algorithm, which exploits discrete information. This lies in the vertices of polyhedra, which grow stepwise up to a possible stopping. We study gene-expression data in time, mathematically model it by least squares optimization as a continuous system, and discretize this. By our algorithms we compute regions of (in-)stability. We give an introduction from genetics, interpretations, and an outlook.

: RD28 **Fuzzy Sets in OR**

Invited Session Room: L12

Chair: Bernard De Baets
Ghent University

1 : F-TRIBES - A Fuzzy Parameter Free Particle Swarm Optimizer. Maurice Clerc, France Telecom.

Particle Swarm Optimization is a population based method in which a swarm of particles "flies" inside the search space, looking for an optimum. Adaptive versions need some rules like "if a particle is bad, then remove it". Also, all PSO versions make use of proximity areas around given positions. First, I present a crisp adaptive PSO version (Tribes). Then, decision rules are replaced by fuzzy rules, and proximity areas by fuzzy vectors, defining non uniform distributions. Finally, it is shown that the fuzzy Tribes is not only more stable, as expected, but is also often better than the crisp one.

2 : On the Dice Model Framework for the Comparison of Probability Distribution Functions. Bart De Schuymer, Ghent University; De Meyer, Hans; De Baets, Bernard.

We introduce the notion of a discrete dice model as a framework for describing classes of probabilistic relations. It yields a way to compare random variables uniformly distributed on discrete number sets. This interpretation allows to extend the dice model so that arbitrary, not necessarily independent, discrete or absolutely continuous random variables can be compared. It is shown that the n-copula expressing the joint cumulative distribution (c.d.f.) of the collection of random variables as a function of the univariate marginal c.d.f.'s, plays a key role in the determination of the transitivity of the probabilistic relation generated by the collection.

3 : A New Consistency Index. Mª Teresa Lamata, Universidad de Granada; Alonso, Jose Antonio.

The Analytic Hierarchy Process provides the decision maker a index for measure the consistency of pairwise comparison matrices. Although is one of the most commonly used it presents same disadvantages. One of them is that this index is an absolute index. In this paper we present a new index for represent the consistency that allows the decision maker to study the problem for each matrix in a relative way. Therefore, the user can decided about the consistency using not only the matrix figures but also the level of consistency we need in this particular case.

4 : Perception based Function with Fuzzy Initial Value. Ildar Batyrshin, Kazan State Technological University; Sheremetov, Leonid; Panova, Alexandra.

Perception based function (PBF) is given by rules like "If X is LARGE then Y is QUICKLY DECREASING". Such rule may be considered as a perception based description of the speed of the variable Y change when X is increasing within the fuzzy interval evaluated as LARGE. The set of such rules may be considered

as a linguistic description of fuzzy granular derivative dY/dX. PBF describes a family of fuzzy functions. The method of reconstruction of PBF with fuzzy initial value based on an extension principle of fuzzy logic is described. Possible applications of PBF are discussed.

: RD29 **Forecasting - C2**

Contributed Session Room: L13

Chair: M. Sinan Gönül
Bilkent University

1 : On Persistence of Performance Measures. David Moreno, Universidad de Alcala; Nawrocki, David; Olmeda, Ignacio.

We analyze the persistence of several performance measures (PM) used by investors to pick stocks. Our results suggest the following: i) A passive strategy is no worse than an active strategy which chooses the asset with the best performance. ii) Only two PM show some degree of persistence for almost all horizons (GH2 and Sharpe). The R/SV measure exhibits some persistence when utilized in an active strategy. iii) The rest of the PM do not demonstrate any persistence. iv) With a number of the PM, there is a high probability of reversals which may or may not be useful information.

2 : News, Mood and Consumer Sentiment. Fergus Bolger, University of Leicester; Antonides, Gerrit.

The 'index of consumer sentiment' (ICS), based on responses to a short attitude questionnaire, is widely used to predict consumer spending. However, there is evidence that respondents are influenced by things bearing little relation to their future spending, thereby undermining the ICS's forecasting utility. We test the hypothesis that non-economic news events influence mood of questionnaire respondents, and thus the ICS, both retrospectively, and by examining the relationship between current mood and responses to various expectation questions. Practical implications of the results are discussed, and also what they tell us about the contribution of cognitive psychology to understanding economic behaviour.

3 : The Impact of the Forecasting Horizon when Forecasting with Product Families. Pim Ouwehand, Eindhoven University of Technology; van Donselaar, Karel; de Kok, Ton.

Due to increased product variety and shorter product lifecycles, forecasting individual product demand with exponential smoothing methods becomes increasingly difficult. We try to improve these forecasts by using seasonal indices at a higher aggregation level, i.e. at the level of families of products with similar seasonal patterns. Empirical results for three wholesalers show significant improvements of the product-aggregation method compared with classical methods. This paper looks at the impact of the forecasting horizon on the performance of this method. We investigate the impact on the forecast error and expect to see even bigger improvements than for short term forecasts.

4 : Effects of the Structural Characteristics of Explanations on the Adjustment of Point Forecasts. M. Sinan Gönül, Bilkent University; Önkal-Atay, Dilek; Lawrence, Michael.

Past research has shown that judgmental adjustments to presented forecasts may be influenced by providing an explanation regarding the forecast and the time-series. This study outlines an experiment to examine the effects of the structural characteristics of provided explanations. In particular, the effects of the length and the style of the language used in these explanations are investigated via short/long explanations and vague/confident language used. The subjects are asked whether they would want to adjust the provided point forecasts after examining the time-series graphs and the given explanations. Results are discussed and future research directions are given.

: RD30 **Work Flow Management Systems - C1**

Contributed Session Room: L14

Chair: Vasilis Gerogiannis
Technological Education Institute of Larissa

1 : Process Integration - From Workflow Models to Web Service Choreography. Michael zur Muehlen, Stevens Institute of Technology; Nickerson, Jeffrey V.; Stohr, Edward A.

With the increasing number of web service standards, the modeling of inter-organizational processes based on web service technology has received a lot of attention. The composition of workflow applications across multiple organizational domains creates new challenges, such as the handling of security information across administrative boundaries, the local independence of communicating parties, and the management of loosely coupled interaction. In this paper we take a look at the technical, organizational and managerial issues of inter-organizational process integration. We position current standardization efforts in the web service choreography field and evaluate these standards for completeness against a holistic framework.

2 : Case-based Performance Analysis of Workflow Models. Khodakaram Salimifard, Persian Gulf University; Wright, Mike.

Performance evaluation of a workflow model is one of the key non-functional requirements. Due to their complex structure, workflow models are mainly analysed as a single process using stochastic branching. The dynamic behaviour of each possible case has been ignored. This paper introduces a methodology based on Petri nets for case-based performance analysis of workflows. It allows the extraction of all possible and valid cases from a single workflow model. To obtain the completion time density function for each case, convolution of random variables is used. Discrete event simulation is applied, if a closed form density function cannot be computed.

3 : Representation and Analysis of Business Processes: Emphasis on Workflows Time Management. Vasilis Gerogiannis, Technological Education Institute of Larissa; Sirakoulis, Kleanthis; Ypsilandis, Pandelis.

The competition of continuous chaining business environment leads organizations to apply business process redesign - reengineering. The proper use of workflow management systems is a crucial point for the success in their efforts. Of main important for these systems is the management of operations according to time requirements and to resource constraints. This paper presents the use of quantitative analysis techniques, originally derived from the real-time scheduling area, to systematically manage various time parameters of workflow applications.

Schedulability analysis is proposed to examine the timing feasibility of complex workflow instances under varying job priorities and resource constraints

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: RD31 **OR & Internet**

Contributed Session Room: M33

Chair: Larissa Matveeva
Unversité Catholique de Louvain

1 : A Choice Model for Consumer Behavior in On-Line Banking Services. Maria Mavri, Athens University of Economics & Business; Ioannou, George.

The competitive environment in the financial services market is transforming the way services are delivered. Internet seems to be the new delivery channel in banking sector. A series of factors such as security, play crucial role in consumer's attitude-adoption or rejection- of this new alternative channel. We examine consumer's behavior by modelling multivariate categorical response data using utility functions and a binary probit model. To motivate our choice model we assume that the decision of using online banking services or not for a casual individual depends on an utility index, which is determined by a number of explanatory variables.

2 : Dynamic Pricing for Peer-to-Peer Networks. S. Ilker Birbil, Erasmus University Rotterdam; Yolum, Pinar.

The users in a peer-to-peer network are represented as the agents in a non-cooperative game. The set of alternatives for the users are determined by the amounts that they share or download. Associated with every download and sharing decisions, there exist a utility and a disutility, respectively. The users are paid or billed for the amounts that they share or download. The server sets the prices for downloading and sharing. Moreover, the server gains a utility with every transaction. We model this problem as a mathematical program with equilibrium constraints. We discuss the solution methods and provide an illustrative example.

3 : OSPF Routing of Multicommodity Flows. Larissa Matveeva, Unversité Catholique de Louvain; Fortz, Bernard.

Two types of traffic exist on the Internet: data type and multimedia traffic. In terms of Quality of Service, one wants to minimize the rate of error for data type traffic and minimize the delay of delivery of the multimedia traffic. The existing routing protocols like the OSPF protocol only take into account the first quality criterion. The purpose of our work is to find a way to integrate the second criterion into the currently used OSPF protocol.

MONDAY, July 7 08:30am - 10:00am

MA03 Optimization Problems in Railway Applications
MA04 Tutorial on Logical Analysis of Data
MA05 Queueing Models and Traffic Control
MA06 Scheduling in Computer Systems
MA07 Supply Chain Design and Management
MA08 Demand Aggregation in Facility Location Models
MA09 Management of Innovation and New Products
MA10 Environmental Aspects of Closed-Loop Supply Chains
MA11 Applications in the Utilities Sector - I
MA12 Communications and Transportation Network
MA13 OR in Agriculture and Forestry Management
MA14 Queueing Applications in Telecommunications
MA15 SADERYL: A Decision Support System for Vehicle Routing and Facility Location Problems
MA16 Integer Programming - I
MA17 Simulation and Logistics
MA18 Facility Location and the Environment
MA19 Measurement and Evaluation Models in Health Care
MA20 Non-Smooth and Non-Convex Programming
MA21 Scalable Enterprise Systems
MA22 2D Rectangular C&P
MA23 Opportunities and Wealth Creation
MA24 EWG MCAD - I
MA25 System Dynamics and Theory
MA26 OR Applications in South Pacific - I
MA27 Contemporary Issues in Option Pricing
MA28 Meta-Heuristics Directions
MA29 Airline Applications - I
MA30 Teaching Revenue Management
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MC02 Disaster Management - I
MC03 MODM - I (DEA)
MC04 Data Mining
MC05 Traffic Assignment
MC06 Meta-Heuristics for Flow-Shop Scheduling
MC07 New Directions in Supply Chain Research
MC08 Robust Optimization
MC09 Consumer Expectations and Marketing Strategy
MC10 Information Technology and Closed-Loop Supply Chains
MC11 Empirical Applications - I
MC12 Combinatorial Methods for Graph Problems
MC13 Pricing and Revenue Management - I
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MC15 Exact and Heuristic Algorithms for Vehicle Routing Problems
MC16 Integer Programming - II
MC17 Applications of Simulation
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MC20 Classification via Mathematical Programming
MC21 Multi-Echelon Systems
MC22 3D Packing
MC23 Market Entry
MC24 EWG MCAD - II
MC25 Energy and Related Public Sector Applications
MC26 OR Applications in South Pacific - II
MC27 Modeling and Managing Financial Risk
MC28 Meta-Heuristics for Scheduling
MC29 Airline Applications - II
MC30 Education Arcade
MC31 AHP - C2

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MD05 Air Traffic Management
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MD08 GDN Keynote Session (Opening) - I
MD09 Customer Relationship Management - I
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MD11 Theoretical Issues in DEA - I
MD12 Telecommunications Network Design
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MD15 Rich Vehicle Routing Problems - I
MD16 Integer Programming - C1
MD17 Metamodels in Simulation
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MD19 Simulation Models in Health Care
MD20 Discrete and Continuous Non-Convex Optimization
MD21 Lot Sizing and Scheduling
MD22 Additional Objectives and Constraints in C&P
MD23 Financial Modelling
MD24 DSS Applications - C1
MD25 Environmental and Ecological Applications
MD26 OR Applications in South Pacific - III
MD27 Special Topics in Risk Management
MD28 Meta-Heuristics for Routing
MD29 Hazmat - I
MD30 Artificial Intelligence, Expert Systems and Neural Networks - I
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ME02 OR/MS in Health Care: Contemporary Issues and Solutions
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ME06 Flow-Shop and Just-In-Time Scheduling
ME07 New Approaches in Inventory Management
ME08 Social Choice
ME09 Competitive Marketing Strategy
ME10 Inventory Control and Reverse Logistics - I
ME11 Theoretical Issues in DEA - II
ME12 Cutting Plane Methods for Graph and Flow Problems
ME13 Revenue Management in Services
ME14 Management Information Systems
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ME17 Modeling and Analysis Methodology
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ME19 Issues in Long-Term Care and Quality
ME20 Approximation Algorithms and Interior Point Methods
ME21 Performance Evaluation and Optimization of Stochastic Models - I
ME22 Nesting - I
ME23 Innovation and Growth
ME24 Tutorial on Cross Entropy Method for Combinatorial Optimization
ME25 Health and Related Sector Applications
ME26 OR Applications in South Pacific - IV
ME27 Risk Management - C1
ME28 Parallel Meta-Heuristics
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ME31 Strategic Management - I

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WC23 Financial Engineering - C1
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WE08 Innovative Applications of Group Decision and Negotiation
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RB03 Disruption Management: Airline and Other Applications
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THURSDAY, July 10 2:00pm - 3:30pm

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WINER, Russell TC09
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Author Index

Y

Y. RUBINSTEIN, Reuven ME24, TA24
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YOLUM, Pinar RD31
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YUGE, Tetsushi RD12
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YÜCEL, Gönenç MD25
YÜCESAN, Enver TC17
YÜKSEL ÖZKAYA, Banu MC21
YÜZÜGÜLLÜ, Nihat ME14, TE17, RA06
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Z

ZABINSKY, Zelda B. RC17
ZACCOUR, Georges MD09, WD09, RC24
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ZAIM, Osman TD11
ZAK, Jacek TA05
ZAKHAROV, Igor MA19
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ZIJM, Henk TC07, TD07
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ZOPOUNIDIS, Constantin RC27
ZOPPOLI, Riccardo TC12, TD12
ZOROA, Noemi WC28
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ZOTT, Christoph MA23
ZUDDAS, Paola TC12, WC11
ZUIDWIJK, Rob MC10
ZUR MUEHLEN, Michael RD30
ZURRIAGA, Oscar WA20
ZUST, Sibylle TE14

A

Abbas, Khaled
King Faisal University
College of Architecture and Planning
PO Box 2397
Saudi Arabia
kaabbas13@yahoo.com

Abbas, Moncef
USTHB
Algeria
moncef_abbas@yahoo.com

Abdelaziz, Ouabdesselam
Ecole Nationale Polytechnique d'Alger
10, Avenue Hassen Badie - El Harrach
Algeria
tesorus@wissal.dz

Abramov, Vyacheslav
Tel Aviv University
24/6 Balfour st.
Israel
vyachesl@inter.net.il

Acemoğlu, Daron
Massachusetts Institute of Technology
United States
daron@mit.edu

Adam, Otmar
Institute for Information Systems
Geb. 43.8 Im Stadtwald
Germany
adam@iwi.uni-sb.de

Adamski, Andrzej
University of Mining and Metallurgy
Institute of Automatics Al. Mickiewicza 30
Poland
aad@zts30.ia.agh.edu.pl

Adjabi, Smail
University of Bejaïa
Algeria
adjabi@hotmail.com

Adler, Nicole
Hebrew University of Jerusalem
Mount Scopus
Israel
msnic@huji.ac.il

Agca, Senay
George Washington University
2023 G Street, Lisner Hall 540G
United States
sagca@gwu.edu

Ahipaşaoğlu, Damla
Bilkent University
Ankara
Turkey
ahipasa@bilkent.edu.tr

Ahn, Heinz
RWTH Aachen
Templergraben 64
Germany
ahn@lut.rwth-aachen.de

Ainslie, Andrew
UCLA
110 Westwood Plaza Room B412
United States
andrew.ainslie@anderson.ucla.edu

Aissani, Djamil
University of Bejaïa
Algeria
lamos_bejaia@hotmail.com

Akartunalı, Kerem
University of Wisconsin-Madison
2924 Harvey Street #7D
United States
kerema@cae.wisc.edu

Akçalı, Elif
University of Florida
303 Weil Hall
United States
akcali@ise.ufl.edu

Akçay, Yalçın
Koç University
İstanbul
Turkey
yakcay@ku.edu.tr

Akcura, Tolga
Purdue University
403 W. State St.
United States
akcurat@krannert.purdue.edu

Akkermans, Henk
Technische Universiteit Eindhoven
Den Dolech 2 PavF.8
Netherlands
h.a.akkermans@tm.tue.nl

Aksen, Deniz
Koç University
Rumlifeneri Yolu, Sarıyer
Turkey
daksen@ku.edu.tr

Akşin, Zeynep
Koç University
Graduate School of Business
Turkey
zaksin@ku.edu.tr

Akşit, Habibe
Elginkan Holding
Turkey

Aktan, Mehmet
University of Wisconsin-Madison
464 Mechanical Engineering
1513 University Ave
United States
maktan@wisc.edu

Aktar Demirtaş, Ezgi
Osmangazi University
Endüstri Müh. Bölümü
Turkey
eaktar@ogu.edu.tr

Aktaş, Emel
İstanbul Technical University
İTU İşletme Fak. Maçka
Turkey
emelaktas@yahoo.com

Aktürk, M. Selim
Bilkent University
Bilkent
Turkey
akturk@bilkent.edu.tr

Akyer, Hasan
Boğaziçi University
Bebek
Turkey
hasanakyer@hotmail.com

Al-Khalifah, Hisham
P.O. Box 92787
Saudi Arabia
halkhalifah@hotmail.com

Al-Khedhairi, Abdulrahman
University of Birmingham
Edgbaston
United Kingdom
alkhedha@for.mat.bham.ac.uk

Alagöz, Oğuzhan
University of Pittsburgh
1048 Benedum Hall
United States
oga1@pitt.edu

Alain, Chevalier
ESCP-EAP
79, Avenue de la République
France
chevalier@escp-eap.net

Alanyalı, Murat
Boston University
8 Saint Mary's Street
United States
alanyali@bu.edu

Albal, Özgür
Ford-Otosan
Turkey

Albareda Sambola, Maria
Technical University of Catalonia
Pau Gargallo, 5
Spain
maria.albareda@upc.es

Albornoz, Victor
Univ. Tec. Fed. Santa Maria
Departamento De Industrias
Av. Santa Maria 6400
Chile
victor.albornoz@ind.utfsm.cl

Alharkan, Ibrahim
King Saud University
P.o. Box 25371
Saudi Arabia

Participant List

imalhark@ksu.edu.sa

Aljinovic, Zdravka
University of Split
Faculty of Economics
Matice hrvatske 31
Croatia
zdravka.aljinovic@efst.hr

Alkhatib, Ghazi
Qatar College of Technology
P. O. Box 36152 (Madinat Khalifah)
Qatar
alkhatib@qu.edu.qa

Allen, Greenwood
Mississippi State University
PO Box 9542 260 McCain Engineering Building
United States
662-325-7618

Alonso, Jose Antonio
University of Cadiz
C/Chile S/N
Spain
joseantonio.alonso@uca.es

Alonso Ayuso, Antonio
Universidad Rey Juan Carlos
C/Tulipan, s/n
Spain
a.alonso@escet.urjc.es

Alp, Aysun
Boğaziçi University
Bebek
Turkey
alpaysun@boun.edu.tr

Alpay, Şerafettin
Göztepe Mah. Ali Çetinkaya Cad. B Blok 7/21
Turkey
salpay@ogu.edu.tr

Alpern, Steve
London School of Economics
Houghton St
United Kingdom
s.alpern@lse.ac.uk

Altay, Nezih
University of Richmond
Robins School of Business
United States
naltay@richmond.edu

Altekin, F. Tevhide
METU
Turkey
tev@ie.metu.edu.tr

Altınkemer, Kemal
Purdue University
Krannert Sch. of Mgmt.
United States
kemal@mgmt.purdue.edu

Altuğ, Mehmet Sekip
Columbia Business School
Ankara Cad. 93/3 Akasya Apt D:13
Turkey
ms_altug@hotmail.com

Altınel, İ. Kuban
Boğaziçi University
Bebek
Turkey
altinel@boun.edu.tr

Alumur, Sibel
Bilkent University
Erdemkent Ardıç Sk. No:5 Çayyolu
Turkey
alumur@bilkent.edu.tr

Alvarez, María Jesús
Universidad de Navarra
Escula Superior de Ingenieros P. Manuel de Lardizabal, 13
Spain
mjalvarez@tecnun.es

Alvarez-Valdes, Ramon
Universidad de Valencia
Doctor Moliner, 50
Spain
ramon.alvarez@uv.es

Alvelos, Filipe
Universidade do Minho
Departamento de Produção e Sistemas
Portugal
falvelos@dps.uminho.pt

Alves, Rui
Universidade do Porto
Rua Dr. Roberto Frias
Portugal
ralves@fep.up.pt

Amaldi, Edoardo
Politecnico Milano
Piazza L. Da Vinci 32
Italy
amaldi@elet.polimi.it

Amine, Mahjoub
GILCO (INPG)
13 Street Arago
France
amine.mahjoub@gilco.inpg.fr

Amiri, Ali
Oklahoma State University
41 S. University Pl #8
United States
amiri@okstate.edu

Amit, Raffi
The University of Pennsylvania
United States
amit@wharton.upenn.edu

Anandalingam, Gnana
University of Maryland
Van Munching Hall
United States
ganand@rhsmith.umd.edu

Anbari, Frank
George Washington University
302 Monroe Hall,2115 G Street, NW
United States
anbarif@aol.com

Andırınlı, Barış
İstanbul Teknik Üniversitesi
Bilişim Enstitüsü, İTÜ Ayazağa Kampüsü
Maslak
Turkey
andirinli@be.itu.edu.tr

Angun, M. Ebru
Tilburg University
Warandelaan 2 P.O. Box 90153
Netherlands
m.e.angun@uvt.nl

Anily, Shoshana
Tel Aviv University
Ramat Aviv
Israel
anily@post.tau.ac.il

Anjos, Miguel
University of Southampton
University Road
United Kingdom
m.anjos@maths.soton.ac.uk

Anton, Jose M
Universidad Politecnica de Madrid
Spain
jmanton@mat.etsie.upm.es

Antunes, Antonio
University of Coimbra
Dep. Engª Civil - Polo 2
Portugal
antunes@dec.uc.pt

Aparisi, Francisco
UPV
Impresor Lambert 14-31
Spain
faparisi@eio.upv.es

Apollonio, Nicola
Università degli Studi di Roma "La Sapienza"
P.le A. Moro 5
Italy
nicola.apollonio@uniroma1.it

Appa, Gautam
London School Of Economics
Houghton Street
United Kingdom
g.appa@lse.ac.uk

Araman, Victor
New York University
44 West 4th street KMC- 8-74
United States
varaman@stern.nyu

Aras, Necati
Boğaziçi University
Bebek
Turkey
arasn@boun.edu.tr

Araújo, Maria Madalena
Universidade do Minho
Campus de Azurem
Portugal
mmaraujo@dps.uminho.pt

Araz, Ceyhun
Dokuz Eylül Üniversitesi
Endüstri Müh. Bölümü
Ege Üniversitesi Kampüsü B Blok
Bornova
Turkey
ceyhun.araz@deu.edu.tr

Arbib, Claudio
University of L'Aquila
V. Vetoio, Coppito
Italy
arbib@di.univaq.it

Archibald, Thomas
University of Edinburgh
William Robertson Bldg 50 George Square
United Kingdom
t.archibald@ed.ac.uk

Ariu, Toshio
CRIEPI
1-6-1 Ohtemachi
Japan
ariu@criepi.denken or.jp

Armentano, Vinícius
Universidade Estadual de Campinas
Av. Albert Einstein 400 Cidade Universitaria
Brazil
vinicius@densis.fee.unicamp.br

Armero, Carmen
Universitat de València
Doctor Moliner 50
Spain
carmen.armero@uv.es

Aron Mebrahtu, Yohannes
Bergzicht Plaza 213, Andringa Street
South Africa
arex@yahoo.com

Arslan, Hasan
Massachusetts Institute of Technology
30 Wadsworth St.E53-390
United States
harslan@mit.edu

Arthur, Jeff
Oregon State University
Department of Statistics 44 Kidder Hall
United States
arthur@stat.orst.edu

Artiba, Albelhakim
Fucam
Chaussee de Binche 151
Belgium
artiba@fucam.ac.be

Asgari, Nasrin
Tarbiat Modarres University
Jalala Al-Ahmad & Chamran Cross
Iran
asgarin@modares.ac.ir

Asghar, Sohail
Monash University
Wellington Road, ClaytonVIC 3808
Australia
damminda.alahakoon@infotech.monash.edu
.au

Assaf, David
The Hebrew University
Israel
msdave@mscc.huji.ac.il

Ataman, Berk
Tilburg University
Warandelaan 2, Postbus 90153
Netherlands
b.m.ataman@uvt.nl

Atamtürk, Alper
University of California, Berkeley
4135 Etcheverry Hall
United States
atamturk@ieor.berkeley.edu

Atan, Tankut
Işık University
Maslak
Turkey
tankut_atan@yahoo.com

Averbakh, Igor
University of Toronto at Scarborough
1265 Military Trail, Scarborough, Ontario
Canada
averbakh@utsc.utoronto.ca

Avkiran, Necmi
University of Queensland
11 Salisbury Rd.
Australia
n.avkiran@business.uq.edu.au

Avşar, Zeynep
METU
Turkey
muge@ie.metu.edu.tr

Awumee, Kweku
E, Q
P.O.BOX CT 606 Cantonment
Ghana
smilejorge@yahoo.com

Aybat, Serhat
Boğaziçi University
Bebek
Turkey
seraybat@hotmail.com

Aydın, Ali Orhan
Egekom Ltd.
Çaybaşı Mh. 1582 Sk. No: 14/1
Turkey
aliorhanaydin@egecom.net

Aydın, Gülşen
Kocaeli University
Mühendislik Fakültesi Veziroğlu Kampüsü
Endüstri Mühendisliği Bölümü
Turkey
gulsen_a@mynet.com

Aydın, Özlem
Başkent University
Bağlıca Campus, Eskişehir Road 20th km.
Turkey
ozlem@baskent.edu.tr

Aytekin, Umut
Northwestern University
2245 Sheridan Road MEAS C210
United States
umut@northwestern.edu

Aytug, Haldun
University of Florida
351 Stuzin PO Box 117169
United States
aytugh@ufl.edu

Azapagic, Adisa
University of Surrey
United Kingdom
a.azapagic@surrey.ac.uk

Azizi, Majid
University of Tehran
Wood and Paper Department
Faculty of Natural Resources
31585-4314 Karaj Tehran
Iran
mazizi@chamran.ut.ac.ir

Azmat, Carlos Salvador
University of Fribourg
Rue Fausigny 2
Switzerland
carlos.azmat@unifr.ch

B

Baatar, Davaatseren
Univ. Kaiserslautern Paul-Ehrlich Strasse
Fachbereich Mathematik
Germany
baatar@mathematik.uni-kl.de

Bagchi, Uttarayan
The University of Texas at Austin
Department of Management, CBA 4.202
United States
uttarayan.bagchi@bus.utexas.edu

Bakal, İsmail S.
METU
Turkey
ismailsb@ie.metu.edu.tr

Bako, Andras
Szechenyi University
Hungary
bako@kmf.hu

Balas, Egon
Carnegie Mellon University
Pittsburgh
United States

Participant List

eb17@andrew.cmu.edu

Balci, H. Hakan
Auburn University
207 Dunstan Hall
United States
balcihh@eng.auburn.edu

Balçık, Burcu
METU
Turkey
burcu@ie.metu.edu.tr

Baldacci, Roberto
University of Modena and Reggio Emilia
Viale Alleon 15
Italy
baldacci.roberto@unimore.it

Ball, Michael
University of Maryland
United States
mball@rhsmith.umd.edu

Bao, Jie
National University of Singapore
Dept. of Industrial & Systems Engineering
119260
Singapore
engp1004@nus.edu.sg

Baptiste, Philippe
CNRS - Ecole Polytechnique
France
philippe.baptiste@polytechnique.fr

Barahona, Francisco
IBM Research
99 Barnwell Dr
United States
barahon@us.ibm.com

Barbarosoğlu, Gülay
Boğaziçi University
Bebek
Turkey
barbaros@boun.edu.tr

Barcellos Gouvêa Campos, Vania
Military Institute of Egineering
Rua Ministro Correia de Melo, 127 Apt.401
Leblon
Brazil
d2vania@epq.ime.eb.br

Barcelo, Jaume
Universitat Politecnica de Catalunya
Pau Gargallo 5
Spain
jaume.barcelo@upc.es

Barjaktarovic, Sladjana
University of Belgrade
Faculty of Organizational Sciences
Jone Jlica 154
Serbia and Montenegro
barjaks@fon.bg.ac.yu

Barlas, Yaman
Boğaziçi University
Bebek
Turkey
ybarlas@boun.edu.tr

Barnhart, Cynthia
Massachusetts Institute of Technology
United States
cbarnhar@mit.edu

Barut, Mehmet
Wichita State University
1845 Fairmount Box 77 324 Clinton Hall
United States
mehmet.barut@wichita.edu

Barzinpour, Farnaz
Tarbiat Modarres University
Industrial Engineering Dep.
Tehran
Iran
barzin_f@modares.ac.ir

Batislam, Emine
Sabancı University
Orhanlı - Tuzla
Turkey
batislam@sabanciuniv.edu

Batta, Rajan
University at Buffalo (SUNY)
342 Bell Hall
United States
batta@eng.buffalo.edu

Batyrshin, Ildar
Kazan State Technological University
K. Marx St. 68
Russia
batyr1@hotbox.ru

Baucells, Manel
IESE Business School and Duke University
Ave. Pearson, 21
Spain
mbaucells@iese.edu

Bayer, Steffen
Imperial College London
South Kensington Campus
United Kingdom
s.bayer@imperial.ac.uk

Bayindir, Z. Pelin
Erasmus University Rotterdam
POB 1738
Netherlands
bayindir@few.eur.nl

Bayraksan, Guzin
The University of Texas at Austin
1 University Station, C2200
United States
guzinb@mail.utexas.edu

Bayraktar, Erhan
Princeton University
Department of Electrical Engineering
United States
ebayrakt@princeton.edu

Bayraktar, Erkan
Beykent University
Beylikdüzü, B.Çekmece
Turkey
erkanb@beykent.edu.tr

Bazaraa, Mokhtar
Georgia Tech
765 Ferst Drive
United States
mo.bazaraa@isye.gatech.edu

Başkan, Fevzi
METU
Turkey
baskan@ie.metu.edu.tr

Beaumont, Nicholas
Monash University
900 Dandenong Rd
Australia
nicolas.beaumont@buseco.monash.edu.au

Becejski-Vujaklija, Dragana
University of Belgrade
Faculty of Organizational Sciences
Jove Ilica 154
Serbia and Montenegro
draganab@fon.bg.ac.yu

Beddoe, Gareth
University of Nottingham
Jubilee Campus
United Kingdom
grb@cs.nott.ac.uk

Bednarczuk, Ewa
Systems Research
Institute Newelska 6
Poland
bednarcz@ibspan.waw.pl

Begen, Mehmet
University of British Columbia
2053 Main Mall - COE
Canada
mabegen@coe.ubc.ca

Behjat, Laleh
University of Calgary
Department of Electrical and Computer
EngineeringUniversity of Calgary 2500
University Drive, NW,
Canada
laleh@cheetah.vlsi.uwaterloo.ca

Beim, Gina
Weatherhead School of Mgmt, CWRU
20001 S. Woodland Rd
United States
gkb2@po.cwru.edu

Bekki, Özgün Barış
METU
Turkey
barbekki@ie.metu.edu.tr

Bektaş, Tolga
Başkent University
Bağlıca Kampüsü Mühendislik Fakültesi

Etimesgut
Turkey
tbektas@baskent.edu.tr

Belacel, Nabil
NRC Canada
E-Commerce Center 127 Carleton Street
Canada
nabil.belacel@nrc.gc.ca

Belenguer, Jose M.
Universidad de Valencia
Doctor Moliner, 50
Spain
jose.belenguer@uv.es

Belien, Jeroen
Katholieke Universiteit Leuven
Naamsestraat 69
Belgium
jeroen.belien@econ.kuleuven.ac.be

Bell, Peter
Richard Ivey School of Business
UWO
Canada
pbell@ivey.ca

Bellei, Giuseppe
Università degli Studi di Roma "La Sapienza"
Via Eudossiana 18
Italy
giuseppe.bellei@uniroma1.it

Bellini, Fabio
University of Milan Bicocca
Ponte Bucci, cubo 3C
Italy
fabio.bellini@unimi.it

Belmokhtar, Oumhani
Ecole Nationale Polytechnique d'Alger
BP182, 10 rue Hacen Badi EL Harrach
Algeria
oumh@caramail.com

Belohlavek, Radim
Palacky University
Tomkova 4.D
Czech Republic
radim.belohlavek@upol.cz

Belton, Valerie
University of Strathclyde
40 George Street
United Kingdom
val@mansci.strath.ac.uk

Belzunce, Felix
Universidad de Murcia
Campus de Espinardo
Spain
belzunce@um.es

Ben Amor, Hatem
GERAD
3000 Chemin de la Cote Sainte-Catherine
Canada
hatem@crt.umontreal.ca

Ben-Ameur, Walid
GET/INT Institut National des Télécommun
9 Rue Charles Fourier
France
walid.benameur@int-evry.fr

Benli, Ömer
California State University, Long Beach
1250 Bellflower Boulevard
United States
obenli@csulb.edu

Bennell, Julia
University of Southampton
Highfield
United Kingdom
jab2@socsci.soton.ac.uk

Berend, Daniel
Ben-Gurion University of the Negev
Ben Gurion Rd. 1
Israel
berend@cs.bgu.ac.il

Berman, Oded
University of Toronto
105 St. George Street
Canada
berman@rotman.utoronto.ca

Bernstein, Fernando
Duke University
1 Towerview Dr.
United States
fernando@mail.duke.edu

Berrachedi, Abdelhafid
USTHB
Algeria
abdelhafid_berrachedi@yahoo.fr

Bertel, Sylvain
LIMOS
11 rue des petites collanges
France
bertel@isima.fr

Bertsekas, Dimitri
Massachusetts Institute of Technology
United States
dimitrib@mit.edu

Beugnies, Frédéric
University of Valenciennes
Building ISTV2 Campus Le Mont Houy
France
frederic.beugnies@meletu.univ-valenciennes.fr

Bhatti, Tariq
Zayed University
PO Box 19282
United Arab Emirates
tariq.bhatti@zu.ac.ae

Bicer, Batur
Princeton University
Engineering Quadrangle
United States
bbicer@princeton.edu

Bidanda, Bopaya
University of Pittsburgh
1048 Benedum Hall
United States
bidanda@pitt.edu

Bielli, Maurizio
National Research Council
Viale Manzoni 30
Italy
bielli@iasi.rm.cnr.it

Bilge, Ümit
Boğaziçi University
Bebek
Turkey
bilge@boun.edu.tr

Bilgen, Bilge
Dokuz Eylül University
Bornova
Turkey
bilge.bilgen@deu.edu.tr

Bilgiç, Taner
Boğaziçi University
Bebek
Turkey
taner@boun.edu.tr

Biller, Bahar
Carnegie Mellon University
5000 Forbes Avenue Posner Hall 360
United States
billerb@andrew.cmu.edu

Biller, Stephan
General Motors
30500 Mound Rd
United States
stephan.biller@gm.com

Binici, Murat
Ford-Otosan
Turkey

Bioch, Jan Corstiaan
Erasmus University Rotterdam
Postbus 1738
Netherlands
bioch@few.eur.nl

Birbil, S. Ilker
Erasmus University Rotterdam
Erasmus Research Institute of Management
Econometric Institute POB 1738
Netherlands
sibirbil@few.eur.nl

Birgören, Burak
Kırıkkale University
Kırıkkale
Turkey
birgoren@kku.edu.tr

Bischoff, Eberhard
European Business Management School
United Kingdom
e.lydiard@swansea.ac.uk

Participant List

Bisdorff, Raymond
Universitaire de Luxembourg
Luxembourg
bisdorff@cu.lu

Bisschop, Johannes
Paragon Decision Technology B.V.
P.O. Box 3277
Netherlands
j.bisschop@paragon.nl

Biyalogorsky, Eyal
UC-Davis
1959 Lake Blvd. #228
United States
eyalog@ucdavis.edu

Bjørndal, Mette
NHH
Helleveien 30
Norway
mette.bjorndal@nhh.no

Blazewicz, Jacek
Poznan University of Technology
Ul.Piotrowo 3a
Poland
blazewic@put.poznan.pl

Bobeanu, Carmen-Veronica
Ghent University
Technologiepark 903
Belgium
carmen.bobeanu@rug.ac.be

Bodur, Onur
Concordia University
1455 de Maisonneuve Blv. West.
Canada
bodur@jmsb.concordia.ca

Boduroğlu, İlkay
Boğaziçi University
Bebek
Turkey
ilkay@boun.edu.tr

Bolger, Fergus
University of Leicester
Astley Clarke Building University Road
United Kingdom
fmib1@le.ac.uk

Bolic, Tatjana
UC Berkeley
107 McLaughlin Hall
United States
tbolic@uclink.berkeley.edu

Bonfrer, Andre
Singapore Management University
School of Business 469 Bukit Timah Rd
Singapore
andrebonfrer@smu.edu.sg

Borhan, Burak
Boğaziçi University
Bebek
Turkey
borhan@boun.edu.tr

Boros, Endre
Rutgers University
640 Bartholomew Road
United States
boros@rutcor.rutgers.edu

Bosch, Maximo
Universidad de Chile
Republica #701
Chile
mbosch@dii.uchile.cl

Boschetti, Marco
University of Bologna
Via Sacchi, 3
Italy
boschett@csr.unibo.it

Bosnjak, Sasa
Faculty of Economics
Put Mose Prahde 9-12
Serbia and Montenegro
bsaleso@eunet.yu

Bourjolly, Jean-Marie
Concordia University
1455, de maisonneuve blvd. w.
Canada
brjolly@vax2.concordia.ca

Boute, Robert
Katholieke Universiteit Leuven
Naamsestraat 69
Belgium
robert.boute@econ.kuleuven.ac.be

Boutet, Annabelle
Cemagref
361, Rue Jean-François Breton PO Box 2095
France
annabelle.boutet@montpellier.cemagref.fr

Boyabatli, Onur
INSEAD
Boulevard de Constance
France
onur.boyabatli@insead.edu

Boyaci, Tamer
McGill University
1001 Sherbrooke St. W.
Canada
tamer.boyaci@mcgill.ca

Bozbay, Mehmet
University of Wisconsin-Madison
1513 University Avenue #275
United States
mbozbay@facstaff.wisc.edu

Bozdogan, Hamparsum
University of Tennessee
336 Stokely Management Center
United States
bozdogan@utk.edu

Bradl, Peter
Bavarian Research Center for Knowledge-Based Systems
Am Wassenchloss 43a
Germany
bradl@forwiss.de

Brailsford, Sally
University of Southampton
United Kingdom
scb@soton.ac.uk

Brams, Steven J.
New York University
726 Broadway, 7th Fl.
United States
steven.brams@nyu.edu

Brander, Pär
Luleå University of Technology
Sweden
par.brander@ies.luth.se

Brandl, Reinhard
Universität Karlsruhe (TH)
Éichstätter Str. 16
Germany
reinhard.brandl@stud.uni-karlsruhe.de

Brandt, Andreas
Humboldt-Universität zu Berlin
Spandauer Strasse 1
Germany
brandt@wiwi.hu-berlin.de

Brans, J-Pierre
University of Brussels
Belgium

Brenner, Ulrich
University of Bonn
Lennestr. 2
Germany
brenner@or.uni-bonn.de

Brentnall, Adam
University of Southampton
4 Kingfisher Court Highfield road
United Kingdom
a.r.brentnall@maths.soton.ac.uk

Breton, Michèle
HEC Montréal
3000 Chemin de la Côte Sainte-Catherine
Canada
michele.breton@hec.ca

Broekmeulen, Rob
Technische Universiteit Eindhoven
P.O. Box 513, Pav. E10
Netherlands
r.a.c.m.broekmeulen@tm.tue.nl

Brotcorne, Luce
LAMIH-ROI Université de Valenciennes
Le Mont Houy
France
luce.brotcorne@univ-valenciennes.fr

Brugha, Cathal
University College Dublin
Quinn School of Business, Belfield
Ireland

cathal.brugha@ucd.ie

Brunn, Paul
UMIST
PO BOX 88
United Kingdom
paul.brunn@umist.ac.uk

Bruno, Giuseppe
Università di Napoli "Federico II"
Piazzale Tecchio 80
Italy
giubruno@unina.it

Bräysy, Olli
SINTEF Applied Mathematics
P.O. Box 124
Norway
olli.braysy@sintef.no

Bulbul, Kerem
Rapt Inc.
625 2nd Street
United States
kerem.bulbul@rapt.com

Bulfin, Bob
Auburn University
207 Dunstan Hall
United States
bulfin@eng.auburn.edu

Buniyamin, Norlida
UMIST, PO Box 88
United Kingdom
n.buniyamin@postgrad.umist.ac.uk

Burkard, Rainer Ernst
Technische Univ. Graz
Inst. für Mathematik
Steyrergass 30, A-8010 Graz
Austria

Burnetas, Apostolos
Case Western Reserve University
10900 Euclid Avenue
United States
atb4@weatherhead.cwru.edu

Bushenkov, Vladimir
University of Evora
Romao Ramalho, 59
Portugal
bushen@uevora.pt

Buyukkurt, Kemal
Concordia University
1455 De Maisonneuve Blvd. West
Canada
kemalbk@jmsb.concordia.ca

Büyükdamgacı, Güldal
Marmara University
Göztepe Campus Kadıköy
Turkey
bdamgaci@eng.marmara.edu.tr

Büyüközkan, Gülçin
Galatasaray University
Çırağan Caddesi No:36 Ortaköy
Turkey
gbuyukozkan@gsu.edu.tr

C

Cabo, Marta
University of Southampton
Highfield Campus Building 54
United Kingdom
m.cabo@maths.soton.ac.uk

Çağlar, Mine
Koç University
Rumelifeneri Yolu Sarıyer
Turkey
mcaglar@ku.edu.tr

Caggiano, Kathryn
UW-Madison School of Business
975 University Ave
United States
kcaggiano@bus.wisc.edu

Cakanyildirim, Metin
University of Texas at Dallas
PO BOX 830688 M/S JO4.7 School of Management
United States
metin@utdallas.edu

Cakici, Kemal
George Washington University
1111 Arlington Blvd. #1001
United States
cakici@gwu.edu

Çakmak, Ahmet
İTÜ İşletme Fakültesi
İşletme Mühendisliği Bölümü Oda No:C202
Maçka
Turkey
cakmakahm@itu.edu.tr

Çakmak, Ulaş
Georgia Tech
326133 Georgia Tech Station
United States
gtg687i@mail.gatech.edu

Caldentey, Rene
NYU
44 West Fourth Street, KMC 8-77
United States
rcaldent@stern.nyu.edu

Çalışkan, Fethullah
TÜSSİDE
Barış Mah. Koşuyolu Cad. No:48 Gebze
Turkey
fcaliskan@tusside.gov.tr

Camci, Alper
University of Central Florida
4000 Central Florida Blvd.
United States
acamci@mail.ucf.edu

Canbolat, Yavuz
Wayne State University
4815 Fourth St., Room #1061
United States
canbolat@wayne.edu

Cangalovic, Mirjana
University of Belgrade
Faculty of Organizational Science
Jove Ilica 154
Serbia and Montenegro
canga@fon.fon.bg.ac.yu

Canos, Maria J.
Universidad de Valencia
Av. Dels Tarongers S/N
Spain
maria.j.canos@uv.es

Cantos, Pedro
Universidad de Valencia
Avda. de los Naranjos, s/n
Spain
pedro.cantos@uv.es

Canıbek, Havva
Marmara University
Ünalan Mah. Filiz Sk. Akkuş Apt. No:13/8
Üsküdar
Turkey
havva_canibek@yahoo.com

Çapar, İsmail
İstanbul Technical University
İTU İşletme Fakültesi
Turkey
caparis@itu.edu.tr

Caprara, Alberto
Universita' di Bologna
Viale Risorgimento, 2
Italy
acaprara@deis.unibo.it

Caramanis, Michael C.
Boston University
406 Mystic Street
United States
mcaraman@bu.edu

Carravilla, Antonia
University of Porto
Rua Dr. Roberto Frias, 378
Portugal
mac@fe.up.pt

Casu, Barbara
University Of Reading
URS Building Whiteknights
United Kingdom
b.casu@reading.ac.uk

Çatay, Bülent
Sabancı University
Tuzla
Turkey
catay@sabanciuniv.edu

Çelikyurt, Uğur
Koç University
Turkey
ucelikyurt@ku.edu.tr

Participant List

Cepek, Ondrej
Charles University
Maloseranske Namesti 25
Czech Republic
ondrej.cepek@mff.cuni.cz

Cerulli, Raffaele
Università di Salerno
Via S. Allende
Italy
raffaele@unisa.it

Çetiner, Selim
METU
Emek Mah. 82. Sokak No:16/2
Turkey
selimcetiner@softhome.net

Çetinkaya, Eda
TÜSSİDE
Barış Mah. Koşuyolu Cad. No: 48 P.K.14
Turkey
ecetinkaya@tusside.gov.tr

Cetinkaya, Sila
Texas A&M University
Zachry Engineering Center
United States
sila@tamu.edu

Chaabane, Djamal
USTHB
Algeria
chaabane_dj@yahoo.fr

Chadwick, David
United Kingdom
d.r.chadwick@gre.ac.uk

Chandra, Pankaj
Indian Institute of Management Ahmedabad
Vastrapur
India
chandra@iimahd.ernet.in

Chandy, Rajesh
University of Minnesota
3-150 Carlson School, 321 19th Ave S
United States
rchandy@csom.umn.edu

Chang, Pao-Long
Feng Chia University
100, Wen-Hwa Rd, Seatwen
Taiwan
paolong@cc.nctu.edu.tw

Chatterjee, Rabikar
University of Pittsburgh
340 Mervis Hall
United States
rabikar@katz.pitt.edu

Chauvet, Fabrice
Bouygues Telecom
10 rue Paul Dautier
France
nicole.cheneaux@tci.tm.fr

Chelst, Kenneth
Wayne State University
4815 Fourth St.
United States
kchelst@wayne.edu

Chen, Bo
University of Warwick
Gibbet Hill Road
United Kingdom
b.chen@warwick.ac.uk

Chen, Victoria
University of Texas at Arlington
500 W. First St. Suite 420 Woolf Hall
United States
vchen@uta.edu

Chevalier, Philippe
Université Catholique de Louvain
Place des Doyens, 1
Belgium
chevalier@poms.ucl.ac.be

Chiang, Jeongwen
National University of Singapore
1 Business Link
Singapore
jwchiang@nus.edu.sg

Chick, Stephen
INSEAD
Boulevard de Constance
France
steve.chick@insead.edu

Chiu, Herng-Chia
Kaoshiung Medical University
100.Shih-Chun 1st Road
Taiwan
chiu@cc.kmu.edu.tw

Choi, Sunmee
Penn State University
201 Mateer Building
United States
sc128@psu.edu

Chong, Juin Kuan
National University of Singapore
1 Business Link, BIZ 2, #04-41
Singapore
bizcjk@nus.edu.sg

Chou, Ying-Chyi
Tunghai Univeristy
181 Taichung-kang Rd, Sec 3,
Taiwan
ycchou@mail.thu.edu.tw

Christiansen, Marielle
Norwegian University of Science and Technology
Norway
marielle.christiansen@iot.ntnu.no

Cilacı, Ayşe
Boğazici University
Selami Ali M. Karakol S. No:3/3 Fıstıkağacı
Üsküdar
Turkey
aysecilaci@yahoo.com

Cileg, Marija
Faculty of Economics
Put M. Pijade 9-11
Serbia and Montenegro
macileg@yahoo.com

Cincotti, Silvano
University of Genoa
Via Opera Pia, 11a
Italy
cincotti@dibe.unige.it

Çınlar, Erhan
Princeton University
Department of Operations Research and Financial Engineering
United States
ecinlar@princeton.edu

Ciric, Zoran
Faculty of Economics Subotica
Put M. Pijada 9-11
Serbia and Montenegro
zotis@tippnet.co.yu

Clark, Alistair
University of the West of England
Frenchay Campus, Coldharbour Lane
United Kingdom
alistair.clark@uwe.ac.uk

Clarke, John-Paul
Massachusetts Institute of Technology
77 Massachusetts Ave 33-314
United States
johnpaul@mit.edu

Cleanthous, Paris
New York University
104 Lake Place, Apt. 203
United States
pcleanth@stern.nyu.edu

Cocks, Graeme
Mt Eliza Business School
Level 3 380 St Kilda Road
Australia
gcocks@mteliza.com.au

Codina, Esteve
Universitat Politècnica de Catalunya
C/ Pau Gargallo, 5
Spain
esteve.codina@upc.es

Coelho, José
CESUR - IST
Av. Rovisco Pais
Portugal
jcoelho@civil.ist.utl.pt

Colak, Selcuk
University of Florida
300 Diamon Village #14
United States
scolak@ufl.edu

Comfort, Louise
University of Pittsburgh
3E30 Wesley W. Posvar Hall
United States
comfort@birch.gspia.pitt.edu

Çomut, Tuncer
Yeditepe University
Sistem Müh. Bölümü
Turkey
cotuncer@yahoo.com

Conesa, David
Universitat de Valencia
C/ Dr. Moliner 50
Spain
david.v.conesa@uv.es

Connolly, Graham
BT
30, Narrow LaneAughton
United Kingdom
graham.r.connolly@bt.com

Consigli, Giorgio
University of Catania
Via Sebastiano del Piombo 21
Italy
giorgio@giorgioconsigli.it

Consiglio, Andrea
Università di Palermo
Facoltà di Economia Viale delle Scienze
Italy
consiglio@unipa.it

Constans, Sophie
INRETS
25 av François Mitterrand
Bron
France
sophie.constans@inrets.fr

Constantino, Miguel
University of Lisbon
Bloco C2Cidade UniversitariaCampo Grande
Portugal
miguel.constantino@fc.ul.pt

Conti, Pier Luigi
Università degli Studi di Roma "La Sapienza"
P.le Aldo Moro, 5
Italy
pierluigi.conti@uniroma1.it

Cooper, Keith
University of Southampton
University Road Highfield
United Kingdom
kc@soton.ac.uk

Corbacioglu, Umut
Erasmus University Rotterdam
Burg.Oudlaan 50
Netherlands
ucorbacioglu@fbk.eur.nl

Corberan, Angel
Universidad de Valencia
Avda. Dr. Moliner, 50
Spain
angel.corberan@uv.es

Cortazar, Gonzalo
Universidad Catolica de Chile
Lo Beltran 2512
Chile
gcortaza@ing.puc.cl

Coslovich, Luca
University of Trieste
Via A. Valerio, 10
Italy
coslovic@units.it

Crainic, Teodor Gabriel
V.Q.A.M
315, rue Sainte-Catherine Est Local R-3570
Canada
theo@crt.umontreal.ca

Crama, Pascale
London Business School
Regent's Park
United Kingdom
pcrama@london.edu

Crama, Yves
University of Liège
Boulevard du Rectorat 7 (B31)
Belgium
y.crama@ulg.ac.be

Cristianini, Nello
UC Davis
Kerr Hall,UC Davis
United States
nello@wald.ucdavis.edu

Croll, Grenville
Arthur Andersen
United Kingdom
grenville@croll-management.freeserve.co.uk

Cubbin, John
City University
Northampton Square
United Kingdom
j.s.cubbin@city.ac.uk

Culioli, Jean-Christophe
Air France
1, Avenue du Maréchal Devaux
France
jcculioli@airfrance.fr

Cunha, Maria
University of Coimbra
Dep. Eng. Civil, Poloii-pinhal De Marrocos
Portugal
mccunha@dec.uc.pt

Çınar, Esra
Boğaziçi University
Bebek
Turkey
cinare@boun.edu.tr

D

D'Ecclesia, Rita
Università degli Studi di Roma "La Sapienza"
Piazza Aldo Moro 5
Italy
ritadec@uniurb.it

Dalkıran, Evrim
Boğaziçi University
Bebek
Turkey
dalkiran@boun.edu.tr

Dasci, Abdullah
University of Alberta
Room 3-23 Business Building
Canada
adasci@ualberta.ca

Daskalaki, Sophia
University of Patras
Greece
sdask@upatras.gr

Daskin, Mark
Northwestern University
Dept. of IE/MS
2145 Sheridan Rd.
United States
m.daskin@northwestern.edu

Davidovic, Tatjana
Serbian Academy of Sciences and Art
Knez-Mihailova 35
Serbia and Montenegro
tanjad@mi.sanu.ac.yu

Davies, Ruth
University of Southampton
School of Management
Highfield
United Kingdom
rmd@socsci.soton.ac.uk

Davis, Miles
Shenadoah University
1460 University Drive
United States
mdavi3@su.edu

Dawudu, Olusanya Adebayo
Discovery International Limited
35 Maye Street Sabo
Nigeria
bayufit@yahoo.com

Daysal, Sinem
Boğaziçi University
Bebek
Turkey
sinem_daysal@hotmail.com

De Frutos, Javier
Universidad de Valladolid
Prado de la Magdalena sn
Spain
javier.defrutos@gerad.ca

Participant List

De Koster, René
Erasmus University Rotterdam
Burg. Oudlaan 50
Netherlands
rkoster@fbk.eur.nl

De Leone, Renato
Univ. Camerino
Via Madonna Delle Carceri 9
Italy
renato.deleone@unicam.it

De Loor, Pierre
E.N.I.B.
CS 73 862
France
deloor@enib.fr

De Reyck, Bert
London Business School
United Kingdom
bdereyck@london.edu

De Schuymer, Bart
Ghent University
Krijgslaan 281 (S9)
Belgium
bart.deschuymer@rug.ac.be

De Smet, Yves
Université Libre de Bruxelles
Boulevard du Triomphe CP 210-01
Belgium
ydesmet@smg.ulb.ac.be

De Smidt-Destombes, Karin
TNO Physics and Electronics Laboratory
Oude Waalsdorperweg 63 PO Box 96864
Netherlands
desmidt@fel.tno.nl

De Tombe, Dorien
Operational Research Euro Working Group
Netherlands
detombe@lri.jur.uva.nl

De Vericourt, Francis
Duke University
Fuqua School of Business
One Towerview Rd Durham
United States
fdv1@duke.edu

De Werra, Dominique
Institut de Mathématiques
École Polytechnique Fédérale de Lausanne
CH-1015 Lausanne
Switzerland

Debels, Dieter
Ghent University
Hoveniersberg 24
Belgium
dieter.debels@rug.ac.be

Dekker, Rommert
Erasmus University Rotterdam
P.O.Box 1738
Netherlands
rdekker@few.eur.nl

Delen, Dursun
Oklahoma State University
4400 W. Jackson St.
United States
delen@okstate.edu

Delesie, Lucas
Katholieke Universiteit Leuven
Kapucynenvoer 35
Belgium
luc.delesie@med.kuleuven.ac.be

Dell'Olmo, Paolo
University of Rome
P.le Aldo Moro 5
Italy
paolo.dellolmo@uniroma1.it

Della Croce, Federico
Politecnico di Torino
Corso Duca degli Abruzzi 24
Italy
federico.dellacroce@polito.it

Deme, Roland
Eötvös Lóránd University
Faculty of Science
Pázmány Péter sétány 1/c
Hungary
demeroland@freemail.hu

Demeulemeester, Erik
Katholieke Universiteit Leuven
Naamsestraat 69
Belgium
erik.demeulemeester@econ.kuleuven.ac.be

Demirel, Omer
King Fahd University
KFUPM Systems Engineering Dept.
Saudi Arabia
odemirel@ccse.kfupm.edu.sa

Deng, Shijie
Georgia Institute of Technology
765 Ferst Drive
United States
deng@isye.gatech.edu

Dengiz, Berna
Gazi Üniversitesi
Celal Bayar Bulvarı
Turkey
berna@mmf.gazi.edu.tr

Dengiz, Orhan
Auburn University
207 Dunstan Hall
United States
dengior@auburn.edu

Denizel, Meltem
Sabancı University
Orhanlı Tuzla
Turkey
denizel@sabanciuniv.edu

Despotis, Dimitris
University of Piraeus
80 Karaoli & Dimitriou Street
Greece
despotis@unipi.gr

Detti, Paolo
University of Siena
Via Roma 56
Italy
detti@dii.unisi.it

Dew, Kurt
Işık University
Büyükdere Cd. Ayazağa Maslak
Turkey
kdew@isikun.edu.tr

Dewhurst, Frank
UMIST
PO Box 88 Sackville Street
United Kingdom
frank.dewhurst@umist.ac.uk

Dexheimer, Leticia
Instituto Militar de Engenharia
Brazil
imes2ld@epq.ime.eb.br

Di Martinelly, Chrsitine
FUCAM
Chaussee de Binche 151
Belgium
dimartinelly@fucam.ac.be

Diakoulaki, Danae
National Technical University of Athens
Zografou Campus
Greece
diak@chemeng.ntua.gr

Diegel, Adolf
Cutline Research
66 Edmonds Rd
South Africa
cutworks7@iafrica.com

Diegel, Olaf
Massey University
Bldg 38, Oteha Rohe Campus, Albany
New Zealand
o.diegel@massey.ac.nz

Dimopoulou, Maria
Athens University of Economics and Bus.
76 PATISSION Str.
Greece
dimop@aueb.gr

Dimov, Dimo
London Business School
Sussex Place Regent's Park
United Kingdom
ddimov@london.edu

Dink, Delal
Purdue University
Chemical Eng. Bldg. 480 Stadium Mall Dr
United States
ddink@ecn.purdue.edu

Disney, Stephen
Cardiff Business School

Aberconway Building Colum Drive
United States
disneysm@cardiff.ac.uk

Djurisic, Miladin
INFORMS
Pfaendwiesenstr 9
Switzerland
miladin00@yahoo.com

Dlouhy, Martin
University Of Economics Prague
W. Churchill Sq. 4
Czech Republic
dlouhy@vse.cz

Doğan, İbrahim
İstanbul Technical University
İşletme Fakültesi Endüstri Mühendisliği Bölümü
Maçka/İstanbul
Turkey
doganibra@itu.edu.tr

Dodin, Bajis
University of California
AGSM
United States
bajis.dodin@ucr.edu

Dogan, Koray
I2 Technologies
37 Revere St #7
United States
koray_dogan@i2.com

Doğanoğlu, Toker
University of Kiel
Olshausenstr. 40
Germany
toker@stat-econ.uni-kiel.de

Doğramacı, Ali
Bilkent University
Turkey
rector@bilkent.edu.tr

Doherty, Mark
INFORMS
901 Elkridge Landing Road, Suite 400
United States
mark.doherty@informs.org

Donati, Alberto V.
IDSIA
Galleria 2
Switzerland
alberto@idsia.ch

Doraszelski, Ulrich
Stanford University
969 Clark Way
United States
doraszelski@hoover.stanford.edu

Doumpos, Michael
Techn. University of Crete
University Campus
Greece
mdoumpos@dpem.tuc.gr

Doyle, E. Kevin
Bruce Power Inc.
PO Bag 3000 (B06)
Canada
kevin.doyle@brucepower.com

Draganska, Michaela
Stanford University
518 Memorial Way Stanford, CA 94305
United States
draganska_michaela@gsb.stanford.edu

Drakulic, Mirjana
Faculty of Organizational Sciences
Jove Ilica 154
Serbia and Montenegro
mirjanad@fon.fon.bg.ac.yu

Drakulic, Ratimir
University of Belgrade
Faculty of Organizational Sciences
Jove Ilica 154
Serbia and Montenegro
drakula@fon.fon.bg.ac.yu

Drozdowski, Maciej
Poznan University of Tehcnology
Institute of Computing Science
Piotrowo 3A
Poland
maciej.drozdowski@cs.put.poznan.pl

Druckman, Daniel
George Mason University and
Sabancı University
10509 Gainsborough RD
United States
ddruckma@gmu.edu

Duer, Mirjam
Technische Universität Darmstadt
Schlossgartenstr. 7
Germany
duer@mathematik.tu-darmstadt.de

Dullaert, Wout
University of Antwerp
Prinstraat 13
Belgium
wout.dullaert@ua.ac.be

Duman, Ekrem
Doğuş University
Acıbadem, Zeamet Sk.
Turkey
eduman@dogus.edu.tr

Durusüt, Erhan
Boğaziçi University
Bebek
Turkey
durusute@boun.edu.tr

Dutta, Amitava
George Mason University
4400 University Drive
United States
adutta@som.gmu.edu

Dutta, Goutam
I.I.M
Production and Quantitative Methods Area
Wing 3, PMQ Area, Vastrapur, Ahmedabad
India
goutam@iimahd.ernet.in

Dündar, Selim
Yıldız Technical University
Beşiktaş
Turkey
selim@1907unifeb.org

Dyner, Isaac
Universidad Nacional de Colombia
AA 1027
Colombia
idyner@unalmed.edu.co

E

Eben-Chaime, Moshe
Ben-Gurion University of the Negev
P.O. Box 653 84105 Beer-Sheva
Israel
even@bgumail.bgu.ac.il

Edis, Emrah
Dokuz Eylül University
8050 Sok. No: 139/4 Egekent Çiğli
Turkey
emrah.edis@deu.edu.tr

Edvardsen, Dag Fjeld
NBI
Skogerveien 32
Norway
dfe@byggforsk.no

Eglese, Richard
Lancaster University
Department of Management Science
United Kingdom
r.eglese@lancaster.ac.uk

Ehrgott, Matthias
University of Auckland
Private Bag 92019
New Zealand
m.ehrgott@auckland.ac.nz

Eisenbrand, Friedrich
MPI-Informatik
Stuhlsatzenhausweg 85
Germany
eisen@mpi-sb.mpg.de

Eker, Mehmet
Karadeniz Technical University
Faculty of Forestry
Turkey
meker@ktu.edu.tr

Ekim, Tınaz
EPFL
FSB-IMA MA-Ecublenc
Switzerland
tinaz.ekim@epfl.ch

Participant List

Ekin, Serap
İstanbul Bilgi Üniversitesi
İnönü Cd. No:28 Kuştepe Şişli
Turkey
ekin@bilgi.edu.tr

Ekin-Karasan, Oya
Bilkent University
Dept. of Industrial Engineering, Bilkent
Turkey
karasan@bilkent.edu.tr

Ekinci, Esra
İzmir Yüksek Teknoloji Enstitüsü
Gaziosmanpaşa Bul. No:16
Turkey
esraekinci@iyte.edu.tr

Ekşim, Ali
Koç University
Resitpaşa C. Dadaloğlu S.
Gözdeler St. No:78 D:50 Ümraniye
Turkey
aeksim@ku.edu.tr

El-Darzi, Elia
University of Westminster
Harrow School of Computer Science
Watford Rd. Northwick Park
United Kingdom
eldarze@westminster.ac.uk

Elder, Mark
University of Strathclyde
United Kingdom
mark.e@simul8.com

Elimam, Abdelghani
San Francisco State University
1600 Holloway Ave.
United States
aelimam@sfsu.edu

Elmaghraby, Wedad
Georgia Tech
765 Ferst Dr.
United States
wedad@isye.gatech.edu

Emanet, Nahit
Boğaziçi University
Turkey
emanetn@boun.edu.tr

Emek, Evren
Bilkent University
Turkey
evrene@bilkent.edu.tr

Enserink, Bert
Delft University of Technology
P.O. Box 5015
Netherlands
b.enserink@tbm.tudelft.nl

Erdem, Tulin
Haas School of Business
S545 Student Services Building #1900
United States
erdem@haas.berkeley.edu

Erdem Sencer, Aslı
Boğaziçi University
Hisar Campus, Bebek
Turkey
erdemas@boun.edu.tr

Erdoğan, Güneş
Bilkent Üniversitesi
Araştırma Görevlisi Lojmanları No:79/23
Turkey
egunes@bilkent.edu.tr

Erdoğmuş, Pakize
Atatürk University
Turkey
besir@rocketmail.com

Erel, Erdal
Bilkent University
Turkey
erel@bilkent.edu.tr

Eren, Cihat
Ford-Otosan
Turkey

Eren, Serkan Sinan
Columbia University
Uris Hall 4R, 3022 Broadway
United States
se2027@columbia.edu

Ergun, Ozlem
Georgia Tech
765 Ferst Drive Atlanta, GA
United States
oergun@isye.gatech.edu

Ergün, Kadriye
Balıkesir University
Dept. of Industrial Eng. Cagis Campus
Turkey
kergun@balikesir.edu.tr

Erhun, Feryal
Stanford University
Terman Engineering Center Room 305
United States
ferhun@stanford.edu

Eriş, S. Bülent
Marmara University Engineering Faculty
Yapı Kredi Emeklilik A.S.
Turkey
sbulenteris@yahoo.com

Erkan, Hafize
Princeton University
Engineering Quadrangle
United States
herkan@princeton.edu

Erkanli, Al
Duke University Medical Center
Box 3454
United States
al@psych.mc.duke.edu

Erkilic, Sabriye Sibel
Wichita State University
1845 Fairmount
United States
sibelerkilic@yahoo.com

Erkip, Nesim
METU
İnönü Bulvarı
Turkey
erkipn@metu.edu.tr

Erkut, Erhan
University of Alberta
Canada
erhan.erkut@ualberta.ca

Ertek, Gürdal
Sabancı University
Orhanlı, Tuzla
Turkey
ertekg@sabanciuniv.edu

Ertogral, Kadir
King Fahd University
Box 1420
Saudi Arabia
ertogral@ccse.kfupm.edu.sa

Escudaro, Laureano
Universidad Miguel Hernandez
Avda. Del Ferrocarril
Spain
president@euro-online.org

Escudero, Laureano Fernando
Universidad Miguel Hernández
Ave. del Ferrocarril, Ed. TorreTamarit
Spain
escudero@umh.es

Esenduran, Gökçe
Boğaziçi University
Bebek
Turkey
esendura@boun.edu.tr

Eskigun, Erdem
General Motors R&D
30500 Mound Rd.Mail Code: 480-106-359
United States
erdem.eskigun@gm.com

Esmer, Özcan
METU
İnönü Bulvarı
Turkey
esmer@arch.metu.edu.tr

Essegaier, Skander
New York University
44 West 4th Street, Suite 9-76
United States
sessegai@stern.nyu.edu

Esswein, Carl
University of Tours
Computer Science Laboratory
64, Av. Jean Portalis
France
carl.esswein@etu.univ-tours.fr

Evans, Joanne
University of Hull
Cottingham Road
United Kingdom
j.e.evans@hull.ac.uk

Eveborn, Patrik
Linköping University
Sweden
paeve@mai.liu.se

Everett, Jim
University of Western Australia
Stirling Highway
Australia
jeverett@ecel.uwa.edu.au

Evranuz, Çetin
Elginkan Holding
Turkey

Eymer, Burkhart
Leipzig Graduate School of Management
Jahnallee 69
Germany
burkhart.eymer@hhl.de

Ezechukwu, Obinna
Imperial College London
180 Queen's Gate, South Kensington
United Kingdom
oce@doc.ic.ac.uk

F

F. Vaz, A. Ismael
Universidade do Minho
Escola de Engenharia Campus de Gualtar
Portugal
aivaz@dps.uminho.pt

Fadıloğlu, Murat
Bilkent University
Dept. of Industrial Engineering
Turkey
mmurat@bilkent.edu.tr

Falbo, Paolo
University of Brescia
C. da Santa Chiara 50
Italy
falbo@eco.unibs.it

Falk, James
Boğaziçi University
Bebek
Turkey
falk@boun.edu.tr

Fang, Weiwu
Chinese Academy of Sciences
Box 2734 Zhong GuanCun Beijing
China
fangww@amss.ac.cn

Farsijani, Hassan
Shahid Beheshti University
Iran
farsijani@ikido.org

Fathali, Jafar
Vakil-abad Bolevar
Iran
fathali@math.um.ac.ir

Fausten, Dietrich
Monash University
Wellington Road, Victoria
Australia
dietrich.fausten@buseco.monash.edu.au

Feglar, Tomas
Academy of Sciences of the Czech Republic
Vondrousova 1199
Czech Republic
feglar@seznam.cz

Feillet, Dominique
Université d'Avignon
339, Chemin des Meinajariés Agroparc BP 1228
France
dominique.feillet@lia.univ-avignon.fr

Feki, Rochdi
Sfax Graduate Business School
Route de l'aérodrome BP 1081,
Tunisia
rochdi.feki@escs.rnu.tn

Feremans, Corinne
Universiteit Maastricht
FdEWB-KE P.O. Box 616
Netherlands
c.feremans@ke.unimaas.nl

Fernandes, Edite
Universidade do Minho
Campus de Gualtar
Portugal
emgpf@dps.uminho.pt

Fernandes, Gabriela
Universidade de Minho
Camila Gomes Leite
L. S. Miguel - Figueiredo
Portugal
g.fernandes@madeicado.pt

Fernandez, Jose
Universidad de Murcia
Facultad de Matemáticas
Campus de Espinardo
Spain
majose@um.es

Ferreira, Fátima
CEMAT
A/C António Pacheco
Portugal
mmferrei@utad.pt

Ferreira, José Soeiro
Universidade do Porto
Portugal
jsoeiro@fe.up.pt

Festa, Paola
Università di Napoli "Federico II"
Compl. MSA Via Cintia
Italy
paola.festa@unina.it

Fethi, Meryem Duygun
University of Leicester
University Road
United Kingdom
m.fethi@le.ac.uk

Feyzioğlu, Orhan
Galatasaray University
Çırağan Caddesi No:36 Ortaköy
Turkey
ofeyzioglu@gsu.edu.tr

Fiala, Petr
University of Economics
W. Churchill Sq. 4
Czech Republic
pfiala@vse.cz

Figueira, José
University of Coimbra, INESC
Av. Dias da Silva, 165
Portugal
figueira@dimacs.rutgers.edu

Filar, Jerzy
Australia
jerzy.filar@unisa.edu.au

Finger, Shai
Ben-Gurion University of the Negev
8 Bardichevsky St. Apt. 2
Israel
shaif@bgumail.bgu.ac.il

Fischetti, Matteo
University of Padova
V. Gradenigo 6/a
Italy
matteo.fischetti@unipd.it

Fiş, Ahmet Murat
Sabancı University
Orhanlı, Tuzla
Turkey
mfis@su.sabanciuniv.edu

Flapper, Simme Douwe
Technische Universiteit Eindhoven
Den Dolech 2
Netherlands
s.d.p.flapper@tm.tue.nl

Flitman, Andrew
Monash University
Australia
andy.flitman@infotech.monash.edu.au

Flynn, James
Cleveland State University
1801 E 12 Street APT 1007
United States
j.flynn@csuohio.edu

Forman, Howard
Drexel University
32nd and Market Streets Matheson, 501E
United States
hf26@drexel.edu

Participant List

Fortz, Bernard
Université Catholique de Louvain
Place des Doyens 1
Belgium
fortz@poms.ucl.ac.be

Fourer, Robert
Northwestern University
2521 Sheridan Rd
United States
4er@iems.nwu.edu

Francis, Richard
United States
francis@ise.ufl.edu

Frangioni, Antonio
Università di Pisa
Via Buonarroti, 2
Italy
frangio@di.unipi.it

Freeman, James
UMIST
PO Box 88
United Kingdom
jim.freeman@umist.ac.uk

Frick, Lynette
University of Exeter
Laver Building, North Park Road,
United Kingdom
l.frick@exeter.ac.uk

Friedman, Lea
Ben Gurion University of the Negev
Israel
leaf@bgumail.bgu.ac.il

Friedrich, Bernhard
University Hannover
Appelstr. 9A
Germany
friedrich@ivh.uni-hannover.de

Fu, Michael
University of Maryland
Smith School of Business Van Munching Hall
United States
mfu@rhsmith.umd.edu

Fuertes, Ariadna
University of Valencia
Poligono de la Coma s/n
Apartado de Correos 2085
Spain
ariadna.fuertes@uv.es

Fujita, Toshiharu
Kyushu Institute of Technology
1-1 Sensui-cho, Tobata-ku
Japan
fujita@comp.kyutech.ac.jp

Förster, Alexander
Otto-von-Guericke-Universität Magdeburg
Germany
alexander.foerster@ww.uni-magdeburg.de

Førsund, Finn R
Oslo University
Box 1095
Norway
f.r.forsund@econ.uio.no

G

Gaivoronski, Alexei
NTNU
Alfred Getz vei 1
Norway
alexei.gaivoronski@iot.ntnu.no

Gal, Shmuel
University of Haifa
Aba Hushi
Israel
sgal@univ.haifa.ac.il

Gallien, Jeremie
Massachusetts Institute of Technology
United States
jgallien@mit.edu

Galvao, Roberto
COPPE/Federal University of Rio de Janei
Rua Igarapava 103 Apt. 201 (Leblon)
Brazil
galvao@novanet.com.br

Gandibleux, Xavier
Universite de Valenciennes
Campus "Le Mont Houy"
France
secretary@euro-online.org

Garcia, Ricardo
Universidad de Castilla la Mancha
Plaza Manuel Meca Almaden Ciudad Real
Spain
ricardo.garcia@uclm.es

Garcia Marquez, Fausto Pedro
Universidad de Castilla-La Mancha
ETSIIEdificio Politécnica
Campus Universitario s/n
Spain
faustopedro.garcia@uclm.es

Garín, M. Araceli
Fac. CC. EE. y Empresariales Avd. Lehemdakari
Aguirre 83
Spain
etpgamaa@bs.ehu.es

Gavish, Bezalel
Southern Methodist University
United States
gavishb@charter.net

Gehring, Hermann
University of Hagen
Profilstrasse 8
Germany
hermann.gehring@fernuni-hagen.de

Gel, Esma
Arizona State University
United States
esma.gel@asu.edu

Geldermann, Jutta
University of Karlsruhe (TH)
Hertzstr. 16
Germany
jutta.geldermann@wiwi.uni-karlsruhe.de

Gelenbe, Erol
University of Central Florida
4000 Central Florida Blvd., CSB 201
United States
erol@cs.ucf.edu

Gendreau, Michel
Université de Montréal
Pavillon Andre-Aisenstadt 2920 Chemin de
LAtour,Bureau 3520
Canada
michelg@crt.umontreal.ca

Gentile, Claudio
IASI-CNR
Viale Manzoni, 30
Italy
gentile@iasi.rm.cnr.it

Gentile, Guido
Università degli Studi di Roma "La Sapienza"
Via Eudossiana 18
Italy
guido.gentile@uniroma1.it

Gentili, Monica
University of Salerno
Via S.Allende, Baronissi
Italy
monica.gentili@uniroma1.it

Gerchak, Yigal
Tel-Aviv University
Ramat-Aviv
Israel
ygerchak@eng.tau.ac.il

Gerontidis, Ioannis
Technological Institute of Kavala
Agios Loukas
Greece
igeront@teikav.edu.gr

Gerstner, Eitan
UC Davis
807 Falcon Avenue
United States
egerstner@ucdavis.edu

Gezdur, Arda
Koç University
Rumelifeneri Yolu 34450 Sarıyer
Turkey
agezdur@ku.edu.tr

Ghosh, Soumyadip
Cornell University
301 Maple Ave, apt H4
United States
sdghosh@orie.cornell.edu

Giacometti, Rosella
University of Bergamo
Via dei Caniana 2
Italy
rosella.giacometti@unibg.it

Gil, Dalia
University of Central Florida
P.O. Box 162450
United States
dgil@mail.ucf.edu

Gilles, Roland
RWTH Aachen
Templergraben 64
Germany
gilles@lut.rwth-aachen.de

Giner, Vicent
Universidad Politecnica de Valencia
Caminero de Vera S/N
Spain
vigibos@eio.upv.es

Gines, Miguel
Universitat Jaume I
Campus Riu Sec
Spain
mgines@eco.uji.es

Gintner, Vitali
University of Paderborn
Warburgerstr. 100
Germany
vitali@upb.de

Giordani, Stefano
University of Rome "Tor Vergata"
Via del Politecnico, 1
Italy
giordani@disp.uniroma2.it

Glass, Celia
City University London
106 Bunhill Row
United Kingdom
c.a.glass@city.ac.uk

Glazebrook, Kevin
University of Edinburg
William Robertson Building,50, George Square
United Kingdom
kevin.glazebrook@ed.ac.uk

Glickman, Ted
George Washington University
4706 Hunt Ave
United States
glickman@gwu.edu

Godart, Jean-Marc
Polytechnic Faculty of Mons
9, rue de Houdain
Belgium
jean-marc@godart.net

Goetschalckx, Marc
Georgia Institute of Technology
765 Ferst Drive
United States
marc.goetschalckx@isye.gatech.edu

Goffin, Jean-Louis
McGill University
1001 Sherbrooke St. West, Rm 454
Canada
jean-louis.goffin@mcgill.ca

Gokce, Mahmut Ali
North Carolina State University
2512 Avent Ferry Rd. Apt:101
United States
magokce@unity.ncsu.edu

Golany, Boaz
Technion
Technion City
Israel
golany@ie.technion.ac.il

Goldbarg, Elizabeth
Universidade Federal Do Rio Grande Do Nova
Campus Universitário Lagoa Nova
Brazil
bgouvea@ufrnet.br

Goldsman, David
Georgia Tech
School of ISYE
United States
sman@isye.gatech.edu

Goletsis, Yorgos
University of Ioannina
University Campus P.O. Box 1186
Greece
goletsis@cc.uoi.gr

Gomes, A. Miguel
FEUP / INESC Porto
Rua Dr. Roberto Frias, s/n NIF 600027716
Portugal
agomes@fe.up.pt

González, Beatriz
University of Oviedo
Campus de Viesques Edificio de Energía
Spain
beatrizgt@etsiig.uniovi.es

González-Pachón, Jacinto
Technical University of Madrid
Campus de Montegancedo s/n
Spain
jgpachon@fi.upm.es

Gordon, Valery
National Academy of Sciences of Belarus
Surgenova 6
Belarus
gordon@newman.bas-net.by

Gören, Selçuk
Bilkent University
Rektörlük Binası No:EA330
Turkey
goren@bilkent.edu.tr

Gotzamani, Katerina
University of Macedonia
University of Macedonia Egnatia 156
Greece
kgotza@uom.gr

Graasvoll, Ottar
Norwegian Defence Research Establishment
P O BOX 25
Norway
ogr@ffi.no

Gramani, Maria Cristina Nogueira
Mackenzie University
Rua da Consolacao, 896-prédio 06
Brazil
gramani@mackenzie.com.br

Green, Richard
University of Hull
Business School
United Kingdom
r.j.green@hull.ac.uk

Grispolakis, Joachim
Technical University of Crete
University Campus
Greece
mgrysp@science.tuc.gr

Grossman, Thomas
University of Calgary
Canada
thomas.grossman@haskayne.ucalgary.ca

Gruenert, Tore
RWTH Aachen
Templergraben 64
Germany
tore@or.rwth-aachen.de

Grunow, Martin
Technische Universität Berlin
WIL-B-1-1 Wilmersdorfer Str. 148
Germany
m.grunow@ww.tu-berlin.de

Guerra, Maria Letizia
University of Urbino Faculty of Economic
Via Saffi, 42
Italy
letizia@uniurb.it

Guessow, Jens
University of St. Gallen
IfU-HSG Holzstrasse 15
Switzerland
jens.guessow@unisg.ch

Guide, Jr., V. Daniel R.
The Pennsylvania State University
United States
dguide@psu.edu

Guirchoun, Samuel
Ecole Polytechnique de l'Université de Tours
Computer Science Department
64, Av Jean Portalis
France
samuel.guirchoun@et.univ-tours.fr

Guler, Osman
UMBC
1000 Hilltop Circle

United States
guler@math.umbc.edu

Gulledge, Thomas
George Mason University
4400 University Drive, Virginia
United States
gulledge@gmu.edu

Gülüt, Cüneyd
Akademi Consulting
Erenköy Istasyon Cad. Derya Ap. No:40/3 D:
4 Erenköy
Turkey
cgulut@akademiconsulting.com

Gumus, Zeynep
Princeton University
United States
zeynep@titan.princeton.edu

Gunal, Murat
Lancaster University
Management School, Bailrigg
United Kingdom
m.gunal@lancaster.ac.uk

Gunes, Evrim
INSEAD
Bvd de Constance
France
evrim-didem.gunes@insead.edu

Gunluk, Oktay
IBM Research
United States
gunluk@us.ibm.com

Gurbuz, Mustafa Cagri
University of Washington
Mackenzie Hall PO Box 353200
United States
mgurbuz@u.washington.edu

Gurkan, Gul
Tilburg University
Warandelaan 2 PO. Box 90153
Netherlands
ggurkan@uvt.nl

Gurses, Ayse
University of Wisconsin-Madison
2121 University Avenue, Apt#16
United States
apgurses@students.wisc.edu

Gurtuna, Ozgur
Concordia University / Futuraspace
331 Clarke Av. Apt 16.
Canada
gurtuna@futuraspace.com

Gurvich, Vladimir
Rutgers University
640 Bartolomew Rd.
United States
gurvich@rutcor.rutgers.edu

Gvozdenovic, Nebojsa
University of Novi Sad
Ive Andrica 20
Serbia and Montenegro
mrmot@eccf.su.ac.yu

Güllü, Refik
METU
Turkey
gullu@ie.metu.edu.tr

Gültekin, Hakan
Bilkent Üniversitesi
Rektörlük Binası EA330
Turkey
ghakan@bilkent.edu.tr

Gümüş, Mehmet
Turkish Navy
Deniz Kuvvetleri Komutanlığı
Personel Başkanlığı TKY EGT SB
Bakanlıklar
Turkey
mehmet_gum@gmx.net

Gümüştaş, Emre
Boğaziçi University
Bebek
Turkey
gumustas@boun.edu.tr

Güneralp, Burak
University of Illinois at Urbana-Champai
1102 S. Goodwin Ave. W-503 Turner Hall
United States
guneralp@uiuc.edu

Günther, Hans-Otto
Technische Universität Berlin
Wilmersdorfer Str. 148
Germany
ho.guenther@pm-berlin.net

Gürel, Sinan
Bilkent Üniversitesi
Rektörlük Binası Kat:3
Turkey
sgurel@bilkent.edu.tr

Gürler, Ülkü
Bilkent University
Dept. of Industrial Engineering
Turkey
ulku@bilkent.edu.tr

Gürsoy, Kemal
Long Island University
United States
kemal.gursoy@liu.edu

Güzel, Ali
Kırıkkale University
Kurtuluş Mahallesi Dağ Sokak No:1 Elmadağ
Turkey
aliguzel@hotmail.com

Gönül, M. Sinan
Bilkent University
Faculty of Business Administration
Turkey
msinan@bilkent.edu.tr

H

Haasis, Hans-Dietrich
ISL, University of Bremen
Wilhelm-Herbst-Str. 12
Germany
haasis@isl.org

Habenicht, Walter
University of Hohenheim
Lehrstuhl fuer Industriebetriebslehre(510A)
Germany
habenich@uni-hohenheim.de

Hachicha, Ridha
ISCAE
Manouba Tunis
Tunisia
ridha.hachicha@iscae.rnu.tn

Hachmi, Khabab
King Saud University
P.O.Box 62830
Saudi Arabia
khabbab@hachimi.net

Hadad, Yossi
Negev Academic College of Engineering
71 Basel St. P.O.B 45
Israel
yossi@mace.ac.il

Hafeez, Khalid
Sheffield Hallam University
Howard street city campuss1 1wb
United Kingdom
k.hafeez@shu.ac.uk

Hafstein, Sigurdur F.
University of Duisburg-Essen
Lotharstr. 1
Germany
hafstein@traffic.uni-duisburg.de

Hahn, Eugene
Salisbury University
1101 Camden Ave.
United States
edhahn@salisbury.edu

Hahn, Peter
University of Pennsylvania
Room 278, Towne Building 220 South 33rd
Street
United States
hahn@seas.upenn.edu

Haksever, Cengiz
Rider University
2083 Lawrenceville Rd.
United States
haksever@rider.edu

Haktanırlar, Berna
Osmangazi University
Endüstri Müh.Böl.
Turkey
bhaktan@ogu.edu.tr

Hamacher, Horst

University of Kaiserslautern
Germany
hamacher@mathematik.uni-kl.de

Hammar, Mikael
University of Salerno
Dipartimento di Informatica ed Applicazioni
Baronissi (SA) 84081
Italy
hammar@dia.unisa.it

Hammer, Peter
Rutgers University
640 Bartholomew Road
United States
hammer@rutcor.rutgers.edu

Hans, Erwin
University of Twente
Drienerlolaan 5
Netherlands
e.w.hans@utwente.nl

Hansen, Karsten
Northwestern University
646 West Barry, 2F
United States
karsten-hansen@northwestern.edu

Hansen, Mark
UC Berkeley
5010 Nevin Ave
United States
hansen@ce.berkeley.edu

Hansen, Michael P.
Technical University of Denmark
Belgium
mph@imm.dtu.dk

Hansen, Zeynep
Washington University in St. Louis
Campus Box 1133 One Brookings Dr.
United States
hansen@olin.wustl.edu

Haouari, Mohamed
Ecole Polytechnique de Tunisie
Laboratory of Mathematical Engineering BP
743 La Marsa
Tunisia
mohamed.haouari@ept.rnu.tn

Harmantzis, Fotios
Stevens Tech
Castle Point on the Hudson
United States
fharmant@stevens-tech.edu

Harper, Paul
University of Southampton
Highfield
United Kingdom
p.r.harper@maths.soton.ac.uk

Haruna, Shaibu
Fredstino Ventures Limited
P.O.BOX 5406 ACC-NTH
Ghana
papring1@yahoo.com

Hasköse, Ahmet
Kırıkkale University
Dept. of Business Administration
Turkey
haskose@hotmail.com

Hasle, Geir
SINTEF Applied Mathematics
P.O. Box 124 Blindern
Norway
geir.hasle@sintef.no

Hassan, Nazar
University of Massachusetts-Amherst
E-LAB Building 220
United States
nhassan@ecs.umass.edu

Haus, Utz-Uwe
Otto-von-Guericke-University Magdeburg
FMA-IMO Universitätsplatz 2
Germany
haus@mail.math.uni-magdeburg.de

Hayya, Jack
Penn State University
303 Beam Bldg.
OTHER
jch@psu.edu

Heemskerk, Linda
University of Amsterdam
P/a HJ van der Sluis Roetersstraat 11
Netherlands
h.j.vandersluis@uva.nl

Held, Stephan
University of Bonn
Lennestr. 2
Germany
held@or.uni-bonn.de

Hellermann, Rolf
WHU, Otto Beisheim Graduate School
Burgplatz 2
Germany
rolf.hellermann@whu.edu

Henig, Mordecai
Tel Aviv University
Ramat aviv
Israel
henig@post.tau.ac.il

Hepdurluk, Murat
BRISA
Bridgestone Sabancı Lastik San. ve Tic. A.S.
Turkey

Heragu, Sunderesh
Rensselaer Polytechnic Institute
DSES Dept., CII 5129 R P I 110, Eighth St.
United States
herags@rpi.edu

Herer, Yale
Technion - Israel Institute of Technology
Israel
yale@technion.ac.il

Herroelen, Willy
Katholieke Universiteit Leuven
Naamsestraat 69
Belgium
willy.herroelen@econ.kuleuven.ac.be

Heukamp, Franz
IESE Business School
Av. Pearson 21
Spain
fheukamp@iese.edu

Hiele, Rachel
Delft University of Technology
Weidezoom 7
Netherlands
rachelhiele@hotmail.com

Higgins, Andrew
CSIRO Sustainable Ecosystems
120 Meiers Road
Australia
andrew.higgins@csiro.au

Hildebrandt, Lutz
Humboldt-Universität zu Berlin
Spandauer Str. 1
Germany
hildebr@wiwi.hu-berlin.de

Hindi, Khalil
AUB
P.O.Box 11-0236 Riad El-Solh
Lebanon
khalil.hindi@aub.edu.lb

Hirotsu, Nobuyoshi
Japan Institute of Sports Sciences
3-15-1 Nishigaoka, Kita-ku
Japan
hirotsu.nobuyoshi@jiss.ntgk.go.jp

Hitsch, Guenter
University of Chicago
1101 East 58th Street
United States
guenter.hitsch@gsb.uchicago.edu

Ho, Teck
Haas School of Business
S545 Student Services Building #1900
United States
hoteck@haas.berkeley.edu

Hochbaum, Dorit
UC Berkeley
4181 Etcheverry Mc1777
United States
hochbaum@ieor.berkeley.edu

Hochreiter, Ronald
University of Vienna
Universitaetsstrasse 5
Austria
ronald.hochreiter@univie.ac.at

Hoffman, Karla
George Mason University
United States

Participant List

khoffman@gmu.edu

Hohzaki, Ryusuke
National Defense Academy
1-10-20 Hashirimizu
Japan
hozaki@cc.nda.ac.jp

Holder, Allen
Trinity University
715 Stadium Drive
United States
aholder@trinity.edu

Hong, Yushin
POSTECH
San 31, Hyoja
South Korea
yhong@postech.ac.kr

Hood, Alasdair
DSTL
77 Judd Road
United Kingdom
amhood*dstl.gov.uk

Horsky, Dan
University of Rochester
PO 270100
United States
horsky@simon.rochester.edu

Horsky, Sharon
Interdisciplinary Center Herzliya
PO Box 167
Israel
horsky@idc.ac.il

Hortacsu, Ali
University of Chicago
3660 N. Lake Shore Drive, Apt. 4411
United States
hortacsu@uchicago.edu

Howard, John
London School of Economics
Houghton Street
United Kingdom
j.v.howard@lse.ac.uk

Huchzermeier, Arnd
WHU, Otto Beisheim Graduate School
Burgplatz 2
Germany
ah@whu.edu

Hulett, David
Hulett & Associates, LLC
12233 Shetland Lane
United States
david.hulett@verizon.net

Hultqvist, Daniel
Mid Sweden University
Holmgatan 10
Sweden
daniel.hultqvist@mh.se

Hörmann, Wolfgang
Boğaziçi University
Bebek
Turkey
hormannw@boun.edu.tr

I

Ianovsky, Eduard
Ben-Gurion University of the Negev
Amos Yarkoni 16/14
Israel
ianovsky@bgumail.bgu.ac.il

Ibáñez, Alfredo
ITAM
Río Hondo #1 Col. Tizapán-San Angel
Mexico
ibanez@itam.mx

Ibaraki, Toshihide
Kyoto University, Graduate School of Inf
Yoshida-Honmachi, Sakyo-ku
Japan
ibaraki@i.kyoto-u.ac.jp

İçen, Yeşim
Galatasaray University
Çırağan Cd. No:36 Ortaköy
Turkey
yicen@gsu.edu.tr

Ichoua, Soumia
Sultan Qaboos University
College of Commerce & Economics
P.O. Box 20 PC 123 Al Khod
Oman
soumia@squ.edu.om

Ikkai, Yoshitomo
Osaka University
Yamadaoka, 2-1
Japan
ikkai@ist.osaka-u.ac.jp

İlçöl, Cüneyt
Akkök
Turkey

Ileri, Yetkin
Georgia Tech
325569 Georgia Tech Station
United States
yetkin@isye.gatech.edu

İlhan, Ahmet B.
Turkish Navy
1.cad No 24/2 Ümit Apt. Bahçelievler
Turkey
ahmetb_ilhan@hotmail.com

Ilhan, Aytac
Princeton University
Dept. of ORFE E-Quad
United States
ailhan@princeton.edu

Ilıcak, Işıl
METU
Beyazgül sok. 12/10
Turkey
ilicakisil@hotmail.com

Imahori, Shinji
Kyoto University
Yoshida Honmachi Sakyo-ku
Japan
imahori@amp.i.kyoto-u.ac.jp

Impastato, Stefano
Università degli Studi di Roma "La Sapienza"
Via Eudossiana, 18 c/o prof. G. Malavasi
Italy
stefano.impastato@uniroma1.it

İnal, Gülay Arzu
Sabancı University
Faculty of Engineering and Natural Sciences
Orhanlı Tuzla
Turkey
arzuinal@su.sabanciuniv.edu

Inal, Mehmet
New Mexico Tech
801 Leroy Pl.
United States
myi@nmt.edu

Inderfurth, Karl
University of Magdeburg
Universitaets Platz 2
Germany
inderfurth@ww.uni-magdeburg.de

Ingolfsson, Armann
University of Alberta
Room 4-30K Business Building
Canada
armann.ingolfsson@ualberta.ca

Iori, Giulia
King's College London
Strand
United Kingdom
giulia.iori@kcl.ac.uk

Iovanella, Antonio
Università degli Studi di Roma "Tor Vergata"
Via del Politecnico,1
Italy
iovanella@disp.uniroma2.it

Irnich, Stefan
RWTH Aachen
Templergraben 64
Germany
sirnich@or.rwth-aachen.de

Ishii, Hiroaki
Osaka University
2-1 Yamada-oka
Japan
ishii@ist.osaka-u.ac.jp

Ito, Hiro
Kyoto University
Yosida Honmati
Japan
itohiro@kuis.kyoto-u.ac.jp

Ittmann, Hans.W.

CSIR
South Africa
hittmann@csir.co.za

Ivanescu, Cristina
Technische Universiteit Eindhoven
Den Dolech 2P.O. box 513
Netherlands
c.v.ivanescu@tm.tue.nl

Ivy, Julie
University of Michigan
701 Tappan Street
United States
jsimmons@umich.edu

Iwamoto, Seiichi
Kyushu University
Hakozaki 6-19-1 Higashi Ward
Japan
iwamoto@en.kyushu-u.ac.jp

Iyer, Ananth
Purdue University
1310 Krannert Building
United States
aiyer@mgmt.purdue.edu

Iyer, Ganesh
Haas School of Business
S545 Student Services Bldg. #1900
United States
giyer@haas.berkeley.edu

J

Jabbour, George
George Washington University
2023 g street NW Room 530
United States
jabbour@gwu.edu

Jablonsky, Josef
University of Economics
W. Churchill Sq. 4
Czech Republic
jablon@vse.cz

Jaillet, Patrick
Massachusetts Institute of Technology
77 Massachusetts Avenue
United States
jaillet@mit.edu

Jakubowski, Andrzej
Polish Academy of Sciences
Newelska 6, st.
Poland
ajakibs@ibspan.waw.pl

Jans, Raf
Erasmus University Rotterdam
PO Box 1738
Netherlands
rjans@fbk.eur.nl

Jansen, Guus
Paragon Decision Technology
Julianastraat 30
Netherlands
g.jansen@paragon.nl

Jaramillo, Gloria Patricia
Universidad Nacional de Colombia
Escuela de Sistemas,Apartado Aéreo 1027
Colombia
gpjarami@unalmed.edu.co

Jarman, Rodney B.
Curtin University of Technology
Hayman Road
Australia
jarmanr@cbs.curtin.edu.au

Jarrar, Ramla
HEC Montréal
3325 Edouard Montpetit
Canada
ramla.jarrar@hec.ca

Jaruphongsa, Wikrom
National University of Singapore
111 Clementi Rd., Block C, # 11-05
Singapore
isejw@nus.edu.sg

Jasmina, Omerbegovic-Bijelovic
University of Belgrade
Faculty of Organizational Sciences
Jove Ilica 154
Serbia and Montenegro
omeja@fon.bg.ac.yu

Jassbi, Javad
I.A.U. Science & Research Campus
No. 360, Pasdaran Ave.
Tehran
Iran
jassbi@iaucss.org

Jemai, Jaber
Institut Supérieur de Gestion de Tunis
44 avenue de la liberté cité bouchoucha
Tunisia
jaber.jemai@isg.rnu.tn

Jensen, Paul A.
University of Texas
United States
pjensen@mail.utexas.edu

Jiménez, Antonio
Technical University of Madrid
Facultad de Informática
Spain
ajimenez@fi.upmes

Johnson, Johnnie
Centre for Risk Research
University of Southampton Highfield
United Kingdom
jej@soton.ac.uk

Jozefowiez, Nicolas
Université des Sciences et Technologies
Bâtiment M3 - Cité Scientifique
France
jozef@lifl.fr

Judit, Ivankay
Budapest University
Varosmajor u. 26/D
Hungary
jucz@freemail.hu

Jurun, Elza
University of Split
Faculty of Economics
Matice hrvatske 31
Croatia
elza@efst.hr

Jyoti, Gupta
ESCP-EAP
79, Avenue de la République
France
gupta@escp-eap.net

K

Kabak, Özgür
İstanbul Technical University
ITU İşletme Fakültesi Maçka
Turkey
kabak@itu.edu.tr

Kaçamak, Hasan
Sakarya Üniversitesi
Bilgi İşlem Daire Başkanlığı
Esentepe Kampüsü
Turkey
hkacamak@sakarya.edu.tr

Kachani, Soulaymane
Columbia University
133 Otis Street Apt 3
United States
sk2267@columbia.edu

Kadıoğlu, Nalan
Koç Allianz Hayat ve Emeklilik A.Ş.
Bağlarbaşı, Kısıklı Cad. No:18 Altunizade
Turkey
nalan.kadioglu@kocallianz.com.tr

Kalic, Milica
University of Belgrade
Faculty of Transportation and Traffic Engineering
Vojvode Stefe 305
Serbia and Montenegro
m.kalic@sf.bg.ac.yu

Kaliszewski, Ignacy
Systems Research Institute
Newelska 6
Poland
ignacy.kaliszewski@ibspan.waw.pl

Kallrath, Josef
BASF AG
Care-Bosch-Strasse
Germany
josef.kallrath@t-online.de

Kaminsky, Phil
University of California
4135 Etcheverry Hall

Participant List

United States
kaminsky@ieor.berkeley.edu

Kandiller, Levent
METU
Endüstri Müh.
Turkey
kandil@ie.metu.edu.tr

Kara, Bahar
Bilkent University
Depratment of Industrial Engineering
Turkey
bkara@bilkent.edu.tr

Kara, İmdat
Başkent University
Bağlıca Kampüsü Eskişehir Yolu 20.km.
Turkey
ikara@baskent.edu.tr

Karaarslan, Nevin
Sakarya University
Esentepe Kampüsü Bilgi İşlem D.Bsk.
Turkey
nevink@sakarya.edu.tr

Karabati, Selçuk
Koç University
Rumeli Feneri Yolu, Sarıyer
Turkey
skarabati@ku.edu.tr

Karabuk, Suleyman
University of Oklahoma
202 W. Boyd, Room 124
United States
karabuk@ou.edu

Karacapilidis, Nikos
University of Patras
Greece
nikos@mech.upatras.gr

Karacsonyi, Jorge
Consultant Mercados Energéticos
Marbella 49
Spain
jkaracsonyi@mercadosenergeticos.com

Karaesmen, Fikri
Koç University
Dept. of Ind. Engineering
Rumelifeneri Yolu
Turkey
fkaraesmen@ku.edu.tr

Karaesmen, Itır
University of Maryland
2745 29th Street NW Apt. 520
United States
ikaraes@rhsmith.umd.edu

Karagiannidis, Avraam
Aristotle University
University Campus Box 483
Greece
makis@aix.meng.auth.gr

Karahalil, Uzay
Karadeniz Technical University
Faculty of Forestry
Turkey
uzay@ktu.edu.tr

Karakayalı, İbrahim
METU
Turkey
ibrahim@ie.metu.edu.tr

Karakoç, Çağın
Kocaeli University
Veziroğlu Campus
Turkey
caginkarakoc@yahoo.com

Karanfil, Özge
Boğaziçi University
Bebek
Turkey
karanfio@boun.edu.tr

Karasakal, Esra
METU
İnönü Bulvarı
Turkey
esra@ie.metu.edu.tr

Karayel, Mahmut
Babcock & Brown
2 Harrison St.
United States
mahmut.karayel@babcockbrown.com

Karpak, Birsen
Youngstown State University
One University Plaza, WCBA 635
United States
bkarpak@cc.ysu.edu

Karray, Salma
HEC Montreal
3000, chemin de la Côte-Sainte-Catherine
Canada
salma.karray@hec.ca

Karsak, E. Ertuğrul
Galatasaray University
Çırağan Cd. 36 Ortaköy
Turkey
ekarsak@gsu.edu.tr

Kasap, Nihat
University of Florida
2901 SW 13 St. Apt. 329
United States
nkasap@ufl.edu

Katoh, Naoki
Kyoto University
Yoshida Honmachi, Sakyo-ku
Japan
naoki@archi.kyoto-u.ac.jp

Katsikopoulos, Konstantinos
Max Planck Institute for Human Development
Lentzeallee 94
Germany
katsikop@mpib-berlin.mpg.de

Kavrakoğlu, İbrahim
Kavrakoğlu Consulting
Turkey
ikavrakoglu@kavrakoglu.com

Kawano, Hiroyuki
Kyoto University
Yoshida Hommmachi, Sakyo-ku,
Japan
kawano@i.kyoto-u.ac.jp

Kayalıgil, Sinan
METU
Dept. of Industrial Engineering
Turkey
skayali@metu.edu.tr

Kayan, Rabia
Bilkent University
Turkey
krabia@bilkent.edu.tr

Kaylan, Ali
Boğaziçi University
Bebek
Turkey
kaylan@boun.edu.tr

Kayman, Ahmet Yekta
Kocaeli University
Veziroğlu Kampüsü
Mühendislik Fakültesi
Endüstri Mühendisliği Bölümü
Turkey
yektakayman@yahoo.com

Kazaz, Burak
University of Miami
School of Business414 Jenkins Building
United States
bkazaz@miami.edu

Keleş, Sedat
Karadeniz Technical University
Faculty of Forestry
Turkey
skeles@ktu.edu.tr

Kersten, Gregory
University of Ottawa
136 Jean-Jacques Lussier Str.
Canada
gregory@sprott.carleton.ca

Keskinaslan, Abdülkadir
Pfizer
Turkey

Keskinocak, Pinar
Georgia Tech
765 Ferst Drive
United States
pinar@isye.gatech.edu

Khanmohammadi, Sohrab
I.A.U, Science & Research Campus
No. 47, Colahdooz Ave., Shahrak Parvaz
Tabriz
Iran
khan@iaucss.org

Khoufi, Walid
Sfax Graduate Business School
Route de l'aérodrome BP 1081,
Tunisia
walid.khoufi@escs.rnu.tn

Kijima, Masaaki
Kyoto University
Yoshida-Honmachi
Japan
kijima@econ.kyoto-u.ac.jp

Kikuta, Kensaku
Kobe University of Commerce
Gakuen-nishi 8-2-1
Nishi-ku
Japan
kikuta@kobeuc.ac.jp

Kilgour, Marc
Wilfrid Laurier University
75 University Avenue
Canada
mkilgour@wlu.ca

Kilinc, Fatma Selcen
Auburn University
115 Textile Building
United States
fselcenk@eng.auburn.edu

Kim, Chaiho
Santa Clara University
500 El Camino Real
United States
ckim@scu.edu

Kim, Chan Gyu
ETRI
161 Gajeong-dong
Yuseong-gu
South Korea
kcg63222@etri.re.kr

Kim, Heetak
Sangmyung University
7 Hongjidong
Chongrokoo
South Korea
htkim@smu.ac.kr

Kim, Junhyuk
Virginia Tech
7054 Haycock Road
United States
jukim3@vt.edu

Kim, Min-jeong
ETRI
161 Gajeong-dong
Yuseong-gu
South Korea
mjk@etri.re.kr

Kim, Seung-Lae
Drexel University
3141 Chestnut Street
United States
kimsl@drexel.edu

Kim, Woo-Je
Daejin Univsersity
San 11-1 Pochunup Pochun-koon
South Korea
wjkim@road.daejin.ac.kr

Kimyonok, Alphan
Boğaziçi University
Dikilitaş Mah Emirhan Cad.
Aşıkkerem Sok. No:6/3
Turkey
alphank@yahoo.com

Kingsman, Brian
Lancaster University
LUMSBailrigg
United Kingdom
b.kingsman@lancaster.ac.uk

Király, Tamás
Eötvös University
Pazmany Peter Setany 1/C
Hungary
tkiraly@cs.elte.hu

Kiranoudis, Chris
National Technical University of Athens
Iroon Polytexneiou 9
Greece
kyr@chemeng.ntua.gr

Kirchmer, Mathias
IDS Scheer
United States
m.kirchmer@ids-scheer.com

Kiris, Esin
AT&T Labs
104 Cranbrook St
United States
kiris@att.com

Kis, Tibor
University of Belgrade
Put M. Pijade 9-11
Serbia and Montenegro
tbkis@yahoo.com

Kise, Hiroshi
Kyoto Institute of Technology
Matsugasaki
Japan
kise@ipc.kit.ac.jp

Kittelsen, Sverre A.C.
Frisch Centre
Gaustadalleen 21
Norway
sverre.kittelsen@frisch.uio.no

Klamroth, Kathrin
University of Erlangen-Nuremberg
Martensstr. 3
Germany
klamroth@am.uni-erlangen.de

Klapper, Daniel
University of Kiel
Westring 425
Germany
klapper@bwl.uni-kiel.de

Kleijnen, Jack
Tilburg University
2 Warandelaan
Netherlands
kleijnen@uvt.nl

Kobor, Adam
The World Bank
1818 H Street
United States
akobor@worldbank.org

Kobu, Bulent
University of Massachusetts-Dartmouth
245 Old Westport Road
United States
bkobu@umassd.edu

Koca, Eylem
Boğaziçi University
Bebek
Turkey
kocaeyle@boun.edu.tr

Kocabasoglu, Canan
University of Kansas
Summerfield Hall 1300 Sunnyside Avenue
United States
canan@ku.edu

Kocabiyikoglu, Ayse
INSEAD
Blvd. de Constance
France
ayse.kocabiyikoglu@insead.edu

Kocas, Cenk
Michigan State University
N370 North Business Complex
United States
kocas@msu.edu

Koçdor, Cenk
BRISA
Bridgestone Sabancı Lastik San. ve Tic. A.S.
Turkey

Koçkesen, Talip Kerem
METU
Turkey
kerem@ie.metu.edu.tr

Koeszegi, Sabine
University of Vienna
Bruennerstrasse 72
Austria
sabine.koeszegi@univie.ac.at

Koide, Takeshi
University of Marketing and Distribuiton
3-1, Gakuen-Nishimachi, Nishi-ku
Japan
koide@umds.ac.jp

Köksal, Gülser
METU
İnönü Blvd.
Turkey

Participant List

koksal@ie.metu.edu.tr

Köksalan, Murat
METU
Turkey
koksalan@ie.metu.edu.tr

Koku, Paul Sergius
Florida Atlantic University
220 S.E. 2nd Avenue
University Tower, Room 531
United States
koku@fau.edu

Koliousis, Alexandros
Tei of Thessaloniki
15 Triantafillopoulou St.
Greece
koliousi@otenet.gr

Kolisch, Rainer
Technische Universität Muenchen
Arcisstr. 21
Germany
rainer.kolisch@wi.tum.de

Komiya, Toru
Japan National Defense Academy
Computer Science
Hashirimizu 1-10-20
Japan
komiya@nda.ac.jp

Komoda, Norihisa
Osaka University
2-1, Yamadaoka
Japan
komoda@ist.osaka-u.ac.jp

Konak, Abdullah
The Pennsylvania State University
Tulpechocken Road P.O. Box 7009
United States
konak@psu.edu

Korhonen, Pekka
Helsinki School of Economics
Runeberginkatu 14-16
Finland
korhonen@hkkk.fi

Korte, Bernhard
University of Bonn
Lennestr. 2
Germany
dm@or.uni-bonn.de

Korugan, Aybek
Boğaziçi University
Bebek
Turkey
aybek.korugan@boun.edu.tr

Kostoglou, Vassilis
TEI of Thessaloniki
Department of Information Technology
Greece
bas@it.teithe.gr

Kotsis, Gabriele
Johannes Kepler University of Linz
Altenberger Strasse 69
Austria
gabriele.kotsis@jku.ac.at

Koyuncu, Onur
Hacettepe University
İşletme Bölümü
Beytepe
Turkey
okoyuncu@hacettepe.edu.tr

Kozan, Erhan
QUT
2 George Street
Australia
e.kozan@qut.edu.au

Kozan, M. Kamil
St John Fisher College
25 Pine Brook Cir.
United States
kozan@sjfc.edu

Kranenburg, Bram
Technische Universiteit Eindhoven
P.O. Box 513
Netherlands
a.a.kranenburg@tue.nl

Krarup, Jakob
University of Copenhagen
Denmark
krarup@diku.dk

Krass, Dmitry
University of Toronto
105 St. George st
Canada
krass@rotman.utoronto.ca

Krebs, Tobias
Humboldt-Universität zu Berlin
Spandauer Strasse 1
Germany
krebs@wiwi.hu-berlin.de

Kristal, Murat
University of North Carolina
Kenan-Flagler Business School McColl Building
United States
kristal@unc.edu

Krivonozhko, Vladimir
Institute for Systems Analysis of Russia
Bolshoi Zlatoustinskii per. 3/5, building 1
Russia
vladimir@dol.ru

Kubiak, Wieslaw
MUN
Prince Philip Drive
Canada
wkubiak@mun.ca

Kucera, Petr
Charles University
Malostranske namensti 25
Czech Republic
kucerap@kti.ms.mff.cuni.cz

Küçük, Bilge
Sabancı University
MDBF Fak.
Turkey
bilge@su.sabanciuniv.edu

Kucukemiroglu, Orsay
The Pennsylvania State University
1031 Edgecomb Ave.
United States
ojk@psu.edu

Kuefer, Karl-Heinz
University of Kaiserslautern
Fraunhofer ITWM
Germany
kuefer@itwm.fhg.de

Kuhn, Daniel
University of St. Gallen
IfU-HSG Holzstrasse 15
Switzerland
daniel.kuhn@unisg.ch

Kuik, Roelof
Erasmus University Rotterdam
P.O. Box 1738
Netherlands
rkuik@fbk.eur.nl

Kulluk, Sinem
Erciyes University
Mühendislik Fakültesi
Endüstri Mühendisliği Bölümü
Talas/KAYSERİ
Turkey
scingoz@hotmail.com

Kulturel-Konak, Sadan
The Pennsylvania State University
Tulpechocken Road P.O. Box 7009
United States
sadan@psu.edu

Kumbaroglu, Gürkan
Boğaziçi University
Bebek
Turkey
gurkank@boun.edu.tr

Kuosmanen, Timo
Wageningen University
Hollandseweg 1
Netherlands
timo.kuosmanen@wur.nl

Kurtulus, Mumin
INSEAD
Boulevard de Constance
France
mumin.kurtulus@insead.edu

Kuyumcu, Ahmet
Zilliant, Inc.
2301 South Mo Pac, Apt 837
United States
ahmet.kuyumcu@zilliant.com

Kvam, Paul
Georgia Tech

765 Ferst Drive, ISyE
United States
pkvam@isye.gatech.edu

Kıbrıs, Özgür
Sabancı University
Orhanlı, Tuzla
Turkey
ozgur@sabanciuniv.edu

Kılıç, Elgin
Ege University
Faculty of Sciences
Mathematics Department
Turkey
ekilic@sci.ege.edu.tr

Kılıç, Kemal
Sabancı University
Orhanlı, Tuzla
Turkey
kkilic@sabanciuniv.edu

Kılıç, Murat
Sabancı University
Turkey
murkil@su.sabanciuniv.edu

Kılıç, Sezgin
Hava Harp Okulu
Havacılık ve Uzay Teknolojileri Enstitüsü
Yeşilyurt
Turkey
skilic@superonline.com

Kyparisis, George
Florida International University
University Park
United States
kyparis@fiu.edu

Kıraç, Furkan
Boğaziçi University
Dr. Muhit Tümerkan S. 16/17
Turkey
kiracmus@boun.edu.tr

Kırca, Ömer
METU
Turkey
kirca@ie.metu.edu.tr

L

Labbé, Martine
Université Libre de Bruxelles
CP 210/01Boulevard du Triomphe
Belgium
mlabbe@smg.ulb.ac.be

Labriet, Maryse
GERAD
GERAD-HEC 3000 ch. de la Cote Ste-Catherine
Canada
maryse.labriet@gerad.ca

Ladanyi, Laszlo
IBM
1101 Kitchawan Rd., Route 134
United States
ladanyi@us.ibm.com

Lagergren, Marten
Stockholm Gerontology Research Center
Olivecronas väg 4
Sweden
marten.lagergren@aldrecentrum.se

Lagha, Karima
University of Bejais
Algeria
karima_lagha@yahoo.com

Lambiase, Alfredo
University of Sacerno
Via Ponte Don Melillo 1
Italy
lambiese@unisa.it

Lambrecht, Marc
Katholieke Universiteit Leuven
Naamsestraat 69
Belgium
marc.lambrecht@econ.kuleuven.ac.be

Landete, Mercedes
Universidad Miguel Hernandez
Avda. Ferrocarril S/N Edificio Torretamarit
Spain
landete@umh.es

Laporte, Gilbert
HEC Montréal
Canada
gilbert@crt.umontreal.ca

Larsen, Christian
Fuglesangs Alle 4
Denmark
chl@asb.dk

Laslier, Jean-François
Ecole Polytechnique
1 rue Descartes
France
laslier@poly.polytechnique.fr

Laslo, Zohar
NACE - Negev Academic College of Enginee
71 Bazel St. POB 45
Israel
zohar@nace.ac.il

Lau, Hoong Chuin
National University of Singapore
School of Computing 3 Science Drive 2
Singapore
lauhc@comp.nus.edu.sg

Le Anh, Tuan
Erasmus University Rotterdam
Burg. Oudlaan 50
Netherlands
ltuan@fbk.eur.nl

Le Duc, Tho
Erasmus University Rotterdam
Burgemeester Oudlaan 50
Netherlands
tleduc@fbk.eur.nl

LeBlanc, Larry
Vanderbilt University
401 21st Avenue South
United States
larry.leblanc@owen.vanderbilt.edu

Lebreton, Baptiste
University of Augsburg
Lehrstuhl für Umweltmanagement,Universitä
tsstr. 16
Germany
baptiste.lebreton@wiwi.uni-augsburg.de

Lechler, Thomas
Stevens Institute of Technology
Castle Point on Hudson
United States
tlechler@stevens-tech.edu

Lee, Chang W.
Jinju National University
150 Chilam Dong
South Korea
cwlee@jinju.ac.kr

Lee, Chulung
National University of Singapore
Dept. of Ind. and Systems Eng., 1 Eng. Dr. 2
Singapore
iseleecu@nus.edu.sg

Lee, Chung-Yee
Hong Kong University of Science and
Technology
Clearwater Bay Road Kowloon
Hong Kong
cylee@ust.hk

Lee, Daisun
Sogang University
1 Shinsoo-dong Mapo-ku
South Korea
daisun@ccs.sogang.ac.kr

Lee, Hyo-Seong
Kyung Hee University
Seocheon 1, Kiheung
South Korea
hslee@khu.ac.kr

Lee, Jon
IBM TJ Watson Research Center
United States

Leleur, Steen
Technical University of Denmark
Building 115
Denmark
sl@ctt.dtu.dk

Lemoine, Caroline
LCPC
58, Bd Lefebvre
France
lemoine@lcpc.fr

Lempiäinen, Jyri
Finnish Defence Forces
Technical Research

Participant List

P.O.Box 5
Finland
jyri.lempiainen@pvtt.mil.fi

Lenstra, Jan Karel
Georgia Tech
United States
jkl@isye.gatech.edu

Leonard, Kevin
University of Toronto
903 - 1001 Bay Street
Canada
k.leonard@utoronto.ca

Leskelä, Riikka-Leena
Helsinki University of Technology
Otakaari 1
Finland
rleskela@cc.hut.fi

Letmathe, Peter
University of Siegen
Hoelderlinstr. 3
Germany
peter.letmathe@uni-siegen.de

Leurent, Fabien
SETRA
46 avenue Briand
France
fabien.leurent@equipement.gouv.fr

Leus, Roel
Katholieke Universiteit Leuven
Naamsestraat 69
Belgium
roel.leus@econ.kuleuven.ac.be

Lev, Ben
University of Michigan - Dearborn
4901 Evergreen Rd.
United States
blev@umich.edu

Levén, Erik
Luleå University of Technology
IES - Logistik
Sweden
erik.leven@ies.luth.se

Levesque, Moren
Case Western Reserve University
10900 Euclid Avenue
United States
mxl101@cwru.edu

Levi, Moti
The Pennsylvania State University
509 Business Administration Building I
United States
mlevi@tulane.edu

Levin, Genrikh
United Institute of Infotmatics Problems
G Surganov Str.
Belarus
levin@newman.bas-net.by

Levin, Yuri
Queen's University
Goodes Hall 143 Union str.
Canada
ylevin@business.queensu.ca

Levina, Tatsiana
Rutgers University
180 University Av.
United States
tlevina@pegasus.rutgers.edu

Lewis, Tony
Oxford Brookes School
Wheatley Campus, Wheatley
United Kingdom
ajlewis@brookes.ac.uk

Li, Haijun
Washington State University
Mathematics Washington State University
United States
lih@math.wsu.edu

Li, Shanling
McGill University
1001 Sherbrooke Street West
Canada
shanling.li@mcgill.ca

Li, Stan
University of Alberta
Edmonton, AB T6G 2R6
Canada
stan.li@ualberta.ca

Li, Ta-Hsin
IBM Watson Research Center
Dept. of Math. Sciences
United States
thl@watson.ibm.com

Libai, Barak
Tel-Aviv University
Faculty of Management
Israel
libai@post.tau.ac.il

Liberopoulos, George
University of Thessaly
Pedion Areos
Greece
glib@mie.uth.gr

Liern, Vicente
Universitat de Valencia
Avda Tarongers, S/N
Spain
vicente.liern@uv.es

Liesio, Juuso
Helsinki University of Technology
Otakaari 1M P.O.Box 1100
France
jiliesio@cc.hut.fi

Lilien, Gary
The Pennsylvania State University
United States
g5l@psu.edu

Lin, Grace
IBM TJ Watson Research and
IBM Academy of Technology
United States
gracelin@us.ibm.com

Linard, Anna
Christ the Priest Primary School
5 Blackwood Drive
Australia
anna@linard.net

Linard, Keith
University of New South Wales
5 Blackwood Drive
Australia
k-linard@adfa.edu.au

Lippert, Susan
Drexel University
101 N 33rd Street Room 331
United States
lippert@drexel.edu

Lips, Markus
TU Dresden
Mommsenstraße 13
Germany
markus.lips@mailbox.tu-dresden.de

Litvak, Nelly
University of Twente
Drienerlolaan 5
Netherlands
n.litvak@math.utwente.nl

Llamazares, Bonifacio
Universidad De Valladolid
Avda Valle De Esgueva 6
Spain
boni@eco.uva.es

Lo, Nassirou
Université Laval Pavillon Palasis-Prince
Faculté des Sciences de l'Administration
Canada
nassirou.lo@fsa.ulaval.ca

Lodi, Andrea
University of Bologna
Viale Risorgimento 2
Italy
alodi@deis.unibo.it

Lohmander, Peter
SUAS
University Campus
Sweden
plohmander@hotmail.com

López-Cerdá, Marco A.
Alicante University
Ctra. San Vicente de Raspeig s/n
Spain
marco.antonio@ua.es

Lorena, Luiz A. N.
INPE-Brazilian Space Reaearch Institute
Av. dos Astronautas - 1758
Brazil
lorena@lac.inpe.br

Lowe, David
DSTL
Portsdown West
United Kingdom
dalowe@dstl.gov.uk

Lowe, Timothy
University of Iowa
United States
tlowe@blue.weeg.uiowa.edu

Lozano-Vivas, Ana
University of Málaga
Department of Economics, Plza El Ejido s/n
Spain
avivas@uma.es

Lu, Fadian
Swedish University of Agricultural Scien
Pedagoggrand 11 B 103
Sweden
fadian.lu@sekon.slu.se

Lu, Zhiqiang
Ecole des Mines de Nantes
La Chantrerie
France
zhiqiang.lu@emn.fr

Luè, Alessandro
Politecnico di Milano
Via Fucini 2
Italy
lue@poliedra.polimi.it

Lukac, Zrinka
Faculty of Economics
Kennedyev Trg 6
Croatia
zlukac@etzg.hr

Lynn, Nicholas
Canadian Imperial Bank of Commerce
Cottons Centre Cottons Lane
United Kingdom
nick.lynn@cibc.co.uk

M

Maani, Kambiz
University of Auckland
Old Choral Hall7 Symonds St
New Zealand
k.maani@auckland.ac.nz

Maaranen, Heikki
University of Jyvaskyla
Math. Info Tech. P.O. Box 35 Agora
Finland
vimaaran@mit.jyu.fi

Macambira, Elder M.
Universidade Federal do Rio de Janeiro / Cidade Universitária Centro de Tecnologia
Bloco H - 319
Brazil
elder@cos.ufrj.br

Madlener, Reinhard
ETH Zurich
ETH Zentrum WEC C
Switzerland
madlener@cepe.mavt.ethz.ch

Maglaras, Costis
Columbia University
409 Uris Hall 3022 Broadway
United States
c.maglaras@columbia.edu

Magnanti, Thomas
Massachusetts Institute of Technology
Room 1-206 77 Massachusetts Avenue
United States
magnanti@mit.edu

Magrogan, Mary
IFORS
901 Elkridge Landing Road Suite 400
United States
secretary@ifors.org

Mahjoub, Ali Ridha
LIMOS, Blaise Pascal University
Complexe Scientifique des Cézeaux
France
ridha.mahjoub@math.univ-bpclermont.fr

Makai, Márton
Eötvös University
Pazmany Peter Setany 1/C
Hungary
marci@cs.elte.hu

Makimoto, Naoki
Tsukuba University
3-29-1 Otsuka, Bunkyo
Japan
makimoto@gssm.otsuka.tsukuba.ac.jp

Makkonen, Simo
Process Vision Oy
Melkonkatu 18
Finland
simo.makkonen@processvision.fi

Malkoc, Selin
The University of North Carolina
Kenan-Flagler Business School UNC-Chapel Hill
McColl Building, CB #3490
United States
selin_malkoc@unc.edu

Mallett, Dan
Daniel Mallett Associates
300 Central Park West
United States
danmallett@worldnet.att.net

Malone, Kerry
TNO Inro
P.O. Box 6041
Netherlands
k.m.malone@inro.tno.nl

Mandic, Vladimir
University of Novi Sad
Serbia and Montenegro
vladman@uns.ns.ac.yu

Manger, Robert
University of Zagreb
Bijenicka cesta 30
Croatia
manger@math.hr

Mansur, Iqbal
Widener University
One University Place School of Business Adm.
United States
iqbal.mansur@widener.edu

Mantegna, Rosario N
Palermo University
Viale delle Scienze
Italy
mantegna@unipa.it

Marcotte, Patrice
Université de Montréal
C.P. 6128, Succursale Centre-Ville
Canada
marcotte@iro.umontreal.ca

Maria Franca, Norese
Politecnico Torino
Cso Duca Degli Abruzzi nr 24
Italy
mariafranca.norese@polito.it

Maria Victoria, Rodriguez Uria
Avda Dez Cristo S/N Facultas Economicas
Spain
vrodri@correo.uniovi.es

Marianov, Vladimir
Pontificia Universidad Catolica de Chile
Vicuna Mackenna 4860
Chile
marianov@ing.puc.cl

Marín, Ángel
Universidad Politecnica de Madrid
E.T.S. Ingenieros Aeronáuticos Plaza Cardenal Cisneros, 3
Spain
amarin@dmae.upm.es

Marinelli, Fabrizio
University of L'Aquila
V, Vetoio, Coppito
Italy
marinelli@di.univaq.it

Marklund, Johan
University of Colorado
2890 Kalmia Ave. #302
United States
marklund@colorado.edu

Marshall, Adele
Queen's University of Belfast
David Bates Building
United Kingdom
a.h.marshall@qub.ac.uk

Martello, Silvano
University of Bologna
Italy
smartello@deis.unibo.it

Participant List

Martin, Birgi
Bocconi University
Via San Francesco, 3
Italy
birgi.martin@uni-bocconi.it

Martin-Herran, Guiomar
Universidad de Valladolid
Avda. Valle Esgueva, 6
Spain
guiomar@eco.uva.es

Martins, Isabel
Instituto Superior de Agronomia Tapada da Ajuda
Portugal
isabelinha@isa.utl.pt

Martzoukos, Spiros
University of Cyprus
75 Kallipoleos Str.
Cyprus
baspiros@ucy.ac.cy

Mason, Andrew
University of Auckland
New Zealand
a.mason@auckland.ac.nz

Matarazzo, Benedetto
University of Catania
Corso Italia, 55
Italy
matarazz@unict.it

Mather, Dineli
Monash University
Wellington Road
Australia
dineli.mather@infotech.monash.edu.au

Matschke, Irina
University Hannover
Appelstr. 9A
Germany
matschke@ivh.uni-hannover.de

Maturana, Sergio
Universidad Católica
Vicuña Mackenna 4860 Campus San Joaquin
Chile
smaturan@ing.puc.cl

Matveeva, Larissa
Université Catholique de Louvain
Place des Doyens, 1
Belgium
matveeva@poms.ucl.ac.be

Mauguiere, Philippe
Université de Tours
64 avenue Jean Portalis
France
philippe.mauguiere@etu.univ-tours.fr

Mautor, Thierry
Université de Versailles
45, Avenue des Etats Unis,
France
thierry.mautor@prism.uvsq.fr

Mavri, Maria
Athens University Business and Economics
47A Evelpidon And 33 Lefkados
Greece
mania-mav@hotmail.com

Mavrotas, George
National Technical University of Athens
Zografou Campus
Greece
mavrotas@chemeng.ntua.gr

McGarraghy, Sean
University College Dublin
Quinn School of Business
Ireland
john.mcgarraghy@ucd.ie

Meadows, Maureen
University of Warwick
Gibbet Hill Road
United Kingdom
m.meadows@wbs.ac.uk

Mehta, Nitin
University of Toronto
105 St. George St. East, Room 105
Canada
nmehta@rotman.utoronto.ca

Meissner, Joern
Columbia Business School
2840 Broadway #284
United States
jm531@columbia.edu

Melachrinoudis, Emanuel
Northeastern University
360 Huntington Avenue
United States
emelas@coe.neu.edu

Mendel, Max
Boston Fund Services
0 Broad Street
United States
max@bostonfundservices.com

Mercankaya, Burcu
Sabancı University
Orhanlı, Tuzla
Turkey
mercankaya@su.sabanciuniv.edu

Mercer, Alan
Lancaster University
United Kingdom

Merino, María
Universidad del País Vasco
Avenida Lehendakari Aguirre 83
Spain
etdmemam@bs.ehu.es

Merkuryev, Yuri
Riga TU
1, Kalku : :reet
Latvia
kezkuz@i l.ztu.lv

Mertoğlu, Benin
METU
Kutlugun sok. Bayraktar apt. 1/10
Turkey
beninmertoglu@hotmail.com

Meschini, Lorenzo
Università degli Studi di Roma "La Sapienza"
Viale Parioli 12
Italy
lorenzo.meschini@uniroma1.it

Meskens, Nadine
FUCAM
Chaussee De Binche 151
Belgium
meskens@fucam.ac.be

Mesquita, Marta
CIO-ISA
Instituto Superior de Agronomia Tapada da Ajuda
Portugal
marta@math.isa.utl.pt

Messina, Vincenzina
University of Milano Bicocca
Via Bicocca degli Arcimboldi, 8
Italy
messina@disco.unimib.it

Mestan, Esen
Koç University
Rumelifeneri Yolu Sarıyer
Turkey
emestan@ku.edu.tr

Mészáros-Komáromy, Gergely
Budapest University
Rakosi ut 51.
Hungary
meszaros@itm.bme.hu

Mete, Hüseyin Onur
Boğaziçi University
Bebek
Turkey
onurmete@boun.edu.tr

Meyr, Herbert
University of Augsburg
Universitaetsstr. 16
Germany
herbert.meyr@wiwi.uni-augsburg.de

Miichi, Akira
Otemon University
2-1-15
Japan
miichi@res.otemon.ac.jp

Mild, Pekka
Helsinki University of Technology
Otakaari 1 M P.O. Box 1100
Finland
pekka.mild@hut.fi

Milioni, Armando
Instituto Tecnologico de Aeronautica
CTA - ITA - IEMB
Brazil

milioni@mec.ita.br

Milosevic, Sladjana
University of Belgrade
Jove Ilica 154
Serbia and Montenegro
sladjamil@yahoo.co.uk

Min, Hokey
University of Louisville
LL23 Burhans Hall-Shelby
United States
h0min001@gwise.louisville.edu

Min, Jae H.
Sogang University
#1, Shinsoo-dong, Mapo-ku
South Korea
jaemin@ccs.sogang.ac.kr

Mingzhe, Li
Fukuoka University
Nanakuma 8-19-1 Jonan-ku
Japan
lmz@fukuoka-u.ac.jp

Minniti, Maria
Babson College
Mustard Hall
United States
minniti@babson.edu

Miquel, Silvia
University of Lleida
Fac. Derecho y Economia Jaume II, 73
Spain
smiquel@matematica.udl.es

Mishra, Sanjay
University of Kansas
1300 Sunnyside Avenue
United States
smishra@ku.edu

Misra, Sheo
Misra Associates
5, Catalpa Street
United States
misra@rtc1.icdi.wvu.edu

Missbauer, Hubert
University of Innsbruck
Universitätsstrasse 15
Austria
hubert.missbauer@uibk.ac.at

Mitrovic-Minic, Snezana
Simon Fraser University
8888 University Drive
Canada
smitrovi@cs.sfu.ca

Mizuyama, Hajime
Kyoto Univwersity
Yoshida Hon-machi, Sakyo-Ku,
Japan
mizu@prec.kyoto-u.ac.jp

Mocanu, Stéphane
Laboratoire d'Automatique de Grenoble
LAG/ENSIEG BP. 46
France
mocanu@lag.ensieg.inpg.fr

Mohamad, Zainuddin
UMIST, PO Box 88
United Kingdom
z.mohamad@postgrad.umist.ac.uk

Möhring, Rolf
Technische Universität Berlin
Germany
moehring@math.tu-berlin.de

Monaci, Michele
University of Bologna
Viale Risorgimento 2
Italy
mmonaci@deis.unibo.it

Montero, Lídia
Universitat POlitècnica de Catalunya
C/ Pau Gargallo, 5
Spain
lidia.montero@upc.es

Montibeller, Gilberto
University of Strathclyde
40 George Street
United Kingdom
gilberto@mansci.strath.ac.uk

Moon, Tae Hee
Yonsei University
School of Industrial Engineering
134 Shinchon-Dong Sudaemoon-Ku
South Korea
mthstat@yonsei.ac.kr

Morabito, Reinaldo
UFSCAR
Av. Brasil 652
Brazil
morabito@power.ufscar.br

Moreno, David
University of Alcala
Pontevedra, 3,9°B
Spain
jesusdav@eresmas.com

Moreno-Jiménez, José María
University of Zaragoza
Faculty of Economics, Gran Vía, 2
Spain
moreno@posta.unizar.es

Morita, Hiroshi
Osaka University
2-1 Yamadaoka
Japan
morita@ist.osaka-u.ac.jp

Moses, Scott
University of Oklahoma
202 W Boyd, Room 124
United States
moses@ou.edu

Mosheiov, Gur
The Hebrew University of Jerusalem
Mount Scopus
Israel
msomer@mscc.huji.ac.il

Mostard, Julien
Erasmus University Rotterdam
P.O. Box 1738
Netherlands
jmostard@fbk.eur.nl

Moulai, Mustapha
USTHB
Algeria
mustapha_moulai@yahoo.fr

Moura, Ana
INESC Porto
Rua Dr. Roberto Frias
Portugal
anamoura@fe.up.pt

Muniru, Badaru
PO.BX MD 72
Ghana
mazoo80gh@hotmail.com

Musal, Muzaffer
George Washington University
Management Science Department
United States
rmusal@gwu.edu

Mustajoki, Jyri
Helsinki University of Technology
P.O. Box 1100
Finland
jmustajo@cc.hut.fi

Musti, Silvana
Università di Foggia
Via IV Novembre 1
Italy
smusti@libero.it

Mutlu, Fatih
Texas A&M University
2802 Brandywine Cir.
United States
fmutlu@neo.tamu.edu

Müller, Dirk
University of Bonn
Lennestr. 2 53113 Bonn Germany
Germany
mueller@or.uni-bonn.de

N

Nagy, Gabor
University of Kent
Park Wood Road
United Kingdom
g.nagy@ukc.ac.uk

Nahavandi, Nassim
Tarbiat Modarres University
Forth Floor-No 10-Yasaman 3 Alley-No 10
Avenue-Velenjak
Iran
n_nahavandi@hotmail.com

Participant List

Naik, Prasad
University of CA, Davis
151 AOB IV One Shields Avenue
United States
panaik@ucdavis.edu

Nait Abdallah, Rabie
Bouygues Telecom
10 rue Paul Dautier
France
nicole.cheneaux@tci.tm.fr

Najafi, Amir Abbas
Sharif University of Technology
Azadi Ave.
Iran
aa_najafi@yahoo.com

Najiazimi, Zahra
Ferdowsi University of Mashhad
Vakilabad Bolvar
Iran
zahranaji@yahoo.com

Nakai, Toru
Kyushu University
Faculty of Economics
Hakozaki 6-19-1 Higashi
Japan
nakai@en.kyushu-u.ac.jp

Nalca, Arcan
METU
Turkey
arcan@ie.metu.edu.tr

Naor, Seffi
Technion
Technion City
Israel
naor@cs.technion.ac.il

Naseraldin, Hussein
Technion
Street 8, POB 4527
Israel
nhussein@tx.technion.ac.il

Ndiaye, Malick M.
KFUPM
Dhahran
Saudi Arabia
mndiaye@kfupm.edu.sa

Nechval, Konstantin
Transport and Telecommunication Institud
Lomonosov Street 1
Latvia
konstan@tsi.lv

Nechval, Nicholas
Transport and Telecommunication Institud
Lomonosov Street
Latvia
nechval@junik.lv

Neftçi, Salih
City University of New York and
University of Reading
United States
sneftci@wwc.com

Nemlioğlu, Jülide
Elginkan Holding
Turkey

Netjasov, Fedja
University of Belgrade
Division of Airports and Air Traffic Safety
Vojvode Stepe 305
Serbia and Montenegro
f.netjasov@sf.bg.ac.yu

Neumann, Klaus
University of Karlsruhe
Kaiserstr. 12
Germany
neumann@wior.uni-karlsruhe.de

Nickel, Stefan
Universität des Saarlandes and ITWM Kais
Im Stadtwald Gebäude 16
Germany
nickel@itwm.fhg.de

Nicola, Victor
University of Twente
P.O. Box 217
Netherlands
nicola@cs.utwente.nl

Nikolov, Nikola
University of Limerick
CSIS Department, University of Limerick
Ireland
nikola.nikolov@ul.ie

Noguchi, Hiroshi
University of Marketing and Distribution
3-1, Gakuen-Nishimachi
Nishiku, Kobe
Japan
hiroshi_noguchi@red.umds.ac.jp

Nonobe, Koji
Kyoto University
Sakyo-ku
Japan
nonobe@amp.i.kyoto-u.ac.jp

Norman, John
University of Sheffield
9 Mappin Street
United Kingdom
j.norman@sheffield.ac.uk

Norsworthy, John R.
Rensselaer Polytechnic Institute
334 Shaver Rd
United States
norswj@rpi.edu

Nowak, Ivo
Humboldt-Universität zu Berlin
Rudower Chaussee 25
Germany
ivo@mathematik.hu-berlin.de

Nsakanda, Aaron Luntala
Carleton University
1125 Colonel By Drive
Canada
aaron_nsakanda@carleton.ca

Nyirenda, Lemba
University of Zambia
Electrical & Electronic Engineering
Lusaka
Zambia
lemba.nyirenda@undp.org

O

O'Brien, Greg
La Trobe University
Victoria 3086
Australia
g.obrien@latrobe.edu.au

O'Neill, Liam
Cornell University
PAM Dept. 105 MVR Hall
United States
lo22@cornell.edu

Ochoa, Patricia
Université de Lausanne
BFSH 1
Switzerland
patricia.ochoa@hec.unil.ch

Odoni, Amedeo
Massachusetts Institute of Technology
Room 33-219 MIT 77 Massachusetts Av
United States
arodoni@mit.edu

Oğuz, Osman
Bilkent University
Turkey
ooguz@bilkent.edu.tr

Oguz, Ceyda
The Hong Kong Polytechnic University
Hung Hom, Kowloon
Hong Kong
msceyda@polyu.edu.hk

Oh, Sewon
ETRI
161, Gajeong-Dong, Yuseong-Gu, Daejeon
South Korea
sewonoh@etri.re.kr

Okten, Giray
Ball State University
2000 W.University Ave.
United States
gokten@bsu.edu

Olafsson, Snjolfur
University of Iceland
Oddi
Iceland
snjolfur@hi.is

Olinick, Eli
SMU
PO Box 750123

United States
olinick@engr.smu.edu

Oliva, Cristian
University of Avignon
29 avenue des lierres
France
cristian.oliva@lia.univ-avignon.fr

Oliveira, Jose Fernando
FEUP/INESC Porto
Rua Dr. Roberto Frias NIF - 600 027 716
Portugal
jfo@fe.up.pt

Oluwaseun Olugbemi, Dada
Discovery Intenational Limited
35 Maye Street SABO
Nigeria
discoveryinternational_limited@hotmail.com

Omero, Marta
University of Trieste
Via A. Valerio, 10
Italy
omero@units.it

Onal, Hayri
University of Illinois
305 Mumford Hall1301 W. Gregory Dr.
United States
h-onal@uiuc.edu

Onculer, Ayse
INSEAD
Blv de Constance
France
ayse.onculer@insead.edu

Onn, Shmuel
Technion - Israel Institute of Technology
Technion City
Israel
onn@ie.technion.ac.il

Or, İlhan
Boğaziçi University
Bebek
Turkey
or@boun.edu.tr

Orbak, Ali Yurdun
Plajyolu Kadiraga sokak No:43 D:8
Caddebostan
Turkey
orbak@alum.mit.edu

Ordin, Burak
Ege University
Department of Mathematics
Turkey
bordin@sci.ege.edu.tr

Oren, Shmuel
UC Berkeley
4119 Etcheverry Hall, California
United States
oren@ieor.berkeley.edu

Oriolo, Gianpaolo
Università degli Studi di Roma "Tor Vergata"
Via del Politecnico,1
Italy
oriolo@disp.uniroma2.it

Orman, Zeynep
Marmara University
Göztepe Kampüsü
Turkey
zeynep_orman@yahoo.com

Oron, Daniel
The Hebrew University of Jerusalem
Business School Mount Scopus Campus
Israel
msdanno@mscc.huji.ac.il

Ortobelli, Sergio
University of Bergamo
Via dei Caniana, 2
Italy
sol@unibg.it

Oruç, Cihan
Koç University
Rumeli Feneri Yolu Sarıyer
Turkey
coruc@ku.edu.tr

Osman, Ibrahim
American University of Beirut
Bliss Street,
Lebanon
ibrahim.osman@aub.edu.lb

Osorio-Lama, Maria
Autonomous University of Puebla
Calle Pino 128-5 Col. Bugambilias
Mexico
aosorio@cs.buap.mx

Otilija, Sedlak
University of Belgrade
Faculty of Economics
Put M.Pijade 9-11
Serbia and Montenegro
otilijas@eccf.su.ac.yu

Otto, Peter
Dowling College
Idl Houre Blv.
United States
ottop@dowling.edu

Ouwehand, Pim
Technische Universiteit Eindhoven
P. O. Box 513 Pav. E.08
Netherlands
p.ouwehand@tm.tue.nl

Owusu, Gilbert
BT
MLB1/pp12 Adastral ParkMartlesham Heath
United Kingdom
gilbert.owusu@bt.com

Oyama, Tatsuo
National Graduate Institute for Policy S
2-2 Wakamatsu-cho Shinjuku-ku
Japan
oyamat@grips.ac.jp

Ozbay, Kaan
Rutgers University
623 Bowser Road
United States
kaan@rci.rutgers.edu

Ozcan, Gokce
Princeton University
88 College Road West, Alexandar Street
United States
gozcan@princeton.edu

Ozcelik, Yasin
Purdue University
1310 Krannert Building
United States
ozcelik@mgmt.purdue.edu

Ozdaglar, Asuman
Massachusetts Institute of Technology
77 Mass Ave.
United States
asuman@mit.edu

Ozdemir, Deniz
INSEAD
Boulevard de Constance
France
deniz.ozdemir@insead.edu

Ozden, Mufit
Miami University
String Str.
United States
ozdenm@muohio.edu

Özekici, Süleyman
Koç University
Turkey
sozekici@ku.edu.tr

Ozen, Umit
Planetenweg 76-78
Netherlands
umit.ozen@dupontsa.com

Ozer, Ozalp
Stanford University
314 Terman
United States
ozalp@stanford.edu

Özkal-Şanver, İpek
Bilgi University
İnönü Cad. No 28 Kuştepe
Turkey
isanver@bilgi.edu.tr

Ozluk, Ozgur
San Francisco State University
1311 Ulloa Street
United States
ozgur@sfsu.edu

Ozok, Ant
University of Maryland
1000 Hilltop Circle
United States
ozok@umbc.edu

Participant List

Öncan, Temel
Galatasaray University
Çırağan Cad. No 36
Turkey
ytoncan@gsu.edu.tr

Öner, Kurtuluş Barış
Boğaziçi University
Bebek
Turkey
onerb@boun.edu.tr

Öner, Selma
Boğaziçi University
İşkuleler Cam Kule kat:13 Levent
Turkey
selmao@sisecam.com.tr

Önkal-Atay, Dilek
Bilkent University
Faculty Of Business Administration
Turkey
onkal@bilkent.edu.tr

Örmeci, E. Lerzan
Koç University
Rumeli Feneri Yolu
Turkey
lormeci@ku.edu.tr

Örnek, Arslan
Izmir Institute of Technology
Gaziosmanpaşa Bulv. No.16, Çankaya
Turkey
arslanornek@iyte.edu.tr

Özatalay, Savas
Widener University
United States
sxo0001@mail.widener.edu

Özaydın, Ekim
Sabancı University
Orhanlı, Tuzla
Turkey
ekimozaydin@su.sabanciuniv.edu

Özcan, Ozan
TÜSSİDE-TÜBİTAK
Barış Mah. Koşuyolu Cad. No:48 Gebze
Turkey
oozcan@tusside.gov.tr

Özcan, Yasar
Virginia Commonwealth University
United States
yaozcan@vcu.edu

Özçelik, Feriştah
Osmangazı University
Industrial Engineering Department
Turkey
fdurmaz@ogu.edu.tr

Özdemir, H. Murat
Sabancı University
Orhanlı, Tuzla
Turkey
ozdemir@su.sabanciuniv.edu

Özdemir, Müjgan
Osmangazi University
Bademlik
Turkey
mujgano@ogu.edu.tr

Özdemir, Özlem
Yeditepe University
Turkey
oozdemir@yeditepe.edu.tr

Özdemir, Rifat Gürcan
İstanbul Kültür University
E-5 Karayolu, No:22
Turkey
rg.ozdemir@iku.edu.tr

Özdemirel, Nur Evin
METU
Turkey
nurevin@ie.metu.edu.tr

Özener, Okan Orsan
METU
Turkey
orsan@ie.metu.edu.tr

Özerol, Gül
Ziraat Bankası
Tandoğan Hizmet Binası Kat:1
GMK Bulvarı No:164
Turkey
gulozerol@yahoo.com

Özgen, Hacer
Hacettepe University
Samanpazarı
Turkey
hozgen@hacettepe.edu.tr

Özkaynak, Mustafa
TÜSSİDE
Baris Mah. Kosuyolu Cad. No:48 Gebze
Turkey
mozkaynak@tusside.gov.tr

Özkısacık, Kerem
Boğaziçi University
Bebek
Turkey
keremo@boun.edu.tr

Özlen, Melih
METU
Turkey
melih@ie.metu.edu.tr

Özmutlu, Seda
Uludağ University
Mühendislik-Mimarlık Fakültesi
Görükle Kampüsü
Turkey
seda@uludag.edu.tr

Özsoy, Aykut
Bilkent University
Industrial Engineering Department
Turkey
aykut@bilkent.edu.tr

Öztürk, Bilgen
Boğaziçi University
Bebek
Turkey
bozturk@boun.edu.tr

P

Pachamanova, Dessislava
Babson College
319 Babson Hall Babson College
United States
dpachamanova@babson.edu

Pacheco, António
Instituto Superior Técnico
Av. Rovisco Pais 1
Portugal
apacheco@math.ist.utl.pt

Pacifici, Andrea
Università degli Studi di Roma "Tor Vergata"
Via del Politecnico, 1
Italy
andrea.pacifici@uniroma2.it

Paias, Ana
CIO - DEIO
DEIO, FCUL Bloco C2, piso 2 Campo Grande
Cidade Universitária
Portugal
ampaias@fc.ul.pt

Pakdil, Fatma
Uludağ University
Turkey
fpakdil@uludag.edu.tr

Pala, Ozge
Nijmegen University
Thomas van Aquinostraat 5.0.77
P.O. Box 9108
Netherlands
o.pala@nsm.kun.nl

Pallottino, Stefano
University of Pisa
Via F. Buonarroti, 2
Italy
pallo@di.unipi.it

Panagiotidou, Sophia
Aristoteles University of Thessaloniki
University Campus P.O. Box 461
Greece
span@auth.gr

Pankova, Vaclava
University of Economics, Prague
W. Churchill Sq.4
Czech Republic
pankova@vse.cz

Pankratz, Giselher
University of Hagen
Profilstrasse 8
Germany
giselher.pankratz@fernuni-hagen.de

Papadakis, Yanni
Drexel University
3141 Chestnut Street
United States
isp@drexel.edu

Papadimitriou, Thanos
UCLA
The Anderson School at UCLA
110 Westwood Plaza, Suite B501 Box 951481
United States
apapadim@anderson.ucla.edu

Papamichail, K. Nadia
Manchester University
Booth Street West.
United Kingdom
nadia.papamichail@mbs.ac.uk

Pappis, Costas P.
University of Piraeus
80 Karaoli & Dimitriou str.
Greece
pappis@unipi.gr

Paralikas, Apostolos
National Technical University of Athens
Zografos Campus, Zografos
Greece
aparal@tee.gr

Park, Chan S.
Auburn University
204 Dunstan Hall
United States
park@eng.auburn.edu

Parkan, Celik
Long Island University
9 Soundcrest Lane
United States
cparkan@liu.edu

Parlar, Mahmut
McMaster University
1280 Main St. W.
Canada
parlar@mcmaster.ca

Parreno, Francisco
Castilla La Mancha University
C/ Pozo Posadas,18
Spain
fparreno@al-basit.info-ab.uclm.es

Paschalidis, Yannis
Boston University
15 St. Mary's St.
United States
yannisp@bu.edu

Passerini, Katia
NJIT
Via Ostiense 121
Italy
pkatia@gwu.edu

Pastor, Jesús T.
Universidad Miguel Hernandez
Avd. Del Ferrocarril
Spain
jtpastor@umh.es

Pastor, José Manuel
Universitat de Valencia e Ivie
Avenida de los Naranjos s/n
Spain
jose.m.pastor@uv.es

Patton, Pandora
University of the Nations
12 SRI DONCHAI
Thailand
pandoraletitia@yahoo.com

Pauwels, Koen
Tuck School of Business at Dartmouth
212 Tuck Hall
United States
koen.h.pauwels@dartmouth.edu

Pavlicic, Dubravka
University of Belgrade
Kamenicka 6
Serbia and Montenegro
dubravka@one.ekof.bg.ac.yu

Pavlov, Oleg
Worcester Polytechnic Institute
100 Institute Road
United States
opavlov@wpi.edu

Pavloviæ, Ljiljana
University of Krag
Radoja Domanovica 12
Serbia and Montenegro
pavlovic@knez.uis.kg.ac.yu

Pawlak, Grzegorz
Poznan Institute of Technology
Institude of Computing Science
Piotrowo 3A
Poland
grzegorz.pawlak@cs.put.poznan.pl

Paşaoğlu, Güzay
İstanbul Kültür University
E5 Karayolu Üzeri
Turkey
g.pasaoglu@iku.edu.tr

Peeters, Marc
CWI
PO BOX 94079
Netherlands
m.peeters@reizigers.ns.nl

Pekgün, Pelin
Georgia Tech
328988 Georgia Tech Station
United States
gtg568e@mail.gatech.edu

Pelizzari, Cristian
University of Brescia
Contrada S. Chiara, 50
Italy
pelizcri@eco.unibs.it

Pellizzari, Paolo
University of Venice
Dorsoduro 3825/E
Italy
paolop@unive.it

Pelzer, Edith
People SPRL
22 Avenue de la Laiterie
Belgium
edith.pelzer@skynet.be

Penn, Michal
Technion
Technion City
Israel
mpenn@ie.technion.ac.il

Perakis, Georgia
Massachusetts Institute of Technology
50 Memorial Drive Rm E53-359
United States
georgiap@mit.edu

Percy, David F.
University of Salford
Maxwell Building, The Crescent
United Kingdom
d.f.percy@salford.ac.uk

Pérez, Eloy
Université de Lausanne
BFSH1
Switzerland
eloy.perez@hec.unil.ch

Perez, Mª Angeles
Universidad De Valencia
Doctor Moliner, 50
Spain
angeles.perez@uv.es

Pérez, Yezid Orlando
Javeriana University
Carrera 7 No:40-62
Colombia
yperez@javeriana.edu.co

Persson, Fredrik
Linköping Institute of Technology
Sweden
fredrik.persson@ipe.liu.se

Pesch, Erwin
University of Siegen
Hölderlinstr. 3
Germany
pesch@fb5.uni-siegen.de

Pesen, Şafak
METU
Turkey
osinda1@yahoo.com

Peter, Tumbas
University of Belgrade
Faculty of Economics
Put M.Pijade 9-11
Serbia and Montenegro
ptumbas@eccf.su.ac.yu

Participant List

Peters, Lois
Rensselaer Polytechnic Institute
110 8th Street Pittsburgh Bld 3200
United States
robiln@rpi.edu

Petkov, Doncho
Eastern Connecticut State University
83 Windham St
United States
petkovd@easternct.edu

Petrosyan, Vardan
Yerevan State University
Alex Manoogian 1
Armenia
vvpetrosyan@yahoo.com

Petrovic, Sanja
University of Nottingham
Jubilee Campus Wallaton Road
United Kingdom
sxp@cs.nott.ac.uk

Petrovic, Slavica P.
Faculty of Economics
D Pucara 3
Serbia and Montenegro
pslavica@ptt.yu

Pettersen, Erling
Norwegian University of Science and Tech
IOT Alfred Getz' v. 1
Norway
erling.pettersen@iot.ntnu.no

Peyer, Sven
University of Bonn
Lennestr. 2
Germany
peyer@or.uni-bonn.de

Pflug, Georg
University of Vienna
Liechterstein strasse 30
Austria
georg.pflug@univie.ac.at

Phillips, Robert
Columbia University
2290 Yale St.
United States
rp2051@columbia.edu

Pidd, Michael
Lancaster University
Management School, Bailrigg
United Kingdom
m.pidd@lancaster.ac.uk

Pınar, Mustafa
Bilkent University
Faculty of Engineering
Turkey
mustafap@bilkent.edu.tr

Pince, Çerağ
Bilkent University
Rektörlük Binası
Turkey
cerag@bilkent.edu.tr

Pinhas, David
Boğaziçi University
Bebek
Turkey
pinhas@boun.edu.tr

Piramuthu, Selwyn
University of Florida
351 Stuzin Hall
United States
selwyn@ufl.edu

Pirayesh, Ali
Sharif University of Technology
Tehran
Iran
a_pirayesh@mehr.sharif.edu

Pirlot, Marc
FPMs
Rue de Houdain 9
Belgium
marc.pirlot@fpms.ac.be

Pizarro, Celeste
Universidad Rey Juan Carlos
C/Tulipán,S/N Departamental Ii
Spain
cpizarro@escet.urjc.es

Pla, Lluis M.
University of Lleida
Fac. Derecho y Economia Jaume II, 73
Spain
lmpla@matematica.udl.es

Ploog, Martin
TU Braunschweig
Katharinenstraße 3
Germany
m.ploog@tu-bs.de

Podinovski, Victor
University of Warwick
Gibbet Hill Road
United Kingdom
v.podinovski@warwick.ac.uk

Podobedov, Vitaly
STB CARD
Smolnaya str. 22
Russia
podobedov@paytech.ru

Pohler, Matthias
Dresden University of Technology
Helmholtzstrasse 10
Germany
matthias.pohler@mailbox.tu-dresden.de

Polat, Ayçin
Boğaziçi University
Bebek
Turkey
polatayc@boun.edu.tr

Popescu, Ioana
INSEAD
Blvd. de Conastance
France
ioana.popescu@insead.edu

Popova, Elmira
University of Texas at Austin
1 University Station C2200
United States
elmira@mail.utexas.edu

Popovic, Zeljko
Parsons Brinkerhoff - PB Power Ltd.
PO Box 47445
United Arab Emirates
popovicz@pb-middleeast.com

Porras, Eric
Erasmus University Rotterdam
Econometric Institute, P.O. Box 1738
Netherlands
porrasmusalem@few.eur.nl

Portela, Maria
Portuguese Catholic University
Rua Diogo Botelho, 1327
Portugal
csilva@porto.ucp.pt

Possani, Edgar
Universtiy of Southampton
Highfield
United Kingdom
epossani@socsci.soton.ac.uk

Pot, Auke
Free University
De Boelelaan 1081a
Netherlands
sapot@cs.vu.nl

Potts, Chris
University of Southampton
Highfield
United Kingdom
vp2@euro-online.org

Powell, Naomi
University of Southampton
Faculty of Mathematics
United Kingdom
n.h.powell@maths.soton.ac.uk

Prahinski, Carol
University of Western Ontario
1151 Richmond St.
Canada
cprahinski@ivey.uwo.ca

Prekopa, Andras
Rutgers University
Rutgers Center for Operations Research
New Brunswick, NJ
United States
prekopa@rutcor.rutgers.edu

Primbs, James
Stanford University
444 Terman Engr. Ctr.
United States
japrimbs@stanford.edu

Printezis, Antonis
Case Western Reserve University
2435 Overlook Rd. Apt #36

United States
antp@cwru.edu

Proietti, Guido
University of L'Aquila
Via Vetoio, Coppito
Italy
proietti@di.univaq.it

Pulat, Pakize
University of Oklahoma
Carson Room 124 202 West Boyd
United States
pulat@ou.edu

Punkka, Antti
Helsinki University of Technology
Otakaari 1 M, P.O.Box 1100
Finland
antti.punkka@hut.fi

Q

Qi, Thomas
JP Morgan Chase
900 Stewart Avenue 4th Floor
United States
thomas.qi@chase.com

Quadt, Daniel
Catholic University of Eichstaett-Ingols
Auf der Schanz 49
Germany
daniel.quadt@ku-eichstaett.de

Quindos, Mª del Pilar
University of Oviedo
Facultad de CC. Económicas Campus del Cristo
Spain
pqmoran@correo.uniovi.es

Quintanilla, Sacramento
Universidad de Valencia
Doctor Moliner, 50
Spain
maria.quintanilla@uv.es

R

Radfar, Reza
I.A.U.
Iran
radfar@mcg-co.com

Radjef, Mohammed Said
University of Bejaia
Algeria
msradjef@hotmail.com

Radulescu, Constanta Zoie
Research Institude for Information
8-10 Avereson Avenue
Romania
radulescu@ici.ro

Rahaniotis, Nikolaos
University of Piraeus
80 Karaoli & dimitriou str.
Greece
nraxan@unipi.gr

Raith, Matthias
Otto-von-Guericke-Universität Magdeburg
P.O. Box 4120
Germany
matthias.raith@wirtschafts-w.uni-magdeburg.de

Raman, Kalyan
University of Michigan Flint
509 N. Harrison Street
United States
kalyanr@umich.edu

Ramdas, Kamalini
University of Virginia
721 Lexington Avenue
United States
ramdask@darden.virginia.edu

Rand, Graham
Lancaster University
Management School
United Kingdom
g.rand@lancaster.ac.uk

Rappold, James
University of Wisconsin-Madison
975 University Ave.
United States
jrappold@bus.wisc.edu

Rauner, Alexander
Austria perspektiv - Ein Institut der Ös
Wiedner Hauptstraße 73
Austria
alexander.rauner@austriaperspektiv.at

Rauner, Marion
University of Vienna
Bruennerstr. 72
Austria
marion.rauner@univie.ac.at

Ravindran, James
Quality Reimbursement Services
150 N Santa Anita Ave, Suite 570A
United States
corporate@qualityreimbursement.com

Raz, Gal
Australian Graduate School of Management
Room 205, UNSW
Australia
galraz@agsm.edu.au

Rebstock, Michael
FH Darmstadt University of Applied Sciences
Haardtring 100
Germany
rebstock@t-online.de

Reda, Malak
Maastricht School of Management
Egypt
mreda@soficom.com.eg

Reeves, Colin
Coventry University
United Kingdom
srx014@coventry.ac.uk

Reis, Richard
Stanford University
Building 530, Room 225 440 Escondido Mall
United States
reis@stanford.edu

Resing, Jacques
Technische Universiteit Eindhoven
Den Dolech 2
Netherlands
j.a.c.resing@tue.nl

Resteanu, Cornel
ICI
8-10 Averescu Avenue
Romania
resteanu@ici.ro

Resteanu, Cornel
National Institute for R&D in Informatic
8-10 Averescu Avenue
Romania
resteanu@ici.ro

Ribeiro, Isabel
Universidade do Porto
Faculdade de Engenharia
Rua Dr. Roberto Frias, s/n
Portugal
iribeiro@fe.up.pt

Ricca, Federica
Università degli Studi di Roma "La Sapienza"
P.le Aldo Moro 5
Italy
federica.ricca@uniroma1.it

Ricciardi, Nicoletta
Università degli Studi di Roma "La Sapienza"
Piazzale Aldo Moro 5
Italy
nicoletta.ricciardi@uniroma1.it

Ridder, Ad
Vrije Universiteit Amsterdam
De Boelelaan 1105
Netherlands
aridder@feweb.vu.nl

Riesgo, Laura
Pablo de Olavide University
CTRA. Utrera, KM. 1
Spain
lriealv@dee.upo.es

Rinaldi, Giovanni
IASI - CNR
Viale Manzoni 30
Italy
rinaldi@iasi.rm.cnr.it

Rindfleisch, Aric
University of Wisconsin

Participant List

975 University Avenue
United States
aric@bus.wisc.edu

Rinnooy Kan, Alexander H.G.
Netherlands

Rismondo, Silvia
Tor Vergata University
Via del Politecnico 1
Italy
rismondo@disp.uniroma2.it

Rivano, Hervé
CNRS/INRIA/FT RD
2000 route des Lucioles
France
herve.rivano@sophia.inria.fr

Rodrigues, Rita
INPE
Av. dos Astronaoutas 1758 Jardim da Granja
Brazil
rita@lac.inpc.br

Rodríguez, Victoria
MIK
Uribarri Etorbidea,3
Spain
vrodriguez@tecnun.es

Roig-Sannemann, Gustavo Daniel
Itaipu Binacional Hydroelectric Power
Av. Silvio Americo Sasdelli 2882
Brazil
groig@itaipu.gov.py

Rom, Walter
Cleveland State University
1860 E. 18 St.
United States
w.rom@csuohio.edu

Romanin-Jacur, Giorgio
University of Padova
Stradella San Nicola, 3
Italy
romjac@dei.unipd.it

Romano, Simon Pietro
University of Napoli
Via Claudio 21
Italy
spromano@unina.it

Romero, Carlos
Technical University of Madrid
Avda. Ramiro de maeztu s/n
Spain
auggiegp@montes.upm.es

Rosehart, William
University of Calgary
2500 University Drive N.W.
Canada
rosehart@enel.ucalgary.ca

Rosenthal, Richard
Department of Operations Research
Naval Postgraduate School
United States
rrosenthal@nps.navy.mil

Rossello, Damiano
Faculty of Economics
Corso Italia, 55
Italy
rossello@unict.it

Roucairol, Catherine
University of Versailles
45 Avenue des Etats Unis
France
catherine.roucairol@prism.uvsq.fr

Roy, Bernard
Paris-Dauphine University
Place du M^{al} de Lattre de Tassigny
75775 Paris Cedex 16
France

Rozakis, Stelios
INRA
UMR Economie Grignon
France
rozakis@inra.grignon.fr

Ruggeri, Fabrizio
CNR-IMATI
Via Bassini 15
Italy
fabrizio@mi.imati.cnr.it

Ruhhal, Nasser
King Fahd University
PO Box 1411
Saudi Arabia
ruhhal@ccse.kfupm.edu.sa

Ruiz, Jose L.
Universidad Miguel Hernandez
Avd. del Ferrocarril
Spain
jlruiz@umh.es

Ruiz, Ruben
Universidad Politécnica de Valencia
DEIOAC, Edificio I-3,Camino de Vera S/N
Spain
rruiz@eio.upv.es

Ruzzier, Christian
Universidad Argentina de la Empresa
Lima 717 1° Floor
Argentina
cruzzier@uade.edu.ar

Ryu, Hoyeol
KAIST
IE Dept. VMS Lab.373-1 Guseong-dong,
Yuseong-gu
South Korea
mrbrown@vmslab.kaist.ac.kr

Rüzgar, Bahadtin
Marmara University
Barbaros Mah. Nuhkuyusu Cad.
Hakses Apt. No:60/6 Pazarbaşı-Üsküdar
Turkey
bruzgar@marmara.edu.tr

Rönnqvist, Mikael
Linköping University
Sweden
miron@mai.liu.se

S

Saatçioğlu, Ömer
METU
İnönü Blv.
Turkey
omers@ie.metu.edu.tr

Sabuncuoğlu, İhsan
Bilkent University
Turkey
sabun@bilkent.edu.tr

Sacco, Nicola
Politecnico di Torino
C.so Duca degli Abruzzi, 24
Italy
nicola.sacco@polito.it

Sadeh, Arik
Holon Academic Institute of Technology
52 Golomb St.
Israel
sadeh@hait.ac.il

Safi Samghabadi, Azamdokht
Tarbiat Modarres University
Jalal e al e Ahmad Ave.
Tehran
Iran
safi_a@modares.ac.ir

Sahin, Evren
Ecole Centrale Paris
Laboratoire Génie Industriel Grande Voie des Vignes
France
evren@lgi.ecp.fr

Sahin, Funda
The University of Tennessee
College of Business 310 Stokely Management Center
United States
fsahin@utk.edu

Sak, Halis
Boğaziçi University
Bebek
Turkey
halis_sak@yahoo.com

Sakalauskas, Leonidas
The Lithuanian State Research Institute of Mathematics and Informatics
Lithuania
sakal@ktl.mii.et

Salimifard, Khodakaram
Lancaster University
Bailrigg
United Kingdom
k.salimifard@lancaster.ac.uk

Salo, Ahti
Helsinki University of Technology
P.O. Box 1100 Otakaari 1 M
Finland
ahti.salo@hut.fi

Samanlioglu, Funda
Clemson University
806 College Avenue Apt # 14
United States
fsamanl@clemson.edu

San Matías, Susana
Universidad Politecnica de Valencia
Camino de Vera
Spain
ssanmat@eio.upv.es

Sanguineti, Marcello
University of Genoa
Via Opera Pia, 13
Italy
marcello@dist.unige.it

Sansò, Brunilde
École Polytechnique de Montréal
C.P.6079 succ Centre-Ville
Canada
bruni@crt.umontreal.ca

Sanver, Remzi
Bilgi University
İnönü Cad. No 28 Kuştepe
Turkey
sanver@bilgi.edu.tr

Sarfaraz, Ahmad Reza
California State University, Northridge
18111 Nordhoff Street
United States
sarfaraz@ecs.csun.edu

Sargent, Robert
Syracuse University
United States
rsargent@ecs.syr.edu

Sarigollu, Emine
McGill University
1001 Sherbrooke St. W.
Canada
emine.sarigollu@mcgill.ca

Sarin, Rakesh
Univesity of California, LA
United States
rakesh.sarin@anderson.ucla.edu

Sarı, Kazım
Beykent University
Beylikdüzü Gürpınar E-5 Yol Ayırımı
Beykent
Turkey
kazims@beykent.edu.tr

Sarıca, Kemal
Boğaziçi University
Bebek
Turkey
saricake@boun.edu.tr

Sarıçiçek, İnci
Osmangazi Üniversitesi
Müh. Mim. Fak. Endüstri Müh. Böl.
Turkey
incid@ogu.edu.tr

Sasaki, Mihiro
Nanzan University
27 Seirei
Japan
mihiro@ms.nanzan-u.ac.jp

Sashi, C. M.
Florida Atlantic University
710 NE 36 ST
United States
sashic@fau.edu

Sato, Yuji
Matsusaka University
1846 Kubo
Japan
ysatoh@matsusaka-u.ac.jp

Saunders, David
University of Pittsburgh
301 Thackeray Hall, Department of Mathematics
United States
saunders@math.pitt.edu

Savic, Ana
College for Engineering
Obilicev Venac 1
Serbia and Montenegro
anas@vets.edu.yu

Sawaki, Katsushige
Nanzan University
18 Yamazato-cho Showa-ku
Japan
sawaki@nanzan-u.ac.jp

Sawicki, Piotr
Poznan University
3. Piotrowo st.
Poland
piotr.sawicki@put.poznan.pl

Sawik, Tadeusz
AGH-UST
Al. Mickiewicza 30
Poland
ghsawik@cyf-kr.edu.pl

Saydam, Cem
UNC Charlotte
9201 Univ City Blvd College of Business
United States
saydam@email.uncc.edu

Sayin, Serpil
Koç University
Rumeli Feneri Yolu, Sarıyer
Turkey
ssayin@ku.edu.tr

Sayman, Serdar
Koç University
Rumeli Feneri Yolu, Sarıyer
Turkey
ssayman@ku.edu.tr

Saysel, Ali Kerem
University of Bergen
Hermanfossgaten 6
Norway
ali@ifi.uib.no

Scardovi, Luca
University of Genoa
Via all'Opera Pia 13
Italy
lucas@dist.unige.it

Scarf, Philip
University of Salford
Maxwell Building Rm 509
United Kingdom
p.a.scarf@salford.ac.uk

Schade, Christian
Humboldt-Universität zu Berlin
Spandauer Strasse 1
Germany
schade@wiwi.hu-berlin.de

Schaffhauser-Linzatti, Michaela
University of Vienna
Bruennerstrasse 72
Austria
michaela.linzatti@univie.ac.at

Scheer, August-Wilhelm
Universität des Saarlandes
Germany
scheer@iwi.uni-sb.de

Scheimberg, Susana
Professor
Centro de Tecnologia Bl. H/319 Cidade Universitária Cx.Postal 68511
Brazil
susana@cos.ufrj.br

Scheinberg, Katya
IBM Research
1101 Kitchewan Rd.rt 134 & Taconic
United States
katyas@watson.ibm.com

Scheubrein, Beate Carina
University of Hohenheim
Schloss Osthof-Nord
Germany
beate@scheubrein.de

Scheubrein, Ralph
University of Hohenheim
Schloss Osthof-Nord
Germany
ralph@scheubrein.de

Schieber, Baruch
IBM Research
P.O. Box 218
United States
sbar@us.ibm.com

Participant List

Schmedders, Karl
Northwestern University
KSM-MEDS 5th floor 2001 Sheridan Rd
United States
k-schmedders@kellogg.northwestern.edu

Schneeweiss, Christoph
University of Mannheim
Schluss
Germany
schneeweis@bwl.uni-mannheim.de

Schoebel, Anita
University of Kaiserslautern
Postfach 3049
Germany
schoebel@mathematik.uni-kl.de

Scholl, Susanne
Universitaet Kaiserslautern
Gaustraße 6a
Germany
sscholl@mathematik.uni-kl.de

Schroeder, Andreas
Humboldt-Universität zu Berlin
Spandauer Strasse 1
Germany
aschroed@wiwi.hu-berlin.de

Schryen, Guido
University of Technology Aachen
Templergraben 64
Germany
schryen@winfor.rwth-aachen.de

Schultmann, Frank
University of Karlsruhe
Hertzstrasse 16
Germany
frank.schultmann@wiwi.uni-karlsruhe.de

Schwartz, Leroy
Purdue University
808 Carrolton Blvd
United States
lee@krannert.purdue.edu

Schwindt, Christoph
University of Karlsruhe
Kaiserstrasse 12
Germany
schwindt@wior.uni-karlsruhe.de

Scozzari, Andrea
Università degli Studi di Roma "La Sapienza"
Via del Castro Laurenziano 9
Italy
andrea.scozzari@uniroma1.it

Segura, José Vicente
Universidad De Valencia
Doctor Moliner, 50
Spain
jush@umh.es

Sekiguchi, Yasuki
Hokkaido University
Kita 9 Nishi 7 Kita-ku
Japan
seki@econ.hokudai.ac.jp

Selçuk, Barış
Tweelingenlaan 80
Netherlands
b.selcuk@tm.teu.nl

Selim, Hasan
Dokuz Eylül University
Ege Üniv. Kampüsü B-Blok Bornova
Turkey
hasan.selim@deu.edu.tr

Semet, Frederic
LAMIH-ROI Université de Valenciennes
Le Mont Houy
France
frederic.semet@univ-valenciennes.fr

Şen, Alper
Bilkent University
Turkey
alpersen@bilkent.edu.tr

Sepil, Canan
METU
Turkey
sepil@ie.metu.edu.tr

Sergio, Perelman
University of Liege
Bd. du Rectorat 7 (B31)
Belgium
sergio.perelman@ulg.ac.be

Serin, Yasemin
METU
Turkey
serin@ie.metu.edu.tr

Serrano, Lorenzo
Universitat de Valencia & Ivie
Avda. dels Tarongers s/n
Spain
lorenzo.serrano@uv.es

Serrão, Amílcar
Universidade de Evora
Largo dos Colegiais
Portugal
amilcar-serrao@clix.pt

Sevin, Umut
Boğaziçi University
Tevfik Sağlam Cad. Enünlü Ap. 12/A No:11
Küçükyalı
Turkey
umutsevin@yahoo.com

Şevkli, Mehmet
Fatih University
Büyükçekmece
Turkey
msevkli@fatih.edu.tr

Sezer, Semih Onur
Princeton University
88 College Rd. W. Alexander Street
United States
ssezer@princeton.edu

Sforza, Antonio
Università di Napoli "Federico II"
Vice Chudin 21
Italy
sforza@unina.it

Shahalizadeh, Mohammad
Islamic Acad University
Management & Accounting School
Yakhchal Ave.
Iran
mshahalizadeh@hotmail.com

Shaked, Moshe
University of Arizona
617 North Santa Rita
United States
shaked@math.arizona.edu

Shakun, Melvin
New York University
273 Dover Road
United States
mshakun@stern.nyu.edu

Shalaby, Amer
University of Toronto
35 St. George St.
Canada
amer@ecf.utoronto.ca

Sharif Yazdi, Mehdi
Sharif University of Technology
Dept. of Industrial Engineering, Azadi Ave.
Tehran
Iran
sharifyazdi@mehr.sharif.edu

Shavandi, Hassan
Sharif University of Technology
Azadi Ave.
Iran
hsahavandi@yahoo.com

Sher, Mali
Israel Poice & Hebrew University
Rechov Kipodan 15/2
Israel
mali_sher@yahoo.com

Sherali, Hanif
Virginia Tech
250 Durham Hall
United States
hanifs@vt.edu

Shibata, Takashi
Kyoto University in Japan
Daiwa-shoken-simoochiai-ryo 502,1-1-29
Nakaochiai, Shinjyuku-ward
Japan
tshibata@poplar.ocn.ne.jp

Shimkin, Nahum
Technion
Electrical Engineering
Israel
shimkin@ee.technion.ac.il

Shinmura, Shuichi
Seikei University
Kichijoji Kitamachi 3-3-1, Musashinoshi
Japan
shinmura@econ.seikei.ac.jp

Shmueli, Galit
University of Maryland
4361 Van Munching Hall, Robert H. Smith School of Business
United States
gshmueli@rhsmith.umd.edu

Shumsky, Robert
University of Rochester
Simon School
United States
shumsky@simon.rochester.edu

Sigl, Thomas
Fraunhofer IIS
Nordostpark 91/93
Germany
sigl@atl.fraunhofer.de

Silva, Jose
Haas School of Business
S545 Student Services Building #1900
United States
silva@haas.berkeley.edu

Simchi-Levi, David
Massachusetts Institute of Technology
77 Massachusetts Avenue
United States
dslevi@mit.edu

Simeone, Bruno
Università degli Studi di Roma "La Sapienza"
Piazzale Aldo Moro 5
Italy
bruno.simeone@uniroma1.it

Simga-Mugan, Can
Bilkent University
Turkey
simga@bilkent.edu.tr

Simsek, Koray
Princeton University
Department of ORFE
United States
ksimsek@princeton.edu

Şimşir, Fuat
Sakarya University
Esentepe Kampüsü Endüstri Mühendisliği Bölümü
Turkey
fsimsir@sakarya.edu.tr

Sinay, Maria Cristina
Military Institute of Engineering
Praca General Tiburcio 80, Praia Vermelha
Brazil
d2mcris@epq.ime.eb.br

Singh, Surendra
University of Kansas
1300 Sunnyside Avenue
Uzbekistan
ssingh@ku.edu

Sinuany-Stern, Zilla
Ben Gurion University of the Negev
P.O. Box 653
Israel
vp1@euro-online.org

Sipper, Dan
Tel Aviv university
Ramat Aviv
Israel
sipperds@netvision.net.il

Sirvent, Inmaculada
Universidad Miguel Hernandez
Avd. Del Ferrocarril
Spain
isirvent@umh.es

Sivrikaya Şerifoğlu, Funda
Abant İzzet Baysal Üniversitesi
Gölköy
Turkey
fss@ibu.edu.tr

Skelly, Ivan
University College Dublin
Quinn School of Business, Belfield Campus
Ireland
ivan.skelly@ucd.ie

Skorin-Kapov, Darko
Adelphi University
1 South Av.
United States
skorin@adelphi.edu

Skorin-Kapov, Jadranka
Stony Brook University
Off Nicolls Rd
United States
jskorin@notes.cc.sunysb.edu

Skulimowski, Andrzej M.J.
Academy of Mining & Metallurgy
Al. Mickiewicza 30
Poland
ams@agh.edu.pl

Sleptchenko, Andrei
Technische Universiteit Eindhoven
Den Dolech 2
Netherlands
a.sleptchenko@tue.nl

Slowinski, Roman
Poznan University of Technology
Lab. of Intelligent Decision Support Systems
Street Piotrowo 3a
Poland
slowinsk@sol.put.poznan.pl

Smeers, Yves
Université catholique de Louvain
Voie du Roman Pays 34
Belgium
smeers@core.ucl.ac.be

Smith, David
University of Exeter
School of Mathematical Sciences
United Kingdom
d.k.smith@exeter.ac.uk

Smith, Ricardo
Universidad Nacional
Calle 16 No. 43B - 44, Apto 604
Colombia
rasmith@perseus.unalmed.edu.co

Sniedovich, Moshe
University of Melbourne
Richard Berry Bldg.
Australia
m.sniedovich@ms.unimelb.edu.au

Soldic-Aleksic, Jasna
Faculty of Economics
Kahenicka 6
Serbia and Montenegro
sinalex@eunet.yu

Soloveitchik, David
Ministry of National Infrastructures
216 Jaffo Street
Israel
mosheo@compugen.co.il

Soner, Mete
Koç University
Turkey
msoner@ku.edu.tr

Sood, Anshul
Massachusetts Institute of Technology
1, Amherst St. Building E40-130
United States
anshul@mit.edu

Soofi, Ehsan
University of Wisconsin-Mılwaukee
P.O. BOX 742
United States
esoofi@uwm.edu

Soukhikh, Sergey
Omsk Branch of Sobolev Inst. of Mathematics
13 Pevijov Str.
Russia
soukhikh@iitam.omsk.net.zu

Souren, Rainer
Aachen University
Templergraben 64
Germany
souren@lut.rwth-aachen.de

Sousa Lobo, Miguel
Duke University
Fuqua School of Business Box 90120
United States
mlobo@duke.edu

Sox, Charles
University of Alabama
Box 870226
United States
csox@cba.ua.edu

Participant List

Soyer, Refik
George Washington University
2115 G St, NW, Monroe Hall 403 SBPM
United States
soyer@gwu.edu

Soylu, Banu
METU
Turkey
bsoylu@metu.edu.tr

Sozer, Sevin
Auburn University
207 Dunstan Hall
United States
sozerse@eng.auburn.edu

Spadoni, Gigliola
University of Bologna
Viale Risorgimento 2
Italy
sarah.bonvicini@mail.ing.unibo.it

Speckbacher, Gerhard
Vienna University of Economics
Augasse 2-6
Austria
gerhard.speckbacher@wu-wien.ac.at

Spinler, Stefan
The Wharton School
Braugasse 7
Germany
sspinler@wharton.upenn.edu

Spitter, Judith
Technische Universiteit Eindhoven
Den Dolech 2 P.O. Box 513
Netherlands
j.m.spitter@tm.tue.nl

Spronk, Jaap
Erasmus University Rotterdam
P.O. Box 1738
Netherlands
spronk@few.eur.nl

Srinivasan, Mandyam
The University of Tennessee
611 Stokely Management Center
United States
msrini@utk.edu

Stadtler, Hartmut
Technische Universität Darmstadt
Germany
h.stadtler@web.de

Stahel, Albert A.
Swiss Military Academy
Steinacherstr. 101b
Switzerland
albert.stahel@milak.ethz.ch

Stam, Antonie
University of Missouri
College of Business,418 Cornell Hall
United States
stama@missouri.edu

Stamoulis, George D.
Athens University of Economics and Business
76, Patission Str.
Greece
gstamoul@aueb.gr

Stankosky, Michael
George Washington University
1776 "G" Street, NW Suite 110
United States
mstanko@gwu.edu

Stecke, Kathryn E.
University of Texas at Dallas
2601 N. floyd Road PO Box 830488
United States
kstecke@utdallas.edu

Stein, Oliver
Aachen University
Templergraben 55
Germany
stein@mathc.rwth-aachen.de

Stewart, Kathryn
Napier University
10 Colinton Road
United Kingdom
k.stewart@napier.ac.uk

Stewart, Theodor
University of Cape Town
Private Bag
South Africa
tjstew@stats.uct.ac.za

Still, Georg
University of Twente
P.O.Box 217
Netherlands
g.still@math.utwente.nl

Stohr, Edward A.
Stevens Institute of Technology
Castle Point on Hudson
United States
estohr@stevens-tech.edu

Stolletz, Raik
University of Hannover
TU Clausthal Inst. f. Wirtschaftsw.
Julius-Albert-Str. 2
Germany
raik.stolletz@tu-clausthal.de

Stolyar, Artem
Sobotev Institute of Mathematics
Pr. Akademika Koptyuga, 4
Russia
asto@math.nsc.ru

Stosic, Biljana
University of Belgrade
Faculty of Organizational Sciences
Jove Ilica 154
Serbia and Montenegro
biljst@fon.bg.ac.yu

Strauss, Christine
University of Vienna
Bruenner Strasse 72
Austria
christine.strauss@univie.ac.at

Strelchonok, Vladimir
Baltic Russian Institude
Lomonov Street 4
Latvia
tsi@tsi.lv

Stremersch, Stefan
Erasmus University Rotterdam
Burg. Oudlaan 50
Netherlands
stremersch@few.eur.nl

Stummer, Christian
University of Vienna
Bruenner Str. 72
Austria
christian.stummer@univie.ac.at

Stölting, Wiebke
TU Braunschweig
Katharinenstr. 3
Germany
w.stoelting@tu-bs.de

Suarez Llorens, Alfonso
University of Cádiz
Duque de Nájera N°8
Spain
alfonso.suarez@uca.es

Sudhir, K.
Yale School of Management
135 Prospect Street
United States
sk389@mail.som.yale.edu

Suhl, Leena
University of Paderborn
Warburger Strasse 100
Germany
suhl@upb.de

Sun, Baohong
UNC, Chapel Hill
103 Claris Court
United States
sunb@bschool.unc.edu

Sunam, Arzu R.
Boğaziçi University
Bebek
Turkey
sunam@boun.edu.tr

Sungur, Ilgaz
Boğaziçi University
Bebek
Turkey
ilgazsungur@hotmail.com

Sural, Haldun
METU
İnönü Bulvarı
Turkey
sural@ie.metu.edu.tr

Suzuki, Keiji
Future University-Hakodate
Kamedanakano 116-2
Japan
suzukj@fun.ac.jp

Swann, Julie
Georgia Tech
765 Ferst Drive
United States
julie.swann@isye.gatech.edu

Swiercz, Paul
George Washington University
2215 G. St. NW Monroe 302E
United States
prof1@gwu.edu

Syrjanen, Mikko
Helsinki School of Economics
Runeberginkatu 22-24 P.O.Box 1210
Finland
mikko.syrjanen@hkkk.fi

Sztrik, Janos
U.D.
Egyetem Ter. 1
Hungary
jsztrik@math.klte.hu

Şahin, İsmail
Yıldız Technical University
Beşiktaş
Turkey
sahin@yildiz.edu.tr

Şirvancı, Mete
Koç University
Math. Department, İstanbul
Turkey
msirvanci@ku.edu.tr

T

Tabordon, Nathalie
UCL
Place des Doyens, 1
Belgium
tabordon@poms.ucl.ac.be

Taboubi, Sihem
HEC Montréal
3000 Chemin de la Cote Sainte Catherine
Canada
sihem.taboubi@hec.ca

Tadei, Roberto
Politecnico di Torino
Corso Duca degli Abruzzi 24
Italy
roberto.tadei@polito.it

Tagaras, George
Aristotle University of Thessaloniki
Department of Mechanical Engineering
PO Box 461
Greece
tagaras@auth.gr

Tagg, Roger
University of South Australia
Mawson Lakes Boulevard
Australia
roger.tagg@unisa.edu.au

Taghizadeh Kakhki, Hossein
Ferdowsi University of Mashhad
Vakil Abad Blvd
Iran
taghizad@math.um.ac.ir

Taicir, Loukil
Faculté des Sciences Economiques et de Gestion
BP 1088- 3018 Sfax
Tunisia
taicir.loukil@fsegs.rnu.tn

Takehara, Hitoshi
University of Tsukuba
1-1-1 Tennoudai
Japan
takehara@shako.sk.tsukuba.ac.jp

Talay, Mehmet Berk
Sabancı University
Orhanlı, Tuzla
Turkey
berktalay@su.sabanciuniv.edu

Tamaki, Mitsushi
Aichi University
Kurozasa 370 Miyoshi Nishikamogun
Japan
tamaki@vega.aichi-u.ac.jp

Tammer, Christiane
University Halle-Wittenberg
Theodor-Lieser-Strasse 5
Germany
tammer@mathematik.uni-halle.de

Tan, Barış
Koç University
Rumelifeneri Yolu Sarıyer
Turkey
btan@ku.edu.tr

Tan, Burcu
Boğaziçi University
Bebek
Turkey
seyyah99@yahoo.com

Tan, Pınar
Bilkent University
Rektörlük Binası No:330
Turkey
zarif@bilkent.edu.tr

Tan, Tarkan
Technische Universiteit Eindhoven
Den Dolech 2Postbus 513
Netherlands
tan@atilim.edu.tr

Tansel, Barbaros
Bilkent University
Turkey
barbaros@bilkent.edu.tr

Tanyeri, Kadir
George Washinton University
105 Shepherdson Lane
United States
tanyeri@gwu.edu

Tarassov, Alexandre
University of Limerick
CSIS Department
Ireland
alexandre.tarassov@ul.ie

Tareghian, Hamed Reza
Ferdowsi University of Mashhad
Faculty of Mathematical Science
P.O.Box 1159, Mashhad 91775
Iran
taregian@ferdowsi.um.ac.ir

Tari, Abdelkamel
University of Béjaia
Faculté des Sciences et Sciences de l'Ingénieur
Département d'Informatique
Algeria
tarikamel@yahoo.fr

Tari, Megdouda
University of Béjaia
Faculté des Sciences et Sciences de l'IngénieurDépartement d'Informatique
Algeria
megtari@yahoo.fr

Tarim, Armagan
University of York
Heslington
United Kingdom
at@cs.york.ac.uk

Tarımcılar, Murat
George Washington University
Management Science Department
United States
muratt@gwu.edu

Tasbogaz, Eyup
Auburn University
Dunstan Hall INSY department
United States
tasboey@eng.auburn.edu

Taslacıoğlu, Ergül
Marmara University
Göztepe Kampüsü Özmen Aktar Kız Yurdu
Kuyubaşı
Turkey
ergul_t@yahoo.com

Tavares, Luis
CESUR - IST
Av. Rovisco Pais 1049-001 Lisbon
Portugal
lavt@civil.ist.utl.pt

Taşkın, Z.Caner
Boğaziçi University
Bebek
Turkey

Participant List

zctaskin@yahoo.com

Techanitisawad, Anulark
Asian Institute of Technology
Phaholyothin Rd., Klong Luang
Thailand
anulark@ait.ac.th

Teghem, Jacques
Faculté Polytechnique de Mons
9, rue de Houdain
Belgium
teghem@mathro.fpms.a

Teich, Jeffrey
Erasmus University Rotterdam
Burg. Oudlaan 50
Netherlands
jteich@fbk.eur.nl

Tekin, Eylem
1127 Saluda Court
United States
eylem@email.unc.edu

Tellis, Gerard
University of Southern California, Marshall Sc
3660 Trousdale Pky, ACC 301D
United States
tellis@marshall.usc.edu

Tenfelde-Podehl, Dagmar
Graz University of Technology
Steyrergasse 30
Austria
tenfelde@opt.math.tu-graz.ac.at

Teodorovic, Dusan
Virginia Tech.
7054 Haycock Road
United States
duteodor@vt.edu

Tercinet, Fabrice
Ecole Polytechnique de l'Université de Tours
Computer Sciences Laboratory
64 Avenue Jean Portalis
France
fabrice.tercinet@etu.univ-tours.fr

Tereso, Anabela
Universidade do Minho
Sistems and Production
Campus de Azurem
Portugal
anabelat@dps.uminho.pt

Terlaky, Tamas
McMaster University
1280 Main Street West
Canada
terlaky@mcmaster.ca

Terzidis, Konstantinos
Tei of Kavala
Agios Loukas
Greece
kter@teikav.edu.gr

Tewfiq, Lamraoui
Ecole Nationale Polytechnique d'Alger
BP182, 10 rue Hacen Badi EL Harrach
Algeria
tewfiql@hotmail.com

Thanassoulis, Emmanuel
Aston University
Aston Triangle
United Kingdom
e.thanassoulis@aston.ac.uk

Thiriez, Hervé
Groupe HEC
France
thiriez@hec.fr

Thomo, Lida
University of Macedonia
156 Egnatia Str.
Greece
lida@uom.gr

Tilanus, C. Bernhard
Technische Universiteit Eindhoven
P.O.Box 513, 5600 MB
Eindhoven
Netherlands

Tiryaki, Fatma
Yıldız Technical University
Davutpaşa Kampüsü
Turkey
ftiryaki@yildiz.edu.tr

Tiryaki, Müjdat
Ford-Otosan
Turkey

Todorov, Maxim
UDLA
Sta. Catarina Martir Cholula
Mexico
mtodorov@mail.udlap.mx

Toktas, Berkin
University of Washington
Box 352650
United States
berkin@u.washington.edu

Toktay, Beril
INSEAD Boulevard de Constance
France
beril.toktay@insead.edu

Toloie, Abbas
I.A.U. Science & Research campus
No.360, pasdaran Ave.
Tehran
Iran
toloie@mcg-co.com

Tomic - Plazibat, Neli
Faculty of Economics
Matice Hrvatske 31
Croatia
neli@efst.hr

Tompkins, Robert
Hochschule fur Bankwirtschaft
Doeltergasse 33
Austria
rtompkins@ins.at

Ton, Zeynep
Harvard Business School
Morgan Hall T61
United States
zton@hbs.edu

Topaloğlu, Fulden
Boğaziçi University
Bebek
Turkey
fuldent@yahoo.com

Topaloğlu, Seyda
Dokuz Eylül Üniversitesi
Endüstri Mühendisliği Bölümü
Bornova-İzmir
Turkey
seyda.topaloglu@deu.edu.tr

Topaloglu, Huseyin
Cornell University
School of ORIE
223 Rhodes Hall
United States
huseyin@orie.cornell.edu

Toroyan, Vasak
Yerevan State University
Alex Manoogian 1
Armenia
vasaktoroyan@yahoo.com

Torres, Diego
Universidad de Valencia
Doctor Moliner, 50
Spain
diego@umh.es

Tortosa-Ausina, Emili
Universitat Jaume I
Campus del Riu Sec
Spain
tortosa@uji.es

Tosic, Vojin
University of Belgrade
Department of Air Transport
Division of Airports and Air Traffic Safety
Serbia and Montenegro
v.tosic@sf.bg.ac.yu

Toth, Paolo
University of Bologna
Viale Risorgimento 2
Italy
ptoth@deis.unibo.it

Trafalis, Theodore
University of Oklahoma
202 W. Boyd Room 124
United States
ttrafalis@ou.edu

Trautmann, Norbert
University of Karlsruhe
Kaiserstrasse 12
Germany
trautmann@wior.uni-karlsruhe.de

Triantis, Konstantinos
Virginia Tech
Northern Virginia Center 7054 Haycock Road
United States
triantis@vt.edu

Trick, Michael
GSIA Carnegie Mellon University
United States
trick@cmu.edu

Tsoulfas, Giannis
University of Piraeus
54-56 Messinias street
Greece
tsoulfas@unipi.gr

Tsumura, Joji
CRIEPI
2-11-1 Iwado Kita Komae-shi
Japan
tsumura@criepi.denken.or.jp

Tukel, Oya
Cleveland State University
1860 East 18th Street
United States
o.icmeli@csuohio.edu

Tunç, Yavuz
Boğaziçi University
Bebek
Turkey
ytunc@boun.edu.tr

Tunçbilek, Fatih
BRISA Bridgestone Sabancı Las. San. ve Tic. A.S
Turkey

Tuncel, Gonca
Dokuz Eylul University
Department of Industrial Engineering
35100 Bornova/izmir
Turkey
gonca.tuncel@deu.edu.tr

Turetken, Ozgur
Temple University
1810 N 13th
United States
turetken@temple.edu

Turut, Ozge
Harvard Business School
74 The Fenway Unit:31
United States
oturut@hbs.edu

Tuzmen, Ayca
University of Sydney
Sch. of Architecture, Design Sci. and Planning
Australia
atuz8087@mail.usyd.edu.au

Türçak, Hande
Boğaziçi University
Bebek
Turkey
turcak@boun.edu.tr

Türkay, Alper
Uludağ Üniversitesi
Müh. Mim. Fak. Endüstri Müh. Bölümü
Turkey
aturkay@yahoo.com

Türkay, Metin
Koç University
Rumelifeneri Yolu Sarıyer
Turkey
mturkay@ku.edu.tr

Türkcan, Ayten
Bilkent Üniversitesi
Endüstri Müh. Bölümü
Turkey
ayten@bilkent.edu.tr

Türsel Eliiyi, Deniz
METU
Turkey
deniz@ie.metu.edu.tr

U

Ueno, Takayuki
Nagasaki Prefectural University
123 Kawashimo-cho, Sasebo
Nagasaki, 858-8580
Japan
ueno@nagasakipu.ac.jp

Uetz, Marc
Maastricht University
P.O. Box 616
Netherlands
m.uetz@ke.unimaas.nl

Ukovich, Walter
University of Trieste
Via Valerio 10
Italy
ukovich@units.it

Ülengin, Füsun
İstanbul Technical University
ITU İşletme Fakültesi Maçka
Turkey
ulengin@itu.edu.tr

Ulu, Canan
Duke University
Box 90120
United States
cu2@duke.edu

Ulusoy, Gündüz
Sabancı University
Orhanlı, Tuzla
Turkey
gunduz@sabanciuniv.edu

Umetani, Shunji
Kyoto University
Guaduate School of Informatics
Yoshida Honmachi, Sakyo
Japan
umetani@amp.i.kyoto-u.ac.jp

Ünal, Ali Tamer
Boğaziçi University
Bebek
Turkey
unaltam@boun.edu.tr

Ünlüyurt, Tonguç
Sabancı University
Orhanlı, Tuzla
Turkey
tonguc@sabanciuniv.edu

Unsal, Didem
University of Rochester
20 River Ct. Apt. 2904
United States
unsaldi@simon.rochester.edu

Unsal, Fahri
Ithaca College
406 Smiddy Hall Danby Road
United States
unsal@ithaca.edu

Üstün, A. Korkut
Boğaziçi University
Bebek
Turkey
austun@boun.edu.tr

Uysal, Özgür
Fatih University
Akçaburgaz Mevkii Büyükçekmece
Turkey
ouysal@fatih.edu.tr

Uzunoğlu Koçer, Umay
Dokuz Eylül Universitesi
Fen-Edebiyat Fak. İstatistik Böl.
Turkey
umay.uzunoglu@deu.edu.tr

Uzunovic, Faik
Cyprus International University Haspolat
KKTC
faiku@ciu.edu.tr

V

Valente, Patrick
Brunel University
Cleveland Road
United Kingdom
masrppv@brunel.ac.uk

Vallada, Eva
Polytechnic University of Valencia
Cno de Vera s/n edificio I-3
Spain
evallada@eio.upv.es

Participant List

Valls, Vicente
Universidad de Valencia
Doctor Moliner, 50
Spain
vicente.valls@uv.es

Van Ackere, Ann
HEC Lausanne
BFSH 1 Université de Lausanne
Switzerland
ann.vanackere@hec.unil.ch

Van Asbroeck, Philippe
Universite de Bruxelles
SMG/ EURO Office CP 210/01 Boulevard du Triomphe
Belgium
office@euro-online.org

Van Beers, Wim
Tilburg University
Warandelaan 2 room B725
Netherlands
wvbeers@uvt.nl

Van den Heuvel, Wilco
Erasmus University Rotterdam
Burg. Oudlaan 50 P.O. Box 1738
Netherlands
wvandenheuvel@few.eur.nl

Van Der Heijden, Matthieu
University of Twente
Drienerlolaan 5
Netherlands
m.c.vanderheijden@utwente.nl

Van der Kloet, Irene
Royal Netherlands Army
Kasteelplein 10
Netherlands
ie.vd.kloet@mindef.nl

Van der Laan, Erwin
Erasmus University Rotterdam
P.O Box 1738
Netherlands
elaan@fbk.eur.nl

Van der Sluis, Erik
University of Amsterdam
Roetersstaat 11
Netherlands
h.j.vandersluis@uva.nl

Van Der Wal, Jan
Technische Universiteit Eindhoven
Den Dolech 2
Netherlands
jan.v.d.wal@tue.nl

Van Grinsven, Jürgen
Delft University of Technology
Jaffalaan 5
Netherlands
jurgeng@tbm.tudelft.nl

Van Harten, Aart
University of Twente
Drienerlolaan 5
Netherlands
a.vanharten@utwente.nl

Van Houtum, Geert-Jan
Technische Universiteit Eindhoven
Den Dolech 2
Netherlands
g.j.v.houtum@tm.tue.nl

Van Mieghem, Jan
Northwestern University
United States
vanmieghem@kellogg.northwestern.edu

Van Nunen, Jo A.E.E.
Erasmus University
P.O. Box 1738
Netherlands
j.nunen@fbk.edur.nl

Van Ryzin, Garret
Columbia University
412 Uris Hall
United States
gjv1@columbia.edu

Van Wassenhove, Luk
INSEAD
United States
luk.van-wassenhove@insead.edu

Van Woensel, Tom
UFSIA
Prinsstraat 13
Belgium
tom.vanwoensel@ua.ac.be

Vandaele, Nico
University of Antwerpen-UFSIA
Prinsstraat 13
Belgium
nico.vandaele@ua.ac.be

Vanhoucke, Mario
Ghent University and Vlerick LG Manageme
Hoveniersberg 24
Belgium
mario.vanhoucke@vlerick.be

Varas, Samuel
University of Chile
Republica 701
Chile
svaras@dii.uchile.cl

Vasermanis, Edgars
University of Latvia
Raina Blvd 19
Latvia
evf@lanet.lv

Vasilakis, Christos
University of Westminster
Watford Road Northwick Park
United Kingdom
c.m.vasilakis@westminster.ac.uk

Vatinlen, Benedicte
Bouygues Telecom
10 rue Paul Dautier
France
nicole.cheneaux@tci.tm.fr

Vazacopoulos, Alkis
Dash Optimization
560 Sylvan Avenue
United States
av@dashoptimization.com

Velásquez, Jesús
Universidad de La Sabana
Calle 125 Bis No. 40A-82Apartamento 209
Colombia
jvelasquez@decisionware-ltd.com

Ventura, Paolo
IASI-CNR
Via dei Campani, 38
Italy
ventura@iasi.rm.cnr.it

Vercher, Enriqueta
Universidad de Valencia
Doctor Moliner, 50
Spain
enriqueta.vercher@uv.es

Verter, Vedat
McGill Unviersity
1001 Sherbrooke St. West R454
Canada
vedat.verter@mcgill.ca

Vertinsky, Ilan
University of British Columbia
5551 Chancellor Blvd
Canada
ilan.vertinsky@commerce.ubc.ca

Vetschera, Rudolf
University of Vienna
Bruenner Strasse 72
Austria
rudolf.vetschera@univie.ac.at

Vicente, Maria Rosalía
University of Oviedo
Facultad de CC. Económicas Campus del Cristo s/n
Spain
mrosalia@correo.uniovi.es

Vidovic, Milorad
University of Belgrade
Faculty of Transport and Traffic Engineering
Serbia and Montenegro
mvidovic@sf.bg.ac.yu

Viehweger, Bernd
University of Potsdam
August-Bebel-Str. 89
Germany
berndv@rz.uni-potsdam.de

Vigo, Daniele
University of Bologna
Vlale Risorgimento, 2
Italy
dvigo@deis.unibo.it

Villa, Mª Fulgencia
Florida Universitaria
Rei en Jaume I,nº2
Spain
fvilla@florida_uni.es

Villén-Altamirano, José
Universidad Politécnica de Madrid
Calle Arboleda s/n (Escuela de Informática)
Spain
jvillen@eui.upm.es

Vincent, T'kindt
Laboratory of Computer Science
DI-Polytech'Tours 64 avenue Jean Portalis
France
tkindt@univ-tours.fr

Vincke, Philippe
Universite Libre de Bruxelles
Bld. du Triomphe CP210/01
Belgium
pp@euro-online.org

Vissers, Jan
Technische Universiteit Eindhoven
PO Box 513 5600 MB
Eindhoven
Netherlands
j.m.h.vissers@tm.tue.nl

Viswanathan, Prem
National University of Singapore
Block E5, Basement 08, 4 Engineering Drive 4
Singapore
cpevpk@nus.edu.sg

Vízvári, Béla
Eötvös University of Budapest
Páymány Péter sétány1/c
Hungary
vizvari@math.elte.hu

Vlachos, Dimitrios
Aristotle University of Thessaloniki
Research Committee
VAT 090049627 P.O. Box 461
Greece
vlachos1@auth.gr

Vladimirou, Hercules
University of Cyprus
75 Kallipoleos Str.
Cyprus
hercules@ucy.ac.cy

Vojvodic Rosenzweig, Visnja
Faculty of Economics
Kennedyev Trg 6
Croatia
ksoric@efzg.hr

Vossen, Thomas
University of Colorado
UCB 419
United States
vossen@colorado.edu

Voudouris, Christos
British Telecommunications plc
United Kingdom
chris.voudouris@bt.com

Voutsinas, Theodore
University of Piraeus
80 Karaoli & Dimitriou str.
Greece
vutsinas@apopsinet.gr

Vujosevic, Mirko
University of Belgrade
Faculty of Organizational Sciences
Jove Ilica 154
Serbia and Montenegro
mirkov@fon.bg.ac.yu

Vulcano, Gustavo
Stern School of Business - NYU
44W 4th Street Suite 8-76
United States
gvulcano@stern.nyu.edu

Vural, Arif Volkan
Sabancı University
MDBF Binası
Orhanlı, Tuzla
Turkey
avolkan@su.sabanciuniv.edu

Vychodil, Vilem
Palacky University
Tomkova 40
Czech Republic
vilem.vychodil@upol.cz

Vygen, Jens
University of Bonn
Lennestr. 2
Germany
vygen@or.uni-bonn.de

W

Wagelmans, Albert
Erasmus University Rotterdam
PO Box 1738
Netherlands
wagelmans@few.eur.nl

Waissi, Gary
University of Michigan
United States
gwaissi@umd.umich.edu

Walker, Cameron
University of Auckland
20 Symonds Street
New Zealand
cwalker@scitec.auckland.ac.nz

Wallenius, Hannele
Helsinki University of Technology
Otakaari 1
Finland
hannele.wallenius@hut.fi

Wallenius, Johanna
Helsinki School of Economics
Runeberginkatu 14-16
Finland
johanna.wallenius@ky.hkkk.fi

Wallenius, Jyrki
Helsinki School of Economics
Runeberginkatu 14-16
Finland
walleniu@hkkk.fi

Walther, Grit
TU Braunschweig
Katharinenstr. 3
Germany
g.walther@tu-bs.de

Wang, Wenbin
University of Salford
Maxwell Building
United Kingdom
w.wang@salford.ac.uk

Wäscher, Gerhard
Otto-von-Guericke-Universität Magdeburg
Germany
gerhard.waescher@ww.uni-magdeburg.de

Wassan, Niaz
University of Kent
Park Wood Road
United Kingdom
n.a.wassan@ukc.ac.uk

Wasti, S. Nazli
METU
Turkey
nazli@metu.edu.tr

Watson, Noel
Harvard Business School
Soldiers Field Road
United States
nwatson@hbs.edu

Weber, Gerhard-Wilhelm
METU
Turkey
gweber@metu.edu.tr

Weglarz, Jan
Poznan University of Technology
Poland
weglarz@put.poznan.pl

Weintraub, Andres
University of Chile
Republica
Chile
aweintra@dii.uchile.cl

Weismantel, Robert
Otto-von-Guericke-Universität Magdeburg
FMA-IMO Universitätsplatz 2
Germany
weismant@mail.math.uni-magdeburg.de

Weiss, Gideon
Haifa University
Morad Hayasmin 2

Participant List

Israel
gweiss@stat.haifa.ac.il

Werners, Brigitte
Ruhr-University Bochum
Universitätsstr.
Germany
or@ruhr-uni-bochum.de

Widmer, Marino
Universite de Fribourg
Faucigny 2
Switzerland
marino.widmer@unifr.ch

Wijnmalen, Diederik J.D.
TNO-FEL
2509 JG
Netherlands
wijnmalen@fel.tno.nl

Wilkinson, Kevin
Massey University
Wallace St Wellington
New Zealand
k.j.wilkinson@massey.ac.nz

Willems, Rene
TNO-FEL
Oude Waalsdorperweg 63
Netherlands
r.f.w.m.willems@fel.tno.nl

Wilson, Amy
University of Minnesota
420 Delaware St. SE, MMC 729
United States
arwilson@umn.edu

Wilson, Simon
Universidad Carlos III
C/ Madrid, 126
Spain
simon.wilson@tcd.ie

Winer, Russell
New York University
44 W.4th Street
United States
rwiner@stern.nyu.edu

Wiper, Michael
Universidad Carlos III
C/ Madrid 126
Spain
mwiper@est-econ.uc3m.es

Wirasinghe, Dr. Chan
University of Calgary
2500 University Dr. NW EN C202
Canada
wirasing@ucalgary.ca

Wolfler Calvo, Roberto
Université de Technologie de Troyes
France
roberto.wolfler@utt.fr

Wolsey, Laurence A.
Université Catholique de Louvain
Belgium
mailto:wolsey@core.ucl.ac.be

Wong, Hartanto
Katholieke Universiteit Leuven
Celestijnenlaan 300 A
Belgium
hartanto.wong@cib.kuleuven.ac.be

Woo, Jehyun
Yonsei Inuv.
College of Engineering
134 Shinchon-dong Sudaemoon-Ku
South Korea
imint97@empal.com

Wood, Michael
University of Portsmouth
Locksway Road, Milton
United Kingdom
michael.wood@port.ac.uk

Wright, Mike
Lancaster University
Management Science Department
United Kingdom
m.wright@lancaster.ac.uk

Wullink, Gerhard
University of Twente
Drienerlolaan 5
Netherlands
g.wullink@utwente.nl

Wutz, Alexander
University of Siegen
Hoelderlinstr. 3
Germany
alexander.wutz@uni-siegen.de

Wuyts, Stefan
Erasmus University Rotterdam
Burg. Oudlaan 50
Netherlands
wuyts@few.eur.nl

X

Xie, Ying
Coventry University, U.K.
Priory Street
United Kingdom
y.xie@cov.ac.uk

Y

Y. Rubinstein, Reuven
Technion
Technion City
Israel
ierrr01@ie.technion.ac.il

Yagiura, Mutsunori
Kyoto University
Yoshida Honmachi, Sakyo-Ku
Japan
yagiura@amp.i.kyoto-u.ac.jp

Yajima, Yasutoshi
Tokyo Institute of Technology
2-12-1 O-okayama, Meguro-ku
Japan
yasutosi@me.titech.ac.jp

Yalabik, Baris
University of Illinois at Urbana-Champai
350 Wohlers Hall 1206 S. Sixth St
United States
yalabik@uiuc.edu

Yalınkılıç, Faysal
TÜSSİDE-TÜBİTAK
Barış Mah. Koşuyolu Cad. No:48 P.K:14 Gebze
Turkey
fyalinkilic@tusside.gov.tr

Yamada, Takeo
National Defense Academy
1-10-20 Hashirimizu
Japan
yamada@nda.ac.jp

Yamaguchi, Kazunori
Rikkyo University
3-34-1 Nishi-ikebukuro Toshima-ku
Japan
kyamagu@rikkyo.ac.jp

Yaman, Hande
Université Libre de Bruxelles
Boulevard du Triomphe CP 210/01
Belgium
hyaman@smg.ulb.ac.be

Yanasse, Horacio
INPE
Av. Dos Astronautas, 1758 INPE/LAC
Brazil
horacio@lac.inpe.br

Yang, Jian-Bo
UMIST
PO Box 88Sackville Street
United Kingdom
jian-bo.yang@umist.ac.uk

Yano, Candace
UC Berkeley
4135 Etcheverry Hall, CA
United States
yano@ieor.berkeley.edu

Yaprak, Onur
Clemson University
College of Business and Behavior Science
United States
oyaprak@clemson.edu

Yassine, Ali
University of Illinois, USA
104 South Mathews Ave.
United States
yassine@uiuc.edu

Yavuz, Mesut
University of Florida
Department of Industrial and Systems
Engineering 303 Weil Hall

United States
yavuzm@ufl.edu

Yayla, Hesna Muge
Bilkent University
Turkey
myayla@bilkent.edu.tr

Yazgaç, Tülin
İstanbul Kültür University
E-5 Karayolu, No:22
Turkey
t.yazgac@iku.edu.tr

Yazgan, Yaman
BRISA
Bridgestone Sabancı Lastik San. ve Tic. A.S.
Turkey

Yaşarcan, Hakan
Boğaziçi University
Bebek
Turkey
yasarcan@boun.edu.tr

Yeghoyan, Karen
Yerevan State University
Alex Manoogian 1
Armenia
karyegh@yahoo.com

Yesayan, Michael
St. Eng. University of Armenia
105 Teryan St.
Armenia
michael@freenet.am

Yildirim, Semih
University of Tennessee
439 Stokely Mgmt Center College of Business
United States
semih@utk.edu

Yildirim, Yildiray
Syracuse University
School of Management
United States
yildiray@syr.edu

Yilmaz, Ersin
Eastern Mediterranean Forestry Research
İnönü Mah. 1403 sk. Arzu Apt. 17/5
Turkey
yilmazersin@hotmail.com

Yilmaz, Ihsan Onur
Technische Universität Berlin
WIL-B-1-1 Wilmersdorferstr. 148
Germany
ioyilmaz@pm-box.ww.tu-berlin.de

Yoon, Moon-Gil
Hankuk Aviation University
200-1 hwajun-dong
South Korea
mgyoon@mail.hau.ac.kr

Yoruk, Seviye
University of Florida
303 Weil Hall
United States
yoruks@notes.cba.ufl.edu

Yoshida, Yuji
University of Kitakyushu
4-2-1 Kitagata, Kokuraminami
Japan
yoshida@kitakyu-u.ac.jp

Yu, Gang
United States
yu@uts.cc.utexas.edu

Yucesan, Enver
INSEAD
Boulevard de Constance
France
enver.yucesan@insead.edu

Yuge, Tetsushi
National Defense Academy
Hashirimizu 1-10-20
Japan
yuge@nda.ac.jp

Yuzukirmizi, Mustafa
Univeristy of Massachusetts at Amherst
E-lab Building
United States
myuzukir@ecs.umass.edu

Yücel, Gönenç
Boğaziçi University
Bebek
Turkey
yucelgo@boun.edu.tr

Yüksel Özkaya, Banu
Bilkent Üniversitesi
Endüstri Müh. Bölümü
Turkey
ybanu@bilkent.edu.tr

Yılmaz, Özlem
Koç University
Rumeli Feneri Yolu, No:118, Sarıyer
Turkey
ozyilmaz@ku.edu.tr

Z

Zaccour, Georges
HEC Montréal
3000 Côte-Sainte-Catherine
Canada
georges.zaccour@hec.ca

Zahavi, Jacob
Tel Aviv University
Facukty of Management Tel Aviv University
Israel
jacobz@tauex.tau.ac.il

Zaim, Osman
Bilkent University
Department of Economics
Turkey
zaim@bilkent.edu.tr

Zak, Jacek
Poznan University of Technology
3. Piotrowo st.
Poland
jacekzak@put.poznan.pl

Zaraté, Pascale
IRIT - INPT118 Route de Narbonne
France
zarate@irit.fr

Zenios, Stavros
University of Cyprus
Cyprus
zenios.stavros@ucy.ac.cy

Zettelmeyer, Florian
UC Berkeley
2220 Piedmont Avenue
United States
florian@haas.berkeley.edu

Zhang, Jie
University of Michigan Business School
701 Tappan Street
United States
jiejie@umich.edu

Zhang, Kejing
Hertzstrasse 16
Germany
kejing.zhang@wiwi.uni-karlsruhe.de

Zhang, Rachel
Cornell University
364 Sage Hall
United States
rqz2@cornell.edu

Zhou, Wenchao
Swedish University of Agricultural Sciences
Department for Economics
Sweden
zhou.wenchao@sekon.slu.se

Zijm, Henk
University of Twente
Drienerlolaan 5
Netherlands
zijm@cs.utwente.nl

Zimmermann, Hans Jurgen
RWTH Aachen
Germany

Zineb, Benmeziane
USTHB
Algeria
zbenmeziane@yahoo.fr

Zipkin, Paul
Duke University
Fuqua School of Business
United States
paul.zipkin@duke.edu

Zoppoli, Riccardo
University of Genoa
Via Opera Pia, 13
Italy

rzop@dist.unige.it

Zoroa, Noemi
Universidad de Murcia
Campus de Espinardo
Facultad de Matemáticas
Spain
nzoroa@um.es

Zouaoui, Faker
Sabre Holdings
3150 Sabre Dr. MD 8203
United States
faker.zouaoui@sabre-holdings.com

Zuddas, Paola
University of Cagliari
Piazza d'armi
Italy
zuddas@unica.it

Zuidwijk, Rob
Erasmus University Rotterdam
Burgemeester Oudlaan 50 PO Box 1738
Netherlands
rzuidwijk@fbk.eur.nl

Zur Muehlen, Michael
Stevens Institute of Technology
Castle Point on the Hudson
United States
mzurmuehlen@stevens-tech.edu