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Reflection of a 40-year analytics career

MODERN CONSUMER SUPPLY CHAINS
And the generative AI revolution of goods

FROM UNDERDOG TO GOLD MEDALISTS
USA Cycling pedals to two top podiums

CELEBRATING 50 YEARS

ORMS TODAY

2025 I Volume 52, Issue 3

informs Smarter Decisions for a Better World

COLLABORATE. INNOVATE. DOMINATE: THE STORIES BEHIND REAL-WORLD O.R. WINS

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BRIDGING IDEAS AND IMPACT

CELEBRATING 50 YEARS ORMS TODAY

BREAKING BOUNDARIES, BUILDING BRIDGES

BY KARA TUCKER

ONE OF THE THINGS I LOVE MOST ABOUT editing *OR/MS Today* is the sheer range of stories that come across my desk. At first glance, they might seem worlds apart – an Olympic cycling team's gold medal, the optimization of consumer supply chains in the age of generative AI or a student-led forecasting project in Colombia. But somehow, I'm always able to find a unifying thread. This time? The creative, often unexpected, ways the OR/MS community takes mathematical models, algorithms and analytics out into the world to solve problems that matter.

This issue reinforces the importance of industry-academia collaboration in guiding the trajectory of the field in the age of artificial intelligence, machine learning and quantum optimization.

We'll start with Warren Powell's "Working with Industry: From the Laboratory to the Field and Back" (p. 20), a reminder that ideas don't always thrive where they're born. Research, no matter how brilliant, can't make an impact unless it's tested in the messy, unpredictable environment of the real world – and O.R. researchers are notorious for working on problems that don't fit in a lab. In this feature, you'll see how industry-academic collaborations act as a two-way street: industry gains innovative, data-driven solutions, and academics get feedback that sharpens their work for the next cycle of discovery. This give-and-take can be the lifeblood of progress in this field, and one of the main reasons for INFORMS' existence as your forever professional home.

The laboratory-to-field journey also underpins "Commercializing Optimization Research" (p. 24), the origin story of Opturion – a university spinoff formed to commercialize the results of constraint programming research, and has been further developing and applying artificial intelligence (AI)-based optimization to problems in transport, logistics and supply chain. The authors assure that a spinoff is not the end of collaboration with academia; it is just the beginning. The benefits of ongoing collaboration are manifold. The Opturion story is one of tackling difficult problems and finding innovative solutions.

From there, we leap into the generative AI (GenAI) revolution. In "GenAI Revolution in Modern Consumer Supply Chains" (p. 34), we see how generative AI is not just a buzzword – it's a force reshaping everything from demand forecasting to logistics planning. It's easy to think of GenAI as something confined to text or image generation, but it has deeper capabilities: synthesizing insights from massive, messy datasets, simulating complex supply chain disruptions and uncovering efficiencies that may not have been spotted otherwise. What's most exciting is that GenAI isn't replacing the human expertise of O.R. and analytics professionals – it's amplifying it.

But not every revolution is technological. Sometimes, it's personal. In "Lessons from a Career in Analytics: Bridging Academia, Industry and Society" (p. 30), we hear from Tilburg University colleagues Melvin Drent and Hein Fleuren for a look inside a decades-long career journey, showing how the roles we take on – researcher, consultant, educator – aren't boxes to be checked but perspectives to be integrated. The wisdom gleaned here is that analytics is not confined to one domain. The same rigor that drives a breakthrough

in a university lab can also help a city government tackle congestion, or a nonprofit distribute aid more effectively. Bridging those worlds is not only possible, but also essential.

Speaking of bridging worlds, "Forecasting Social Impact: How Georgia Tech Students are Helping Comfama Predict the Future of the Middle Class in Colombia" (p. 42) reminds us that analytics can illuminate pathways for communities, not just corporations. Working with Comfama, a Colombian social enterprise, Georgia Tech students applied forecasting methods to anticipate how economic shifts could affect the country's middle class. The stakes here may be different from those on the Olympic track, but no less urgent: understanding the pressures that can cause families to rise – or fall – on the economic ladder. This is analytics in service of equity, long-term planning and human dignity.

From human dignity to human performance, the 2025 Edelman Award winner USA Cycling is featured in "From Underdogs to Gold Medalists: How USA Cycling Pedaled Predictive Analytics to the Podium" (p. 38). USA Cycling's Women's Pursuit Team didn't just pedal harder, they pedaled smarter. Predictive models shaped training regimens, optimized race strategies and informed every decision leading up to Paris 2024. In a sport where margins are measured in thousandths of a second, analytics became a competitive edge as real as the athletes' grit. It's a story that's equal parts engineering, coaching and mathematics, and a perfect example of how high stakes and high data can combine for unforgettable results – and gold across the board.

When you put all of these stories together, you start to see a pattern. Operations research and analytics are not single-destination disciplines. They are methods and mindsets that can be applied to almost anything: a freight network, a race track, a city street, a rural clinic. The tools are versatile not because they are simple, but because they are adaptable – shaped by the domain they serve.

In working with the INFORMS Committee on Industry-Academia Collaborations (CIAC), I've noticed a shift in how the community sees itself – moving from "solvers of technical problems" to "partners in shaping systems." That's a powerful evolution, because systems thinking naturally connects the dots between sectors, geographies and even generations.

It's also why, in one magazine issue, we can just as easily be talking about commercializing an optimization algorithm as we can be celebrating students tackling social mobility in South America. Why we can examine the cutting edge of generative AI one moment and cheer on cyclists the next. Why we understand that industry collaboration isn't just a pragmatic necessity, but the crucible where the best ideas are tested and refined.

I hope this issue leaves you with the same sense of energy and curiosity it gave me while assembling it. If there's one thing OR/MS proves over and over, it's that solutions are rarely born in isolation. They're forged in collaboration, in experimentation and sometimes in a sprint toward a finish line.

KARA TUCKER is editor of *OR/MS Today* and *Analytics* magazines.

INFORMS ELECTION: **CALL FOR CANDIDATES**

INFORMS holds an election for the INFORMS Board of Directors every year. Here is a brief review of the nomination and election process. More detail is provided in INFORMS Bylaw 3 and P&P 4.5.

Each year, a call for nominations of candidates for the next year's INFORMS Board occurs.

- The individual selected as president-elect serves three years: one year as president-elect, one year as president and one year as past president.
- INFORMS vice presidents (VPs) are elected for a two-year term. The treasurer and secretary positions are also two-year terms, and they are staggered so that in each year not more than one of the two positions has a newly elected person starting a term of office.
    - Because these offices involve a significant learning experience, first-term incumbents may be nominated without opposition for a second term for reasons of continuity and stability. This is why one or several positions on the INFORMS ballot may have only a single candidate.
- The positions of Vice President – Sections and Societies and Vice President – Chapters and Fora are filled through election by the Subdivisions Council. These positions serve one two-year term.

INFORMS elections begin in the summer, in recent years running from August through the end of September. INFORMS employs a voting process called approval voting, which means INFORMS members can vote for as many candidates as they think are qualified for a position. According to Bylaw 3, "Elections shall be conducted by approval voting, whereby each voter may vote for any number of candidates for an office and the individual elected shall be the one receiving the largest number of votes… A quorum for membership voting is 10 percent of the members eligible to vote."

If you think that someone, including yourself, would be a good candidate, please consider sending your recommendation(s) to nominations@informs.org.

INFORMS' ACTIONS FOR A SHIFTING GLOBAL LANDSCAPE

BY DAVID HUNT

I'M WRITING THIS COLUMN WHILE IN Singapore attending the 2025 INFORMS International Meeting and having just completed a trip to Beijing at the invitation of Professor Su Shuai to visit with faculty and students at Beijing Jiaotong University (BJTU). At BJTU, I had the opportunity to talk with Professor Su (a past chair of the INFORMS Railway Applications Section), Professor Lixing Yang (president of the Operations Research Society of China) and several other faculty and students to exchange ideas and discuss collaboration with INFORMS. The International Meeting in Singapore has over 1,100 participants from more than 30 countries who have come together to network and hear the terrific program assembled by general co-chairs Jie Xu and Szu Hui Ng and the many other volunteers.

Both of these trips have given me an even greater appreciation of the role INFORMS plays in the global operations research community and the respect carried by the INFORMS brand. Of course, I am also hearing concerns about the U.S. and other countries' governmental policies, especially around obtaining visas to participle in INFORMS events in the U.S., and the rising cost of travel.

Within the INFORMS membership, 30% resides outside the U.S., across more than 80 countries, which means that 70% of our members live in the U.S. Within the U.S., I am also hearing concerns about threats to research funding, academic careers and student pipelines. Erosion of scientific legitimacy, global collaboration and external trust. Risks to global engagement and INFORMS' perceived neutrality.

These topics were considered at the INFORMS Board of Directors meeting held in April 2025 during the INFORMS Analytics+ Conference. Board meetings often identify a "mega issue" for discussion to identify a strategic plan of action. The mega issue at the spring meeting was "Emerging Risks in a Shifting Policy Landscape: Impacts on INFORMS and Our Members."

What came out of that board discussion was a set of concrete actions that INFORMS has now implemented to support members who may have lost funding or their job or may have difficulty or concerns about traveling to the U.S. On June 11, INFORMS Executive Director Elena Gerstmann sent an email to members with a link to a new website listing the ways INFORMS is assisting our community in these challenging times (visit https://www.informs.org/About-INFORMS/Supporting-Our-Community). On June 20, the INFORMS Executive Committee held its second open member town hall of the year to discuss the actions INFORMS is taking on behalf of the membership. These actions, along with others that members and staff have been advancing, include the following.

Help with Membership Dues

- INFORMS is reducing or waiving fees for those facing financial hardship. This is similar to the program INFORMS offered during the height of the COVID-19 pandemic.
- INFORMS also offers discounted memberships for individuals in developing countries.

Supporting Communities and Other Groups

- INFORMS created an Executive Rapid Response Fund to provide just-in-time support for urgent community needs. We will provide up to $20,000 to an INFORMS community if, for example, an event they were planning to host lost funding because of the unique challenges of 2025.

- Vinod Cheriyan, VP Chapters & Forums, and Theresa Roeder, VP Sections & Societies, are working on ways to better support INFORMS communities navigating today's challenges.

Meetings Access

- INFORMS will be offering a "lite" virtual option at the 2025 Annual Meeting in Atlanta to provide access to plenaries, keynotes and *TutORials* for members who can't make it in person (although we still hope to see you in person this October in Atlanta!).

Global Support

For members who reside outside the U.S., we are offering services designed to support this important segment of the INFORMS community.

- As I write this, INFORMS is hosting the 2025 International Meeting in Singapore to better serve our members living in the Asia-Pacific region. Talking with people at the conference, and given the overall success of this meeting, we will be exploring additional non-U.S. meeting options.
- INFORMS modified policies to help navigate possible visa and entry challenges for U.S.-based meetings.
- We are enhancing the promotion of community members from around the world, the global impact of INFORMS and improved publication visibility for non-U.S. research.
- We are transitioning the INFORMS Section on Public and Societal O.R.-led one-day event, "2025 Contemporary Operations Management in Developing Economies," into a full INFORMS-level virtual event that connects researchers who may not be able to attend the 2025 INFORMS Annual Meeting.

Student Support and Career Growth

- INFORMS Career Center serves as your hub for job opportunities and other career resources in operations research, analytics and data science – and a revitalized Career Services Committee is exploring how we can provide better job support. We have also initiated discussions with employers about how INFORMS career services can better support their needs.
- "Speak Up" is a new preconference event funded by the Bonder Foundation and will be hosted in conjunction with the 2025 Annual Meeting to help students build communication and presentation skills.

Advocacy and Impact

We launched the INFORMS Advocacy Toolkit, which provides members with a step-by-step guide to engage with policymakers and the media.

- The INFORMS Advocacy team continues to monitor current events to identify ways to support the community. Most recently, INFORMS joined dozens of scientific associations in signing a joint letter to congressional leaders in support of the National Science Foundation's vital role in research.
- INFORMS is tagging published articles aligned with the UN Sustainable Development Goals to spotlight research driving real-world impact.

(l-r) Zhikai Wang, Professor Su Shuai, David Hunt, Ze Fu and Chen Shu Lu in front of the high-speed railway simulator at the Automation and Control Laboratory at Beijing Jiaotong University, Beijing, China in July 2025. ***Source: David Hunt.***

We continue to follow the news and its impact on all our members and will continue to take appropriate steps to support the INFORMS community and advocate for the importance of our members' work, both in research and in practice.

This column describes some of the specific steps we have taken to build on my earlier President's Desk column titled "The Power of Collaboration" [1]. By fostering a strong community and encouraging collaboration across countries and cultures, disciplines, generations, and perspectives, INFORMS strengthens not only our profession but the communities we serve. To truly achieve the INFORMS vision – better decision-making for a just, prosperous and sustainable world – requires facilitating a vibrant global community of operations researchers collaborating and sharing the best ideas.

DAVE HUNT is a vice president at the management consulting firm Oliver Wyman. He is the 2025 INFORMS president.

REFERENCE

1. Dave Hunt, 2025, "The Power of Collaboration," *OR/MS Today,* June 16, https://doi.org/10.1287/orms.2025.02.05.

> For members who reside outside the U.S., we are offering services designed to support this important segment of the INFORMS community.

THE MEMBER-DRIVEN MISSION OF PROFESSIONAL ASSOCIATIONS

BY ELENA GERSTMANN

MY FRIEND – AN EXPERIENCED PUBLIC health professor – recently shared her struggles with incorporating artificial intelligence (AI) into her teaching. When I asked if she had looked to her professional association for advice, she initially dismissed the idea, saying that her association doesn't care about providing help for teaching – only caring about research and its own goals. It was this latter part about "its own goals" that surprised and struck me.

She went on to explain that she feels her public health association doesn't reflect the broader membership but instead represents the opinions of a few board members and the CEO. My friend is someone who presents at her association's events and is well regarded in her field, and while not an "insider," she is a relatively knowledgeable member. I fear her perception echoes an all too common sentiment about how associations operate.

To me, her comments underscored the importance of transparency and engagement in professional associations, particularly in ensuring they reflect and serve the needs of their members. After all, associations are not remote, faceless entities. They are member-driven communities established to serve the public good. Her comments also highlighted how crucial it is for associations to communicate their member-driven nature clearly. The strategic goals of professional associations – *their raison d'être* – are guided by the collective input of volunteer leaders, members and staff.

I share this not only as the executive director of INFORMS but also as chair of CESSE (Council of Engineering and Scientific Society Executives). CESSE represents professionals who work at hundreds of STEM-related associations much like INFORMS, whose members include millions of scientists, engineers and technical experts. Like INFORMS, these associations are powered by communities that thrive on shared knowledge, collaboration and a deep commitment to the public good.

Role of Members in Shaping Associations

A core function of any professional association is to provide stewardship of the profession. This responsibility serves the public good by ensuring that members are well informed, educated and guided by shared ethics. It requires a strategic vision shaped collaboratively by members, volunteer leaders and staff.

If a member feels that their association isn't focused on the right priorities, the most effective response is to speak up. Associations rely on this input to remain aligned with their members. No association can succeed without understanding the diverse voices within its community.

Team INFORMS at CESSE Conference in June in Philadelphia.

I often think of associations as a twin-engine plane: One engine is powered by the members who serve as volunteers, and the other by the staff who provide professional expertise. These two engines must seamlessly interact, working in harmony to keep the organization in flight and serving the public good in a financially sustainable way.

Of course, associations aren't perfect. We learn and adapt based on member input, and sometimes we fall short. *That's why member engagement matters.* Member involvement helps us course-correct and serve our community more effectively.

When a member says, "I wish INFORMS did this or stopped doing that," I encourage them to reflect: Who is "INFORMS" in this scenario? It's not a faceless institution. INFORMS – and all associations – is a dynamic community made up of people like you. Your voice matters and your involvement shapes the future of our field.

You can help shape the direction of INFORMS by nominating someone – or yourself – for the board (INFORMS.org/nomination), participating in a society/section/chapter/forum, responding to surveys, voting in elections, attending member meetings and town halls, volunteering (check out our volunteer platform [1]), participating in the mentoring program, and so many other ways. These actions ensure your voice is heard and help you contribute to our collective success.

A Call to Action

If you love INFORMS but know someone who has drifted away or hasn't felt seen, invite them to reconnect. Sometimes all it takes is a conversation. And if you've ever felt that INFORMS wasn't meeting your needs or reflecting your priorities, don't step back – lean in. Your input makes us stronger, more responsive and better equipped to serve our community.

Member perspectives are invaluable, not only for shaping INFORMS' strategic direction but for guiding the evolution of our profession. When we reflect the collective expertise and aspirations of our members, we thrive.

As for my friend, I hope our conversation inspires her to reengage with her association. And for all of us, let's remember that the strength of any professional association lies in its members. Let's make our voices heard and ensure INFORMS remains a vibrant, member-driven community committed to the public good and the future of our field.

You can always reach me via email.

ELENA GERSTMANN, Ph.D., FASAE, CAE (egerstmann@informs.org), is the executive director of INFORMS (5521 Research Park Drive, Ste. 200, Catonsville, MD 21228). She can be reached via email.

REFERENCE

1. https://connect.informs.org/volunteeropportunities/i-volunteer

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Are you on the hunt for top-tier analytics, AI, and operations research talent to propel your organization forward? Get ready to discover your next game-changer at the 2025 INFORMS Annual Meeting Career Fair on October 26-28 in Atlanta, Georgia.

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TOP SOCIAL POSTS

1

Recognized by the U.S. Department of Labor: The Certified Analytics Professional (CAP) has officially been named one of the top in-demand analytics certifications.
CAP

2

Watch this quick video from our INFORMS AI Series, where Leonard Boussioux, an INFORMS member from MIT, explores how AI is becoming part of our everyday lives!
INFORMS YouTube

3

INFORMS Quantum Computing and Operations Research Ad Hoc Committee
OR/MS Today

4

[Flickr Album] 2025 INFORMS International Meeting – Follow along with all the excitement in Singapore!
INFORMS Flickr

5

INFORMS Member in a Minute with Bahare, from the 2024 INFORMS Annual Meeting
INFORMS YouTube

6

Happy Friday! Take a moment to explore this engaging What's Your StORy? episode with INFORMS member Shannon Shang from Global Holdings and the University of Tulsa as we talk about statistics and all things analytics.
INFORMS YouTube

7

Wrap up your weekend with us! Join our interesting Q&A session in the INFORMS AI Series, where Nathan Gaw from the USAF Institute of Technology shares insights on AI, machine learning, neural network and more.
INFORMS YouTube

8

'LegoGPT' designs Lego models with nothing but a prompt
Fast Company

Check out the top 8 most-clicked items on INFORMS' social media channels last month. Connect with us on your favorite channel!

MEMBERS IN THE NEWS

All decisions have trade-offs. IBM's Wei Sun is an expert at weighing them, *IBM,* featuring Wei Sun

Tariffs 101: What Facility Managers Need to Know About Supply Chains, *FacilitiesNet*, featuring Sunderesh S. Heragu

Data Science and Decision Science Skills: Are They Different and Does It Matter?, *Harvard Data Science Review*, by Jeffrey D. Camm, Michael J. Fry and Scott M. Shafer

FedEx Acquires Company Founded By Four Smith Faculty, *Robert H. Smith School of Business, University of Maryland*, featuring Bruce Golden, Michael Ball and Larry Bodin

Supply chain vulnerabilities and the need for diversification, *The Democracy Forum*, featuring Anna Nagurney

New tariffs now in effect as U.S. economy shows signs of strain, *KTVU FOX 2*, featuring Tinglong Dai

Podcast episode: AI Series: Careers in Operations Research and AI, *Through the Corporate Glass*, featuring Radhika Kulkarni

RESOUNDINGLY HUMAN

May

This month featured an interview with the final 2025 Franz Edelman Award finalist team, Flipkart, discussing their incredible project and reflecting on this year's competition. Then we heard from Matthew Brady, tech entrepreneur, whose Volley app leverages decision science technology to support and empower students as they make important choices about their future.

June

This month's episodes included an update on INFORMS and its activities from the 2025 INFORMS President Dave Hunt. Then, Debdatta Sinha Roy, Oracle Retail Science R&D, shared insight into how the escalating tariff whiplash could impact the upcoming holiday shopping season.

July ... & beyond!

This summer, *Resoundingly Human* is taking a short break … but not for rest and relaxation! We are hard at work with a refresh of the podcast and will be creating exciting and engaging new content. During this downtime, we encourage you to relisten to your favorite episodes. *Resoundingly Human* will return in the fall.

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REINVENTING OPERATIONS: MERGING TRADITION WITH DIGITAL INNOVATION

BY J. PRINCE VIJAI

THE GLOBAL BUSINESS LANDSCAPE HAS experienced a profound transformation in recent decades, driven by advances in technology and the increasing complexity of markets. Amid this evolution, operations – the backbone of any organization – have also undergone significant changes. Traditional operations management (OM), long grounded in principles of efficiency, standardization and cost minimization, is now being redefined by digital technologies [1]. This convergence has given rise to the field of digital operations, blending classical operations management methodologies with cutting-edge innovations such as artificial intelligence (AI), the Internet of Things (IoT), cloud computing and data analytics [2]. This article explores how these two domains – operations management and digital operations – complement each other and shape the future of operational excellence.

Understanding Operations Management

Operations management is the administration of business practices that create and deliver value to customers, with the highest level of efficiency possible within an organization. It involves the planning, organizing, monitoring and controlling of processes and the redesign of business operations in the production of goods or services. The goal is to ensure that organizational resources are effectively used to meet customer needs.

Key functions of OM include process design and optimization, capacity planning, inventory and supply chain management, scheduling and forecasting, and quality assurance. Traditionally, OM focused on lean operations, continuous improvement (Kaizen) and techniques such as Six Sigma to eliminate waste and improve quality. Industries such as manufacturing, logistics and services have long relied on OM to streamline processes and ensure consistent outputs [3].

Rise of Digital Operations

With the advent of the fourth industrial revolution (Industry 4.0), operations are no longer confined to physical workflows. Digital operations refer to the digitization and automation of operational processes using technology. It is the integration of digital technologies into all aspects of business operations to enable greater efficiency, agility and customer responsiveness. Key technologies driving digital operations include AI and machine learning (AI/ML), IoT, cloud computing, robotic process automation (RPA), advanced analytics and digital twins. Table 1 provides a comparison between traditional OM and digital operations.

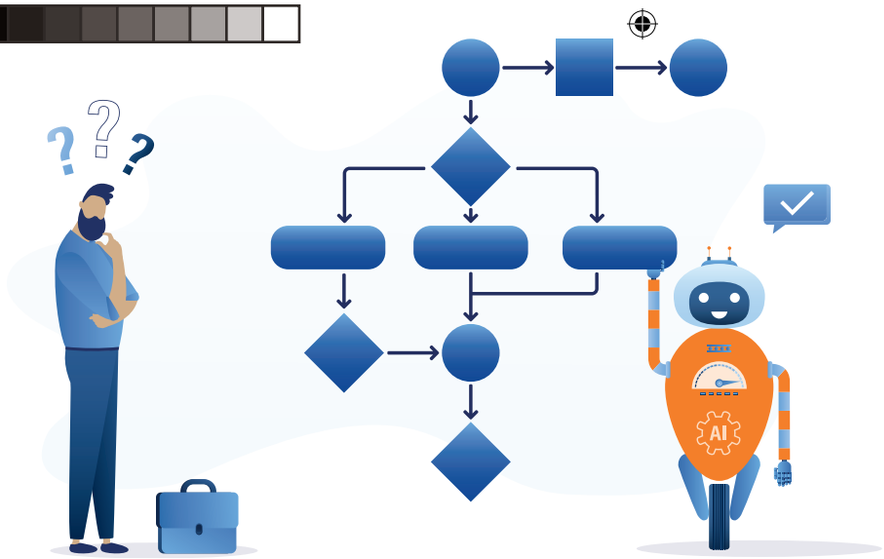
Digital operations aim to enable real-time data access, autonomous decision-making, predictive insights and seamless collaboration across the supply chain and service networks. Companies such as Amazon and Siemens are leading examples of how digital operations can drive innovation and competitiveness [4].

Bridging Traditional to Digital

The transition from traditional OM to digital operations is not a replacement but an evolution.

TABLE 1: Operations Management vs. Digital Operations

FEATURE	OPERATIONS MANAGEMENT	DIGITAL OPERATIONS
Scope	Traditional processes and workflows	Digitally enhanced or fully digital processes
Tools and techniques	Lean, Six Sigma, Enterprise Resource Planning (ERP)	AI, IoT, RPA, cloud, digital twins
Decision basis	Historical data, forecasting models	Real-time data, predictive and prescriptive analytics
Goal	Efficiency, cost control	Agility, resilience and innovation
Industry evolution	Manufacturing, services	Smart factories, Industry 4.0, digital enterprises



Digital tools enhance the classical OM framework by adding intelligence, speed and adaptability.

1. *Process Optimization and Automation*
   In classical OM, process optimization involved detailed mapping and iterative improvements. With digital operations, AI can now identify inefficiencies, simulate improvements and automate decision-making. RPA enables repetitive, rule-based tasks to be performed without human intervention, significantly improving speed and accuracy [5].
2. *Inventory and Supply Chain Management*
   Traditional inventory models rely on forecasts and safety stock assumptions. Digital operations use real-time data from IoT sensors and machine learning to predict demand, monitor inventory levels and automate replenishment. For instance, Walmart uses AI and IoT to streamline its vast supply chain, reducing stockouts and improving shelf availability [6].
3. *Forecasting and Scheduling*
   Operations managers have long used statistical tools for forecasting. Digital operations use advanced analytics and machine learning to provide more accurate, dynamic forecasts. Real-time analytics enables organizations to quickly adapt to market changes, weather disruptions or supply chain breakdowns [7].
4. *Quality Management*
   Whereas traditional quality management emphasizes inspection and control charts, digital quality management integrates data from machines, sensors and customer feedback for continuous, real-time quality assurance. Predictive maintenance, enabled by digital twins and IoT, reduces downtime and improves asset reliability [8].

The Strategic Importance of Digital Transformation in Operations

Digitally enabled operations are becoming a strategic asset. Organizations that adopt digital operations can achieve enhanced agility by providing real-time visibility and predictive insights; enabling faster decision-making and customer-centricity through personalized, responsive services based on data-driven customer insights; achieving resilience with the ability to anticipate and respond to disruptions; and attaining sustainability through optimized resource usage and energy-efficient processes. For example, General Electric developed digital twins to monitor the performance of jet engines in real time, enabling predictive maintenance and reducing unexpected failures. Similarly, Unilever has deployed AI-driven digital factories to reduce waste and enhance productivity [9].

Challenges in Integrating Digital Operations with OM

Despite its benefits, the shift to digital operations is not without challenges.

1. **Cultural Resistance.** Employees accustomed to traditional processes may resist adopting new technologies. Digital transformation requires a mindset shift, ongoing training and change-management strategies.
2. **Data Integration and Governance.** Data from different departments or legacy systems can be siloed, limiting visibility and coordination. Successful digital operations require standardized data models and robust data governance.
3. **Technology Investment.** Implementing AI, IoT and automation involves significant capital expenditure. Small and medium-sized enterprises (SMEs) may find it difficult to justify the investment without a clear return on investment (ROI).
4. **Cybersecurity and Privacy.** Digital operations increase exposure to cyber risks. Securing systems, especially in interconnected supply chains and service networks, is critical to maintaining business continuity and compliance.

> The transition from traditional OM to digital operations is not a replacement but an evolution.

The Digital Factory at Siemens

Siemens, a global leader in industrial automation, has embraced digital operations through its concept of the "digital factory." The company has integrated sensors, cloud platforms and AI to create a digital thread across product design, manufacturing and logistics. This approach results in a 20%

reduction in production time, 30% reduction in energy consumption, and improved product customization and quality. This case illustrates how a traditional manufacturing giant can evolve into a digitally agile enterprise, merging OM principles with cutting-edge technologies [10].

OM Outlook

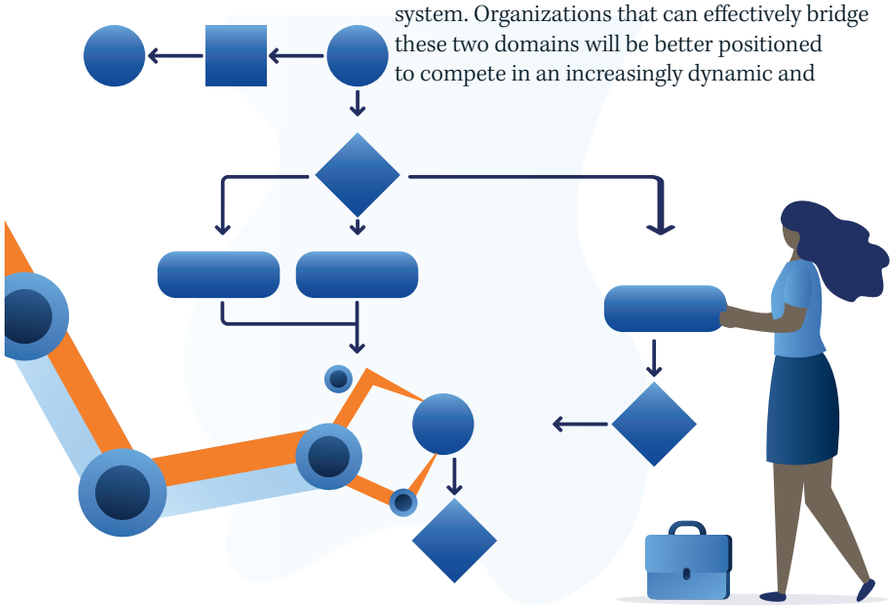
As digital technologies become more accessible, the integration of digital operations with traditional OM is expected to deepen. Future trends include:

- Hyperautomation that combines RPA, AI and machine learning to automate increasingly complex tasks.
- Cognitive operations that use AI not just to automate but to learn and adapt continuously.
- Edge computing that enables data processing closer to the source (e.g., in factories or stores) for faster insights.
- Green operations that leverage digital tools to track carbon footprints and support sustainable practices.

Educational programs and executive training in operations management must also evolve to include digital tools and analytics, preparing the workforce for this transformation.

Conclusion

The convergence of traditional OM and digital operations marks a pivotal moment in the evolution of business practices. Although OM provides the structured foundation and discipline needed for efficient processes, digital operations inject adaptability, intelligence and speed into the system [11]. Digital operations extend and enhance traditional OM by embedding digital tools (e.g., generative AI) into existing practices [12]. Effective OM is the foundation, and digital operations is the evolution toward a more connected, intelligent and adaptive system. Organizations that can effectively bridge these two domains will be better positioned to compete in an increasingly dynamic and digital-first marketplace. Embracing the synergy between OM and digital operations is not merely a technological upgrade – it is a strategic imperative for long-term success.



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COMBINING GENERATIVE AI WITH SIX SIGMA TO CREATE NEW SMART QUALITY MANAGEMENT SYSTEMS

BY GAUTHAM VEDANTHI

FOR A LONG TIME, SIX SIGMA HAS BEEN a reliable way to make processes better and less variable. The development of generative artificial intelligence (GenAI) now gives us a chance to think about what Six Sigma can do in new ways. This article discusses how combining the framework of Six Sigma with the flexibility of GenAI can make systems that improve quality more intelligently, quickly and responsively. We look at what this integration means for operations in different industries, from practical uses to real-world instances.

Six Sigma and GenAI make a strong team – one based on accuracy and the other on prediction. This alliance could change how we think about quality improvement, moving from fixing problems after they occur to proactively and adaptively optimizing them.

How AI Has Changed the Way We Improve Processes

Six Sigma was created in the 1980s and helped companies like Motorola and General Electric lower costs, improve efficiency and eliminate process variation. It made operational problems more statistically sound and disciplined. Today, businesses have to deal with a fresh set of difficulties, such as overwhelming amounts of data, rapid technological changes and complicated global supply chains. GenAI helps solve these problems by making smart systems that learn from data, automate insights and assist in faster decision-making.

Six Sigma and GenAI make a strong team – one based on accuracy and the other on prediction. This alliance could change how we think about quality improvement, moving from fixing problems after they occur to proactively and adaptively optimizing them.

Combining GenAI with the DMAIC Framework

Structured problem-solving and statistical thinking are at the heart of each step of the DMAIC cycle (Define, Measure, Analyze, Improve, Control). When combined with GenAI, these steps are changed by automation, powerful analytics and real-time learning.

1. **Define.** Voice of the Customer (VoC) and Critical to Quality (CTQ) analyses are typically used in this step. GenAI improves this by using natural language processing (NLP) algorithms to analyze tons of consumer feedback, survey data and support interactions. For instance, a generative model can group complaint stories into useful groups, which can help make project goals clearer and find systemic problems sooner.
2. **Measure.** In this step, operational metrics and data collection plans are used to measure the existing state. GenAI constantly takes in and compares real-time data sources, including IoT sensor inputs or enterprise resource planning (ERP) logs. AI algorithms find outliers, fill in missing values using imputation methods and standardize data for quick viewing, which makes measuring systems more reliable.
3. **Analyze.** GenAI's pattern recognition and anomaly detection skills are at their best when it comes to root cause analysis. Teams can use GenAI to find process bottlenecks, link input variables to outputs, and model cause-and-effect relationships using Bayesian networks or SHAP (SHapley Additive exPlanations) values instead of doing fishbone diagrams or Pareto charts by hand.
4. **Improve.** GenAI lets you use reinforcement learning and design of experiments (DOE) to simulate many different solution scenarios. Engineers can give the AI limits including cost, time and materials, and it will make a matrix of possible solutions, ranked by how likely they are to have an effect. This speeds up the decision-making process while maximizing process yield and minimizing rework.
5. **Control.** In this last step, GenAI's capacity to learn from ongoing operations makes traditional control charts better. AI can identify process drift before it goes beyond control boundaries, which can automatically send out alarms or suggest changes. These systems also change over time, learning from feedback loops and making processes more stable in the long run.

Tackling Uncertainty: What GenAI-Enhanced Six Sigma Means in the Real World

When companies use both the framework of Six Sigma and the flexibility of GenAI, they get faster results and more people involved in quality projects. One electronics manufacturer used GenAI to find small flaws in the design of its products. This lowered the danger of recalls and sped up the time it took to get the products to market. Using GenAI,

a logistics company automated the process of analyzing delays. This helped Six Sigma teams restructure routes and cut travel time by 17%.

But this integration changes the ethos of improvement in ways other than speed and accuracy. Data analysis is no longer exclusive for Black Belts because AI tools are available to all teams. Frontline workers can come up with new ideas and test them out, which makes quality improvement more open and flexible.

Also, Six Sigma is easy to train. Instead of spending weeks in class, employees can work with AI systems that help them with every step of a project, which shortens the learning curve and allows more employees to be involved in better decision-making.

Last, but not least, speed is important. GenAI speeds up analysis and solution design (i.e., projects that used to take months are now done in weeks using Six Sigma). In markets that move quickly, this flexibility can make the difference between being ahead or behind.

Use Case: Making Cars

Six Sigma has been around for a long time in the car industry, in which accuracy and rule-following are quite important and are getting much better with GenAI. One company that makes parts for electric vehicles used GenAI tools to look for early signals of flaws, such as bonding problems or structural stress, using sensor data from the production line before the pieces were put together.

Engineers used AI simulations to test new materials and design changes, which cut the design cycle from three months to less than four weeks. GenAI also powered vision systems that found alignment problems in real time, which cut down on errors later. The company has fewer defects and better compliance with quality standards such as IATF 16949 overall.

This example shows that GenAI doesn't replace Six Sigma; it makes it even better. They work together to make continuous development faster, more data-driven and stronger.

Ethical and Technical Issues

GenAI, like any other technology, comes with its own set of problems. AI systems are strong, but they aren't perfect. They sometimes provide incorrect suggestions, especially when the training data is small or skewed, which is why it is still important to keep humans in the loop.

Companies need to review things at every level to make sure the findings are reliable and clear – check the outputs and any decisions made by machines. These controls are much more critical in industries that are regulated.

Six Sigma methods such as FMEA (Failure Mode and Effects Analysis) can help find places where AI might fail (e.g., data changes), the model isn't accurate or new inputs come in. Companies may make their systems stronger and more responsible by adding AI-specific features to these risk analyses.

Future Directions: Moving Toward Six Sigma 2.0

As AI technologies get better, Six Sigma will change along with them. We can already see indications of what some people are calling "Six Sigma 2.0," which is a smarter, more connected version of the process with:

- Dashboards that change in real time based on GenAI's forecasts
- Smart control charts that change limits on their own
- AI agents that complete tests overnight and suggest ways to make things better by morning

The essential idea is still the same: Get rid of waste and make things better. But the ways in which we do this are changing. GenAI helps these goals get done faster, on a larger scale and in a way that works better in today's complicated settings.

Conclusion

When we combine generative AI with Six Sigma, it changes the way we think about improving processes. It's not just about numbers and addressing problems one step at a time anymore. It's about putting intelligence into every step of the process, from figuring out problems to keeping gains.

The benefits are evident for companies who are willing to use both Six Sigma and GenAI: shorter cycles, more people involved and better results.

Quality in the future won't only be leaner or smarter; it will be both. And it's already here.

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LEADING IN ANALYTICS: 12 LESSONS FOR BUILDING AND LEADING HIGH-IMPACT ANALYTICS TEAMS

BY HINA ARORA AND JOSEPH A. CAZIER, CAP-X

SADLY, IN SPITE OF THE INCREDIBLE transformational power of artificial intelligence (AI), more than four out of five AI and analytics projects fail to deliver the value their sponsors expect [1]. This isn't just an individual or organizational challenge – it's a systemic problem the entire analytics profession can and must address.

Fortunately, there's a growing body of knowledge about why these projects fail and how to lead them to success. INFORMS has documented much of this in its "Analytics Body of Knowledge," particularly in Chapter 2, in which Karl Kempf identified these root causes as the Five Manageable Tasks [2] – necessary, although not always sufficient, for success. These are: (1) choosing the right problem, (2) building the right team, (3) having the right data, (4) selecting the right tools and (5) executing effectively.

Without disciplined strategy, analytics efforts risk fragmentation and drift. Strategy must be a living guide, not a static plan.

Lesson 1: Lead with a Clear Mission

Before analytics teams can solve big problems, they need to know why they exist.

Mission is not just a slogan; it's the anchor for culture, decision-making and talent retention. Mission guides everything: technical work, recruitment, engagement and leadership.

Research reinforces this: Mission-driven teams enjoy higher engagement, stronger loyalty and better strategic alignment. A compelling mission helps prioritize efforts, resist scope creep and sustain energy through tough projects.

Lesson 2: Anchor Behavior in Shared Values

If mission defines why you exist, values define how you operate.

Successful teams embed values – including transparency, collaboration, experimentation and innovation – into their daily practices. Field-tested approaches show that values influence not just internal behavior but also external trust.

Organizations that consistently live their values not only attract top talent but also foster environments in which collaboration, creativity and resilience thrive. Values help teams navigate uncertainty, adapt to change and sustain performance under pressure.

Lesson 3: Inspire with a Compelling Vision

With mission and values established, teams also need a vision that guides effort and prioritization.

Although mission defines lasting purpose, vision narrows the focus to where the team is headed right now. A compelling vision doesn't just organize work – it builds momentum and attracts internal and external champions.

Research confirms that vision must be tied to real outcomes and communicated authentically. Skilled analytics translators help carry that vision across organizational boundaries, ensuring alignment and enthusiasm.

Lesson 4: Build a Strategy That Drives Action

Vision without strategy is just aspiration. Strategy makes it real.

Clear, actionable strategies require difficult choices. As Collis and Rukstad highlight [5], effective strategies demand clear priorities, not long lists of initiatives. High-performing analytics leaders visibly map strategies across intake, delivery and refinement – ensuring coherent focus.

Without disciplined strategy, analytics efforts risk fragmentation and drift. Strategy must be a living guide, not a static plan.

Lesson 5: Operationalize Your Vision with a Business Model

Analytics teams that act like startups – with a clear business model – build stronger trust and greater resilience [6].

Treating analytics as a client service helps align delivery with stakeholder expectations. Analytics teams that clearly define how they create, deliver and capture value avoid priority confusion and show tangible value early.

Research shows that clarifying who you serve and how you succeed protects focus, strengthens credibility and secures ongoing support.

Lesson 6: Choose the Right Team Structure

Structure is not just an org chart – it's an enabler.

Hybrid structures combine domain-embedded responsiveness with centralized governance. Early centralization builds trust and quality; mature organizations can thoughtfully decentralize to empower distributed innovation.

Lesson 7: Hire and Cultivate the Right Team Composition

Skills matter. Mindset matters more.

Beyond technical ability, top hires bring mission commitment, value alignment, learning agility, collaborative spirit and the ability to navigate complex stakeholder environments.

Effective hiring focuses on building ecosystems in which talented people thrive. Incentives, culture and leadership development are just as important as recruiting. Field-tested practices also emphasize the importance of aligning incentives and recognition systems with team values and mission – ensuring that collaboration, innovation and resilience are rewarded alongside technical achievement. Teams that hire carefully and cultivate supportive ecosystems tend to outlast and outperform those that focus narrowly on technical skills alone.

Lesson 8: Set the Team Up for Success from Day 1

Great teams don't emerge by accident – they're designed intentionally.

Clear expectations – roles, responsibilities, deliverables – accelerate trust and momentum. Early wins matter, even small ones. They build credibility, reduce skepticism and establish a track record of impact.

Research and field experience both show that psychological safety and early results set the foundation for sustained success.

Lesson 9: Maximize Organizational Synergy

Analytics must be a force multiplier, not a silo.

Successful teams integrate analytics projects visibly into enterprise priorities. When analytics becomes part of decision-making rhythms, it shifts from being a reporting function to a strategic enabler.

Leaders who visibly align analytics with mission-critical initiatives secure stronger sponsorship, better resource support and longer-term relevance.

Lesson 10: Empower Effective Engagement

Analytics leadership is as much about enabling others as delivering insights.

Cross-functional co-education helps partners frame better questions, recognize better opportunities and support analytics success.

Raising analytics literacy builds internal advocates who champion, protect and expand analytics functions – making literacy a form of political capital as well as technical skill.

Lesson 11: Lead Change as a Core Leadership Skill

Analytics transforms workflows, relationships and expectations, which makes change leadership a core competency.

Effective change leaders don't just manage resistance – they proactively engineer early wins, visible pilots and small victories that build momentum. Kotter's 8-Step Change Model [7] and field experience alike show that early validation creates momentum and helps cement lasting transformation.

Lesson 12: Build a Culture of Joy and Fun

Analytics is serious work – but serious work done well should be joyful.

Camaraderie, creativity and joy fuel resilience and innovation. Data storytelling days, hackathons and shared celebrations help transform analytics teams into collaborative, purpose-driven communities.

Teams that intentionally create joyful, trusting environments are better equipped to navigate uncertainty, solve complex problems and retain their best people.

Final Reflection

The lessons shared here aren't theoretical. They are field-tested, research-supported and refined through real-world leadership. As analytics leaders, we are called not just to manage and analyze data but to build cultures in which people thrive, contribute meaningfully and deliver lasting value.

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WORKING WITH INDUSTRY: FROM THE LABORATORY TO THE FIELD AND BACK

BY WARREN B. POWELL

IF YOU WORK AS AN ACADEMIC IN SCIENCE and engineering, you are going to be surrounded by colleagues who work with robots or microchips, materials or mice – objects that fit in a laboratory where you can run real experiments and test hypotheses, which allow you to write papers and obtain patents.

In operations research (O.R.), we have this habit of working on problems that do not fit in a lab: optimizing trucking companies, manufacturing systems, power grids, hospitals or a military operation (which was the problem that originally motivated George Dantzig and his development of the simplex algorithm).

Instead, we followed the style of the early pioneers in the 1950s, who were primarily mathematicians, such as Dantzig and Bellman, in which we would create mathematical models of these physical systems and then develop algorithms and prove theorems to show that *the solution is optimal!* As computers evolved, we started to create computer models, primarily with made-up data, but increasingly with data from the field. The problem was we would collect the data needed for our model without recognizing that the model may be a poor representation of an actual problem. Even today, empirical testing of models by academics remains a major weakness of our field.

In this article, I am going to discuss a number of issues that need to be addressed when going down the path of working with industry, from my experience.

Why Work with Industry?

There are several reasons to work with industry. In my experience, the most important were:

- **Money** – Let's face it: We need funding to pay for graduate students, summer salaries, computers and travel. This is particularly true for those of us working in engineering schools. Over my career, industry support constituted more than $40 million of my $60+ million in research funding (in 2025 dollars).
- **New problems** – Industry is a great source for new research challenges. Without the force of real problems, faculty often go down the path of tweaking the results of published research (there is quite a bit of this).
- **Data** – Government agencies are a source of funding, but they don't have data. Companies have data, but you have to make sure they are willing to share it. I found that trucking companies and railroads were quite willing to share data, whereas manufacturers tended to be possessive of anything related to their supply chains.
- **New theoretical questions** – Real-world problems often create the need for new theory, as I found when I was pulled into the general area of making decisions over time under uncertainty.
- **Field testing** – Companies offer the opportunity to see if your research works in the field. The downside? Companies want to see your research work in the field, and they expect it to work the first time.

A major challenge facing faculty looking to work with industry is making sure that the problems being posed not only are interesting to the sponsoring company but also offer opportunities for publishable research. Identifying these bridges was perhaps the most important skill that I brought to the research.

Why Should Industry Work with You?

It is important to understand the different reasons that a company might have to work with a university. Some of these include:

- **Prestige** – Managers like to be able to say they are working with a university to solve their problem, just as companies might hire famous (and famously expensive) consulting firms.
- **Access to faculty** – By providing funding, companies are buying the ability to talk or meet with you (and possibly other faculty). The company may have an in-house technical team that needs help or managers looking for some expert advice or free consulting.
- **Access to students** – Funding research can be a way for companies to gain visibility with the students, making it easier to attract them for future employment. However, you have to think about whether your students might want to work for these companies. I did a lot of work with freight transportation companies, knowing full well that my students at Princeton University would not necessarily want to work there. I became very accustomed to doing projects with Industrial and Systems Engineering (ISyE) graduates of Georgia Tech.
- **Deliverables** – In my experience, deliverables came in two forms:
  1. Results of studies you might perform to help companies with their planning.
  2. Software that delivers new models and algorithms they can use to improve their business.

In operations research (O.R.), we have this habit of working on problems that do not fit in a lab.

All of my work with industry initially focused on the development of models and algorithms, although I would periodically use my models to conduct studies.

What If They Want Software?

Throughout most of my career, companies wanted software. These requests fell into two categories:

1. Operational software for dispatching trucks in truckload trucking, planning operations for less-than-truckload carriers, dispatching locomotives and planning inventories for high-value spare parts.
2. Models for simulating complex operational problems for performing strategic planning exercises.

Without question, my most demanding projects involved writing software that was implemented in the field for planning operations, but be forewarned: These projects are hard and need to be staffed appropriately (see Figure 1). The biggest challenges of operational models were:

- Getting data into your model and dealing with data problems.
- Recognizing when your model is wrong and then fixing it.
- Designing and then refining your algorithms (which might mean starting from scratch if you realize your model is wrong).
- Working with people who are supposed to use the model.

It was sometimes hard to know whether the behavior of the model was a result of bad data or modeling errors. We developed a general-purpose tool called "Pilotview" (see Figure 1), which was critical for this purpose.

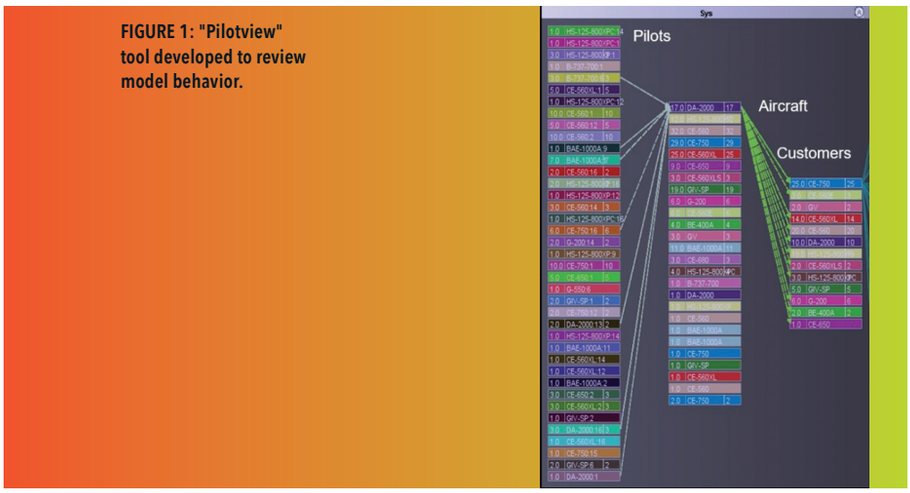

FIGURE 1: "Pilotview" tool developed to review model behavior.

Digital Twins: An Opportunity for Academics

In my experience, from the perspective of an engineering school, universities are particularly well suited for developing "simulators" for performing a wide range of planning studies (called "digital twins"). Examples from my lab included models for a large truckload fleet and a fleet of business jets; an "optimizing simulator" based on approximate dynamic programming for locomotives; scheduling generators for the power grid; and an entire series of simulators for testing policies for energy storage devices. We would also develop simulators for designing, tuning and evaluating policies for a wide range of stochastic search problems, whether optimizing materials in a lab, testing drugs for a patient or evaluating bidding policies for e-commerce.

All of these "simulators" are actually stochastic optimization models that may be used for either of two classes of decisions:

1. Choosing static design parameters, such as the size of a fleet, location of warehouses, design of products and capacity of a manufacturing process.
2. Making decisions over time (dispatching trucks, planning inventories, pricing products), in which we have to search different classes of policies and perform tuning of any parameters (which are almost always present).

A true digital twin is a carefully calibrated simulator that has been designed with the close collaboration of the company, using validation metrics. A digital twin can be used as a test environment in which faculty can pretend they are actually running their models and algorithms in the field. To be credible, a serious effort should be invested to make the model as realistic as possible. This means not only capturing the physics of the problem but also modeling different forms of uncertainty.

The Value of a Joint Research Partnership

The standard academic model is that professors come up with theory in the university and then apply it to industry. The problem is that "theory" (at least in the context of operations research) is typically done with a stylized model.

There is no shortage of examples of academic research that did not survive the transition to the field, from simplified deterministic optimization models to most forms of stochastic optimization. However, all models are approximations, and the only way to evaluate and refine approximations is to try them.

In 2006, I wrote a document titled "From the laboratory … to the field … and back" to capture the need for iterative learning. Some of this learning can be done with a simulator, as long as it is fairly accurate and captures the important characteristics of the problem.

Iterative learning is of central importance, yet it is one that is relatively rare in O.R. Contrast this with the experience of physical scientists who are endlessly trying experiments in the lab. It is this process of trial and error that is the foundation of the sciences but often missing from operations research. It is much easier to sit in our offices and prove theorems and test algorithms on datasets without validating whether the results work in the field.

But Is It Research?

There is a strong bias in the O.R. community that "research" is "theory" (or computational testing), while any work with a real operational problem is "consulting." Academics want to test publishable new methodology, whereas companies actually prefer something that is simpler and more reliable. It is the responsibility of the academic researcher to identify problems in which the real application actually needs new methodology.

I know several colleagues who do all industry projects on a consulting basis. This is fine if the project is well defined with a very high probability of success, but if this is true, then the work really is consulting. I understand the desire to supplement academic salaries, but this model will not work on complex problems that are high risk and require the trial and error of an academic research model.

In 2012, I landed a major grant with AFOSR (joint with Peter Frazier) to do optimal learning for materials science. Although Peter and I brought our traditional bias toward developing new methods, it quickly became clear that it did not matter to the materials scientists that we worked with (a requirement of the project) if our methodology was new; they just wanted something that worked … in real experiments … in the lab.

A number of fields (environmental engineering, public health, forms of biology) have strong traditions of field research. O.R. is a field that embraces many problem areas that do not fit in a laboratory. As a result, our community has adopted a style of research that prioritizes algorithms for simplified models rather than advances to the process of modeling. We run many simulations of stylized models, but we need simulators that have been subjected to a rigorous calibration process.

Staffing the Team

The standard model of a professor supervising a graduate student will not be able to take on serious software development projects. CASTLE Lab was started in 1990 with the hiring of a former Ph.D. student (Hugo Simao), followed a few years later by the addition of another professional programmer, also with a Ph.D. in operations research. Graduate students continued to do the kind of computational testing of algorithms that is familiar to the O.R. community, but the dedicated professional staff were an absolute requirement for the large-scale models that we were developing for industry. Postdocs also played an important role, but their activities tended to be more like the work of graduate students than that of the professional staff.

Ownership and Licensing

Software containing models and algorithms introduces issues that are not familiar to other areas of research, which can create problems when dealing with standard university research contracts.

Who owns the software? At Princeton University, I was able to work out an arrangement in which Princeton owned the software, even if it was developed for a single company. However, the company received a "nonexclusive, perpetual, royalty-free license" to use the code. Sound simple? It is not, and I had multiple colleagues from other universities who wondered how I pulled this off. In my case, it came down to a critical person in the grants office, John Ritter, who understood that the first goal of research is to help the faculty and students. I think he also realized that software of this type is simply not going to generate a significant stream of licensing fees compared with, for example, a license for a breakthrough cancer drug.

Closing Notes

The O.R. community needs to develop a richer tradition of field research if our field is to develop a true understanding of solving real problems. The tradition Dantzig started that emphasizes algorithms needs to be replaced with a focus on designing models.

WARREN B. POWELL is Professor Emeritus, Princeton University, and Chief Innovation Officer, Optimal Dynamics.

There are several reasons to work with industry. In my experience, the most important were money, new problems, data, new theoretical questions and field testing.

COMMERCIALIZING OPTIMIZATION RESEARCH

BY ALAN DORMER AND MARK WALLACE

IN THIS ARTICLE, WE DISCUSS THE experience of Opturion, a university spinoff and its ongoing collaboration with academia.

Opturion was formed to commercialize the results of approximately 8 years of research in constraint programming (CP) and other technologies. Opturion was formed in 2012 and has been further developing and applying artificial intelligence (AI)-based optimization to problems in transport, logistics and supply chain. It has also created standardized platforms to support vertical industry problems such as routing, scheduling and load planning. AI-based optimization has proven itself to be flexible, reliable, powerful and scalable in practical applications.

In our experience, a spinoff is not the end of the collaboration with academia; it is just the beginning. The benefits of ongoing collaboration are manifold. The spinoff can call on the assistance of researchers to solve practical problems, and the researchers gain valuable experience outside of academia. The Opturion story is one of tackling difficult problems and finding innovative solutions; we didn't do this alone!

Background

The Opturion spinoff was managed by NICTA (National ICT Australia). Its purpose was to conduct high-impact, world-class research; deliver information and communications technologies (ICT); and create economic, social and environmental benefits for Australia. NICTA has now been absorbed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

The G12 research project [1] at Monash and Melbourne Universities, in collaboration with NICTA, created a platform in which different solvers, such as mixed-integer linear programming (MILP) and CP, could be combined with various models to solve diverse problems. The G12 project developed a software platform for solving large-scale industrial combinatorial optimization problems. G12 includes a declarative modeling language, independent of any solving methodology and a mapping language for mapping models to underlying solvers. New and more powerful solvers were also part of the G12 project.

Business Perspective

In reality, some of the capabilities of G12 were unnecessary and overcomplicated for commercial software, and the two most valuable outcomes were the modeling language and powerful new solvers. The solvers have proven themselves to be robust, scalable and efficient, and the modeling language can express a wide range of complex problems. Opturion has used these to create industry vertical sectors and problem-specific platform instances, such as vehicle routing and scheduling, load planning, production scheduling and supply chain optimization.

The collaboration with Monash did not end with the Opturion spinoff; it has continued in several forms:

- Professor Mark Wallace was initially seconded to run Opturion and, after his replacement, continues to work part time. Other researchers from Monash also came over.
- Monash and Opturion have collaborated on two Cooperative Research Centres: Alertness CRC, focusing on safety and productivity, and RACE (Reliable, Affordable, Clean Energy), exploring new energy solutions.
- Opturion has developed a software platform for staff rostering, drawing on its work with the Alertness CRC.
- Opturion and Monash have collaborated on a major project for Woodside Energy, optimizing potential investments in green energy and developing tools to enhance engineering design and construction.

Opturion has employed interns from Monash in IT and optimization.

Since the spinoff, Opturion has created optimization technology that has been deployed in Australia, Singapore, the U.K. and Latin America. Based on this success, Opturion has opened offices in the U.K. and Chile, aiming to serve the North American market in due course. Based on our experience, we have focused on detailed and comprehensive supply chain optimization in industries in which transport and logistics costs are complex or a significant proportion of overall costs, such as mining, forestry, bulk materials and bulk liquids. We have successfully replaced legacy supply chain optimization applications with new technology that provides finer-grain scheduling and solutions that require no further adjustment to implement.

One of Opturion's key differentiators is its focus on CP and other solvers from the AI optimization branch. This approach contrasts with that of many established players, where the default, or indeed the only option, is MILP. CP works very differently from MILP. Its key focus is constraint satisfaction or feasibility, and it doesn't impose any conditions on the objective function, constraints or rules. Customers find it easy to understand because it works like a human: find a feasible (or legal) solution and then make it better. No surprise that CP is in the AI branch!

When we examined the market opportunity, we found that the most successful optimization applications were in tactical planning, such as transport planning, supply chain planning, production planning and staff rostering (also known as workforce planning). This outcome is

In our experience, a spinoff is not the end of the collaboration with academia; it is just the beginning. The benefits of ongoing collaboration are manifold.

no coincidence; MILP works well for this sort of application, which is relatively easy to simplify and linearize and is strongly influenced by the objective function. However, many other unsolved problems exist where MILP does not perform well. These include:

- Detailed scheduling with complex rules and nonlinearities
- Problems in which the solution is time-critical, such as reoptimization
- Large-scale strategic optimization problems, such as investment decisions over prolonged time scales

Opturion has leveraged the advantages of CP and other AI solvers to build applications, such as:

- Detailed production scheduling for complex processes, such as multicolor printing or the assembly of intricate products in aerospace. Traditional approaches struggle to optimize more than a handful of jobs. Opturion can schedule two weeks' worth of production, significantly reducing labor costs and machine idle time.
- Courier dispatch, in which new jobs are optimally assigned to the correct driver, taking into account efficiency, workload, compatibility, capacity and customer service constraints. Working over a fleet of more than 1,000 trucks, the optimizer makes a decision in a matter of seconds.
- Integrated optimization for bulk liquid supply chains with demand forecasting, vendor-managed inventory, routing and scheduling, and load optimization.
- Optimizing selection and investment in energy projects, considering capital and revenue expenditure, energy costs, process technology, government incentives and scale over the life of the assets. Compared with a more traditional approach, Opturion reduced the optimization execution time by several orders of magnitude.

Opturion's success has not all been smooth sailing, and there are some lessons to learn from what went well and what didn't.

So, what worked?

- The links to Monash University were strong for two main reasons: the secondment and continuing employment of Prof. Wallace and Monash University being a shareholder in Opturion.
- Monash University recognized that Opturion is its vehicle for commercializing optimization research and acted accordingly. We have had very little competition from their team, even though customers often look to universities to solve their problems, seeking a lower-cost solution.
- Monash has actively promoted Opturion and invited Opturion to join its flagship project with Woodside Energy.
- Monash was very supportive and recommended Opturion for projects in which (1) it could not provide a commercial solution or (2) there was no research content. In my experience, this is somewhat unique.
- Opturion and Monash have worked together closely on the two CRCs, solving problems, creating new technology and acting as a bridge between researchers and industry.
- Opturion has collaborated with Monash to investigate the case for commercializing other technologies based on or similar to optimization, using its experience and market knowledge.
- Having Monash (and CSIRO) as partners and shareholders gives Opturion credibility, particularly with large organizations.

What didn't work?

- The G12 platform was ambitious in scope, overcomplicated and immature. Opturion invested several years in simplifying and improving the performance of the underlying algorithms.
- Like many university spinoffs, Opturion was initially undercapitalized, and the founders underestimated the work required to bring products to market.
- Although Monash as an organization understands the demarcation between Opturion and its optimization research team, there are differences. We have examples of researchers reinventing the wheel, and they could have referred the project to Opturion.
- In retrospect, we should have broadened the scope of our initial collaboration with Monash to include other complementary technologies, such as machine learning. We have since developed this capability independently, but it may have been cheaper and quicker to follow the same path as G12.
- Monash and CSIRO have enviable comms departments. We have had some assistance, but they haven't conveyed a (potentially) strong message that a win for Opturion is a win for Monash and CSIRO.
- The Woodside project is a good example of Monash and Opturion collaborating on large-scale problems in which a solution exists for some elements, and others require further research. We haven't been able to develop this approach more strategically, which is a lost opportunity.

Research Perspective

Monash is Australia's largest research-intensive university, consistently ranked in the world's top 50 universities. Monash published more than 350,000 research papers in 2024 but is also focused on the practical impact of its research. Opturion is one of 30 spinoff companies productizing the result of this research. We briefly summarize the research in optimization algorithms and software that has been productized by Opturion.

The research on optimization at Monash emerged from earlier research on logic programming and constraint programming. Logic programming is highly elegant. It was designed and well suited for natural language analysis. However, its computation model lacks scalability. CP addressed this drawback by using novel AI techniques, including constraint propagation, to achieve spectacularly efficient performance even on industrial-scale NP-hard optimization problems.

Despite performing well on some problem types, CP is not as scalable as mathematical (mixed-integer linear) programming on other problems. Indeed, researchers have recognized that many industrial optimization problems include some subproblems that are solvable in constraint programming and others that are solvable in mathematical programming.

Another advantage of constraint programming is the natural and compact way of expressing (modeling) problems, which is much easier than mapping the problem into integer-linear constraints for mathematical programming.

Accordingly, Monash collaborated with NICTA to build a novel system (G12) that supported a high-level (natural and compact) modeling language, which could be mapped down onto a combination of constraint and mathematical programming. The G12 system supported problem decomposition methods that allowed large-scale problems to be decomposed into smaller problems, whose solvers could intercommunicate to reach optimal solutions.

Fundamental and Applied Research

The research teams who developed G12 were supported by academic and industrial funding, emphasizing fundamental and applied research. Although the industrial funding had benefits for the G12 system, it also had some drawbacks for the researchers. Tackling industrial applications benefited G12 by revealing shortcomings in its design and errors and bugs in its implementation. However, for the researchers, it proved much harder to publish academic papers about tackling the applications than it was to publish papers about the design of G12, showing nice examples where its advantages were highlighted.

It also became clear that the power and flexibility of G12 meant that users of the system had to grasp aspects of problem decomposition and mapping to underlying solvers that required considerable expertise and sophistication.

Interestingly, this issue led to subsequent developments in the research in two directions.

In the academic direction, the G12 system was followed by another smaller general-purpose system called MiniZinc [2]. Over the last decade, MiniZinc has gradually acquired more and more features and underlying solvers.

In the industrial direction, G12 was productized by Opturion. As mentioned earlier, Opturion employed expert software engineers and optimization modelers to build a number of vertical software products that could optimize specific optimization application areas, such as production scheduling (e.g., printing); workforce allocation to tasks and locations (e.g., courier dispatch); logistics planning, control and optimization (e.g., bulk liquids); and industrial plant design, simulation and optimization (e.g., strategic energy projects).

Perhaps the biggest change when moving into industry comes before any implementation commences.

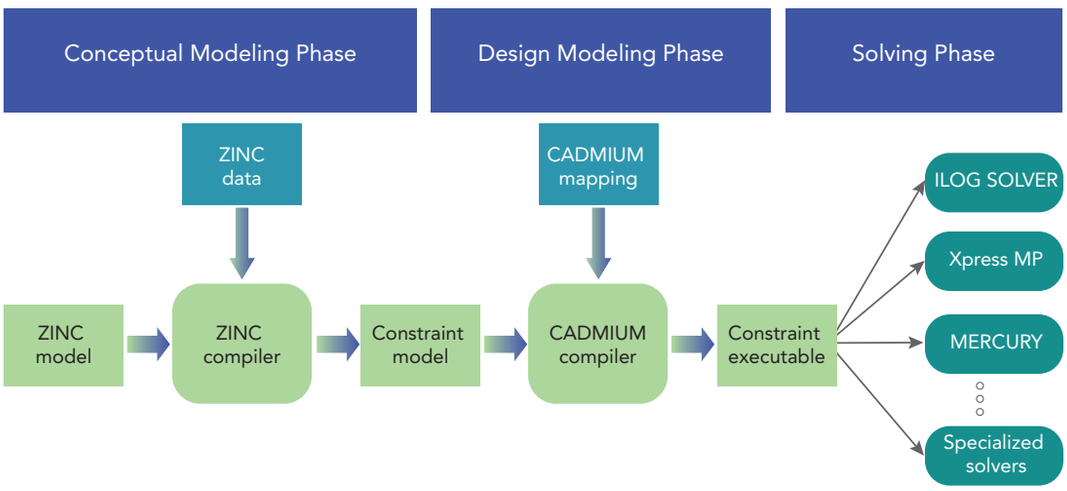

FIGURE 1: Architecture of G12 optimization software system.

Technology Transfer – Transferring the Researchers Themselves

The founding of Opturion introduced a plethora of challenges for the researchers involved.

The first and fundamental requirement is to set up the business – understanding and meeting the regulations that govern business operations and establishing an office, office infrastructure, financial controls and governance. For Opturion, these issues were handled by partnering with an existing company, Genix.

For the researchers who moved to Opturion, a stark change of emphasis was needed.

There is a broad set of activities in deploying (optimization) technology for applications in industry and government: identifying use cases; quantifying benefits; recognizing and supporting the process changes in the customers' business necessary for the success of the optimization solution; productizing ("idiot-proofing") the solution; creating documentation; and providing support and maintenance.

For the success of an optimization application, novelty is not essential: If the next application involves nothing that Opturion hasn't done before, that's a good thing!

However, industrial novelty is important. Consider planning and scheduling applications, for example. Opturion aims to eliminate repetitive deskwork so that the scheduler is only required when exceptional events occur. In current generation solutions all the following activities require desk workers:

- Scheduling customer orders
- Allocating resources
- escheduling on-the-day
- Sharing complete, up-to-date information with stakeholders
- Performance measurement

Opturion targets applications in which all these activities can be automated and optimized, until an exception occurs, which is recognized and flagged to the schedulers. Clearly, this is novel, but it does not require novel algorithms, which have been recently developed in Monash and other research institutions. Indeed, much of the novelty in this example is not in optimization but rather in data management, coordination and automated control.

Discussing the scope of an application with the customer and considering options that conflict with long-held customer practices was, and is, a completely new activity for someone previously involved in academic research. Indeed, implementing a solution to a well-specified optimization problem is typically the easiest part of application delivery.

Perhaps the biggest change when moving into industry comes before any implementation commences. When customers come with their application requirements, these are often only roughly formed in their minds. Opturion's role is to extract a precise definition of a problem and help customers understand their practical business needs. Often, the full sophisticated optimization problem that a researcher would elicit is not the best for Opturion or the customer. A simpler solution would often be cleaner and more reliable if the customer modified some of the requirements. For example, the customer, rather than agreeing to deliver an order at 9 a.m. (peak hour), could offer a later delivery at a cheaper price. This would save customer resources and enables a more efficient fleet allocation.

Finally, a surprising difference for academics is the importance of marketing and the impact of the product's appearance. For developers, this means that the functionality of an optimization solution is, very often, less important than the look and feel of the user interface.

Opturion Stages of Development

In the context of all these challenges, Opturion matured in two stages. During the first stage, the Opturion team focused on enhancing the G12 technology. The software was rationalized and consolidated, and a software development and maintenance environment were set up. Opturion had one initial customer for which a fleet optimization solution was developed. Happily, the customer was satisfied enough with Opturion to be with us after 14 years! During these years, the optimizer was designed to interface with data in spreadsheets and generate results in spreadsheets.

In the second stage, the focus shifted from the underlying optimization technology – now reliable and scalable – to applications related to chosen industry verticals. The development work addressed interfaces for users, customers' data sources and ERP systems. The former researchers on the Opturion team spent much time communicating with customers. This was perhaps an unexpected direction for people who were used to a research environment, but after 14 years, more than half of the original team who joined Opturion at the start have remained with the company.

Conclusions

In our view, Opturion has been successful because of a few key reasons:

- Transfer of the technology and the team
- A deep connection with Monash University
- A (necessarily) pragmatic and flexible approach
- Customer engagement and development

The outcome would have been different if we had more resources and had been able to be more strategic. However, the knowledge we gained by applying our technology to many other applications has served us well.

Finally, for anyone contemplating a spinoff, we would suggest reading "The Lean Startup" [3] and "Crossing the Chasm" [4] and consider what it would be like if everything took twice as long as expected!

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LESSONS FROM A CAREER IN ANALYTICS: BRIDGING ACADEMIA, INDUSTRY AND SOCIETY

BY MELVIN DRENT AND HEIN FLEUREN

Editor's note. *Tilburg University colleagues Melvin Drent and Hein Fleuren reflect on Hein's four decades at the intersection of academia, industry and humanitarian work. Together, they explore the lessons learned from bridging rigorous analytics and real-world impact – and what the future holds for the next generation of analytics professionals.*

Introduction

Professor Hein Fleuren has spent the past four decades at the intersection of academia, industry and humanitarian work, pioneering the application of operations research (O.R.) and business analytics to complex real-world problems. His collaborations span from express delivery networks at TNT Express to the global food aid operations of the United Nations World Food Programme (WFP). Twice recognized with the prestigious Franz Edelman Award (2012, 2021), his work highlights how analytics can create tangible societal value. Now recently retired from his formal position at Tilburg University, Professor Fleuren reflects on the collaborative efforts that shaped his career, the lessons learned from bridging academic rigor and practical impact, and his hopes for the next generation of analytics professionals.

Collaboration Journeys: A Foundation in Dual Ambitions

When joining Tilburg University in 2000, Fleuren was faced with a direct question: Would he focus on securing funding or focus on publications? His answer was clear: both – not simply out of ambition, but from a deep belief that meaningful applied research requires academic excellence, domain knowledge and people involvement to achieve real-world impact. As he puts it, "Excellence in applied research isn't just about building the best academic models. It's about combining academic and domain knowledge – and getting people on board to make it work in practice." This philosophy became the foundation for the collaborations that followed.

One of his first major industry projects began with a modest pilot in Italy for TNT Express. Over time, it evolved into the Global Optimization (GO) program – an organization-wide effort aimed at improving logistics planning through tailored decision-support tools. The team focused on practical outcomes – reducing costs, improving service and reducing carbon dioxide emissions – but always with models grounded in robust methodology.

Transitioning to Purpose-Driven Analytics

A turning point in Fleuren's career came with a visit to the World Food Programme's logistics operations in Rome. Witnessing the immense scale and complexity of humanitarian logistics – and the human stakes behind every operational decision – shifted his perspective.

"Seeing WFP's operations in Rome and the communities they support around the globe left a deep impression," he recalls. "It raised a personal question: could we use the same tools that improved efficiency in industry to save and improve human lives?" This moment marked a significant turning point, leading Fleuren to refocus his skills from corporate logistics to global humanitarian aid.

At WFP, Fleuren collaborated with five master's students to develop several analytics tools. One of them, Koen Peters, worked with Fleuren on the very first version of "Optimus" – an optimization platform that integrates supply chain and diet modeling. After years of further development and data integration at WFP, Optimus now supports the design of food baskets, sourcing strategies and distribution plans that balance nutritional needs with cost constraints. The results were profound: WFP estimates it can feed an additional 2 million people annually within the same budget. This achievement was recognized with the 2021 Edelman Award; however, Fleuren emphasizes that the true reward lies in the measurable humanitarian impact. "The Edelman Award in 2021 was a great honor," he says, "but more important to me was seeing how analytics could make a real difference – helping to feed millions more people." An important side effect, he notes, is that this project proved analytics can work effectively and at scale in humanitarian operations.

Building Lasting Collaborations

Fleuren points out that the real success in both collaborations lay in both achieving operational efficiencies and, further, creating truly sustainable cultural shifts from within.

"In both cases, we embedded analytics into the organization – not just through software, but also through people," he explains.

At TNT, Fleuren and his team set up the GO Academy, through which hundreds of employees were trained to understand and work with optimization tools, embedding analytics deep into the organization. "Analytics is not something you just build and deliver; it needs to live within the people and their processes," he reflects. The

Analytics is not something you just build and deliver; it needs to live within the people and their processes.

Academy focused not only on technical skills but also on building an organizational mindset that embraced data-driven decision-making at all levels. This initiative became a core part of TNT's transformation and contributed to the project being recognized with the 2012 Edelman Award.

At WFP, Fleuren took a different approach to building awareness. Together with one of his Ph.D. students, he developed a serious game that was played by WFP's entire senior logistics leadership. In the simulation, managers had to decide where to build and maintain roads and which transport modes to use – all under strict budget constraints. The goal: ensure fair food distribution between urban and rural areas.

After 1 hour of gameplay, the outcomes of the managers' decisions were compared with those of a simple mixed-integer programming (MIP) solver, which consistently improved performance by 4%-5%. This clear contrast raised awareness among WFP leadership about the potential of analytics to support and improve strategic decision-making, even in complex humanitarian settings.

Whether in commercial or humanitarian settings, Fleuren sees commonalities in his successful collaborations: long-term commitment and mutual respect. Rather than imposing solutions from the outside, his approach has always been to embed analytics through shared understanding and capacity-building. "Our Ph.D. students, thesis researchers and professional teams became bridges between academia and practice. They didn't just bring models; they brought operational urgency back to the university and academic rigor into practice," he adds.

Challenges: Cultural and Operational Gaps

Industry and humanitarian work brought distinct challenges compared with the academic world. One major hurdle Fleuren highlights is the difference in the pace of decision-making. "There's a need for timely, understandable insights – whereas researchers are trained to seek completeness and formal proof," he explains. Bridging this gap, he notes, required listening, iteration and a willingness to move forward with "good enough" solutions where perfection was impractical.

The 2008 financial crisis starkly illustrated this dynamic. Under immense time pressure, Fleuren's team developed the first DELTA model for TNT in just six weeks, supporting strategic decisions such as the closure of operations at 12 airports – a sensitive and impactful recommendation. Trust was built through early stakeholder engagement and transparent communication of model implications. "People trust what they understand," Fleuren reflects, "and involving them in the process fosters ownership."

In humanitarian logistics, Fleuren found that the challenges were of a different nature. "Access to data was often limited, infrastructure like internet connections was unreliable, and political landscapes could shift rapidly," he explains. Unlike in commercial settings, local context played a huge role – operational environments could vary widely from one region to another, requiring flexible approaches and on-the-ground adaptability. Flexibility and perseverance became essential in these settings. Yet even small, demonstrable wins helped build trust and strengthened the case for the role of analytics in humanitarian work.

Data Quality and Semantic Inconsistencies

Data quality emerged as another persistent obstacle across all projects. It was not a lack of data but the inconsistency and fragmentation that often created barriers. Fleuren recounts instances in which depot codes varied by country, system and even department – making it difficult to establish a common network structure. In humanitarian contexts, something as seemingly simple as "rice" can appear under 10 different names, depending on local sourcing, language or nutritional variant. Addressing such inconsistencies requires more than technical fixes – it involves close collaboration with domain experts who understand the context behind the labels and can interpret and reconcile the differences. "It's a reminder that good data work is not only about algorithms, but about translation – between systems, languages and perspectives," he reflects.

Lessons and Advice for the Next Generation

Looking back, Fleuren shares clear advice for young researchers aiming to bridge academia and real-world practice without compromising academic quality. Start with questions that matter beyond academia. "Find real partners – even small ones – and be open to adapting your research to their needs," he advises. "Often, the most interesting academic problems arise from practical constraints."

World Food Programme

A good example, he notes, is the classic location-allocation problem. "In academic literature, we often focus on the capacitated versus uncapacitated variants, assuming demand remains fixed," he explains. "But during my work at TNT Express, I saw how closing a depot is never just an operational decision. Depots often serve as local commercial points of contact; once they are closed, fast delivery options decline, local customer relationships weaken and demand patterns start to shift. Over time, this can cause customers to move elsewhere – altering flows across the entire network. It taught me that real-world location decisions are rarely static; they are embedded in dynamic systems of behavior and trust that extend far beyond the model's immediate inputs."

Supporting Institutional Structures

Fleuren is also quick to acknowledge the institutional support that enabled his applied work. "Without Tilburg University's openness to combining research with practice, much of this work would not have been possible," he says. "Universities need to trust researchers to explore unconventional paths – that's where innovation lives."

This flexibility made it possible to start ventures like BlueRock TMS and co-found the Zero Hunger Lab, initiatives that bridge theory and application in impactful ways. Zero Hunger Lab, in particular, started as a modest initiative but quickly grew into a recognized center for data-driven work on food security. "We began with a simple idea: use analytics to fight food insecurity," Fleuren recalls. "Today, we're collaborating with major NGOs and governments, working toward real, sustainable change."

Humanitarian vs. Commercial

When comparing commercial and humanitarian projects, Fleuren observes important distinctions. Commercial work often focuses on performance, efficiency and scale, whereas humanitarian projects require broader engagement with ethics, equity and long-term resilience – far beyond traditional performance metrics. Nevertheless, both domains benefit from a common foundation: structuring complex decisions with clarity, compassion and attention to real-world constraints.

"In humanitarian contexts, you trade control for purpose," he notes. "You work with incomplete data, unstable timelines and shifting priorities – but the stakes are human lives and well-being. That changes the nature of every conversation, every model and every line of code."

2012 Edelman Award-winning team from TNT.

Legacy and Looking Forward

Reflecting on his career, Fleuren says the greatest pride comes not from specific accolades or models but rather from the people and institutions he helped shape. The Zero Hunger Lab has grown into a recognized center for data-driven work on food security, and former students now lead impactful initiatives across sectors. "That, to me, is the lasting impact," he reflects.

As he steps back from formal academic duties, Fleuren remains committed to supporting efforts in anticipatory action, hunger monitoring and sustainable food systems. "There is still much to be done," he notes, "and I hope universities continue to encourage applied, multidisciplinary efforts with clear societal value."

Closing on a personal note, Fleuren draws a parallel between his professional life and his other passion for photography.

Top Lessons from Professor Fleuren

1. **Let the question guide the method** – Don't begin with a model or a tool, but with a real problem.
2. **Trust builds impact** – Meaningful partnerships grow from honesty, shared goals and time.
3. **Connect precision with purpose** – Analytics is most powerful when it serves people, not just systems.
4. **Listen first, listen second and listen third** – As academics, we're trained to explain; but deep, respectful listening often reveals what our models really should be solving.

Like photography, analytics is about seeing clearly – revealing what is hidden – and telling stories that inspire action.

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GENAI REVOLUTION IN MODERN CONSUMER SUPPLY CHAINS

BY SARA LODHA

HAVE YOU EVER WONDERED HOW YOUR favorite bag of potato chips ends up on the grocery shelf, or why you feel a stitch of annoyance when your preferred pasta brand is missing? Behind each of those everyday moments is an intricate network of people, data and processes working hard to keep products flowing with minimal disruption. In today's consumer world, complex supply chains shepherd every consumer packaged good (CPG) through a series of upstream-to-downstream stages until it finally lands in your grocery cart. The CPG supply chain is the journey a product takes from creation to purchase. It includes every step and person involved in making, moving and selling a product. Think of it as a relay race, in which the product is the baton passed from one stage to the next [1].

In recent years, shifting consumer behaviors and shocks such as the COVID-19 pandemic have exposed vulnerabilities ranging from sudden material shortages to production slowdowns. Although many companies appear to have recovered, aftereffects still ripple through supply networks worldwide. The World Economic Forum's Global Risks Report 2024 warns that the risk landscape will keep evolving across economic, environmental, geopolitical and technological dimensions, even as digital adoption in supply chains lags behind expectations [2].

Against this backdrop, organizations must simultaneously maintain cost efficiency, accelerate time to market, more accurately forecast demand, meet environmental, social and governance (ESG) commitments, absorb new technologies and clear operational bottlenecks. Artificial intelligence (AI) promises relief, and industries from autonomous driving to content creation have already woven it into their workflows. However, a Forbes Advisor survey shows that only 40% of companies apply AI to inventory management and just 30% to broader supply chain operations, which is hardly a wholesale transformation [3].

To unlock AI's full value, businesses need more than bolt-on features; they require holistic, end-to-end integration that replaces fragmented legacy tools with intelligent, connected ecosystems. Only then can supply chain networks evolve from reactive cost centers into resilient, data-driven engines of growth.

What Is Supply Chain AI (and GenAI)?

Before diving into practical uses, let's pin down the terminology. According to IBM, AI is a technology that enables computers and machines to simulate human learning, comprehension, problem-solving, decision-making, creativity and autonomy [4].

This broad umbrella covers many models that emulate human thinking to uncover patterns, surface insights and guide decision-making capabilities now essential for efficient, resilient supply chains.

Generative AI (GenAI) is a newer, fast-growing branch. MIT News defines it as "a machine-learning model that is trained to create new data, rather than making a prediction about a specific dataset. A generative AI system is one that learns to generate more objects that look like the data it was trained on" [5].

Put simply, traditional AI predicts; GenAI invents, such as drafting text, designing images or proposing optimized supply chain scenarios that never existed before. The era of big data ushered in advanced analytics. Companies like Amazon and Walmart leveraged sophisticated data engineering and predictive algorithms to streamline fulfillment and inventory, reducing risk while boosting responsiveness. Descriptive, predictive and prescriptive analytics have already elevated everyday decisions.

What's next? To move beyond forecasting demand or prescribing reorder points, supply chain leaders need technology that anticipates disruptions before they surface and adapts autonomously when they do. GenAI brings that edge: By generating synthetic "what-if" scenarios, it lets planners detect weak signals, model cascading effects and design responses in hours instead of weeks. Applied end to end, from demand planning through post-sale service, GenAI promises not only economic upside but also better resource stewardship, lower risk and greater stability across the entire value chain.

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End-to-End Inclusion of GenAI

Any product you buy as a consumer flows through a series of steps. A fundamental supply chain for a consumer good, such as a T-shirt, involves the following key stages:

- Demand forecasting and supply planning
- Sourcing and procurement
- Manufacturing and operations
- Distribution and logistics

Let's explore how AI, especially GenAI, can be applied across these stages to build a smarter, more efficient supply chain using predictive models and advanced analytics.

Traditionally, demand forecasting has relied on statistical methods like moving average and exponential smoothing, using historical sales data and a limited set of variables. With machine learning, models such as random forests and neural networks improved accuracy by learning complex patterns from a wider set of inputs. Yet even these approaches still treat demand as a single, fixed number extrapolated from past behavior.

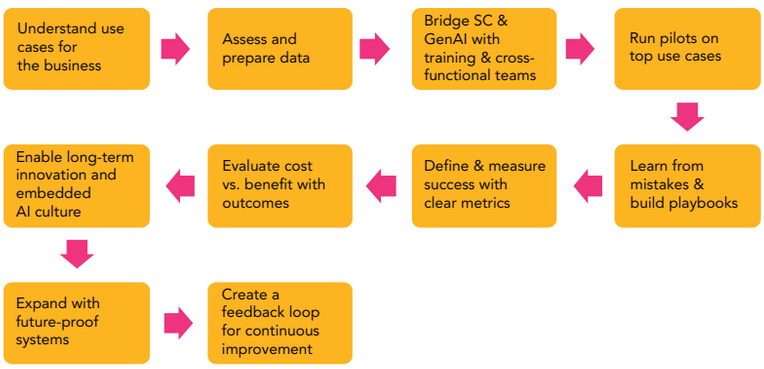
Generative AI introduces a new paradigm: dynamic, contextual demand intelligence. Consider a fashion brand planning a summer drop of graphic tees. Traditional forecasts would lean on last year's

sales and seasonality, but a GenAI model that combines retrieval-augmented generation (RAG) with generative adversarial networks (GANs) can crawl social platforms, detect viral trends and simulate shifting demand curves. It might discover that vintage-style tees are surging after celebrities wore them on a major concert tour. The model could then recommend launching a retro collection in specific regions, timed to local tour dates and supported by synthetic demand scenarios that account for weather forecasts, disposable income and influencer impact. This isn't merely predicting demand; it's blending data, cultural signals and business foresight into a real-time, adaptive strategy.

Sourcing raw materials and equipment involves far more than ticking a risk-assessment box or haggling over price. Large language models (LLMs) trained on both structured and unstructured data surface critical insights: They can identify potential suppliers and evaluate them across dozens of variables and "what-if" scenarios. When these models are paired with automation, chatbots for intake, AI-driven market-intelligence feeds and real-time dashboards, they continually monitor supplier performance, adjust negotiation strategies and stress-test contingency plans. As highlighted by Cui, Li and Zhang (2022), "AI delivers the most value when buyers adopt automation and smartness simultaneously in procurement," because this pairing lets teams swiftly react to market shifts, strengthen leverage at the bargaining table and make data-backed sourcing decisions that align cost, quality and ESG goals [6].

Generative AI takes sourcing a step further by weaving intelligence directly into every decision. In the case of our fashion brand, which needs premium, sustainable cotton and eco-friendly inks for its T-shirts, a GenAI agent can draft tailored requests for proposals (RFPs), run automated ESG compliance checks and simulate supplier performance under potential disruptions like port congestion or severe weather. Rather than manually filtering bids, the system can score responses, flag cost variances and recommend options such as supplier consolidation or volume discounts. It can validate purchase orders in real time, suggest optimal quantities based on lead times and order thresholds, and surface contract terms or supplier histories through a conversational assistant. The result is not just automation, but a smarter, more resilient approach to sourcing that aligns with cost, sustainability and speed.

FIGURE 1: Path to GenAI integration in supply chain operations.



In most factories, materials planners juggle vendor deliveries, operators battle line bottlenecks, and quality engineers chase defects with Six Sigma and statistical process control, often from spreadsheets and aging ERP (Enterprise Resource Planning) dashboards. GenAI injects intelligence at every layer, shifting the plant from reactive to predictive. On the manufacturing front, GenAI can unlock untapped productivity during production, leveraging root cause analysis to predict failures and reduce defects, and draft easy-to-follow dynamic work instructions. It can also augment operator stations by offering live, AI-supported troubleshooting and operating guidelines [7].

Unlike traditional AI that mainly classifies or predicts, generative models are designed to create new data instances, such as designs, materials or even production schedules, that meet predefined objectives such as GANs and variational autoencoder (VAE) [8].

Building upon the T-shirt journey, imagine the brand has production facilities across different U.S. locations, running a digitally simulated schedule for three variants of a new T-shirt. Using transformer and reinforcement learning models, GenAI can identify that a minor screen-printing queue overlap could lead to a 12-hour production delay and then instantly propose alternate machine configurations, retrain the layout in real time and update the MRP (Materials Requirements Planning) system via APIs. In parallel, computer vision models built with VAEs can scan early batches for issues such as faded prints or misaligned graphics. And, when a new operator clocks in, a conversational GenAI assistant can walk them through the SOPs, troubleshooting and safety checks, step by step, personalized and in real time.

Postproduction, distribution and logistics become the next arena for GenAI. An integrated solution can autonomously balance inventory, optimize material flow and decide when to use centralized versus decentralized nodes. This can create significant value for distributors, including reductions of 20%-30% in inventory, 5%-20% in logistics costs and 5%-15% in procurement spend [9].

Embedded in the MRP, GenAI can constantly read stock levels, lead times and reorder points against minimum-order quantities; simulate network-wide flows; and via transformer models, send messages to the warehouse teams in plain language to schedule picks, generate shipping documents and assign loads.

Concluding the story of the T-shirt, the brand's system can run a graph neural network to model warehouse capacity, returns, weather and carrier reliability. It can recommend splitting inventory between Ohio and California to speed coastal deliveries, auto-create pick lists, book dock slots

and file packing slips or customs forms. During last-mile service, a chatbot can watch live order data; instead of merely answering, "Where's my order?," it can flag likely delays, send proactive updates and even trigger apology coupons. In short, GenAI can turn distribution and logistics into a responsive, customer-centric engine that learns and adapts on the fly.

Transition to GenAI-Powered Supply Chain Solutions

Just as the internet transformed industries in the late 1990s and early 2000s, generative AI is now reshaping how businesses operate, from planning to execution. Tools such as email, online search and digital storefronts started as novel innovations but soon became essential to communication, commerce and collaboration. The same pattern is now unfolding with GenAI.

The key difference? Whereas the internet took years to mature, GenAI is advancing at lightning speed, powered by large pretrained models, cloud accessibility and API-first integration. What once seemed experimental- AI-generated reports, conversational assistants, real-time decision copilots- is rapidly becoming standard in modern supply chain and business operations. Those who recognize this shift early and act decisively won't just keep up; they'll lead.

But how do we prepare for this shift? What does a successful transition actually look like? Supply chain AI adoption is now closely associated with business innovation. It involves a significant change in operating norms as well as the incorporation of new technologies [10].

A structured road map is essential, starting from identifying use cases to embedding an AI-driven culture. In addition to model selection or data preparation, the transition involves rethinking how teams operate, how success is measured and how feedback fuels continuous improvement. Figure 1 illustrates a typical path organizations can follow to adopt GenAI in their supply chain, beginning with understanding business-specific use cases and preparing data. From there, supply chain teams must work alongside GenAI experts to codesign training, run pilots and define clear success metrics. Learning from early mistakes, building playbooks and evaluating ROI help mature the strategy. Long-term success depends on embedding AI into everyday operations and expanding with future-proof systems, supported by continuous feedback loops for improvement.

Challenges from GenAI Adoption

Even with the enormous potential of generative AI, a lot of challenges and risks need to be considered. AI implementation in supply chain management comes with obstacles that prevent a smooth integration. At the same time, there are promising opportunities for supply chain AI technology development in the future [11].

Although the potential of GenAI in supply chain management is vast, organizations often face several real-world hurdles during implementation, especially when transitioning from traditional or machine learning-based systems. These challenges can slow progress or even derail adoption without proper planning and cross-functional alignment.

Some of the most common obstacles include:

- Limited availability of high-quality data for training GenAI models
- Difficulty integrating GenAI with existing legacy systems
- Complexity in embedding GenAI into ERP, MRP and WMS (Warehouse Management System) platforms in real time
- Lack of internal expertise and clearly defined GenAI use cases
- Ineffective change-management strategies during large-scale transformation
- Overreliance on GenAI, which can lead to poor or unsupported decision-making
- Risks of model hallucinations, training biases and factually incorrect outputs
- Concerns around data privacy, security and regulatory compliance
- Difficulty mapping ROI and measurable benefits against implementation costs
- Ambiguity around long-term impacts across various supply chain functions

Successfully navigating these challenges requires technical readiness, organizational alignment, education, governance and a well-defined road map tailored to business-specific needs.

Future Steps

As generative AI rapidly reshapes the supply chain landscape, its potential to transform forecasting, sourcing, operations and logistics is no longer a distant promise- it's already unfolding. From dynamic demand sensing to intelligent distribution, businesses that embrace GenAI can unlock new levels of agility, efficiency and resilience. But adoption isn't without its challenges. Success requires more than the right tools; it calls for strategic vision, cross-functional collaboration and a willingness to rethink legacy processes.

For supply chain leaders, the message is clear: GenAI is not simply a trend to observe – it's a capability to build. Start by identifying high-impact use cases, invest in foundational data readiness, and foster a culture open to experimentation and learning. Those who act today will define the next era of intelligent, adaptive supply chains.

Note. *The reference list can be found online: https://doi.org/10.1287/orms.2025.03.07.*

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What once seemed experimental – AI-generated reports, conversational assistants, real-time decision copilots – is rapidly becoming standard in modern supply chain and business operations.

FROM UNDERDOGS TO GOLD MEDALISTS: HOW USA CYCLING PEDALED PREDICTIVE ANALYTICS TO THE PODIUM

BY KARA TUCKER

IN THE SUMMER OF 2024, UNDER THE glaring lights of the Paris Olympic velodrome, the U.S. Women's Team Pursuit Cycling squad pulled off something extraordinary: a stunning gold medal win that shocked the cycling world and delighted a nation. But this wasn't just a sports triumph – it was a victory for math, modeling and a small analytics team that revolutionized the way USA Cycling makes decisions.

In April 2025, that same analytics dream team found themselves on an entirely different stage: the INFORMS Edelman Gala. There, their project was crowned the winner of the world's most prestigious award in operations research and analytics – the Franz Edelman Award.

"It was shocking," recalled Ryan Cooper, the lead data scientist behind the project. "Jim [Miller] kicked me under the table before they announced it and gave me a wink. I decided I'd better start writing an acceptance speech right then."

Cooper, USA Cycling's Senior Data Analyst, wasn't exaggerating when he said they were surprised. In a room filled with inventory models and logistics optimization, USA Cycling's Olympic-sized story of resilience and innovation stood out.

Edelman teammate and USA Cycling veteran Jim Miller called it a "double win."

"Jim and I have been around awhile," Cooper said, "and when you work with elite athletes and you work around sport, you get to see a lot of the highs and the lows. You see big wins, and what that feels like even being adjacent to that. Winning the Edelman, we got to feel that same feeling."

A Different Kind of Race

At first glance, the pairing of elite cycling and analytics might seem odd. But Cooper's and Miller's stories – and that of USA Cycling – reveals just how deep the connection runs.

"Cycling's actually been at the forefront of data science in sport for decades," Cooper explained. "We're talking heart rate monitors, power meters, lactate testing – it's all physics, physiology, and numbers. The challenge wasn't data. It was budget. We didn't have the internal firepower to turn that data into decisions."

That changed in 2023 when Cooper joined the organization, just months before the World Championships in Glasgow. The team had high hopes – and the early results to back them – but walked away with half the medals they'd projected. It was a turning point.

"We ran the numbers. We knew what the data said we were capable of. But on the day, the outcomes didn't match," Cooper said. "That forced us to ask, where did we go wrong – and what can we do better?"

Engineering Gold

With only eight months until Paris, USA Cycling doubled down on its data-driven approach. The Women's Team Pursuit squad became the focal point: a tight team of four riders racing in precise synchronization around a track.

The stakes were high, and the timeline tight. "We had the athletes, we had the talent, but we needed the model to show us the blueprint," Cooper explained.

So that's exactly what they built: a highly granular optimization model that simulated thousands of racing scenarios based on aerodynamics, power output, air density, rotation strategies and fatigue. Every data point mattered – from the riders' physiology to the shape of the velodrome.

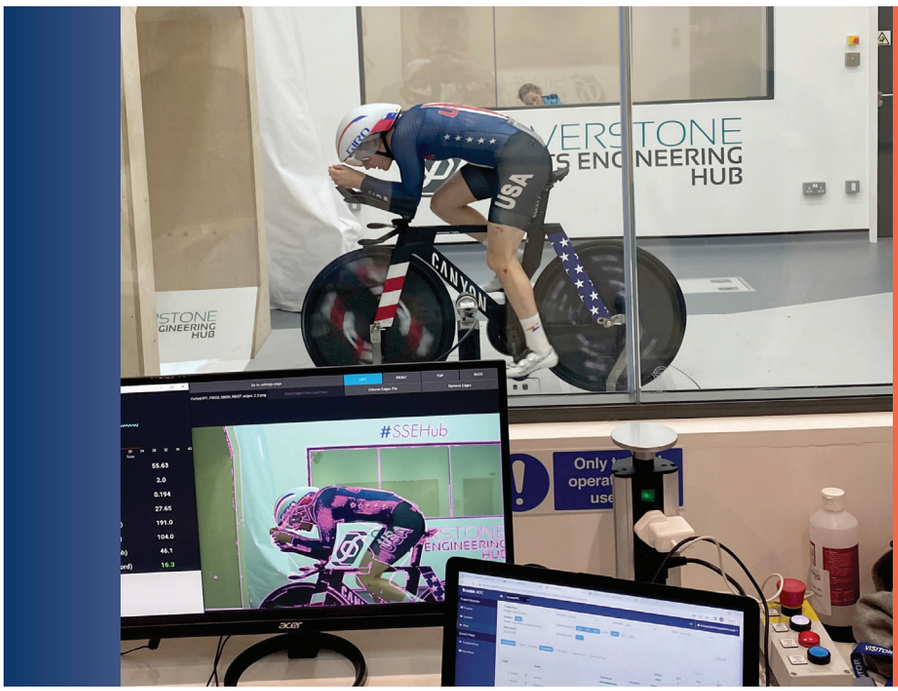
"We broke the race down into KPIs," Cooper said. "Are you increasing power? Are you more aerodynamic? How fast are your lap transitions? And then we modeled exactly what it would take to hit our goal time. If you could check off all those KPIs, you could get the gold."

This wasn't a one-way equation. It was a real-time feedback loop. The model made predictions. The athletes tested them on the track. Data came back. The model evolved.

"It was very clear where the gaps were," Cooper added. "For example, in Glasgow, one of our strongest riders, Chloe Dygert, ended up pulling the team for six or seven laps – which is pretty much unheard of. We knew we had to rethink the rotation strategy entirely."

By the time the team hit the boards in Paris, every decision had been simulated, stress-tested

By the time the team hit the boards in Paris, every decision had been simulated, stress-tested and optimized. And the result? A first-place finish with Project 4:05.



Left: Collecting data from Team USA. Right: Ryan Cooper gives an acceptance speech for the Edelman Award at the 2025 INFORMS Analytics+ Conference in Indianapolis.

and optimized. And the result? A first-place finish with Project 4:05 – and validation of a modeling framework that changed everything.

The Edelman Effect

Winning Olympic gold was just the beginning. The ripple effects of that medal and the analytics engine behind it have transformed USA Cycling from a lean, underfunded outfit into a leader in sports innovation.

Winning the Edelman Award only accelerated that trajectory.

"It's opened doors that we could only dream about before," said Cooper. "Now we've got venture capital attention, a Tech & Innovation Committee with folks from OpenAI and Strava, and a strategic partnership with the U.S. Olympic & Paralympic Committee."

USA Cycling has already secured $1.6 million in new annual funding, hired new analysts, and launched a data warehouse project with the USOPC. They're even building tools that bring AI to the fingertips of coaches – natural language interfaces that can simulate different athlete scenarios at the click of a button.

"We call it the 'death of dashboards,'" Cooper joked. "It's the idea that coaches and directors shouldn't need a data analyst sitting next to them to make sense of complex results. They should be able to say, 'Run this model with these athletes under these conditions' and get a meaningful, predictive output."

Blending Science with Soul

What made the project Edelman-worthy wasn't just the complexity of the model or the high-stakes outcome. It was the blending of technical rigor with human nuance.

"You're dealing with real people – athletes who've dedicated their lives to this," Cooper explained. "The model has to be crisp, but it also has to account for physiological variance, mental fatigue, even travel logistics. That's where O.R. shines – it helps you manage all that complexity and uncertainty."

Cooper's journey into sports analytics began more than a decade ago. A former competitive triathlete, he first built a time trial simulation model as a side project while working at a consulting firm. In 2014, he launched the Best Bike Split platform. By 2015, USA Cycling came calling.

Miller has been involved with USA Cycling for every Olympics since 2004. When he caught wind of a mixed-integer programming model for time trial optimization that Cooper was working on, Miller knew he needed both Cooper and that model on his team.

"We ran all the time trial analysis for Kristen Armstrong for the Rio Olympics in 2016," Cooper said. "She won her third gold. That was when I saw the blending of math and cycling come to life."

Miller, now USA Cycling chief of sport performance, spent many years developing the next generation of American cyclists, earning the International Olympic Committee's highest honor for coaches – the Order of Ikkos – three times, all for

United States' Chloé Dygert, Lily Williams, Jennifer Valente and Kristen Faulkner win gold in the women's team pursuit event at the 2024 Summer Olympics.

coaching three-time Olympic champion Armstrong to victory.

The Next Revolution: Talent ID

Looking ahead to the 2028 Summer Olympics in Los Angeles, USA Cycling has set an ambitious target: 10 medals, nearly doubling their Paris haul. To get there, they're focusing not just on race-day strategy – but on revolutionizing how they discover talent.

"Our challenge is geographic," said Cooper. "We've got the athletes, but very few facilities. We might have someone in Iowa who could dominate sprint track, but no track within 1,000 miles."

The solution? Data.

USA Cycling is developing machine learning models to identify physiological profiles suited to different disciplines, exploring cross-training strategies, and using large language models (LLMs) to mine social and performance data for hidden gems.

One such gem? Kristen Faulkner. Originally an alternate for the road race, Faulkner was redirected to train on the track, having never raced the discipline. The model flagged her as a strong fit and she joined the pursuit team. Not only did she help win gold on the track, but her anaerobic improvements helped her break away and win gold in the road race as well.

"We have all the talent, we just don't have the ability to get the athletes to the place where they can hone it," said Cooper. "This is where we're starting to look at how we can leverage data, machine learning and AI to identify talent for different funding levels."

Changing the Game – And the Conversation

For Cooper, one of the most rewarding parts of the Edelman journey wasn't just the recognition. It was the reaction from the analytics community – especially the next generation.

"Students came up to us at the conference and told us how excited they were about our project," he said. "They saw a new way to apply what they're learning – not just to business problems, but to human problems. They seemed excited that they could use O.R. to think outside the box."

And while Cooper is bullish about AI's potential, he's clear-eyed about the challenges ahead.

"Giving these models access to solvers and tools? Huge multiplier. But you still need expertise. You need someone who knows the sport, the science, the math."

At the end of the day, USA Cycling's win wasn't just a story of gold medals and predictive models. It was about what happens when data meets heart. When operations research steps out of the warehouse and into the arena. And when the underdogs dare to race like champions – backed by algorithms and driven by belief.

As Cooper put it: "We saw what was possible. Then we built the math to get there."

KARA TUCKER is editor of *OR/MS Today* and *Analytics* magazines.

FORECASTING SOCIAL IMPACT

How Georgia Tech Students are Helping Comfama Predict the Future of the Middle Class in Colombia

BY SHERRI VON BEHREN, SRI NARASIMHAN AND SANTIAGO GARCÍA RIVERA

AT THE SCHELLER COLLEGE OF BUSINESS at Georgia Tech, classroom theory regularly meets real-world impact. Each semester, through the Business Analytics Practicum course, students transform data into action, partnering with organizations across the globe to solve pressing problems. For spring 2025, that mission brought a team of undergraduate students to the heart of Latin America's most dynamic social innovation hub: Comfama, a nonprofit compensation fund in Colombia.

Comfama serves about 2.8 million people across Antioquia, a region in northwest Colombia, through a network of services ranging from healthcare to education to housing support. As one of 42 compensation funds in Colombia, Comfama operates on a model in which affiliated employers contribute 4% of their payroll to provide benefits for workers and their families. With 125,000 companies on their roster, forecasting population needs isn't just an academic exercise – it's a social imperative.

So how do you predict the needs of a population that's constantly shifting? This is the question Comfama brought to Georgia Tech's Business Analytics Center (BAC). The answer: data-driven insight, powered by students.

> In each case, the model is the same: Students gain real-world skills, companies gain actionable insights and the community benefits from smarter decisions.

The Business Analytics Practicum: Learning by Doing

The Practicum course isn't your average classroom experience. It's a semester-long consulting-style collaboration between students and industry partners. Every spring, undergraduates tackle these projects, and then every fall, MBA and Master of Science in Analytics (MSA) students take the reins. Regardless of level, the goal remains the same: help organizations make better decisions through analytics.

"Learning is often described as absorbing new concepts. But the Practicum showed me it's also about adaptability," one student shared. "Working on a live project with real stakeholders demanded flexibility and critical thinking every week."

That adaptability was key for the Comfama engagement. Students were tasked with building predictive models to forecast Comfama's affiliated population – a group that includes not only current employees but their families, with ripple effects across regional planning.

The Collaboration

The collaboration with Comfama officially began in fall 2024, when Georgia Tech partnered with the organization on a project focused on predicting Comfama's affiliated population using macroeconomic and demographic variables. This foundational engagement laid the groundwork for continued partnership into spring 2025 and beyond. It marked a significant milestone for the Practicum program by demonstrating how applied analytics can support forward-thinking public service organizations.

With the fall 2024 MBA Practicum cohort leading the initial charge, students explored how external forces – inflation, employment shifts and migration – impacted Comfama's population forecasts. Their models provided early insights that Comfama could use to anticipate changing service needs, particularly as Antioquia continued to evolve demographically.

Importantly, this collaboration was made possible through strong support from Santiago García Rivera, head of the Information and Analytics Laboratory at Comfama; his team members Wbeimar Ossa Giraldo, Alejandra Bernal and Susanna Londoño; and Andrés Santiago Alzate Salazar from the Digital Capacities Team. Their expertise and ongoing guidance helped shape the success of the partnership.

Antioquia: A Region on the Move

In recent years, Antioquia has undergone a major transformation. Medellín, its capital, has attracted migrants from across Colombia and the globe, drawn by economic opportunity and a vibrant cultural scene. Although this growth has boosted

the region's economy, it has also led to challenges: rising living costs, uneven development and a strain on public services.

For Comfama, this meant that traditional forecasting methods were no longer sufficient. According to García Rivera, "Economic and demographic shifts have made it harder to predict how many people will use our services. Recognizing these challenges, we want to build a robust prediction model to help us forecast what will happen to our affiliated population in the future."

The Georgia Tech Connection

The collaboration began when Juan David Penagos, Comfama's head of Ventures and New Business Development, reached out to the Georgia Tech Enterprise Innovation Institute's Medellín Center. That contact led to Sara Araujo Santos, who then connected with Sherri Von Behren, the BAC's corporate engagement manager. From there, Jonathan Fan, faculty in Information Technology Management and lead instructor for the Practicum, stepped in to design a project that could meet Comfama's needs and challenge his students.

The students dove into a dataset rich with time series, economic indicators and demographic variables. Over the semester, they experimented with various modeling techniques, evaluating factors such as employment rates, internal migration trends and inflation. The result? A working model that Comfama can use to anticipate service demand and allocate resources more effectively.

Mutual Learning and Long-Term Value

These projects are as much about student growth as they are about business solutions. "One of the most valuable lessons for students," Fan notes, "is seeing how messy real-world data can be – and learning how to clean, interpret and use it in ways that support decision-making."

But the learning doesn't stop at the campus gates. For Comfama, the engagement was a chance to rethink how analytics can help them evolve. "We're proud to be building a culture of data-driven decision-making," García Rivera said. "Georgia Tech helped us take a big step forward."

Beyond Comfama: A Global Network of Impact

The Comfama partnership is one of the most recent, but it's far from the only one. The Business Analytics Practicum has helped a wide range of companies and nonprofits tackle data challenges, from retail giants to healthcare systems.

In each case, the model is the same: Students gain real-world skills, companies gain actionable insights and the community benefits from smarter decisions.

And the experience leaves a lasting impact. "This project pushed me to think not just as a student, but as a consultant," said one participant. "I now understand how analytics can truly influence organizational strategy."

Looking Ahead

The BAC plans to continue expanding its Practicum portfolio, exploring new international partnerships and deeper engagements with returning collaborators like Comfama. For students, it's a chance to contribute to meaningful work. For partners, it's a chance to harness fresh perspectives and analytic rigor.

In a world increasingly shaped by data, Georgia Tech is making sure the next generation of business leaders knows how to use it – for insight, innovation and impact.

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THE ART OF ASKING SMARTER QUESTIONS IN DECISION INTELLIGENCE

BY MONISHA ATHI KESAVAN PREMALATHA

THIS ARTICLE EXPLORES THE CRITICAL YET often overlooked skill of asking smarter questions to improve data-driven decisions. Drawing from experience in supply chain, fraud strategy and manufacturing, we illustrate how well-crafted questions transform raw data into actionable insights. Through practical strategies and case studies, the article illustrates how precise questioning bridges the gap between data and decision-making. As organizations increasingly adopt decision intelligence – projected by Gartner to reach 36% of enterprises by 2027 [1] – mastering this skill is essential for impactful analytics in a data-driven future.

Asking smarter questions is the secret sauce that turns raw data into game-changing business insights.

Introduction

What's the first thing that pops into your head when you think about decision intelligence? Slick dashboards? Or maybe spotting trends in a chaotic data environment? Those are all vital, but there's one skill that's the unsung hero: **asking smarter questions**.

Yep, questions. Simple, right?

It's the secret sauce that turns raw data into game-changing business insights. Without it, you're just wading through numbers and praying for clarity. This article unpacks why crafting the right questions is the cornerstone of impactful analytics, drawing from my experiences in big tech, finance and consulting firms.

You'll walk away with practical tips, backed by real-world examples that show how transformative this skill is. In a world in which Gartner predicts 75% of Global 500 companies will adopt decision intelligence by 2027 [2], mastering this art isn't just a nice-to-have – it's your edge in a data-drenched future.

Why Smart Questions Matter More Than You Think

I'll never forget a meeting early in my career at a consulting firm. I poured hours into a dashboard – gorgeous visuals, comprehensive metrics, etc. But when I presented it, the room went quiet. Complete crickets.

The data was there, but it wasn't answering anyone's real questions. That's when it clicked: I hadn't asked what the stakeholders actually needed. Were we even tracking the right stuff? It was a humbling moment.

Asking smarter questions isn't just about curiosity – **it's about framing problems to unlock solutions**. As IBM's former CEO Ginni Rometty reportedly stated, "Data is the new oil, but it's only valuable if you refine it." Questions are the refinery. Smarter questions bridge the gap between data and decisions and keep you from chasing pointless metrics or delivering insights that land with a thud.

Take supply chain analytics: Instead of asking, "What's our inventory level?" try, "What's holding up our order fulfillment?" That shift digs into root causes, driving real impact. Analysts who ask precise, open-ended questions spark better collaboration and deeper insights. I've seen this in action – whether streamlining supply chain processes or sniffing out fraud patterns, the right question saves time and sparks innovation.

Case Studies: The Power of Better Questions

Supply Chain: Let me take you back to a previous supply chain project. We were buried in data – logs, schedules, you name it. Do you build a massive report with visuals and metrics? Instead, ask, "What's the biggest bottleneck in our flow?" That question led to chats with suppliers and cross-functional teams, revealing manual data sharing for critical purchase orders as the culprit. We built a self-serve tool that automated data flows, slashing cycle time. Leadership loved it, but the real win was learning that a sharp question can cut through chaos like a blade.

Fraud Detection: Another time, in fraud detection at a financial institution, we were staring at a mountain of transaction data. The obvious question was, "How many fraud cases are there?" But that wouldn't move the needle. Instead, asking, "What patterns are we missing in fraudulent transactions?" led to an analysis of behavioral anomalies, catching subtle fraud like account

takeovers without slowing down legitimate users. The result was a tighter strategy that leadership praised.

These moments proved smarter questions don't just clarify – they revolutionize.

Strategies to Asking Smarter Questions

Here's how I've honed this skill over the years:

1. **Start with the end in mind.** Before touching the data, ask, "What decision will this drive?" This keeps you on track. In a manufacturing project, instead of asking, "What's our production output?" ask, "What's blocking us from meeting demand?" That will lead to a clustering model that pinpoints production bottlenecks, visualized in a dashboard leadership won't stop raving about (true story).
2. **Challenge assumptions.** Don't buy the status quo. Ask, "Why are we measuring this?" In a telecom project, outdated KPIs were the norm. By asking, "Are these still relevant for churn prediction?" you uncover gaps, leading to an AI model that nails churn forecasts.
3. **Engage stakeholders early.** Ask, "What does success look like to you?" In a supply chain initiative, I sat down with cross-functional teams to get their pain points. The result? A tool that streamlined order tracking, saving hours weekly. Stakeholder engagement is the key; it aligns analytics with real needs.
4. **Iterate and refine.** Questions evolve. After rolling out any dashboard, ask, "What's still slipping through?" That iterative mindset uncovers new patterns, boosting decision intelligence. It's like tweaking a recipe – taste, adjust, repeat.
5. **Leverage technology for precision.** Tools such as Power BI and Python supercharge your questions. In a recent project, we asked, "How can we make real-time alerts actionable?" By weaving in data flows and automation, we created a system that pinged teams instantly, ramping up efficiency. AI will "fundamentally change how we interact with data." Smarter questions plus tech are the future.

The Future of Question-Driven Analytics

The ability to ask smarter questions is about to become nonnegotiable. By 2027, Gartner forecasts, 36% of organizations experimenting with AI will adopt high-value decision intelligence use cases, blending analytics and AI to supercharge decisions [1]. But more data doesn't mean better insights – without sharp questions, it's just noise. AI can crunch numbers, but humans frame the problems.

Picture a dashboard that doesn't just show data – it asks, "What do you need to solve?" That's where smarter questions will take us, a trend I see dominating by 2030.

Wrap-up

Asking smarter questions is more than a skill – it's a mindset. It's about curiosity, clarity and the guts to dig deeper. Whether you're streamlining supply chains, catching fraud or forecasting trends, the right question turns data into impact. My journey – from that dead-silent meeting to building tools leadership leans on – shows questions are the spark of innovation. So, next time you're staring at a dataset, pause and ask: "What's the real problem here?" You might just unlock the answer that changes everything.

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THE UNEXPECTED SOFT SKILLS YOU NEED TO SUCCEED IN DATA

BY CHRISTOPHER CHIN

I BEGAN MY CAREER AS A COMPOSER, writing music for short films. My dream was to go to Hollywood one day and help make the movies I loved. However, it was challenging. I was shy, unsure how to communicate my value and unable to make consistent income. I decided to pivot to data – a field that didn't require me to go back to school for another expensive degree, and I could try to learn everything on my own and make a decent income. But with little work experience and a background in *music*, why would hiring managers give me a chance?

Surprisingly, they were actually more than willing to consider me for employment. Since I pivoted, I got a data journalism fellowship at the U.S. Department of Transportation and data visualization/business intelligence roles at top Fortune 500 companies like Humana and Fannie Mae. Now, I run my own business in which I consult and train on data storytelling.

This is the story of how music gave me an edge and made my data career a unique success.

> I realized that the way to inspire action was treating data more like music. Like movies that start with a bang and hold your attention with pacing, emotion and character, data presentations could be the same way.

Creativity

To get my first fellowship, I learned all the technical skills on my own. I watched hour after hour of online tutorials and used what I learned to build a portfolio of projects.

After months of repetition and rejection, I finally landed an interview at the U.S. Department of Transportation. To stand out, I went beyond crunching numbers and turned data into creative visualizations.

Thanks to my musical training, I had an intuition around building graphs that made their insights clear, even to nontechnical audiences. I was hired because that creativity and ability to simplify complex concepts were exactly what the hiring committee was looking for.

Storytelling

After receiving additional guidance during my fellowship and securing my first full-time role as a senior data visualization engineer, I realized music gave me another advantage. It helped me as a storyteller.

Throughout my time in tech, I watched stakeholders ignore dashboards and gloss over slide decks because they were overwhelming dumps of numbers and stats. I realized that the way to inspire action was treating data more like music. Like movies that start with a bang and hold your attention with pacing, emotion and character, data presentations could be the same way. I held stakeholders' attention and persuaded them to share my concerns by connecting data to human impact and showing how it tied to business strategy.

Data storytelling was the ingredient for success in every role I held, and I decided to start my own business to share that knowledge with companies around the world.

Public Speaking

My previous business as a composer was not a success, and I wanted to make sure I learned from my mistakes. I worked on my communication and built my personal brand as a public speaker at international conferences.

I realized music had one last gift to give. As a performer, I was acutely aware of how to inspire people to listen, how to pull them in and give them something to remember.

I used those same techniques as a presenter, eventually being accepted to give the biggest talk of my career on the TEDx stage [1] . During the talk, I shared my realization that music wasn't a liability. It was actually my greatest asset. With its unique transferable skills, I was able to become a confident speaker, storyteller and entrepreneur. And I still get to write music every single day – just with numbers instead of notes and spreadsheets instead of symphonies.

In today's fast-moving world, it's the human skills that remain vital to data career success – because it is those skills that let your technical work be understood and have tangible, memorable impact.

CHRISTOPHER CHIN is founder and CEO of The Hidden Speaker. Formerly a music composer for short films and advertising, he transitioned into tech only to find a very different kind of communication. At Fortune 500 tech companies like Thermo Fisher Scientific, Humana and Fannie Mae, he saw ineffective presentations lead to dead stares, confused questions, and excessive phone scrolling: no decisions made and no interest gained. He launched his business The Hidden Speaker to bridge that gap between numbers and story.

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WHAT'S YOUR STORY?

"I love teaching because it touches your soul in a very different way. You feel like you're giving back, and when you see a student's eyes brighten up because they've understood something, you think, 'I did it!' I can count one person I've touched."

Hina Arora, Clinical Associate Professor, W.P. Carey School of Business, Arizona State University

"Advice for recent graduates: 1) Find a mentor. 2) Never stop learning. Always be curious. 3) Be open to new opportunities. 4) Be a mentor. With those four key principles, you'll be set up for success."

Shaun Doheney, CAP-X, Principal Analytics Leader, Amazon Web Services (AWS)

"Not everybody's transition goes as smoothly from the military, so being part of a professional society like INFORMS, especially with its forums and communities, absolutely helped me. Finding a place professionally that moves you seamlessly from a 20+-year career where you know what you're doing at any given time and you have a career path, to transitioning out of that where you have a lot of uncertainty, having those connections is very valuable. It's a reason why I'm happy that I've maintained my [INFORMS] membership."

Nicholas Ulmer, CAP-X, Principal Operations Research Analyst, CANA

For interviews and clips, scan QR code or visit the INFORMS YouTube channel.

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TRANSLATING RAW DATA INTO NARRATIVES THAT DRIVE STAKEHOLDER DECISIONS

BY GAGAN BANSAL

DATA ANALYSTS PLAY A PIVOTAL ROLE IN transforming complex datasets into clear, actionable narratives that inform decision-making. In an era dominated by information overload, the ability to tell a compelling data story can be the difference between decisions that drive success and missed opportunities. Let's dive deeper into techniques for crafting impactful data stories that resonate with stakeholders, particularly for early-career professionals looking to make their mark.

1. Understand Your Audience

- **Identify Stakeholder Needs:** A successful data narrative starts with knowing your audience. Early-career professionals should prioritize understanding what decisions stakeholders aim to make and which metrics hold value for them. This insight ensures relevance and engagement.
- **Tailor the Message:** The most effective data stories use language, visuals and examples that align with the audience's level of technical expertise and business priorities. For instance, a presentation to a marketing team might emphasize customer demographics and campaign performance, whereas a session with finance executives could focus on ROI and cost efficiency.

2. Start with a Clear Objective

- **Define the Purpose:** Every narrative should aim to answer specific questions or address a clearly defined problem. Clarity in purpose streamlines your storytelling and keeps stakeholders focused on the bigger picture.
- **Focus on Key Takeaways:** Highlighting key insights – those that directly impact business goals or processes – is crucial. Remember, brevity with impact is more effective than overwhelming your audience with excessive details.

3. Simplify and Contextualize Data

- **Use Aggregation:** Summarized metrics, such as averages or trends, help prevent data overload. However, providing the option for deeper dives can cater to stakeholders who desire detailed analysis.
- **Provide Context:** Data rarely speaks for itself. Comparing results to benchmarks, historical trends or industry standards gives stakeholders the context they need to make informed decisions. For example, a 5% increase in customer retention is far more meaningful when contrasted with industry averages or past performance.

4. Structure Your Story

- **Follow a Narrative Arc:** A well-structured narrative mirrors the arc of a story:
  - Introduction: Set the stage by describing the problem or opportunity at hand.
  - Analysis: Present data, methods and findings in a logical sequence.
  - Conclusion: Wrap up with actionable recommendations.
- **Use Headlines and Summaries:** Clear section titles and concise summaries improve comprehension and allow busy stakeholders to grasp key points quickly.

5. Leverage Visuals Effectively

- **Choose the Right Chart:** Each type of chart serves a specific purpose:
  - Line charts illustrate trends over time.
  - Bar charts provide easy comparisons.
  - Scatterplots highlight correlations.
- **Avoid Visual Clutter:** Clean designs with minimal text and subtle color schemes keep the audience focused. Highlight key insights using annotations or color accents to emphasize critical data points.

6. Incorporate Storytelling Techniques

- **Use Real-Life Scenarios:** Framing insights within relatable scenarios or business cases makes data more tangible. For example, instead of stating "sales dropped by 15%," you could say, "Our top-performing region experienced a 15% decline, largely because of reduced marketing efforts."
- **Focus on Cause and Effect:** Stakeholders appreciate understanding the "why" behind the numbers. Explaining the causes of patterns or anomalies – and their implications – builds credibility and drives action.

7. Engage Stakeholders Through Interaction

- **Encourage Questions:** Interactive sessions invite dialogue, fostering deeper understanding of the data and narrative. Early-career professionals should view questions as opportunities to demonstrate expertise and refine their storytelling skills.
- **Provide Interactive Dashboards:** Tools like Tableau or Power BI enable stakeholders to explore data further. Interactive dashboards can enhance engagement and allow for personalized insights.

8. Iterate Based on Feedback

- **Solicit Feedback:** After presenting it, actively seek stakeholder feedback. Did the insights address their concerns? Was the narrative clear?
- **Refine the Story:** Use feedback to fine-tune your approach for future presentations. Continuous improvement is key to mastering data storytelling.

Example: Turning Sales Data into Insights

Imagine your raw data reveals a 15% decline in sales for Q4. A compelling narrative could:

- **Introduce the Problem:** "Sales declined by 15% in Q4 compared with Q3, impacting revenue targets."
- **Analyze the Data:** "The drop correlates with reduced marketing spending and a competitor's product launch."
- **Provide Recommendations:** "To recover, consider increasing ad expenditures and launching a loyalty program to reengage customers."

By framing the data this way, you move beyond presenting numbers to provide actionable solutions that inspire confidence and drive decision-making.

Why Data Storytelling Matters for Early-Career Professionals

For those just starting in the field, data storytelling is a powerful tool to distinguish yourself. By mastering the art of translating raw data into narratives, you can:

- Build trust with stakeholders by delivering clear, relevant insights.
- Influence decision-making processes, demonstrating your strategic value.
- Enhance collaboration across teams by bridging technical and business perspectives.

As organizations increasingly rely on data-driven strategies, the ability to craft compelling narratives will become an indispensable skill. Whether you're analyzing customer behavior, operational efficiency or market trends, remember that your goal is to tell a story that informs, persuades and inspires action.

GAGAN BANSAL is a skilled data analyst with expertise in advanced analytics, supply chain forecasting and process optimization. With experience at Medtronic and a master's in information systems from Cleveland State University, he excels in leveraging tools like Python, SQL and Tableau to deliver actionable insights. Gagan is passionate about solving complex problems and driving impactful data-driven decisions.

INFORMS RETURNS TO ATLANTA FOR 2025 ANNUAL MEETING

BY EDWIN ROMEIJN AND JUAN PABLO VIELMA

AFTER MORE THAN 20 YEARS, ATLANTA is excited to host the 2025 INFORMS Annual Meeting and welcome conference-goers back on October 26-29, 2025! The city is expecting to host more than 6,000 members of the INFORMS community, including academic scholars, students, and industry leaders and experts. The meeting is expected to serve as a catalyst for continuing innovations in the fields of operations research (O.R.), analytics and artificial intelligence (AI) with the goal of *making smarter decisions for a better world*.

Atlanta is a perfect setting for this year's meeting. Over the past decade, the city has experienced a remarkable surge in both population and corporate expansion, reinforcing its status as a premier destination for businesses across industries, often drawn in part by access to top-tier universities. Since 2010, the 28-county Atlanta metropolitan area grew by approximately 20%, adding more than 1 million new residents. Atlanta has long been home to a significant number of Fortune 500 companies and major U.S. and international firms that maintain headquarters (e.g., Coca-Cola, Delta Air Lines, The Home Depot, Porsche, UPS) or major operations (e.g., Google, Hyundai, Microsoft, NCR, Norfolk Southern) in the metro area. Recently, Mercedes-Benz announced expansion of its North American headquarters in Sandy Springs, adding a new R&D center by August 2026; Duracell will shift its R&D operations to Atlanta by mid-2027; and Rivian is establishing its East Coast headquarters along the Beltline's Eastside Trail, part of a multibillion-dollar investment tied to producing vehicles in Georgia starting in 2026. On the tech front, Micron Technology opened a memory design and R&D center in Midtown Atlanta in 2022.

Powering Smarter Decisions

The 2025 Annual Meeting agenda is packed with insightful sessions, dynamic plenary and keynote presentations and discussions, interactive workshops, and ample networking opportunities, as well as several pre-meeting events. Be sure to check the conference agenda and the INFORMS app for the most up-to-date information on tracks, topics and locations. You'll have to use some optimization skills to plan your time in Atlanta and choose which of the thousands of presentations to attend.

Don't miss our lineup of esteemed plenary and keynote speakers featuring experts in optimization, AI, analytics, quantum computing, social policy, supply chains, the environment and sports – all with the goal of making smarter decisions for a better world! A new event among the keynote sessions this year is a panel discussion among INFORMS Fellows, moderated by INFORMS President-Elect Mark Lewis, discussing the future of OR/MS, with topics ranging from AI, connections between industry and academia, the future landscape of research funding, new research directions, and the tools that we should provide to our students for maximum success and impact.

Plenary Speakers

- **Margaret Brandeau** (Stanford University), Opening Plenary: "Operations Research and Social Policy: Models That Can Make a Difference"
- **Ramayya Krishnan** (Carnegie Mellon University), "AI and Society"
- **Eric Phillips** (Delta Air Lines), "Delta at 100: Harnessing a Century of Insight to Power the Future of Travel with AI"
- **Pascal Van Hentenryck** (Georgia Tech), Closing Plenary: "Learning to Optimize: Foundations and Industrial Impact"

Keynote Speakers

- **Carlos Coello Coello** (CINVESTAV-IPN), IFORS Distinguished Lecture, "40 Years of Multiobjective Evolutionary Algorithms: Past, Present, and Future"
- **Georgia Perakis** (MIT), "AI and Decision-making in Operations Management"
- **Ben Recht** (University of California, Berkeley), "The Irrational Decision: How We Gave Computers the Power to Choose for Us"

- **Sridhar Tayur** (Carnegie Mellon University), "How Can INFORMS Contribute to the Second Quantum Revolution?"
- **Yentai Wan** (UPS Logistics), "The UPS Advantage: Integrated Network Powered by O.R. & AI"
- **Andrés Weintraub** (Universidad de Chile), Omega-Rho Lecture, "O.R. and AI Tools to Support Forest Fire Prevention Decisions"
- **Mark Lewis** (moderator), **John Birge**, **Julie Ivy**, **Phil Kaminsky**, **David Shmoys**, INFORMS Fellows Panel, "OR/MS in an Ever-Evolving Environment: Perspectives from INFORMS Fellows"
- **USA Cycling**, 2025 INFORMS Franz Edelman Award Reprise, "Project 4:05 – Optimizing Olympic Gold Medal Performance for USA's Women's Team Pursuit"
- **National University of Singapore**, Business Analytics Center (BAC), UPS George D. Smith Prize Winner Reprise

Job Market Showcase and Career Fair

INFORMS is excited to introduce the **Job Market Showcase Track**, a new initiative designed to allow job seekers, including recent and soon-to-be graduates, to gain exposure by presenting their research and engaging with prospective employers in both academia and industry in a centralized setting and dedicated cluster. This new component of the program complements the Career Fair, which is designed to offer job seekers another excellent opportunity to explore a range of career options, meet with leading organizations, and engage in direct conversations with potential employers about job openings and career advancement. Employers can leverage the Career Fair to showcase their companies, discover talented candidates with specialized skills and build their teams with top professionals in the industry. With a focus on fostering meaningful connections and facilitating professional growth, this in-person Career Fair is a must-attend event for anyone looking to advance their career or find exceptional new talent.

Networking, Career Development and Recognition

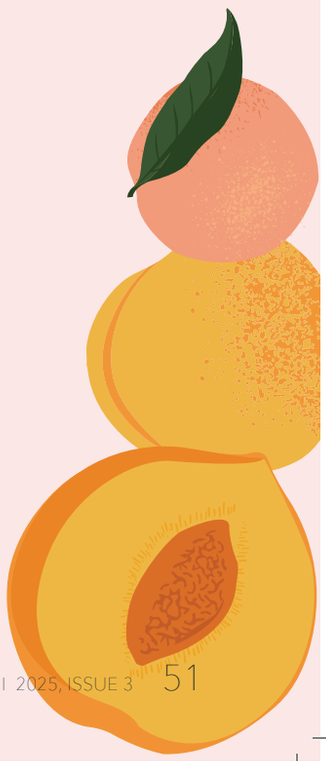
You are invited to enhance your conference experience by participating in a variety of enriching pre-meeting workshops, poster sessions, technology showcases and *TutORials* at the 2025 INFORMS Annual Meeting.

Take advantage of the many pre-meeting workshops, which offer hands-on learning opportunities and in-depth explorations of cutting-edge methodologies and tools. Whether you are interested in advancing your skills in optimization, analytics or O.R., these events are designed to provide valuable insights and practical knowledge from leading experts in the field.

In addition, the *TutORials* sessions serve as an introduction to both emerging and classical subfields of O.R. and management science, allowing members of the INFORMS community to keep pace with new developments in the field and expand their expertise while networking with fellow professionals. This year, the *TutORials* track includes exciting presentations on methodological advances such as large-scale optimization, decision-making under uncertainty, reinforcement learning, responsible machine learning and quantum computing, as well as pressing societal and industry challenges such as the mental health crisis, cyber-physical system security, social media information operations, decarbonized energy systems, and the impact of wildfires on power systems.

The **poster sessions** and **technology showcases** are perfect for those who enjoy discovering the latest innovations and research breakthroughs. This year, the conference features an increased number of poster presentations on a diverse range of topics, allowing conference participants to engage in a more conversational way with presenters through dynamic presentations and interactive displays. Do not miss this opportunity to connect with fellow researchers, practitioners and students pushing the boundaries of our discipline.

Each year, INFORMS holds a **Member Meeting** to provide an opportunity for members to come



together to celebrate achievements, embrace what's ahead and honor our exceptional volunteers. This event celebrating INFORMS – your professional home – will be over breakfast on Tuesday morning.

Finally, please do not miss the **INFORMS Awards Ceremony** and INFORMS Student Chapter Annual Awards Ceremony. Here, you will have a chance to congratulate awardees and celebrate their achievements, honor the exceptional accomplishments of our student chapters and leaders, and share in the collective pride for our outstanding students.

Social Events

As every year, INFORMS will host a welcome reception on Sunday evening in the Georgia World Congress Center, where you can connect and reconnect with colleagues and meet exhibitors.

Once you've had your fill of celebrations, presentations, exhibits, posters and coffee, it's time to put the notebooks and laptops away for an evening of (more) fun. The INFORMS After Hours! General Reception on Tuesday evening will be in one of the largest aquariums in the world, housing thousands of marine animals including whale sharks, manta rays, sea lions and penguins. Come mingle while exploring diverse aquatic environments and watching ocean life. Enjoy delicious bites and drinks while you connect with fellow attendees in this unique setting.

Last, but not least, Downtown Atlanta offers a diverse mix of attractions that reflect the city's rich history, vibrant culture and modern development and is undergoing a period of dynamic transformation. The venue for the 2025 INFORMS Annual Meeting, the Georgia World Congress Center, is in this exciting and rapidly (re-)developing area of the city. The soaring architecture of Mercedes-Benz Stadium, home to the Atlanta Falcons and Atlanta United, will host upcoming marquee events like World Cup 2026 and the 2028 Super Bowl. Adjoining is Centennial Yards, a $5 billion, 50-acre redevelopment rising from the previously underutilized Gulch. It will mix residential towers, hotels and offices with a sprawling entertainment district due to open ahead of the World Cup 2026. These developments are reshaping Downtown Atlanta, turning the area into a vibrant destination with major sports and entertainment infrastructure, walkable mixed-use neighborhoods and cultural attractions.

Please also try to visit the Atlanta Beltline, one of the most ambitious urban renewal projects in the U.S. This transformative project is being built along 22 miles of former railroad corridors encircling central Atlanta and is reshaping the city into a more connected and walkable environment.

Check out more Atlanta highlights and attractions https://hubs.ly/Q03Fyg4J0!

On-site Help

If you are on-site in Atlanta, be on the lookout for members of the INFORMS NavigatORs – the volunteer ambassadors who are available to help answer questions as you navigate the meeting. Whether it's directions to registration, where the closing plenary is or what time the coffee breaks are, if you see an attendee wearing an INFORMS NavigatOR t-shirt or button (featuring our friend Padma P. Pathfinder), don't hesitate to chat with them in the Exhibit Hall or stop them in the hallways – they are here to help new and devoted attendees alike.

New Virtual Lite Option

You asked, INFORMS created. The 2025 INFORMS Annual Meeting is piloting a new Virtual Lite Access option for those who cannot make the trip to Atlanta. INFORMS knows that recent political changes have disrupted many in our global community. As a professional society for students and professionals worldwide, we stand firmly for open inquiry, free exchange of ideas and international collaboration – values vital to advancing operations research, analytics and all our related fields.

Virtual Lite Access includes live-streamed plenaries and keynotes, *TutORials on Operations Research* and interactive engagement on INFORMS Connect and in the INFORMS app. Visit https://meetings.informs.org/wordpress/annual/virtual-access/ for more information and pricing.

We're listening, advocating and partnering with others to protect these principles and support you.

We look forward to your participation in the 2025 INFORMS Annual Meeting – however that looks for you!

REGISTER TODAY!

EDWIN ROMEIJN is the Jill Stewart Archer Family Chair and Professor in the H. Milton Stewart School of Industrial and Systems Engineering (ISyE) at Georgia Tech. He is general co-chair of the 2025 INFORMS Annual Meeting.

JUAN PABLO VIELMA is a research scientist at Google. He is general co-chair of the 2025 INFORMS Annual Meeting.

2025 INFORMS AWARDS CEREMONY

Join us for coffee and dessert on Sunday evening, October 26, while we celebrate and recognize fellow INFORMS members for their achievements in teaching, writing, and practice as well as distinguished service to the Institute, the profession, and contributions to the welfare of society.

AND THE AWARD GOES TO...

ANNA NAGURNEY
INFORMS President's Award

RENATO MONTEIRO
John von Neumann Theory Prize

BRIAN DENTON
Kimball Medal

LES SERVI
Kimball Medal

CONGRATULATIONS!

Be sure to attend the INFORMS Awards Ceremony to congratulate these winners – and more! – and find out the winners of the 2025 George Nicholson Student Paper Competition and 2025 Daniel H. Wagner Prize for Excellence in the Practice of Advanced Analytics and Operations Research.

CRAFTING AN ACADEMIC COVER LETTER

BY ALINA GORBUNOVA

WHETHER YOU ARE LOOKING FOR A summer internship, research position or full-time job, seeing an "Add Cover Letter" button on an application can be daunting and disheartening. "Why do I need to write up the same information I have on my resume?" you might ask. You may not know where to begin writing a cover letter. Not all jobs and roles require a cover letter, but when one does, submitting a strong cover letter gives you a chance to strengthen your application and stand out. Although a curriculum vitae (CV) briefly lists your credentials and skill set, a cover letter gives you the chance to create a narrative that shows your professional journey and lets the recruiters get to know you and why they should hire you.

A cover letter for an industry role is a one-page memo that outlines your interests in a job and the company, as well as highlights why you would be a good fit. For academia, a cover letter can be several pages, depending on seniority and the field. Cover letters in STEM fields are typically one to two pages, whereas cover letters in humanities and social sciences are two to three pages [1]. The goals for an academic and an industry cover letter are the same, but the structure and content will vary slightly between the two.

What Goes into an Academic Cover Letter?

A great place to begin writing your cover letter is with your CV. The information you include in your cover letter should expand upon what you have listed there. Keep in mind that a cover letter should not be a conversion of the bullet points on your CV into sentences and paragraphs. Your cover letter should expand upon your accomplishments and their significance to your past and future research and teaching journey.

In addition to discussing why you are a strong researcher, your cover letter should convey your desire to work at the position and institution you are applying to and why you are a good fit for the role. It is important to research both the institution and the department before you begin drafting your cover letter. Consider the types of institutes to which you are applying – where are they located? Are they more teaching- or research-focused? Are they R1, R2, community colleges, liberal arts colleges, Historically Black Colleges and Universities (HBCU) or some other type of college? Although you do not need to mention every detail in your cover letter, it is important to have a sense of what type of institute you are applying to. As for the department, its specific culture will help guide your cover letter and application. Consider the subfields the department focuses on. Think about whether the department has more of a focus on theoretical work, methodological work or industry collaborations and applications. If there is a specific vacancy the department or organization is trying to fill, tailor your cover letter to discuss why you can fill the vacancy. The University of North Carolina at Chapel Hill's Writing Center has a great list of questions to consider when researching the role, as well as while you are writing your cover letter [2].

Now that you have done your research and prepared your CV, what sections do you put into your cover letter? Begin with an introduction that briefly states the position you are applying to and why you are interested in the role and the institution. Include why you are excited and enthusiastic, whether that is because of the research opportunities, focus or interdisciplinary collaborations (or any other reasons you may have for applying to the position). After the introduction, there are three key components a strong academic cover letter will include: your research experience, teaching experience and philosophy, and service to the academic community [3].

- **Research Experience:** One of the key elements of an academic position is research, and your research experience and goals should be the focus of your cover letter. Use the cover letter to expand upon the focus of your research, its significance, and what methodologies and theories you apply. Take this chance to highlight key publications, collaborations, grants, and notable projects that make you stand out in your field. This might include industry collaborations with prominent companies or awards you have won, such as

being named an INFORMS Fellow. If you are an early-career scholar, it is important to discuss the future direction of your research with ideas about what topics and areas you want to explore. If you are more senior, discuss how your research has shaped your field and how it will continue to do so.

- **Teaching Experience and Philosophy:** Aside from research, teaching is one of the most important parts of any academic role, so it is important to convey your commitment and ability to teach in your cover letter. Your CV will list the courses you have taught, but your cover letter is the place to discuss your approach to teaching, what innovations you have implemented in your classroom and any student evaluations, if available. Often, academic applications will also ask for a statement of teaching, which will discuss your teaching experience and philosophy. Although the information will be very similar between your cover letter and teaching statement, do not simply copy and paste paragraphs between the two. The information in each should support each other, without being repetitive.
- **Service to the Academic Community:** In addition to your research and teaching experience, your cover letter should highlight your contribution to and leadership in the broader academic community. Examples include the editorial boards you have served on, different committees you have participated in, workshops you have organized and students (at both the undergraduate and graduate level) that you have mentored. This is also a good spot in the cover letter to mention any diversity, equity and inclusion efforts you have been part of. This section is your chance to show that you are not only a stronger researcher and teacher but also a leader in your community.

Common Mistakes to Avoid

Make sure you avoid the following common cover letter mistakes:

- **Submitting a generic cover letter.** As previously mentioned, each cover letter you submit should be for a specific role at a specific institution. Search committees can easily detect a cookie-cutter cover letter. Make sure you include specific details about the institution you are applying to, why you are a good fit and why it is a good fit for you.
- **Being too technical and using too much niche terminology**. Although your search committee may comprise experts in your field, that is not a guarantee. You want to ensure that your cover letter can be easily understood by someone outside of it. Additionally, this will showcase your ability to clearly communicate with different audiences.
- **Grammatical errors and typos.** Misspelled words, incorrect punctuation and other errors will make your cover letter unprofessional and leave a bad first impression. Read over your cover letter several times, use spell check and online editing resources such as Grammarly, and have several other people read it to catch small typos you may have missed.

Writing a cover letter requires time and effort, but a well-crafted cover letter will aid your academic applications. By following the tips and suggestions in this article, you are on your way to writing a cover letter that helps you stand out against the competition and portrays you as the perfect fit for the job.

ALINA GORBUNOVA is a Ph.D. student in the H. Milton Stewart School of Industrial and Systems Engineering at Georgia Institute of Technology. She is a member of the *OR/MS Tomorrow* editorial team.

By following the tips and suggestions in this article, you are on your way to writing a cover letter that helps you stand out against the competition and portrays you as the perfect fit for the job.

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PRIMAL-DUAL PARTNERSHIPS

The interior of successful O.R. collaborations

BY ANAND SUBRAMANIAN AND ALICE RAFFAELE

HOLMES AND WATSON, DOC AND MARTY, Calvin and Hobbes, Batman and Robin, Simon and Garfunkel: They are some of the most iconic duos in books, comics, movies and music. These partnerships show how unity is strength to solve riddles, improve the safety of a city, travel back in time, or compose and sing beautiful harmonies. But what about *research*? We can provide many examples of partners in crime. Better, we may call them *partners in science*.

For example, husband-and-wife duos Marie Skłodowska-Curie and Pierre Curie or Lillian Moller Gilbreth and Frank Bunker Gilbreth were pioneers in their fields [1, 2]. However, romantic love is not a necessary condition; for instance, think about Katalin Karikò and Drew Weissman – colleagues who made discoveries concerning nucleoside base modifications that enabled the development of effective mRNA (messenger ribonucleic acid) vaccines against COVID-19, leading to a Nobel Prize [3].

Despite the relatively short existence of the operations research (O.R.) field, we can mention some pairs who joined forces at some point in their careers, starting fantastic collaborations. Here, thanks to their interviews in the "Subject to" (s.t.) series, we tell the story of five of these O.R. pairs by delving into the details of how they met and describing the diversity and evolution of each partner's roles at the beginning and during their collaboration.

Claudia, Anand and Grazia in Leeds, UK, 2025.

M. Grazia Speranza and Claudia Archetti

An O.R. duo often starts traditionally: One is a professor teaching an O.R. course at a university, transmitting their knowledge and passion, while the other attends said course and becomes fascinated with the topic, the field and the thought leader.

Claudia Archetti met Grazia Speranza (INFORMS Fellow and EURO Gold Medalist) for the first time during her first exam session at the University of Brescia, during which Grazia was one of the supervisors in the room. A few years later, Claudia chose to attend a nonmandatory course in O.R. because "it was math" and the professor was known to be excellent. At the end of a lecture, Claudia asked a question, and Grazia thought: "I have to keep an eye on her!" Claudia also requested Grazia for a topic for her master's thesis dissertation. But with a constraint: She was not interested in programming; she wanted to do something methodological. To "capture" her, Grazia agreed. Two months later, Claudia was nevertheless coding [4].

That was the beginning of their collaboration. Grazia became one of Claudia's mentors and played a massive role in her professional life. Claudia further explored the topic of her thesis – a waste collection application – into an internship and a Ph.D. on split delivery vehicle routing problems. Claudia and Grazia published their first paper in 2003 [5]. Since then, they have co-authored four book chapters and 66 journal articles in more than 20 years.

In her s.t. episode, Claudia paid tribute to Grazia, highlighting how she was such a role model for her, such that Claudia almost did not realize that gender discrimination in academia was an issue. She described Grazia as strong, determined, engaged, dedicated, passionate and successful [6, 7]. Their professional partnership also benefits from their strong personal relationship, as revealed in several of Claudia's funny stories about pranks, trips or gifts – a perfect example of a healthy partnership, a balance between work and friendship. "We have always worked perfectly together. We understand each other perfectly, ... she has always guided me. She has a lot of positive attitude," says Claudia.

Left: Panos Pardalos and Mauricio Resende in Tuscany, Italy, 2019. Right: Alexander, Anand and Jan Karel in Leeds, UK, 2025.

Panos Pardalos and Mauricio Resende

The paths of INFORMS Fellows Mauricio Resende and Panos Pardalos first crossed in June 1988 during the AMS-IMS-SIAM Joint Summer Research Conference on Mathematical Developments Arising from Linear Programming held at Bowdoin College in Maine [8]. At that time, Mauricio was working as a full-time consultant at AT&T Advanced Decision Support Systems, and Panos was a faculty member at Pennsylvania State University. Their Brazilian-Greek scientific partnership, rooted in a close friendship, formally began in 1990 when they decided to join forces to study the classic Quadratic Assignment Problem [9]. That same year, Panos began regularly visiting Mauricio at Bell Labs, where he had moved.

Mauricio and Panos collaborated in many ways throughout the years. For instance, Mauricio is known for his extensive contribution to the dissemination of the so-called Biased Random-Key Genetic Algorithm over the past two decades, and his first publication on the topic was co-authored with Panos and Martin Ericsson. As another notable example, Panos' students Michael Hirsch and Claudio Meneses were involved in developing the Continuous Greedy Randomized Adaptive Search Procedure [10].

Mauricio and Panos have also maintained a long-term involvement with DIMACS (the Center for Discrete Mathematics and Theoretical Computer Science). After becoming permanent members of the center in 1994, they, with Ram Ramakrishnan, organized the DIMACS Workshop on Parallel Processing of Discrete Optimization Problems. Nearly 30 years later, in 2022, the duo was part of the organizing team of the 12th DIMACS Implementation Challenge and related workshop on vehicle routing problems, held in honor of the late David S. Johnson [11].

In addition to writing papers, and organizing and attending multiple events together, Mauricio and Panos also co-organized several handbooks on a variety of topics including applied optimization, massive datasets (with James Abello), optimization in telecommunications, and heuristics (with Rafael Martí). Their very fruitful partnership led to five books, 52 journal articles and book chapters, 11 conference papers and one patent.

Jan Karel Lenstra and Alexander Rinnooy Kan

On January 16, 1973, Alexander Rinnooy Kan walked into Jan Karel Lenstra's office at the Mathematisch Centrum (presently, Centrum Wiskunde & Informatica) of the Dutch Science Council, where they talked for three hours. By following the advice of their common supervisor, Gijsbert "Gijs" de Leve, they started collaborating to complete their Ph.D. projects together. Little did they know that the door to a highly successful partnership had literally just opened. That year, Jan Karel and Alexander decided to concentrate their efforts on studying the theory of scheduling. However, they were still not aware of the breakthrough paper by Richard Karp on complexity theory published in 1972 [12] – they found out about it May 1974 when Mike Florian informed them [13]. When they attended the NATO Advanced Study Institute in 1974 (which led to a book organized by Bernard Roy titled "Combinatorial Programming: Methods and Applications" [14]), they were in the right place at the right time and equipped with an appropriate set of tools to make fundamental contributions and reshape the area of complexity of scheduling problems. They also introduced the famous three-field notation together with Ronald Graham and Eugene Lawler [15].

Jan Karel and Alexander traveled across North America and Europe presenting their remarkable findings and strengthening their bond [16]. In his s.t. episode, Alexander attributed the success of their partnership to the fact that they "were sufficiently similar and sufficiently different" [17].

He added that he would always produce the first draft quite quickly, with its main argument, and Jan Karel would take over from there and transform it into a serious publication [17]. Meanwhile, during his s.t. interview, Jan Karel shared that Alexander was ambitious: "He had a sense of purpose, and we were really complementary ... Alex had a global view, and he saw the long lines, he saw the horizon, and I'm the person for details." By defining himself as "minimalist," Jan Karel added that he and Alexander "implicitly decided to profit from each other's strong points and not get irritated by our weak points ... and that worked out pretty well" [18].

Mostly, at the base, in the pair domain, we always find mutual, continuous respect. And this makes research collaborations, partnerships and friendships easier to grow.

Jan Karel made a long, successful career in academia, receiving the EURO Gold Medal in 1997 and becoming an INFORMS Fellow in 2004, among other recognitions. After also being awarded the EURO Gold Medal in 1986, Alexander's professional trajectory underwent a major shift in the early 1990s after finishing his term as rector of Erasmus University. He became the chair of the Association of Dutch Enterprises, then a member of the executive board of the International Netherlands Group (ING), before being named chair of the Social and Economic Council and finally becoming a member of the Senate in the Netherlands. When the duo was interviewed on the s.t. podcast, they had just celebrated the 50th anniversary of their interaction, friendship and work partnership. Together, they co-authored more than 43 journal articles, conference papers and book chapters. They also wrote three contributions to newsletters and newspapers and co-edited six books, often with other colleagues.

Emilio Carrizosa and Dolores Romero Morales

Having colleagues that help one another can make a big difference. Dolores Romero Morales understood she wanted an academic career in O.R. when she met some of her current co-authors during her master's program. In her thesis, she studied a location problem considering some environmental issues. She wrote the related paper with Eduardo Conde and Emilio Carrizosa from the Universidad de Sevilla. Emilio was her master's thesis supervisor, but, as he underlined in his s.t. interview, "In all our careers, we have been at the same level of academia, not the relation teacher-student" [19].

Emilio and Dolores in Leeds, UK, 2025.

Theirs was an equal collaboration from the very beginning and became stronger despite time and space. Although Dolores initially moved to the Netherlands for a Ph.D. and then to Maastricht, Oxford and eventually Copenhagen, she and Emilio continued working together through the years and even increased their pace more recently.

Besides co-authoring 37 journal articles together in almost 30 years, they started co-supervising Ph.D. students and postdoctoral researchers in the intersection between optimization and machine learning by "trying to make the black box a little bit more gray" [20, 21]. In 2024, they were awarded the Spanish Statistics and O.R. Society and the BBVA Foundation Prize for the best contribution of O.R. in data science and big data, with their jointly supervised Ph.D. student Jasone Ramírez-Ayerbe.

Together, they developed the NeEDS project (Network of European Data Scientists; https://riseneeds.eu/), with Dolores as the project coordinator and Emilio as one of the leading experienced researchers. They are working on several additional outreach activities to promote our field.

Eduardo Uchoa and Artur Pessoa

Eduardo Uchoa and Artur Pessoa are two intellectual giants behind many state-of-the-art exact algorithms for different combinatorial optimization problems. They met in 1998 while attending graduate school at the Pontifical Catholic University of Rio de Janeiro, and both quickly developed mutual admiration for each other. In his s.t. episode, Artur recalled having interesting conversations with Eduardo during lunch at the university cafeteria. He enjoyed listening to Eduardo's experiences on what kind of tricks could make algorithms efficient [22]. They also attended a course on combinatorial optimization together at PUC-Rio, teaming up to make a presentation for one of the exams, marking their first official partnership.

Some years later, in 2006, Eduardo was a faculty member at Universidade Federal Fluminense (UFF) when Artur joined him and decided to turn his attention to integer programming because of Eduardo's enthusiasm for the field. Their first joint journal paper, published in *Mathematical Programming*, paved the way for groundbreaking contributions on efficient branch-cut-and-price algorithms for vehicle routing and scheduling solvers [23, 24]. Although Eduardo was one of the masterminds behind these approaches, Artur was crucial for their efficient development. Unfortunately, not many people know this.

Eduardo noted that Artur is a "highly talented researcher, excellent programmer and not as well known in the community as he deserves" [25]. He also calls Artur a "hidden figure" with "comprehensive optimization knowledge and a brilliant mind behind many advances in column generation" [26].

The duo have much in common yet have distinct and complementary personalities. This became clear during the process of writing their recent book on column generation, with Lorenza Moreno [27]. "I tried to escape from it many times, but he did not let me leave, and I thank him for that. I thank Eduardo Uchoa for many things in my career, although we fight a lot!" revealed Artur [28]. He added that he would not be the scientist he is now without Eduardo. Despite their different point of view, they always manage to find a feasible solution to make ends meet, often converging to highly valuable scientific contributions, such as the new book and their 26 co-authored journal papers, 16 conference papers and one book chapter.

Key Components of Good Primal-Dual Algorithms

"*[Paul] provided a lightness, an optimism, while I would always go for the sadness, the discords, the bluesy notes.*" – John Lennon [29]

"*When I write, there are times – not always – when I hear John [Lennon] in my head, 'I'll think, OK, what would we have done here?', and I can hear him gripe or approve.*" – Paul McCartney [30]

In each of these pairs, who is the primal and who is the dual? It doesn't matter. As we know in our field, the dual of the dual is the primal.

Teacher-student relationships and scientific partnerships turned into friendships; seniors supporting younger researchers; peers crossing paths in postgrad; or scholars curious to combine ideas regardless of being on opposite sides of the world – these pairs are just some examples of optimal alliances.

Eduardo Uchoa and Artur Pessoa at LOGIS-UFF, Brazil, 2025.

What are the key components of their primal-dual algorithms that make their execution possible and last throughout the years? Besides the common passion for research and O.R. topics, on each side of these duos, there is transparency and intellectual freedom; trust and admiration; confrontation and compromise; sometimes, even a pinch of good competition to encourage each other; and full acceptance of each other's traits (i.e., diversity). Mostly, at the base, in the pair domain, we always find mutual, continuous respect. And this makes research collaborations, partnerships and friendships easier to grow.

Note. *References can be found online: https://doi.org/10.1287/orms.2025.03.06.*

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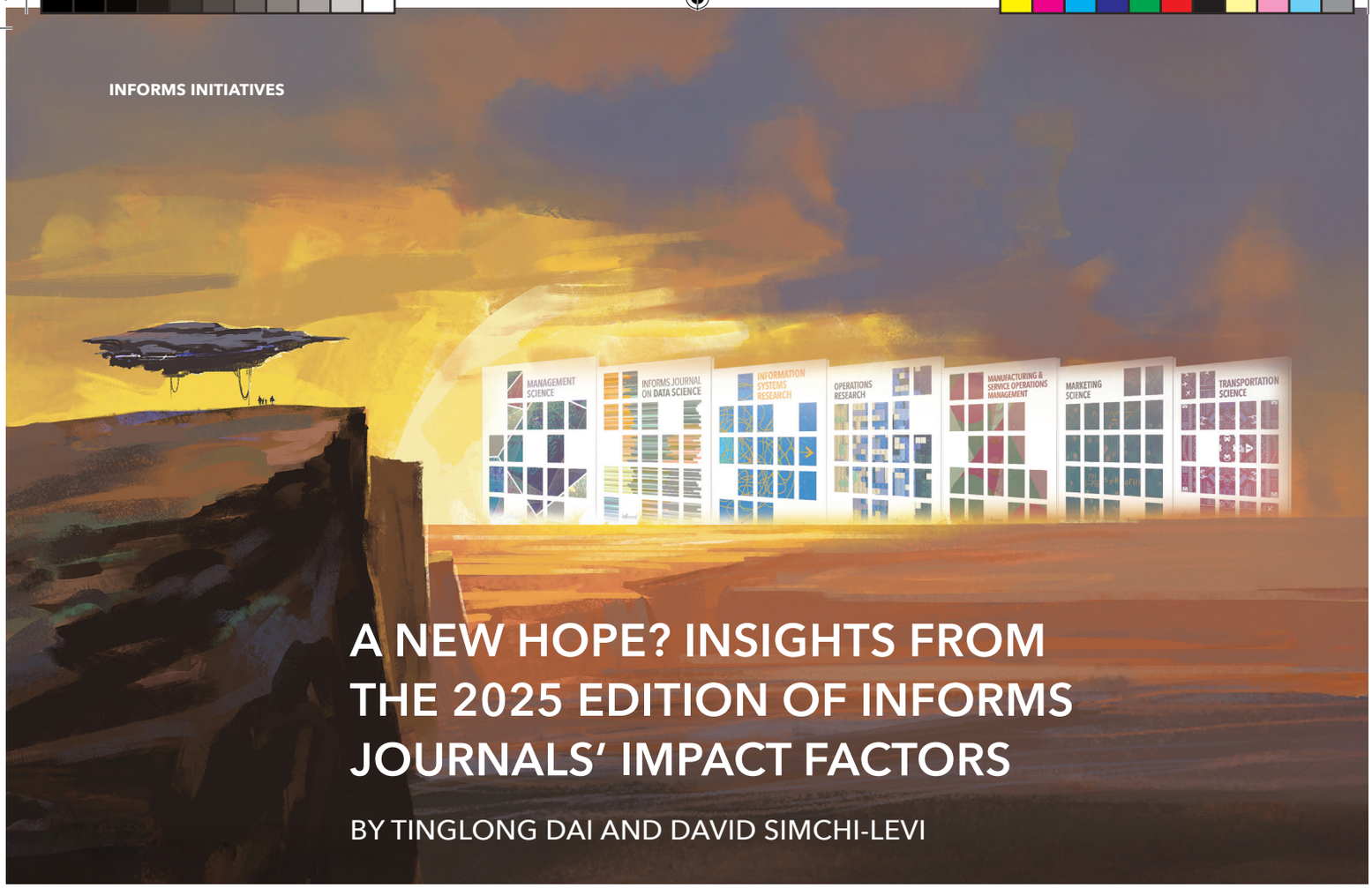
ALICE RAFFAELE is a postdoctoral researcher at the University of Padova in Italy. From 2021-2024, she was one of the two joint coordinators of AIROYoung, the Young Chapter of the Italian Association of Operations Research. She is one of the organizers of the ROAR project and collaborates with "MaddMaths!," the main Italian website of mathematics divulgation.



A NEW HOPE? INSIGHTS FROM THE 2025 EDITION OF INFORMS JOURNALS' IMPACT FACTORS

BY TINGLONG DAI AND DAVID SIMCHI-LEVI

Editors and authors should stop chasing the phantom numbers of 2021 and instead invest in what endures: rigorous scholarship and timely publication.

TWO YEARS AGO, WE WARNED THAT

INFORMS journals were entering a turbulent period due to changes in impact factor methodology, and predicted that "the decline could continue for many journals next year until impact factors stabilize in 2025" [1]. Last year, we reported that this prediction was realized and offered a few thoughts on how our community could respond [2].

With the most recent impact factors now published [3], the third part of our impact factor trilogy offers a new hope: As we predicted in 2023, the decline has markedly slowed, and several journals have rebounded. Yet, as in *Star Wars: Episode IV – A New Hope*, an early victory still leaves deeper structural challenges. In this article, we examine the new baseline, its vulnerabilities and opportunities for the operations research and management science (OR/MS) community.

A New Baseline Emerges

Clarivate's 2025 edition of *Journal Citation Reports* (reporting 2024 impact factors) shows a picture that is both hopeful and sobering (see Table 1). Instead of the across-the-board declines we chronicled in 2023, 8 of 12 INFORMS journals now show year-over-year increases. *Management Science* has climbed from 4.6 to 4.9, partially regaining ground lost in 2022, and *Marketing Science* has jumped from 4.0 to nearly 5.0. *Operations Research* has moved from 2.2 to 2.6 after two years of decline, whereas *Organization Science* has edged up from 4.9 to 5.4. Smaller titles have seen even larger swings: *INFORMS Journal on Applied Analytics* rose from 1.1 to 1.8 (a 64% gain), and *Mathematics of Operations Research* increased by roughly 36% to 1.9.

In total, the average impact factor across all INFORMS journals increased by roughly 6%, suggesting that the free fall has stopped. This widespread, if modest, rebound signals a new baseline. However, the picture is uneven across the roster. Four journals continued to decline in 2024: *Manufacturing & Service Operations Management* (*M&SOM*) slipped from 4.8 to 4.2, its impact factor now 41% below the 2021 high of 7.103; *Decision Analysis* fell from 2.5 to 1.5, erasing the gains it made in 2023; *INFORMS Journal on Computing* nudged down from 2.3 to 2.1; and *Service Science* dropped from 1.9 to 1.3. These declines highlight the fragility of specialized journals: A handful of highly cited papers can lift or depress the metric, and the effects of Clarivate's methodology change have not yet washed through for every title [1].

Looking back to 2021 clarifies just how much the baseline has shifted. At the pandemic-era peak, *Management Science* reached 6.172, *M&SOM* topped 7.103 and *Operations Research* stood at 3.924. Three years later, these journals sit roughly 20%, 41% and 34%, respectively, below those levels, even after this year's uptick. *Decision Analysis* is

JOURNAL TITLES	2021 IF	2022 IF	2023 IF	2024 IF	TREND	% CHANGE (2023-2024)	% CHANGE (2021-2024)
Decision Analysis	1.703	1.9	2.5	1.5		–40%	–12%
Information Systems Research	5.490	4.9	5.0	5.1		2%	–7%
INFORMS Journal on Applied Analytics	1.169	1.4	1.1	1.8		64%	54%
INFORMS Journal on Computing	3.288	2.1	2.3	2.1		–9%	–36%
Management Science	6.172	5.4	4.6	4.9		7%	–21%
Manufacturing & Service Operations Management (M&SOM)	7.103	6.3	4.8	4.2		–13%	-41%
Marketing Science	5.411	5.0	4.0	4.9		23%	–9%
Mathematics of Operations Research	2.215	1.7	1.4	1.9		36%	–14%
Operations Research	3.924	2.7	2.2	2.6		18%	–34%
Organization Science	5.152	4.1	4.9	5.4		10%	5%
Service Science	2.704	2.3	1.9	1.3		–32%	–52%
Transportation Science	4.898	4.6	4.4	4.8		9%	–2%
				Average		6%	–14%

Note 1: Impact Factor (IF) data is released with a one-year lag. For example, the 2024 IF data was released in 2025.

Note 2: Clarivate switched from three to one decimal in 2023 to reduce "false precision."

TABLE 1: Clarivate's 2025 *Journal Citation Reports* (reporting 2024 impact factors) for INFORMS journals.

only slightly below its 2021 level, but because its 2023 figure was unusually high, the 2024 decline appears dramatic.

Only two INFORMS journals now exceed their pre-COVID numbers: *Organization Science* rose from 5.152 to 5.4, whereas the rebranded *INFORMS Journal on Applied Analytics* (formerly titled *Interfaces*) has climbed from 1.169 to 1.8, a 54% increase.

These trajectories reveal that the 2021 numbers were an anomaly fueled by early-access policies and the COVID citation boom [1]; today's figures represent a more realistic equilibrium. Editors and authors must therefore calibrate expectations to this new orbit.

Interdisciplinary Forces Shape Impact

INFORMS flagships occupy a solid mid-tier when benchmarked against journals in adjacent fields: *Management Science* (4.9), *Organization Science* (5.4), *Information Systems Research* (5.1) and *Operations Research* (2.6) trail general-management leaders like *Academy of Management Journal* (10.5) and *Academy of Management Review* (13.9) and top

economics outlets such as *American Economic Review* (11.6) and *Quarterly Journal of Economics* (12.7). In computing and AI, the gap is wider: *ACM Computing Surveys* (28.0) and *IEEE Transactions on Pattern Analysis and Machine Intelligence* (18.6) reflect much larger audiences, survey-driven citation spikes and faster citation cycles. Despite lower impact factors, several INFORMS journals rank near the top of their OR/MS category and appear on prestigious lists like the FT50 [4], showing that perceived quality and institutional value do not map one-to-one to impact factors.

Why do OR/MS journals as a group struggle to keep pace with adjacent fields like finance or economics? A recent analysis of 4.6 million citations across 252 business journals reveals that only 30% of citations in OR/MS journals are internal, versus nearly 50% in finance [5]. This means OR/MS is inherently outward-looking: Our papers draw on and contribute to adjacent fields such as economics, computer science and social science. The main exception in our field is *Management Science*. Indeed, according to this analysis, "*Management Science* is in a unique position: the most dominant journal in the discipline that also has a high ratio of external to internal citations" [5]. That is, looking across operations journals, *Management Science* exemplifies an outward orientation, boasting one of the highest ratios of external to internal citations in the field of operations.

Special issues co-edited with other societies, joint sessions at major conferences and papers that translate OR/MS advances for nonspecialists will widen our citation network.

We believe that editors should embrace this identity by soliciting papers with cross-disciplinary appeal and marketing accepted articles to broader audiences. This was precisely the approach applied by *Management Science* starting in 2018: recruiting referees, editors and papers from other fields including computer science, economics, finance, social science and statistics.

Lessons for the Next Chapter

What should the OR/MS community take away from the impact factor trends?

First, accept the lower baseline. The impact factor trends in the past four years show that the early-pandemic highs were unsustainable. Impact factors for most INFORMS journals remain 20%-40% below their 2021 peaks even after this year's uptick. This reset is not a failure but a return to normalcy after a once-in-a-century event (the COVID-19 pandemic) and a one-time methodology change.

Editors and authors should stop chasing the phantom numbers of 2021 and instead invest in what endures: rigorous scholarship and timely publication. That means speeding up review cycles, providing early access to accepted papers and measuring success on longer horizons. By recalibrating expectations and focusing on quality, the community can weather short-term volatility.

Second, lean into our cross-disciplinary identity. OR/MS has always been a bridge discipline, which explains our outward citation patterns [5]. To turn that openness into impact, journals should actively seek papers that connect OR/MS to economics, computer science, psychology and engineering. Special issues co-edited with other societies, joint sessions at major conferences and papers that translate OR/MS advances for nonspecialists will widen our citation network.

At the same time, O.R. researchers should embrace the empirical revolution transforming the social sciences [6]. Causal inference, field experiments, and data science and AI methods can make our work more relevant to policymakers and practitioners and attract citations from adjacent fields.

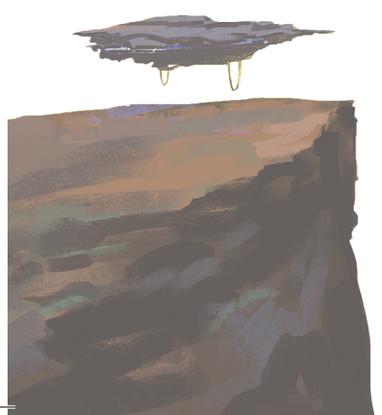
Finally, diversify evaluation metrics and educate gatekeepers. The two-year journal impact factor is only one measure of influence. Alternative metrics tell a richer story. Google Scholar Metrics rely on each journal's most-cited papers, which accumulate influence over time [7]; the Altmetric Attention Score captures how published research is impacting media coverage, social media activities and policy documents [8]. Hiring committees, letter writers, deans and ranking agencies should consider this basket of metrics when evaluating scholars and journals. We also encourage INFORMS journals to adopt Altmetric tracking – common in many fields – to motivate authors to extend the reach and real-world impact of their publications.

Looking Ahead: Hope with Eyes Wide Open

Our previous articles predicted that impact factors would decline before stabilizing by 2025. That forecast has proven largely accurate: The worst is behind us, but the field has settled into a humbler orbit. The new data also yields unexpected insights. OR/MS is more outward-facing than most other business disciplines.

Across our various recommendations, the common theme is openness – to other fields, to varied metrics and to the broader public. If we cultivate that openness and uphold rigorous standards, we can ensure that the "Force" will be with us in the chapters to come.

Note. *References can be found online: https://doi.org/10.1287/orms.2025.03.08.*



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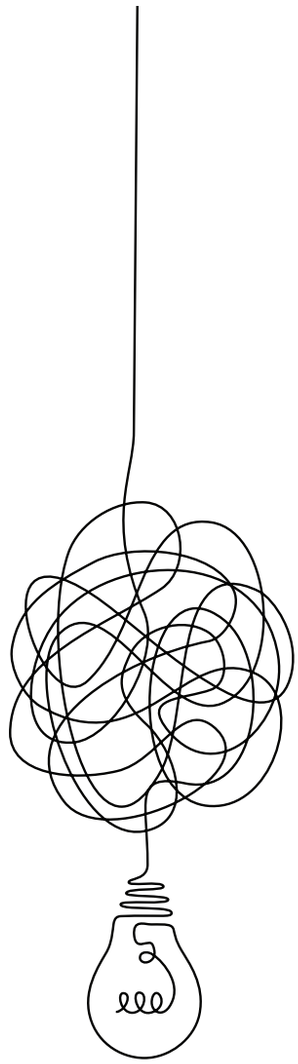
PROGRESSIVE REASONING: AN ITERATIVE APPROACH TO REAL-WORLD CHALLENGES

BY ZOHAR STRINKA, CAP-X



REAL-WORLD PROBLEMS, UNLIKE THE ones we learn to solve in school, always start out vague. This may be a surprising claim. However, real-world problems are about identifying something you would like to be different in the world and then seeing if you can improve it.

There is a section in "The One Minute Manager" that I summarize as "a problem without a solution is just complaining" [1]. Crafting a problem statement is less about finding the *one* right answer and more about noticing a potential opportunity and exploring ways to realize it. Initially, they are more dilemmas to explore than problems to solve.

Linear problem-solving does not cope well with the unclear, complex, messy and constantly evolving problems that we face in the real world. We need a process to learn more. In this third article in our series on the meta-problem approach, I will discuss how to start from a vague problem and move to something more concrete.

The process is iterative, with each loop getting us closer to clarity. I call it progressive reasoning, and it is central to the meta-problem approach.

The meta-problem approach in a nutshell:

- **Start with a dilemma.**
- **Identify your goals.**
- **Explore problems you could solve to improve each goal.**
- **Flip to gathering the high-yield problems that address many goals.**
- **Select the best problems to solve.**
- **Iterate and learn.**

One of the benefits of this approach is that it helps you to recognize when, as the world changes, your solutions may need to adapt as well. The key tool to make the meta-problem approach work for you is to regularly ask yourself, "Which problem do I want to solve right now, given my options?"

Who Defines a Problem?

When solving a problem in school, an instructor has defined that problem for their students. Their goal is clear (teaching), and they craft the problem to match it. If there is ambiguity in the problem, the student may not learn what the instructor intended. In those cases, the problem has not achieved its purpose and should be rewritten before the next round of students is subjected to it.

In daily life, we might define our own problem, or someone else might share their problem with us. The first version of a problem may be vague with many possible answers. Achieving clarity takes feedback and iteration just like for instructors.

The problem might also have so much going on that it is, in fact, impossible to solve. Consider the problem of what to eat for dinner. Until you have defined some criteria, you could choose virtually anything edible. If you instead set out to find a meal under $5 that is healthy, easy to prepare and acceptable to your 5-year-old, you may eventually determine there are no feasible alternatives.

Who defines the problem is crucial. If the purpose of a problem is a choice, it makes sense that the person who will have to make that choice defines the problem. The people who implement the solution or will be subjected to the outcomes should also have a say.

The Need to Iterate

Suppose you have set out to solve a real-world problem that will end with a decision. The interesting thing about decisions is we often don't care what the decision is, but we care a whole lot about the consequences.

One of the key weaknesses of traditional problem-solving is that it assumes that the problem is what matters. For example, people constantly talk about making sure you solve the right problem or ensuring you don't miss a requirement.

The meta-problem approach emphasizes instead that the outcomes are what matters most.

However, *we can't start from the outcomes alone*. Sometimes we try to cut through the complexity of the world by defining an objective – say, increase revenues by 50% – and work backward to the methods we'll use to achieve those goals – the problem.

	LINEAR REASONING	PROGRESSIVE REASONING
Best uses	Applying a specific method; multiple-choice questions; following a standard operating process	Identifying the best method; open-ended questions; creating a new standard operating process
Strengths	Fastest way to solve a specific problem if you know everything up front	Best way to solve a vague problem in which you may learn more as you solve it
Weaknesses	Unable to adapt to new information as you are solving the problem	May accidentally result in the original dilemma going unsolved as you learn
Perspective	Choose a chess move to get the best board position	Choose a chess move based on how your opponent will react

One of the key weaknesses of traditional problem-solving is that it assumes that the problem is what matters.

The meta-problem approach embraces our need to come at the dilemma from both sides. A problem gives us some sense of focus (scope) to pay attention to and use to assess possible solutions.

Complexity, and the fact that both the effort and the outcomes matter, drives us to an iterative exploration of problems and solutions. We start with our initial scope (problem) and see what the likely outcome of solving it would be. Looking at those potential outcomes, we can revise our problem statement to improve it now that we know more about the potential solution.

Loops Converge to Clarity

In optimization, we learn that once the problem is fully modeled, there is an optimal solution we should select once we identify it. In practice, seeing that solution may highlight exactly which criteria we left out of our original model, and invite further iteration.

Because of that complexity, I prefer the term dilemma to describe the initial vague version of a problem. The problem you ultimately decide to solve after converging to a best problem and solution may be distant from the dilemma that started your quest.

Looking at a draft problem and the outcomes you would achieve if you solved it, you begin to clarify what you really want. Whereas a problem is hard to judge as right or wrong, it's much easier to identify desirable or undesirable outcomes.

One other key benefit of treating the process as iterative is it ensures you don't lock into a particular solution too early. The first problem you identify may have lousy potential outcomes. Give yourself the opportunity to rewrite the problem and you may be able to do much better.

Problems – and Solutions – Evolve Over Time

As we solve the meta-problem of choosing a problem, we learn a lot about our preferences and the potential opportunities. We also identify what assumptions we have and learn whether they are accurate.

Because real-world problems are complex, they also often take weeks, months or years to solve. As the time to implement a solution grows, the odds increase that the world will change before we finish our project.

Fortunately, the very same information we used to choose a problem to solve can help us know when we need to modify that choice.

Consider a business leader trying to improve profitability in the coming year. Their initial problem might be to reverse a recent increase in costs. As they dig further into the issue, they may discover that their competitors have experienced those same cost increases but have increased prices to match. Another layer of exploration may show that their industry has moved to algorithm-based pricing, and their current manual review processes just can't keep up.

We also get to see these issues play out every day as governments try to adapt to a changing world. Medicare was originally designed to be sustainable by bringing in money over people's working lives and paying it out in retirement. Analysis shows Medicare will eventually run out of money, and so we need to reexamine the original model. Those on Medicare now live longer, and healthcare has become more expensive, which means policies must change to keep the program solvent.

Conclusions

Approaching problem-solving as iterative has many advantages – not least of which is that it is a more accurate way to describe the work involved. The clarification process is necessary to solve vague, complex, real-world problems.

The next article in this series will focus on how this approach can help empower the next generation of problem-solvers to thrive. By teaching problem-solving as primarily about exploration and discovery, we can foster new levels of creativity and resilience along the way. It's also a lot more fun!

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