THE TUSH PUSH
Unlocking the controversial NFL play with analytics

NEW MAJOR LEAGUE BASEBALL METRIC
Which pitcher truly deserves the win/loss?

ARISTOTLE'S INSIGHT LOOP
Using generative AI as a thinking partner, not a shortcut

U.S. ELECTION SYSTEMS ANALYSIS
Assessing voter confidence in information security

Q&A: MARK LEWIS
Incoming 2026 INFORMS president will lead with purpose

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DEPARTMENTS

CELEBRATING 50 YEARS ORMS TODAY

PHASES, PATTERNS AND THE SIGNALS WE CHOOSE TO SEE

BY KARA TUCKER

LATELY, I'VE FOUND MYSELF PAYING MORE attention to the moon. Not in a "this explains my personality" kind of way (although sometimes it's eerily close), but in the quieter sense of noticing where we are in the lunar cycle. I started tracking the phases (new, waxing, full, waning) almost accidentally, mostly because I liked the visual rhythm of lunar maps. (Full moons almost always coincided when technology was wonky or all three of my children were in a "mood.") But the more I looked up, the more I felt a shift in how I was looking around.

What surprised me wasn't any mystical insight. It was how simply observing a cycle – even one as predictable as the moon – trained my attention. I started catching patterns earlier and noticed transition points. I saw when something was beginning, when it was building pressure, when it was bright enough to mislead and when it was time to reassess.

Maybe that's why this issue feels especially resonant: every feature is, in its own way, about how we read signals. What we trust. What we test. And how we find meaning and insight without slipping into magical thinking.

The moon might not tell me anything about 2026 yet, but this year, it taught me how much clarity comes from simply knowing which phase I'm in.

New Moon: Clearing the Slate

The New Moon is a trickster – it's there, but invisible. You have to trust it's coming back even when you see nothing at all. It's a moment of blankness, and therefore a perfect moment to question assumptions.

That's exactly where the author of our Major League Baseball win/loss metric article begins (see page 24). What if the system we've used for decades doesn't measure what we think it measures? What if pitcher performance has been obscured by something as arbitrary as run support? A New Moon mindset invites us to let go of what's familiar and rebuild a better model from first principles.

It's not about prediction. It's about reconsideration.

First Quarter: Tension and Testing

When the moon reaches its First Quarter, it appears split – half in shadow, half in light. It's a phase of friction and forward pressure. Something is taking shape, but it's not effortless.

That tension is right at the heart of the article on the NFL's controversial "tush push" play (p. 20). For all the brute force it showcases, the real story lies in the analytical tug-of-war: What actually makes this play successful? Which quarterbacks can effectively execute it? What variables matter more than conventional wisdom suggests?

Insight often emerges from this phase of resistance, when data pushes back against intuition and both sides reveal something new.

Full Moon: Illumination

The Full Moon is *dramatic*. Everything looks clearer, but sometimes too clear. Light can illuminate; it can also distort. It's the phase that most tempts us toward overconfidence.

This is the dynamic explored by Joseph Cazier, CAP-X, on "Aristotle's Insight Loop" (p. 28), his framework for using generative AI not as an oracle but as a thinking partner. When a tool can produce endless possibilities, it's easy to mistake visibility for truth, reflection for insight or light for understanding.

Artificial intelligence can brighten a landscape, but only human judgment can determine which features actually matter. The moon may glow, but it's still up to us to interpret the shadows.

Last Quarter: Reassessment and Trust

In the Last Quarter, the moon begins to wane. It's a quieter, more introspective phase – the moment for releasing what no longer serves and reinforcing what remains true.

This aligns closely with the analysis of U.S. election systems and voter confidence on page 32. Trust in these systems doesn't emerge fully illuminated; it's built through continuous evaluation, correction and transparency. You don't wait for a crisis to test integrity. You must constantly test, especially when the light is fading.

It's also a fitting lens for my conversation with 2026 INFORMS President Mark Lewis, who reflects on leading a welcoming and trustworthy community (p. 36). Belonging isn't a Full Moon burst of brilliance – it's a sustained cycle of checking in, adjusting, listening and tending. Leadership has phases, too.

What Patterns Reveal

Some people turn to astrology because they want stories that make sense of the unknown. I get it. Humans have always looked for meaning in the sky. But the older I get, the more I appreciate the discipline of choosing what meaning to trust, and why.

Analytics, at its best, is not about imposing a narrative. It's about noticing the signals that are actually there and using those signals to inform decisions and actions. It's the work of distinguishing pattern from projection.

I'll still probably keep tracking the moon – not to predict anything, but to remind myself that everything moves in cycles, including our work. Insights wax and wane; models improve and are replaced. Every phase has something to teach us, as long as we stay curious enough to look up, or look closer.

As we turn toward 2026, may we keep navigating with both humility and attention. The skies won't give us answers, but they offer a beautiful reminder that clarity often comes from knowing where we are.

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

The Framework That Keeps Us Oriented

It turns out that lunar phases aren't such a strange companion to analytical practice after all. The INFORMS Analytics Framework™, featured in this issue on page 49, offers its own cyclical structure – a sequence of iterative domains that guide organizations from defining problems to implementing and sustaining solutions. Just like tracking moon phases helps us understand where we are in a natural cycle, the Framework clarifies where we are in a decision-making cycle. Are we exploring? Building? Deploying? Evaluating? No phase is permanent, and each prepares the way for the next – or the need to look back at a previous phase. When used well, the Framework doesn't dictate outcomes, but helps analytics professionals and teams stay grounded even when the landscape shifts. In that sense, it's a lot like looking up at the same moon each month: a steady, familiar reference point in a sky that's always changing.

LOOKING BACK, LOOKING AHEAD

BY DAVID HUNT

WHEN I BEGAN MY TERM AS INFORMS president on Jan. 1, 2025, I had ambitious plans that included improving retention of early-career professionals, enhancing engagement with organizations to attract more practitioners and ensuring that solutions developed by INFORMS members are accessible to all – from small nonprofits to large corporations. We have made strides in all these areas, and I'll discuss the groundwork laid this year later on in this column. However, let's first reflect on the past year.

Reflecting on 2025

Twenty days into my INFORMS presidency, there was a change in the U.S. presidency. In reflection on 2025, the executive orders and policy changes emerging from Washington, D.C., significantly impacted the year as well as the activities of the INFORMS board of directors. I am proud of the response from both our organization and our community, particularly in three main areas.

1. **Expanding opportunity and achievement**
We decided to discontinue the use of the phrase and term "diversity, equity and inclusion" (or DEI) for reasons shared in an open letter to members and a member townhall. Although this term has been set aside, our core value of making sure every member of INFORMS feels welcome and has an equal opportunity to participate and achieve, remains stronger than ever. Thanks to the Ad Hoc Committee on Expanding Opportunity and Achievement, INFORMS has implemented policies all members can support. For example, we have a volunteer portal that allows members to explore and sign up for volunteer opportunities, encouraging greater participation across our community. The INFORMS Executive Committee, which approves most committee appointments, encourages committee chairs to use the portal, thus providing more members with an opportunity to participate.
2. **Supporting members impacted by cuts to research funding or job loss**
Some of our members were directly impacted by funding cuts, and others lost their jobs. The board took action to support members who were affected. Our second member townhall of the year covered this topic. INFORMS is offering to cover one year of membership dues for members and nonmembers who have been affected. We also established a Rapid Response Fund to help members with INFORMS-related activities facing funding challenges. This fund issued $35,000 in grants that enabled several groups to continue with events after they found their traditional sources were either cut or simply being more cautious with donations.

   Supporting INFORMS members impacted by funding and job cuts has been a priority for the entire board this year. (Read more at https://www.informs.org/About-INFORMS/Supporting-Our-Community.)
3. **Expanding our global cooperation**
We recognize the challenges that rising costs and visa concerns have on travel to the U.S., but we also recognize the importance of maintaining strong global collaboration in our community. Approximately 30% of INFORMS members live outside the U.S. in over 90 countries, with more than 2,100 in the Asia-Pacific region (APAC).

   A key theme with the board this year, coined by INFORMS VP of Marketing, Communications and Outreach Tinglong Dai, was: "If our member can't come to INFORMS, INFORMS needs to go to them." I had the pleasure of attending a very successful INFORMS International Meeting in Singapore in July with 1,150 participants. The enthusiasm for INFORMS in the region left a lasting impression on me [1]. INFORMS Executive Director Elena Gerstmann and I have been continuing conversations with the APAC national society leadership about various ways we can work together to elevate operations research (O.R.) in the region. We are working to serve our members in the region and increase the footprint of O.R. in APAC – to benefit both INFORMS and the APAC national societies.

Although 2025 didn't unfold exactly as I had planned, I'm proud of the work the board, our members and the INFORMS staff have done, and our collective achievements.

Looking Beyond 2025

I am incredibly optimistic about the future of INFORMS and excited to see where incoming President Mark Lewis and President-elect Wedad Elmaghraby will lead us. Some of the reasons I'm so optimistic include:

- **Publications:** A record-breaking 6 million INFORMS articles are expected to be downloaded in 2025. This is a staggering number that will only grow. The distribution partnership INFORMS has with EBSCO, announced last year by Past-President Julie Swann, will be fully implemented in 2026 [2]. The number of libraries that receive INFORMS journals will expand from about 2,000 to over 30,000 in more than 120 countries
- **INFORMS Annual Meeting:** This year's meeting in Atlanta attracted 6,500 registered attendees – an impressive turnout given the headwinds of visa concerns and a U.S. government shutdown. The improvements in the meeting structure, with dedicated job talks and better management of parallel sessions, were highly successful and will only improve future meetings. Thanks to General Co-chairs Edwin Romeijn and Juan Pablo Vielma for implementing these much-needed changes.
- **Emerging Fields and Technologies:** INFORMS is advancing efforts in emerging technologies – especially artificial intelligence and quantum computing – to better support our members and promote their work. The board is discussing changes that will help INFORMS stay at the forefront of these and other emerging fields and technologies.
- **Early-Career Members:** VP of Membership and Professional Recognition Anahita Khojandi and Director of Membership Scharan Johnson have gathered information through early-career member surveys and focus groups that will support strategies to better serve this group. One item consistently heard was the desire for local meetings that provide networking opportunities at a lower price point. The Ad Hoc Committee on Collaborative Chapter Regional Conferences is designing how this might work.
- **Certified Analytics Professional® (CAP):** CAP continues to build momentum, including rolling out three levels – CAP Essentials, CAP Pro, and CAP Expert – as well as promoting the INFORMS Analytics Framework™ (informs.org/analyticsframework). CAP is well positioned to help INFORMS connect with organizations seeking the best analytical talent. The INFORMS Analytics Framework will benefit both academia with educating their students, and industry for training their employees and implementing more successful projects.
- **Nongovernmental Organizations (NGOs):** When I ran for president, my vision statement discussed that solutions developed by INFORMS members should be equally available to all. The Ad Hoc Committee on NGOs and NPOs is investigating how INFORMS can help connect analysts working at or supporting NGOs and nonprofits, providing them with best practices and facilitating the sharing of ideas.

More Great News

To conclude my final President's Desk column on a positive note, I'm thrilled to announce that the INFORMS board of directors has approved a balanced budget for 2026 – our first deficit-free budget since the COVID-19 pandemic! The challenges we faced during this time, shared by former President Steve Graves, have left lasting impacts, but with your continued support through membership renewals, journal subscriptions and conference attendance, we have successfully navigated these hurdles [3]. Huge thanks to the INFORMS staff for the hard work of keeping costs in check and to the leadership of Treasurer Susan Martonosi and Finance Director Pauline Roberts.

Finally, I want to acknowledge that our accomplishments are made possible only by the incredible member volunteers of INFORMS and our devoted staff. This community achieves remarkable things together. I already knew this, of course, but have gained an even greater appreciation from the vantage point of president. It is this commitment to the science and practice of decision-making, and to INFORMS, that causes me to be so optimistic about our future.

Thank you for all you do for INFORMS! It has been my honor to serve as your president.

I want to acknowledge that our accomplishments are made possible only by the incredible member volunteers of INFORMS and our devoted staff. This community achieves remarkable things together.

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

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TOP SOCIAL POSTS

1

Researchers from George Washington University, Meituan Group Clinch INFORMS 2025 Daniel H. Wagner Prize
INFORMS News Room

2

INFORMS Member in a Minute with Shima, from the 2025 INFORMS Annual Meeting in Atlanta
INFORMS Member in a Minute

3

Every domain in the INFORMS Analytics Framework matters, but let's be honest – some get skipped more than others.
INFORMS Analytics Framework

4

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

5

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

6

HAS Presents: Optimizing the Deployment of Defibrillators
INFORMS YouTube

7

Everything you need to know before you submit your application for the 2026 UPS George D. Smith Prize!
INFORMS YouTube

8

Watch: INFORMS President's Award – 2025 INFORMS Awards Ceremony
INFORMS Annual Meeting

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

RECENT PRESS RELEASES

AI Model Predicts Which Short Videos Could Spark Suicidal Thoughts, Giving Platforms a First-of-its-Kind Early Warning Signal

Generative AI Can Brainstorm Objectives but Needs Human Expertise for Decision Quality

Tourists Give Restaurants Higher Ratings Than Locals, New Study Finds

MEMBERS IN THE NEWS

Are the Shutdown-Era Flight Disruptions Over?, *Time*, featuring Sheldon Jacobson

A seismic shift in computing is on the horizon (and it's not AI), *CNN Business*, featuring Sridhar Tayur

Are We Ready For The Tidal Wave Of AI-Generated Video?, *Forbes*, by Anjana Susarla

Staffing Shortages May Ground Air Travel Even Post-Shutdown, *WORT*, with Laura Albert

RESOUNDINGLY HUMAN: The INFORMS Podcast

We're back!

After a short break this summer – not for rest and relaxation but for a review and refresh of the podcast – *Resoundingly Human*: The INFORMS Podcast is back! We hope you had the chance to catch up on your favorite episodes because you now have access to terrific new content featuring exciting (and fun!) interviews with INFORMS members.

We kicked off our refresh with an interview featuring Margaret Brandeau, Stanford University, who served as the opening plenary speaker at the 2025 INFORMS Annual Meeting in Atlanta. Margaret shares an inside look how OR/MS and analytics are shaping public health policy to combat the opioid epidemic and HIV. In addition, we learn what's at the top of her bucket list!

Another 2025 plenary speaker, Ramayya Krishnan, Carnegie Mellon University, joined us for our next interview to discuss how today's rapid advances in AI technology create new opportunities within OR/MS to enhance workforce development, public policy and education. He also shares how he would describe the future of AI … in one word.

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FIVE YEARS BACK; FIVE YEARS AHEAD

BY ELENA GERSTMANN

WHEN I FIRST RECEIVED THE CALL ABOUT the INFORMS executive director role in April 2020, the world was in the middle of unprecedented disruption. I wasn't looking for a new position, but curiosity led me to research INFORMS and its mission, work and community. At that same time, the New York Times was reporting about the critical role of data in responding to the COVID-19 pandemic.

Another defining event of spring 2020 was the murder of George Floyd. As the executive director search process unfolded, I paid close attention to how INFORMS responded. I knew that if the organization did not live its values, I would not want to be part of it. INFORMS did stand up then, and has continued to stand up, by advancing opportunity and fostering a culture of respect in all we do, for all.

With those events fresh in my mind, my immediate thought was *these are the people who can change the world*. Five years later, having come to know the breadth, depth and passion of our community, I feel this even more strongly. The world needs better decisions, and INFORMS is uniquely positioned to help build a more just, prosperous and sustainable future.

It has now been just over five years since I began my journey with INFORMS. Milestones like this invite reflection on how far we've come and, maybe even more importantly, where we're headed.

Our Resilience and Growth

Our first challenge together was the COVID-19 pandemic. Like so many organizations, INFORMS faced sudden losses – in membership, meetings and finances, as well as our ability to connect in familiar ways. However, over the past five years, not only have we weathered the storm, but we've come back stronger. Membership has rebounded from the pandemic loss and has even surpassed some pre-COVID numbers – and we're still growing.

That renewed energy is visible everywhere. Record numbers of members are submitting award nominations, underscoring both the prestige of our awards and the extraordinary work happening across our community. New members are finding their place more easily through enhanced onboarding, and long-standing members are staying even more connected. The creation of our new Senior Member program reflects and reinforces this momentum.

In 2022, we worked as a community to develop a tagline that captures our shared promise and what INFORMS members do every day: Smarter Decision Making for a Better World. It isn't marketing; it's our mission in plain language, and it guides how we prioritize, invest and communicate.

Expanding Our Global Impact

The peer-reviewed, high-quality research in our journals is about to reach new heights of influence. As of January 1, 2026, our subscription model will change, and EBSCO will begin providing institutions with access to the full suite of INFORMS journals. This means all INFORMS journals will be accessible in more than 30,000 libraries worldwide, up significantly from about 2,000 today. This will result in greater visibility, broader interdisciplinary connections, more discoverability and increased impact factors.

Over the past five years, submissions and readership have also risen to record levels, positioning us to take full advantage of this new partnership with EBSCO.

Our global influence is expanding in other ways too. The 2025 INFORMS International Meeting in Singapore in July was our most successful non-U.S. gathering to date, underscoring that our science and practice are truly global. With the Asia-Pacific now our fastest-growing membership region, we know we must strengthen our presence there to support members and advance open science.

Your Professional Pathways

The transformation of our Certified Analytics Professional® (CAP) program reflects both the maturation of our fields and what professionals seek in career-boosting certifications. What began more than a decade ago as a modest program has blossomed – adding another certification level in 2025 – and is poised to fully bloom in 2026 with the introduction of a third level. Together, these offerings now span the full career cycle of analytics professionals.

We have gone from offering one certification for the "cream of the crop" to providing a full ladder that maps to one's career: CAP-Essentials (CAP-E) for early-career professionals, CAP-Professional (CAP-P) for those with greater experience and the crown jewel of CAP-Expert (CAP-X, which is the new name of the original CAP). Designed by members and grounded in rigorous industry best practices and standards, the CAP ecosystem is built for success.

Bridging Your Worlds

For decades, INFORMS has sought to expand and better serve our academic and industry members. This balance is essential: A robust and diverse mix of practitioners and academics strengthens our collective impact and creates more opportunities for collaboration.

While INFORMS has made progress toward this goal, we believe the new INFORMS Analytics Framework, initially developed for CAP, will be a catalyst for more significant strides. Already, companies are using the framework to structure analytics projects for more successful outcomes, and academic programs are mapping their curricula to it for stronger alignment with practice.

Your Voice in Society

One of my greatest sources of pride has been watching members' expertise gain recognition in the public sphere. During the COVID-19 pandemic, our community had an unexpected opportunity to provide the media and public officials with critical scientific insights and recommendations. Since then, we have built on that momentum by continuing to help members amplify their work through op-eds, media appearances and direct engagement with policymakers.

As an organization, we have also influenced U.S. legislation and federal policymaking, such as in the Mathematical and Statistical Modeling Education Act, the Data Science Literacy Act, and new legislation introducing operations research (O.R.) and analytics into the National Park Service. These efforts broaden INFORMS' impact beyond our immediate fields to society at large. Better decisions at every level – local, national and global – require the rigorous, evidence-based insights INFORMS members provide every day.

Looking Ahead: Our Expanding Influence

As we look forward, I'm energized by an exciting question: How do we capture more of the tremendous growth happening in our fields (O.R., management science, analytics, artificial intelligence, data science, industrial and systems engineering, statistics, applied mathematics, economics, behavioral science, quantum computing, and related areas)? These fields have exploded in growth and impact, yet our membership has held to a familiar range, a clear signal of untapped potential.

INFORMS' influence is undeniable through our products and services, but I'm eager to welcome more brilliant minds into this community. I believe everyone deserves a professional association to call home that offers a place for networking, intellectual exchange and lifelong development. INFORMS should be that home for a community even larger than what our historic membership numbers reflect.

Now that INFORMS is in a stable position, I want to explore whether structural or process changes can unleash new opportunities to significantly grow our reach and impact. I know this will take bold thinking, but I'm confident that our community's insight and creativity will help us seize this moment and shape our future together.

Closing Reflection

Over the next five years, we will:

- Build on the momentum of the CAP program to make it the global gold standard for analytics certification.
- Expand internationally, with particular emphasis on Asia-Pacific.
- Leverage the INFORMS Analytics Framework™ to strengthen industry and academic engagement.
- Leverage expanded publication access to boost our interdisciplinary impact.
- Maintain financial strength while investing in bold initiatives that serve our members.
- Elevate advocacy efforts to ensure our fields are recognized as essential to better decision-making everywhere.

For INFORMS, the journey began decades ago. For me, it began five years ago, when I first read about INFORMS alongside that *New York Times* article on COVID-19 and data. I felt a surge of optimism: This is a community of people who can change the world.

INFORMS is leading the way – saving lives, saving money and solving problems every single day. Together, we've accomplished a great deal in the past five years. And together, we will achieve even more in the next five.

Visit INFORMS.org or your favorite search engine or generative AI to learn about the products and services discussed in this column.

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.

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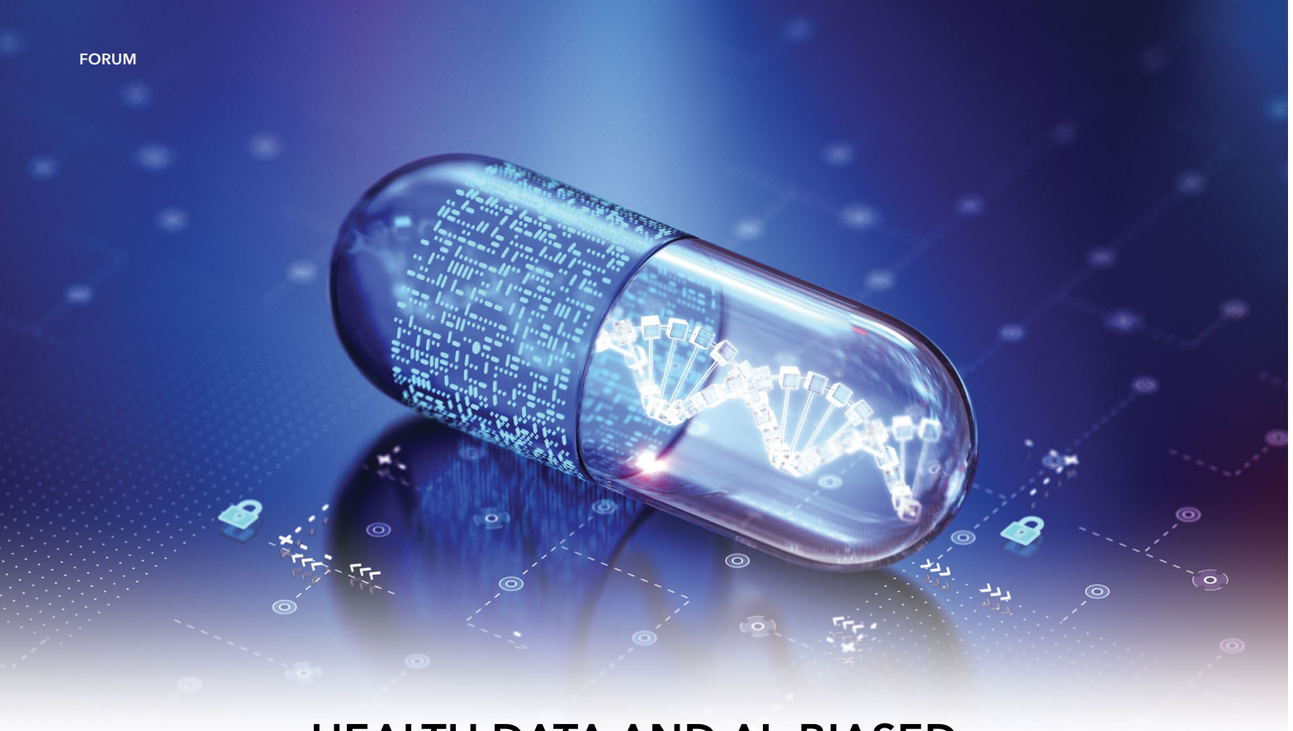

HEALTH DATA AND AI: BIASED DATA, BIASED OUTCOME

BY AARON LAI

CAN WE TRUST THE MODEL? AS A HEALTH analytics professional for decades, this is a question we ask ourselves daily. If we blindly trust an algorithm, we could have considered many patients "healthy" when they are not. There is a regulatory gap in managing data, not just devices or models. Current regulatory policies follow traditional statistical analysis, which is model-driven, but artificial intelligence (AI, or data science) models are data-driven. For example, value-based payment is "model dependent" [1]. Let's start with how we can better govern data. Even though the One Big Beautiful Bill Act does not have a moratorium on states passing their laws regulating AI, it is still too early to tell whether there will be any future AI regulation enforcement pause or preemptive restrictions. The latest U.S. AI policy in "America's AI Action Plan" focuses on "light regulation" and infrastructure. The latter would be a positive factor for AI development.

Mind the Regulatory Gap

Effective governance is critical to the safe and ethical use of data. The primary regulator for medical-related AI is the U.S. Food and Drug Administration (FDA), for whom clinical safety is the primary focus. The FDA oversees AI in the drug development process, Software as a Medical Device (SaMD) and AI-enabled devices. The second area of regulation comes from the Department of Health & Human Services (HHS), which is more focused on patients and health, as compared with the FDA, which is more clinically focused.

Some states also have medical regulations – most related to patient protection. For example, California has three healthcare-specific laws: AB-3030, SB-1223 and SB-1120. AB-3030 requires health providers to disclose the use of generative AI in patient communication; SB-1223 extends privacy law to include neural and biometric data as sensitive personal information; and SB-1120 requires AI or algorithm-based utilization management decisions to have a human clinical evaluation.

AI is a rapidly evolving field, and regulations need to balance safety and innovation. To paraphrase a famous line: the regulators are always planning for the last era. To properly regulate health AI, we need a new way of thinking about what's best for patients and society. Furthermore, it is unclear how the liabilities are allocated among the AI creators, software and product developers, and users. An updated regulatory framework that aligns all stakeholders would be beneficial. My doctoral research is exploring the combination of responsible AI and equitable health policy.

Hidden Bias in Health Data

AI tools are only as good as their training data. Large language models (LLMs) such as ChatGPT have the potential to solve two key issues in AI health tech. First, language is context-dependent. Conversational AI (e.g., LLM) allows users to interact with the machine, ask clarifying questions and solve problems collaboratively. The second challenge is that users need to understand and trust the reasoning behind AI recommendations. Explainable AI will show and explain its logic and rationale.

Sisyphus of AI and the Rock of Healthcare

SF Health AI is the Mr. Godot in "Waiting for Godot": We have been told that he will come very soon, but just not yet. Healthcare is a very complex field, and it is helpful to go back to the basics of knowledge acquisition. There are four ways to acquire knowledge:

1. We can ask the patients (e.g., a survey) and face nonresponse bias.
2. We can observe (e.g., tracking devices) and face nonobservable bias.
3. We can infer from third-party data (e.g., administrative claims data), but spurious correlations may be present.
4. We can use theoretical or empirical models and possibly encounter modeling bias.

There is simply no single best way.

Presumed Evidence

A more subtle issue in health data is hidden assumptions and preconceived notions. How can a model recognize unknown patterns (known as out-of-sample properties in statistics)? How will the machine diagnose a patient if it has no data for that specific group? It is common to presume group behaviors are the same for individuals (known as the ecological fallacy).

Confirmation bias, which is closely related to publication bias, states that we often find evidence to support our preconceived notions, and that is why we seldom see a failed use case in any new product. This limits the universe of training data for AI models.

One of the landmines of adopting health data is the potential misuse of data that is collected for a different purpose. Often, we use what we have, not what we need. As illustrated in the Optum algorithm racial bias controversy, using only available data could lead to unintended consequences [2].

For example, in an arrangement such as a value-based care contract, the providers may not have a strong incentive to fully document all details (more focus on outcome). Additional documentation could cost money. As a result, the data might be biased with unknown missing data. A standard disclosure of data capture and data use would help to increase health data transparency.

A New Social Contract with AI

Without better data governance, AI tools could bring great harm. One of the ironies of history is that we will see things only when it is over. That's why we must be both forward and backward looking. To chart a voyage for responsible AI, we should recognize how centuries of human inquiry have shaped our understanding of reason, ethics and methodology. A comprehensive regulatory framework that establishes "ethical use" standards for health data and a voluntary certification or reporting requirement for responsible AI use would be helpful. I am also trained in evidence-based healthcare, so I would suggest a public-private policy advisory board similar to the NICE (National Institute for Health and Care Excellence) in the U.K., which could be a promising start toward an ethical and equitable AI world.

Concrete Policy Actions

To summarize, here are three areas in which better AI regulation could help:

1. FDA – Expedite SaMD evaluation with a focus on data-use disclosure in AI-enabled models based on risk assessment. This will be particularly helpful to tech startups.
2. States – Harmonize state-level requirements on AI usage in the U.S., such as clinical decision support or utilization management, to improve development efficiency, establish bias audit standards and mandate disclosure.
3. Congress – Develop, clarify and simplify AI safety and safe harbor policies on "extended" use (i.e., not formally assessed) and model liability attributions.

To chart a voyage for responsible AI, we should recognize how centuries of human inquiry have shaped our understanding of reason, ethics and methodology.

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BUILDING SUCCESSFUL INDUSTRY-ACADEMIA COLLABORATIONS: INSIGHTS FROM SF EXPRESS AND TSINGHUA UNIVERSITY

BY YIXIAO HUANG AND LEI ZHAO

COLLABORATIONS BETWEEN INDUSTRY and academia are increasingly important in operations research and management science (OR/MS). These partnerships combine academic expertise with real-world business experience to address practical challenges, enhance efficiency and drive innovation. One successful example is the partnership between SF Express, a leading logistics company in China, and Tsinghua University.

Why Industry-Academia Partnerships Matter

Industry-academia partnerships blend theoretical expertise and practical applications. Universities provide advanced research methods and theoretical models, and companies offer operational data and practical scenarios for implementation. This combination leads to innovative solutions such as more efficient logistics networks, reduced environmental impact and improved customer satisfaction.

SF Express and Tsinghua University

Yixiao Huang, currently chief operations research scientist at SF Technology, joined SF Express after earning his Ph.D. at Tsinghua University under the mentorship of Professor Lei Zhao. This academic-to-industry transition laid the foundation for a lasting partnership that benefited the O.R. team at SF Express, with shared experience in modeling and solving practical optimization problems. The O.R. team also received support and guidance from Georgia Tech, including Professors Martin Savelsbergh, Benoit Montreuil, Alan Erera, etc.

Addressing Real-World Challenges

SF Express faced substantial challenges because of China's booming e-commerce industry, which demands rapid and efficient logistics. Previously, logistics planners manually managed route and hub decisions. However, as parcel volumes grew and customer demands for faster delivery increased, more sophisticated approaches became necessary.

Huang, leveraging his academic training under Professor Zhao, collaborated with skilled operations researchers from the team at SF Express to develop innovative methods for optimizing their logistics networks. The approach balanced complexity and practicality, ensuring that the theoretical models effectively translated into real-world operations.

Objectives and Outcomes

The main objectives of the collaboration were reducing operational costs, speeding up deliveries and minimizing environmental impacts through improved network design.

Through iterative testing and refinement, the collaboration significantly improved operational efficiency. The optimized logistics networks reduced decision-making time for route planning, eliminated redundant trips and enhanced vehicle utilization.

Financially, these improvements resulted in substantial cost savings – over a billion dollars in operational expenses within seven years. Environmentally, optimized routing reduced travel distances for parcels, significantly lowering carbon emissions by millions of tons.

Practical Lessons from the SF Express-Tsinghua Collaboration

Several practical lessons emerged from this partnership:

1. **Clearly defined goals:** It's essential for partners to have clearly defined and shared goals from the beginning, ensuring alignment between academic research and practical business needs.
2. **Phased implementation and feedback:** Small-scale pilot projects allowed for incremental testing, adjustment and refinement, reducing risks during implementation.
3. **Effective communication:** Transparent, regular communication between academic and industry teams was crucial for addressing issues and smoothly integrating new methods.
4. **Mutual learning:** Mutual knowledge sharing between academic and industry teams significantly enhanced solution quality.

Impact and Recognition

The SF Express-Tsinghua collaboration received notable recognition for its innovative outcomes, paving the way for SF Express to become a finalist for the Franz Edelman Award, considered the "Nobel Prize" in analytics. This highlighted the substantial industry value and academic contributions resulting from the partnership.

Looking Ahead: Expanding the Collaboration

Building on their initial success, SF Express and Tsinghua University expanded their partnership into new research topics, such as region design and service network design problems.

The collaboration also contributed broadly to the industry by developing new standards, patents and academic publications. These resources provide valuable insights for other companies seeking efficient and sustainable logistics solutions.

Advice for Future Collaborations

Based on their experience, organizations looking to start similar collaborations should:

- **Define clear objectives early:** Clearly outline the problem, objectives and expected outcomes.
- **Pilot projects first:** Start with manageable pilot projects to test methods and build confidence.
- **Prioritize communication:** Maintain regular communication to align theory with practice effectively.
- **Invest in mutual learning:** Regularly share knowledge and expertise to deepen mutual understanding and enhance solutions.

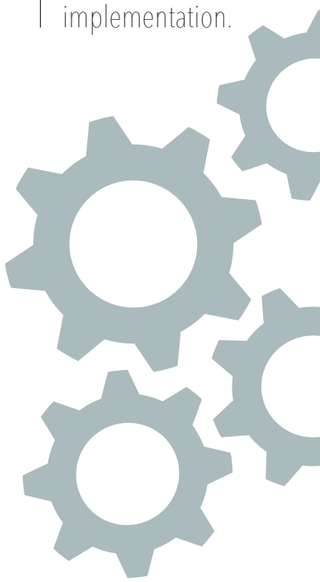
The partnership between SF Express and Tsinghua University demonstrates the significant potential of industry-academia collaborations. With clear objectives and effective communication, similar collaborations can deliver significant innovation and operational excellence.

These partnerships not only benefit the involved organizations but also contribute to the broader community, driving continuous advancements in operations research and management science.

YIXIAO HUANG is chief operations research scientist at SF Technology (SF Express). He holds a Ph.D. in industrial engineering from Tsinghua University. Since joining SF Express in 2018, Huang has led projects on same-day delivery network design, vehicle routing, intercity ground networks and green transportation. He has published in *Transportation Science, Transportation Research Part B* and *Omega*. In 2020, he received the Outstanding Paper in Urban and Transportation Planning and Modeling Award from the TSL Society of INFORMS. He remains active in academia, giving guest lectures and organizing student competitions.

LEI ZHAO is a professor in the Department of Industrial Engineering at Tsinghua University. He serves as the director of the Institute of Systems Intelligence and Industrial Computing, director of the Operations & Services Research (TOpS) Laboratory and director of the Research Center for Transportation Science & Logistics. He earned his Ph.D. in systems and industrial engineering from the University of Arizona. His research interests focus on stochastic optimization methods and their applications in logistics and transportation, supply chain risk management, and omnichannel retail and logistics. Zhao's work has been supported by the National Natural Science Foundation of China and the Ministry of Science and Technology of China. He has collaborated with prominent companies including Sinoair, Sinopec, COSCO Shipping, Alibaba, Meituan, Mitsubishi Heavy Industries, General Mills, IBM China Research, etc. His research has been published widely in many prestigious OR/MS journals.

Universities provide advanced research methods and theoretical models, and companies offer operational data and practical scenarios for implementation.



NEAR-REAL-TIME MEASLES SURVEILLANCE: HOW ANALYTICS CAN HELP TRANSFORM PUBLIC HEALTH RESPONSE

BY FARZIN AHMADI

THE U.S. IS EXPERIENCING ITS LARGEST measles outbreak in more than three decades, with over 1,650 confirmed cases across 42 jurisdictions as of November 2025, nearly eight times the annual average of 200 cases seen from 2000 to 2024. This surge represents not just a public health crisis but also a compelling case study in how analytics can provide critical infrastructure for real-time decision-making in healthcare emergencies.

The Challenge: Data Fragmentation in Crisis Response

Traditional measles surveillance in the U.S. relies on the Centers for Disease Control and Prevention's weekly state-level reporting system (https://www.cdc.gov/ncird-surveillance/about/nndss.html). Although adequate for routine monitoring, this approach creates significant gaps during outbreak scenarios in which rapid, localized response is essential. Measles outbreaks are typically highly clustered geographically, with transmission patterns that can only be understood and addressed through granular, county-level data. The fundamental challenge was one familiar to any analytics-driven researcher: how to integrate heterogeneous data streams from 50+ different reporting systems, each with unique formats, update schedules and data quality standards, into a unified, real-time (or near-real-time) surveillance infrastructure that could support evidence-based public health interventions.

Multisource Data Integration and Standardization

Drawing on methodologies from real-time optimization, our team at the Johns Hopkins Center for Systems Science and Engineering (https://systems.jhu.edu/) developed a comprehensive surveillance system that addresses the core operational challenges of disease tracking.

Automated Data Pipeline Architecture: The system uses a hybrid collection infrastructure combining automated web scraping protocols for structured data sources with manual curation procedures for unstructured reports. Python-based implementations extract data from interactive state dashboards, while standardized data entry templates with validation requirements handle press releases and public health communications.

Dynamic Source Management: Unlike static data systems, our infrastructure dynamically adapts to changing reporting landscapes. Between January and October 2025, we expanded from monitoring dozens of sources to systematically tracking more than 170 unique official sources across 42 jurisdictions. This scalability was achieved through automated alert systems that detect new content and AI-powered search tools that identify emerging data sources.

Addressing Heterogeneous Reporting Standards

One of the most complex operational challenges involved standardizing data across jurisdictions with fundamentally different reporting protocols. As an example, Kansas suppresses exact counts for counties with fewer than five cases, Tennessee reports by health region rather than county and Oklahoma provides only state-level totals. Our solution used hierarchical data processing algorithms that maintain native reporting structures while enabling national aggregation. For vaccination status data – critical for outbreak modeling – we developed standardization procedures that accommodate four-tier classifications across states with different documentation requirements. This mirrors classic analytics problems in multisupplier coordination: The challenge lies not only in data integration but also in preserving the integrity and interpretability of information across disparate reporting systems.

Impact and Practical Applications

The system's public dashboard (https://publichealth.jhu.edu/ivac/resources/us-measles-tracker) and open GitHub repository (https://github.com/CSSEGISandData/measles_data) have provided near-real-time situational awareness that was previously unavailable. Public health departments can now access county-level case counts, transmission classifications (imported vs. local) and demographic breakdowns with weekly updates.

Opportunities for the OR/MS Community

This project illustrates several key principles relevant to OR/MS researchers working in healthcare and emergency management. The intersection of operations research and public health emergency response presents numerous opportunities for the OR/MS community:

1. **Surveillance Under Uncertainty:** Traditional disease surveillance assumes stable reporting systems and standardized processes. Outbreak conditions require adaptive algorithms that can accommodate rapidly changing data structures and reporting frequencies.
2. **Scalable Infrastructure Design:** The system architecture needed to scale from monitoring a few dozen sources to 150+ sources while maintaining data quality and processing speed. This required careful consideration of computational complexity and resource allocation.
3. **Stakeholder Integration:** Success required coordinating with epidemiologists, public health officials, data engineers and visualization specialists, highlighting the importance of interdisciplinary collaboration in such applications.
4. **Emergency Response Optimization:** Beyond surveillance, there are significant opportunities to apply network optimization, resource allocation and scheduling models to vaccine distribution, contact tracing and healthcare capacity management during outbreaks.
5. **Predictive Modeling**: The county-level temporal data enables sophisticated forecasting models that could inform preemptive resource deployment and targeted intervention strategies.
6. **Supply Chain Resilience:** Public health supply chains, from vaccines to diagnostic testing, face many of the same challenges addressed in commercial operations research (O.R.) applications, including demand uncertainty, capacity constraints and geographic distribution requirements.
7. **Decision Support Systems:** There is substantial need for decision support tools that integrate epidemiological models with operational constraints to optimize intervention strategies under resource limitations.

Looking Forward: A Call for Engagement

The COVID-19 pandemic demonstrated both the critical need for real-time public health infrastructure and the power of analytics methodologies in addressing complex, large-scale coordination challenges. The measles surveillance system represents an evolution of these capabilities, but significant opportunities remain.

The OR/MS community has unique expertise in optimization, simulation, forecasting and systems integration, that is directly applicable to public health challenges. Whether through academic partnerships, consulting engagements or pro bono project work, there are substantial opportunities to contribute to infrastructure that directly impacts community health outcomes.

As we continue to face emerging infectious disease threats, the integration of O.R. methodologies with public health practice will be essential for building resilient, responsive surveillance and intervention systems. The measles tracking project demonstrates that these partnerships can produce both immediate practical impact and innovative methodological advances.

For those interested in engaging with this work, our complete datasets, methodological documentation and system architecture specifications are publicly available through our GitHub repository (https://github.com/CSSEGISandData/measles_data). We welcome collaboration from the OR/MS community as we continue to expand and refine these capabilities.

Acknowledgments

The measles tracker project is a collaborative, interdisciplinary effort conducted by a group of researchers at Johns Hopkins University who are tracking and modeling the risk of measles in the U.S. It reflects contributions from the Center for Systems Science and Engineering (CSSE) (https://systems.jhu.edu/) at the Whiting School of Engineering, the International Vaccine Access Center (IVAC) (https://publichealth.jhu.edu/ivac) at the Bloomberg School of Public Health and the Bloomberg Center for Government Excellence (https://govex.jhu.edu/).

The team is led by Lauren Gardner, Shaun Truelove and William Moss of Johns Hopkins University.

The JHU Measles Tracker is publicly available at publichealth.jhu.edu/ivac/measles-tracker with open-source data repository at github.com/CSSEGISandData/measles_data. The accompanying research was recently published in *JAMA* (September 2025) by Ahmadi, Dong and Gardner.

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WHEN THE NUMBERS BECOME THE NEWS: LESSONS IN INTEGRITY FROM A CONTROVERSIAL JOBS REPORT

A data revision, a leadership change and a public controversy – what this reveals about the role of statisticians, analysts and public trust.

BY ERICK WIKUM

ON AUG. 1, 2025, THE BUREAU OF LABOR Statistics (BLS) released its monthly Employment Situation Summary for July. As one of the most closely watched economic indicators in the country, the so-called "jobs report" is a cornerstone of business and policy decision-making. The July report noted that U.S. nonfarm payroll employment rose by just 73,000, a figure that fell below most forecasts.

Perhaps more striking than the modest job gain, however, were the substantial downward revisions to prior months: May's job creation was adjusted from 144,000 to 19,000, and June's from 147,000 to just 14,000. These revisions totaled more than 250,000 jobs and were described by BLS as the result of additional data received from employers and a recalculation of seasonal adjustment factors. Both are standard components of the long-established methodological process at BLS, which is detailed publicly in its "Handbook of Methods."

Still, the sharp magnitude of these revisions attracted significant public and political attention. In the days that followed, the head of the BLS, Commissioner Dr. Erika McEntarfer, was dismissed, and a new nominee was announced for the role. The events set off a wave of commentary about data, trust and institutional independence.

For analytics professionals, this event offers more than a headline. It serves as a valuable reminder of the responsibilities we carry when working with data in high-stakes environments – especially when our work becomes entangled with public narratives, political decisions or major economic consequences.

> Analytics professionals serve decision-makers. Our job is to provide insight, not to validate a preexisting narrative.

Why Revisions Happen – and Why They Matter

It's worth understanding what these revisions actually represent. The monthly jobs report is, by design, a preliminary estimate based on survey responses from thousands of businesses and government agencies. Because the initial snapshot is produced rapidly to meet public demand, it is updated as more complete information becomes available in subsequent weeks.

This practice of revision is well established and transparent. In fact, large revisions have occurred before. In March 2020, amid the early shockwaves of the COVID-19 pandemic, BLS revised payroll data downward by 679,000 jobs. In January 2009, during the Great Recession, a downward revision of 143,000 jobs was issued. These adjustments are not errors – they reflect the statistical challenge of balancing timeliness with completeness.

As Dr. James J. Cochran, professor of statistics at the University of Alabama and a longtime advocate for ethical analytics practice, puts it: "The goal is accuracy, not immediacy. The jobs report is a fast but necessarily incomplete look at the labor market. Adjustments happen in both directions – and there is no evidence to suggest that these revisions have ever been politically motivated."

When Confidence is at Stake

The BLS' data portfolio includes more than just employment numbers. Its indices – such as the Consumer Price Index (CPI) and Producer Price Index (PPI) – play a critical role in decisions that range from setting interest rates to determining wage adjustments and benefits. These datasets shape monetary policy, guide business investment and inform negotiations across every sector.

What makes data powerful is not simply the accuracy but also the confidence users place in its integrity. If there is perceived politicization of the data process – whether in staffing decisions or methodological shifts – it can cast doubt on years of historical data and undermine the value of current and future reporting.

This is not a hypothetical concern. As Cochran warns, "If unwarranted changes are made to the process by which data are collected and reported, we risk losing the ability to compare data over time. That would be a loss not just to statisticians, but to everyone who relies on trusted indicators to make informed decisions."

Lessons for Analytics Professionals

Although this recent event involves a high-profile federal agency, its implications extend to every analytics professional working in the private or public sector. At its core, this is a story about what happens when data intersects with power, perception and pressure.

There are three enduring lessons that merit reflection.

1. Remain Above the Fray

Analytics professionals serve decision-makers but are not themselves decision-makers. Our job is to provide insight, not to validate a preexisting narrative. As the INFORMS Ethics Guidelines assert, we must report our findings "even when they fail to yield the desired outcome." That means resisting pressure to tailor conclusions to fit policy goals, client preferences or organizational politics.

Although we may operate within political or commercial contexts, our credibility comes from staying tethered to facts, methods and transparent reasoning. The data must lead the narrative, not the other way around.

2. Be Honest and Forthcoming

Honesty in analytics is more than just accurate calculations. It includes full transparency about assumptions, methods, limitations and potential biases. Both INFORMS and the American Statistical Association (ASA) call on practitioners to disclose how data was collected, what models were used and where caution is warranted in interpreting results.

In this context, the public documentation from the BLS, especially its "Handbook of Methods," is exemplary. It provides a detailed account of survey procedures, seasonal adjustment techniques and revision protocols. Analysts across sectors should adopt a similar level of transparency in their work, particularly when it affects public policy or institutional decision-making.

3. Safeguard Your Reputation for Integrity

Unlike lawyers or physicians, most analytics professionals are not required to hold a license. But our careers are governed by something equally important: professional trust. That trust can be built over years and lost in a moment.

Choosing to bend findings, withhold assumptions or obscure methodologies for short-term gain can have lasting consequences. Even the perception of bias can erode credibility. As the old adage goes, "Reputation arrives on foot and leaves on horseback." Protecting your integrity isn't just good ethics – it's good strategy.

Why This Matters Now

As data becomes increasingly central to how we govern, invest and lead, the public spotlight on analytics will only intensify. Scrutiny is not a threat. It's a reminder of why our work matters and how it must be conducted.

Institutions like the BLS have long upheld the principle that data must serve the public interest, not political advantage. Whether we work in government, industry or academia, that same principle must guide our work.

Ultimately, analytics is not just about algorithms or forecasts. It's about trust. And trust, earned through transparency, accuracy and professional ethics, is what makes our work meaningful and lasting.

Note: *References can be found online: https://doi.org/10.1287/orms.2025.04.01.*

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MOVING THE CHAINS WITH MATH: THE TUSH PUSH UNPACKED

BY WARNER GEPHARDT, PARKER WHELAN AND SCOTT NESTLER, CAP-X

The Analytics Revolution on the Football Field

Analytics has fundamentally transformed the way football is played, bringing a new level of precision and strategy to on-field decisions. Coaches now rely on real-time data to make tactical adjustments during games, such as optimizing substitutions based on player fatigue, tweaking formations to exploit opponent weaknesses and responding dynamically to in-game developments. Advanced tracking technologies and wearable sensors provide detailed insights into player movements, positioning and workload, allowing for personalized training regimens and more effective game preparation.

Teams use data-informed analysis to refine their playing styles, moving beyond traditional strategies to adopt approaches tailored to their unique strengths and the tendencies of their opponents. Metrics including passing networks, heat maps and spatial control zones help coaches identify and address tactical inefficiencies, while predictive models inform decisions on play calling, fourth-down attempts and defensive alignments. This evidence-based approach has led to more efficient, adaptable and competitive teams, reshaping the very fabric of on-field football strategy.

Analytics in football has changed many ideas in football that were previously considered normal. The notion that teams should punt unless it's late in the fourth quarter is outdated in today's football. Teams are – with the backing of analytics – now going for fourth downs early in the game, even in their own territory. However, these choices have not been met without pushback. Many traditional minds in football, and coaches who want to avoid the pushback when failing while taking an unordinary risk, have chosen to do what is considered "normal" in football instead of making the analytically correct decision. This fear leads to analytical processes in football often being hindered because these long-time coaches have so much power.

We focus here on a particular play that has generated some controversy in recent years. A newer analytical controversy in football revolves around the 2-point conversion. The main debate is whether to always attempt a 2-point conversion after scoring a touchdown when trailing by 8 points in the fourth quarter. The modern age of analytics clearly supports going for the 2-point conversion; however, many old-school coaches, who are considered responsible if the 2-point conversion fails, often just take the extra point. What this study will dive into will be even more radical than that. We will discuss whether some teams should always go for 2, but also whether they should run a certain play when they do it.

Overview: What Exactly Is the Tush Push?

There have been very few plays that have sparked as much debate and fascination as the "tush push." The tush push is a quarterback sneak in which the teammates actively push their quarterbacks from behind to secure a first down or touchdown. Most of the time, it happens when only 1 yard is needed and often happens at the 1-yard line to score a touchdown. The play was first popularized during the 2021 season by the Philadelphia Eagles with quarterback Jalen Hurts providing size in the backfield, and center Jason Kelce, who was considered one of the best in the league, could easily push Hurts forward. Hurts is known as a mobile quarterback with massive leg power to push forward while also having the ability to maneuver around traffic in front of him when needed. With the combination of strength from the offensive line, power from the quarterback and drive from a player pushing the quarterback from behind, the tush push has changed the short-yardage game in the NFL.

Despite controversy and many questions relating to its sportsmanship, the tush push remains a staple in the NFL and has expanded to many teams, particularly the Buffalo Bills and their massive quarterback Josh Allen. As the league continues to evolve, it's important to consider whether there are additional strategic advantages to this play – such as its potential use in 2-point conversions – that haven't yet been explored.

Analyzing the Tush Push: A Statistical Dive into Hurts vs. Allen

To effectively look into the reliability of the tush push, let's begin by taking a look at how it's used by Hurts and Allen, two quarterbacks known for their physicality and effectiveness in short-yardage situations. Looking at the 2024-2025 NFL season for each of the quarterbacks, we see the following achievements with the play in Figure 1a.

Both quarterbacks have a more than 80% conversion rate for these short-yard situations (all under 1 yard), showing why their teams rely on the tush push for plays within 1 yard of the line to gain. However, the one category that shines the most is the average yards per attempt, with Hurts having 1.33 yards while Allen has just under 2 yards at 1.89 yards per attempt. With Allen's yards per attempt so high, it begs the question: Why not go for 2 after every touchdown?

Adjusting for Goal-Line Bias and Its Implications

To assess whether the tush push could revolutionize the 2-point conversion strategies, we must start by isolating plays outside of the goal-line context, otherwise known as plays within 1 yard in which a touchdown was scored. This is because when it is a play on the 1-yard line, the maximum possible yards the quarterback can gain is 1, which can skew the average yards results. When we removed those plays, the following statistics were created in Figure 1b.

TUSH PUSH 2024 STATISTICS

A

	ATTEMPTS	TDs	CONVERSION %	AVG. YARDS
Jalen Hurts	45	15	84.44	1.33
Josh Allen	35	7	85.71	1.89

B

	ATTEMPTS	TDs	CONVERSION %	AVG. YARDS
Jalen Hurts	30	0	76.67	1.47
Josh Allen	28	0	82.14	2.11

FIGURE 1: (a) 2024 tush push statistics; (b) 2024 tush push statistics removing 1-yard-line plays.

Although both quarterbacks dominate in short-yardage scenarios, Allen's higher yards per attempt open up a deeper discussion around the viability of going for 2 – not just occasionally, but consistently. With Allen averaging 2.11 yards per attempt, it's clear that the Bills might benefit from trying more 2-point conversions. Now, let's dive into the actual odds of success for any 2-point play for the Bills.

Figure 2 displays a Poisson fit of the yards gained on all of Allen's tush push attempts (not counting those starting at the 1-yard line) in the 2024-2025 NFL season. By modeling the data with a Poisson distribution (after considering other discrete distributions like the negative binomial and geometric), we were able to visualize how often each yardage outcome occurs (shown in green) and how it aligns with expected probabilities (shown by the black line).

Using this model, we were able to estimate that the probability of Allen gaining 2 or more yards (i.e., the distance required to achieve a 2-point conversion) on a single tush push is 62.2%. This translates to an expected point value of 1.244 per 2-point conversion attempt, which is significantly higher than the expected points of a standard (kicked) extra point for placekicker Tyler Bass, which is 0.964. From this analysis, one might conclude that the Bills should start opting for the 2-point attempt every time because it is a smarter long-term strategy.

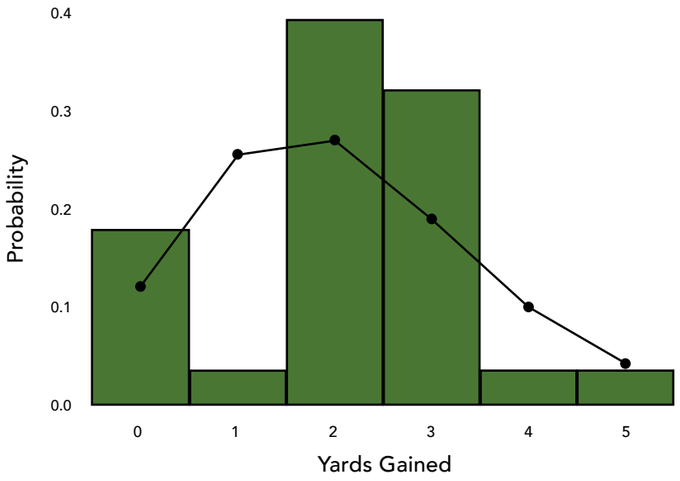
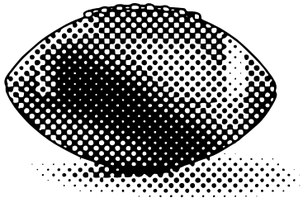


FIGURE 2: Poisson fit on Josh Allen's tush push yards.

Room for Improvement

To further improve their 2-point conversion success rate, the Bills need to take a page from the Eagles' playbook by expanding the versatility of their tush push package. Right now, Allen's ability to perform the tush push in short-yard situations is phenomenal, but when 2 full yards are needed, the play becomes a bit more vulnerable. That being said, Buffalo can easily increase efficiency by introducing layered wrinkles to their current formation, such as motion, misdirection or tight end sneak opportunities. These variations will constantly keep the opponents' defense guessing and prevent them from always crashing the middle of the formation trying to stop Allen. Additionally, with a mobile quarterback like Allen, the Bills could implement fake tush pushes that turn into jump throws (à la 2007 Heisman Trophy winner Tim Tebow) over the line or a 1v1 fade to Keon Coleman, who is their most physically demanding wide receiver. Once the Bills are able to diversify their tush push, as well as adapt to how the defense is set up, their 2-point conversion rate could reach an even higher success rate.



Potential Drawbacks

As previously mentioned, we filtered out all tush push attempts that were within 1 yard of the end zone because those would skew the yards per attempt for tush pushes. However, the rest of the tush push plays may not accurately represent the defense that would be played during a 2-point conversion. First, the vast majority of tush push plays happen during third-and-1 and fourth-and-1. Second, the defensive line may not fully sell out to stop the tush push as they might on a 2-point conversion, because allowing a first down isn't as critical as forcing the defense to fully commit on a 2-point conversion. However, this concern is rather minor because defenses often stack the box when facing a tush push, showing that they are selling out, similar to a 2-point conversion.

Another potential concern with defensive schemes is whether they play differently because it's a traditional 1-yard attempt versus the 1-yard attempt on tush push plays. For example, in Super Bowl 59, Kansas City Chiefs defensive end Chris Jones had a unique strategy in which he lined up sideways to try to prevent the offensive line push. These all-out strategies may be less essential when stopping a 2-yard tush push compared with a 1-yard tush push. That is why it will be critical to measure short-term success if the Bills, Eagles and other teams try this strategy and specifically to focus on whether defensive strategies shift.

Conclusion

As the NFL continues to evolve, evaluating the tush push play is yet another example of how analytics and innovation can reshape the game. With quarterbacks like Hurts and Allen, the tush push could potentially be used not only in short-yardage situations but also in extremely high-leverage situations like the 2-point conversion. A 2-point conversion is a high-leverage play because its outcome can immediately and significantly alter the score margin, often in critical game situations, making it a pivotal decision that can swing a team's win probability. Although concerns remain regarding defensive adaptations and contextual bias, the data shows that the tush push for a 2-point conversion has potential to be successful, especially for Allen and the Bills. If Buffalo and others can expand the tush push with motion, misdirection and fakes, then the tush push could become mainstream after scoring a touchdown. And who knows – maybe, kicking extra points could become a thing of the past for some teams.

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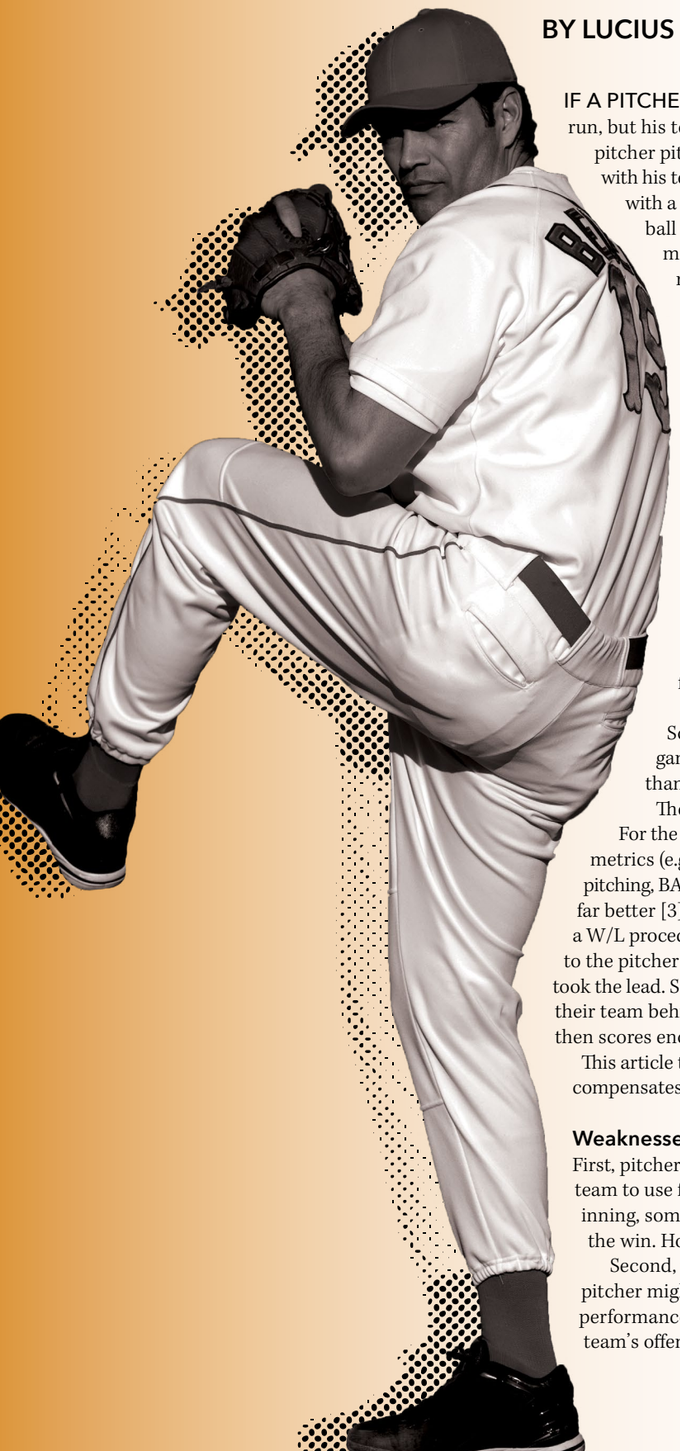
NEW BASEBALL WIN/LOSS METRIC: AN OFFENSE-INDEPENDENT APPROACH



BY LUCIUS RICCIO

IF A PITCHER PITCHES NINE INNINGS AND GIVES UP JUST ONE run, but his team loses the game 1-0, he gets credited with a loss. Another pitcher pitches five innings and gives up five runs but leaves the game with his team ahead 7-5. When his team wins the game, he gets credited with a win. Another starting pitcher throws four innings of no-hitter ball but leaves after the fourth inning because of an injury. No matter what happens next, he cannot get credit for a win. If a relief pitcher starts the top of the ninth with his team ahead 4-3 and gives up an earned run, but his team scores a walk-off in the bottom of the ninth, he gets credit for a win.

Clearly, the current win/loss (W/L) procedure [1] is flawed. We propose a potential new way of calculating W/L records for pitchers given their performance independent of their team's offensive performance.

Background

Traditionally, the W/L record was one of two key measures of pitcher quality, along with earned run average (ERA). The pitcher was the focal point of the team; thus, assigning credit to the pitcher for a win or loss was natural. Pitchers often pitched a complete nine-inning game and were therefore "responsible" for the outcome of the game. Cy Young, who played over 100 years ago, won 511 games, the all-time record for wins. Of the 815 games he started, he completed 749 of them.

Today, pitchers rarely complete games. Analytics from the Society for American Baseball Research (SABR) [2] created game strategies that limit the number of innings pitched to less than needed to complete a game.

The traditional W/L record is an important part of baseball lore. For the devoted analytics fan, there have been several improved pitcher metrics (e.g., WAR – wins above replacement, FIP – fielding-independent pitching, BABIP – batting average of balls in play) that measure performance far better [3]. But the fans, as well as general managers (GMs), should have a W/L procedure that is fan-friendly and logical. All too often, the "win" goes to the pitcher who was the last pitcher in the game when the winning team took the lead. So, pitchers can pitch most of the game, leave a close game with their team behind, be relieved by another pitcher and watch as their team then scores enough runs to win, the win going to the relief pitcher.

This article tries to provide a new way of assigning win credit that compensates for four of the weaknesses of the current system.

Weaknesses of the Current System

First, pitchers today rarely complete their games. It is not unusual for a team to use four or more pitchers in a game, some pitching less than an inning, some throwing only one pitch, yet still being in contention for the win. How much does each pitcher contribute?

Second, the W/L assignment is not offense-independent. A pitcher might earn a win because his team had a great offensive performance that day or, vice versa, be charged with a loss if the team's offense performed poorly.

Third, defense factors in how many runs a team gives up. Unearned runs are not credited to a pitcher's ERA, but they absolutely factor in the current assignment of W/L.

Finally, many appearances by starting pitchers result in a "no-decision," especially in situations in which they pitched well. Many superb starting performances go completely unrecognized by the traditional measure.

Data

To test the efficacy of alternative W/L methods, we compiled the records of every outing by every pitcher in Major League Baseball (MLB) for 2023. The dataset includes the records of 881 pitchers (213 starters and 668 relievers), with 21,013 lines of outings. The innings pitched and earned runs allowed are the two key factors used. The dataset includes 2023 playoff game appearances. As such, there are differences in some cases between the season records reported here and those that report only regular season games.

New Win/Loss

In this proposal, the designation of wins and losses is a function of the number of innings thrown and the pitcher's ERA for that game. For 2023, the MLB average ERA was 4.31. If the game ERA for that game was below the league average, the pitcher is entitled to a portion of the "win." If higher, the pitcher is charged with some portion of a "loss." We are not considering whether the team won or lost the game, just how this pitcher performed.

Second, the portion of W/L is the number of innings pitched divided by nine. For example, a pitcher who had a game ERA of 3.0 (a "win" because it is less than the average) and completed six innings would get credit for two-thirds of a win. A pitcher who had a game ERA of 5.4 (a "loss") and pitched five innings would get credit for 5/9 of a loss.

Note: This approach considers all pitchers to be the same whether they started the game or came in for relief. Also, all runs are considered the same. The first run is worth the same as the last. All innings are the same.

According to this system, all pitchers in a game, for both teams, could be credited with some portion of a win or some portion of a loss. Pitchers could get credit for some portion of a win while others on the same team, some portion of a loss. Because the assignment of W/L in this system is independent of the outcome of the game, a pitcher on the losing team could get credited with a portion of a win and a pitcher on the winning team could get credited with some portion of a loss. It depends on how they pitched, not how the team did.

With this approach applied to the pitchers in the opening paragraph, the pitcher who pitched nine innings of one-run ball (ERA equal to 1.0) would get credit for 1.0 win even though his team lost. The pitcher who threw five innings and gave up five runs (ERA equal to 9.0) would get credit for 5/9 of a loss even though his team won. The pitcher who pitched four innings of no-run ball (ERA equal to 0.0) would be credited with 4/9 of a win regardless of whether his team won or lost. The relief pitcher who gave up one run in one inning (ERA equal to 9.0) would get credit for 1/9 of a loss even though his team eventually won the game.

A perfect example of the power of this technique is to use it on Jacob deGrom's 2018 performance with the Mets. He won the Cy Young Award that year with a 10/9 traditional W/L record for 32 appearances, an unusually weak W/L record for a Cy Young winner. In those 32 appearances, he gave up zero earned runs eight times, one earned run 10 times, two runs five times, three runs five

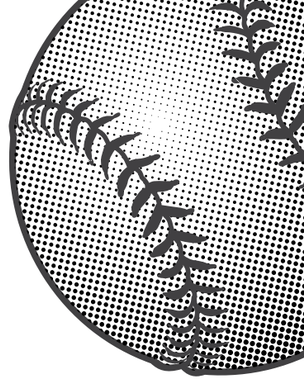


TABLE 1: Top pitchers by total new wins.

PLAYERS	NEW WINS	NEW LOSSES	TRAD WINS	TRAD LOSSES	WIN DIFFERENCE	LOSS DIFFERENCE
Gerrit Cole	19.70	3.52	15	4	-4.70	0.48
Logan Webb	18.81	5.18	11	13	-7.81	7.82
Jordan Montgomery	17.74	6.66	13	12	-4.74	5.34
Zac Gallen	16.85	10.22	19	12	2.15	1.78
Merrill Kelly	16.40	6.00	15	9	-1.40	3.00
Framber Valdez	16.30	7.03	12	14	-4.30	6.97
Blake Snell	16.22	3.78	14	9	-2.22	5.22
Zack Wheeler	15.89	8.52	16	6	0.11	-2.52
Chris Bassitt	15.89	6.70	16	9	0.11	2.30
George Kirby	15.78	5.40	13	10	-2.78	4.60
Kevin Gausman	15.22	5.77	12	10	-3.22	4.23
Pablo López	15.22	8.37	13	8	-2.22	-0.37
Sonny Gray	14.96	6.48	9	9	-5.96	2.52
José Berríos	14.88	6.52	11	13	-3.88	6.48
Kyle Bradish	14.85	4.41	12	8	-2.85	3.59
Logan Gilbert	14.59	6.59	13	7	-1.59	0.41
Spencer Strider	14.52	7.63	20	7	5.48	-0.63
Corbin Burnes	14.15	7.81	10	9	-4.15	1.19
Mitch Keller	13.85	7.74	13	9	-0.85	1.26
Aaron Nola	13.74	10.85	15	11	1.26	0.15
Jesús Luzardo	13.63	6.66	10	11	-3.63	4.34
Kodai Senga	13.59	4.89	12	7	-1.59	2.11
Justin Steele	13.44	5.81	16	5	2.56	-0.81
Luis Castillo	13.37	8.52	14	9	0.63	0.48
Justin Verlander	13.33	6.74	14	9	0.67	2.26
Tanner Bibee	13.26	2.52	10	4	-3.26	1.48
Bryce Elder	13.22	6.48	12	5	-1.22	-1.48
Nathan Eovaldi	13.14	6.92	17	5	3.86	-1.92
Zach Eflin	13.11	7.18	16	9	2.89	1.82
Dean Kremer	12.63	7.11	13	6	0.37	-1.11

TABLE 2: Top total improvement for starters.

PLAYERS	NEW WINS	NEW LOSSES	TRAD WINS	TRAD LOSSES	WIN DIFFERENCE	LOSS DIFFERENCE	TOTAL IMPROVEMENTS
Logan Webb	18.81	5.18	11	13	-7.81	7.82	15.63
Zack Greinke	7.63	8.18	2	15	-5.63	6.82	12.45
JP Sears	11.29	7.85	5	14	-6.29	6.15	12.45
Patrick Sandoval	11.11	4.96	7	13	-4.11	8.04	12.15
Framber Valdez	16.30	7.03	12	14	-4.30	6.97	11.26
Johan Oviedo	12.59	7.14	9	14	-3.59	6.86	10.45
José Berríos	14.88	6.52	11	13	-3.88	6.48	10.37
Graham Ashcraft	11.96	4.66	7	10	-4.96	5.34	10.30
Reid Detmers	10.55	6.41	4	10	-6.55	3.59	10.15
Jordan Montgomery	17.74	6.66	13	12	-4.74	5.34	10.07
Michael King	9.32	2.29	4	7	-5.32	4.71	10.03
Josiah Gray	11.15	6.52	8	13	-3.15	6.48	9.63
Joey Wentz	5.22	6.77	3	14	-2.22	7.23	9.45
Lucas Giolito	11.63	9.29	8	15	-3.63	5.71	9.34
Bailey Falter	5.59	3.37	2	9	-3.59	5.63	9.22
Carlos Hernández	5.85	2.14	1	6	-4.85	3.86	8.71
Sonny Gray	14.96	6.48	9	9	-5.96	2.52	8.48
Seth Lugo	12.41	4.22	8	8	-4.41	3.78	8.19
Jesse Scholtens	5.29	4.15	1	8	-4.29	3.85	8.15
Jesús Luzardo	13.63	6.66	10	11	-3.63	4.34	7.96
Jordan Hicks	5.70	1.74	3	7	-2.70	5.26	7.96
Kevin Gausman	15.22	5.77	12	10	-3.22	4.23	7.45
Blake Snell	16.22	3.78	14	9	-2.22	5.22	7.45
Kutter Crawford	9.63	5.18	6	9	-3.63	3.82	7.44
George Kirby	15.78	5.40	13	10	-2.78	4.60	7.37
Adbert Alzolay	5.70	1.40	1	3	-4.70	2.60	7.30
Chase Anderson	5.55	4.37	1	7	-4.55	2.63	7.19
Kyle Hendricks	10.15	5.07	6	8	-4.15	2.93	7.07
Michael Kopech	7.11	7.26	5	12	-2.11	4.74	6.85
Adam Ottavino	5.40	1.55	1	4	-4.40	2.45	6.85

times and four runs once – a spectacular season. The absurdity of the traditional method is that he had 14 outings of seven or more innings with zero or one earned run, yet in those games he "won" only five games and actually "lost" one, with eight "no-decisions." His performance according to the traditional method looked anemic because the Mets offense gave him no run support.

Using this new method, his W/L record would have been 22.1/2.0. By this method, he was a 20-game winner and only "lost" two games of his 32 starts. Clearly, it was a Cy Young year, but you couldn't see it from the traditional W/L method.

Results

All Pitchers

Table 1 shows the results for the top 30 pitchers based on total new wins according to this procedure. Starters get more win credit with this method. The increase in wins comes from the "no-decision" situations in which they pitched well but left the mound before the game was decided. Some also had a reduction in losses for games in which they got little run support. Relievers also get a boost in wins, most likely for good outings that resulted in "saves" or "holds" rather than wins.

Of the 881 pitchers, 616 saw their records improve (either more wins, fewer losses or a net positive combination; see Table 2). Of the 213 starters, 153 saw their records improve. Of the 668 relievers, 463 improved.

Gerrit Cole, the 2023 Cy Young winner, improves his record from 15/4 to 19.7/3.5. He clearly had a great year and, by the new method, came about as close as possible to winning 20 games. Logan Webb went from 11/13 (a mediocre record) to a new record of 18.8/5.2 (an excellent record). Similarly, Jordan Montgomery's new record paints a very different picture than the traditional method: 13/12 to 17.7/6.7. Sonny Gray went from 9/9 to a very respectable 14.9/6.5. Framber Valdez goes from 12/14 to 16.3/7.0, a very different picture.

On the other hand, 20-game winner Spencer Strider went from a traditional 20/7 to a new 14.5/7.6, still respectable but not as good as Cole.

Another way of sorting the results is to list the pitchers by most improvement. Logan Webb had a total improvement of 15.6 games. Zack Greinke astoundingly went from a traditional record of 2/15 to a new 7.6/8.2, not a good year but not a wipeout as it first appeared.

Relievers

The traditional W/L method is really not designed for relievers. Most often, relievers are charged with either a save, blown save, hold or loss. Rarely, they get credit for a win, and when they do, it might be for the wrong reason, as previously mentioned. This method gives a reliever credit for some portion of a win for those outings when they shut out the other team.

Table 3 shows the top relievers as measured by their W/L improvement under this method.

Michael King went from a W/L record of 4/8 to a new record of 9.3/2.3. He picked up a portion of a win each time he pitched a scoreless outing. In 31 of 49 appearances, he gave up no runs. So, in general, relievers get credit for "no-run" outings and get hurt when they give up any runs.

Note: On rare occasions, pitchers have an outing without getting an out. Although not included in this analysis, adjustments can be made for these rare outings.

Are All Runs the Same?

Who really "loses" the game? The reliever who gives up one run in a 10-9 loss or the starter who gave up the first nine runs? This analysis was based on the notion that each run, no matter when or under what circumstances it was scored, contributes the same toward a loss. Can it be proved that a run in the late innings of a close game is more important than an early run? Until science comes up with a method for measuring pressure (heart rate?), the idea that all runs are the same is not unreasonable.

But if you don't buy that argument, alternate methods can be proposed. (Stay tuned.)

Conclusions

The W/L method proposed here has several significant advantages over traditional W/L, particularly for starting pitchers. There are no "no-decision" outings in this method. This is especially important for giving credit for good outings with no run support, which happen often.

This W/L method rewards good pitchers on teams with poor offensive showings. It "punishes" poor pitchers on teams who score plenty of runs. Of course, as mentioned, there are more sophisticated measures of pitching performance created by SABR analytics experts. However, those are a bit esoteric and not easily understood by the typical fan (although fans are getting more and more sophisticated). This method provides fans with a superior picture of a pitcher's contribution throughout each season. In addition, although designed with the fan in mind, this method is sufficiently structured to give GMs a powerful way of judging pitcher quality.

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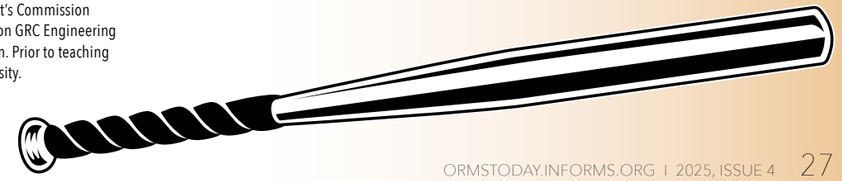
TABLE 3: Top total improvement for relievers.

PLAYERS	NEW WINS	NEW LOSSES	TRAD WINS	TRAD LOSSES	WIN DIFFERENCE	LOSS DIFFERENCE	TOTAL IMPROVEMENTS
Michael King	9.32	2.29	4	8	-5.32	4.71	10.03
Carlos Hernández	5.85	2.14	1	10	-4.85	3.86	8.71
Jesse Scholtens	5.29	4.15	1	8	-4.29	3.85	8.15
Jordan Hicks	5.70	1.74	3	7	-2.70	5.26	7.96
Adbert Alzolay	5.70	1.40	1	3	-4.70	2.6	7.30
Chase Anderson	5.55	4.37	1	7	-4.55	2.63	7.19
Adam Ottavino	5.40	1.55	1	4	-4.40	2.45	6.85
Trevor Gott	5.14	1.40	0	3	-5.14	1.60	6.74
Reid Detmers	10.55	6.41	4	10	-6.55	3.59	10.15
Evan Phillips	6.25	0.81	1	2	-5.25	1.19	6.44
Austin Pruitt	4.36	1.00	2	5	-2.36	4.00	6.37
Jake Diekman	5.32	1.07	0	2	-5.32	0.93	6.25
Sam Moll	5.91	0.99	2	3	-3.91	2.01	5.91
Camilo Doval	6.18	1.33	3	4	-3.18	2.67	5.85
Andrés Muñoz	4.11	1.33	3	6	-1.11	4.67	5.77
Scott Barlow	5.74	1.99	2	4	-3.74	2.01	5.74
Yimi García	5.62	1.96	2	4	-3.62	2.04	5.66
Reynaldo López	5.99	1.37	3	4	-2.99	2.63	5.63
Joe Jiménez	4.99	1.37	0	2	-4.99	0.63	5.63
José Ureña	1.78	3.18	0	7	-1.78	3.82	5.60
Adrián Martinez	4.40	1.81	0	3	-4.40	1.19	5.59
Phil Maton	6.77	1.22	3	3	-3.77	1.78	5.55
Tom Cosgrove	5.10	0.59	1	2	-4.10	1.41	5.51
Yennier Cano	6.84	1.37	1	1	-5.84	-0.37	5.47
Xzavion Curry	7.11	3.66	3	5	-4.11	1.34	5.44
Bryan Abreu	7.66	1.26	2	1	-5.66	-0.26	5.40
José Leclerc	6.69	1.29	1	1	-5.69	-0.29	5.40
David Bednar	6.40	1.07	2	2	-4.40	0.93	5.33
Brusdar Graterol	7.07	0.74	3	2	-4.07	1.26	5.33
Ryan Weathers	3.00	3.81	1	7	-2.00	3.19	5.19
Emmanuel Clase	6.59	1.48	1	1	-5.59	-0.48	5.11



AI²: ESCAPING THE AI SHALLOWS WITH ARISTOTLE'S INSIGHT LOOP

BY JOSEPH A. CAZIER, CAP-X

Is Generative AI Helping Us Make Smarter Decisions?

As a long-time member of INFORMS, and a CAP-X, I strongly believe in our shared mission to make smarter decisions for a better world. Beyond a tagline, it's a guiding principle that defines how analytics should serve society. Most of the time, our tools – from optimization models to predictive algorithms – help us do exactly that: clarify uncertainty, sharpen reasoning and improve outcomes.

But the popularization of generative AI has raised new questions. Unlike traditional analytics, which are grounded in structured data and transparent logic, generative models offer speed and fluency – sometimes at the cost of depth and discernment. They summarize articles before we've read them, draft presentations before doing real analysis and generate fluent language that may sound insightful but lacks the structure required for analytical rigor.

Generative AI can help us get more done, but it is not a given that it will help us get more done better. When we offload too much of the reasoning process, we risk atrophying the skills that make great analysts: questioning assumptions, modeling relationships, testing logic and communicating nuance. The more we skip these steps, the weaker our cognitive muscles become.

So, we have to ask: Is generative AI helping us make smarter decisions or just more decisions, faster?

This article explores that question and introduces AI² – Aristotelian Insight amplified by Artificial Intelligence – as a constructive alternative: a way to use generative AI as a recursive thinking partner instead of a shortcut. We'll explore how this model builds on centuries of structured reasoning, aligns with INFORMS' mission, and transforms how we question, model, test, teach and communicate in the age of AI.

Shallow vs. Deep Thinking

Daniel Kahneman, Nobel laureate and author of "Thinking, Fast and Slow," distinguishes two primary modes of thought. "System 1" is fast, automatic and intuitive. "System 2" is slow, deliberate and analytical.

In this article, we'll refer to these simply as shallow versus deep thinking. Shallow thinking is efficient for everyday tasks but often superficial. Deep thinking is where structured insight, rigor and smart decisions are forged.

In today's high-speed environments, generative AI often reinforces shallow thinking. Its fluent language and instant outputs make it easy to accept the first plausible answer without deeper scrutiny. But in analytics and decision science, fluency is not the same as rigor.

To make smarter decisions – the kind INFORMS champions – we need to engage more with deep thinking. That means refining our questions, testing our assumptions and building clarity step by step. Deep thinking enables analysts to catch errors, reason through uncertainty and apply structured logic, which are all core to analytic practice. The good news? Generative AI can help here too if we use it differently.

Instead of treating it as a tool for output, we can treat it as a tool for thought. That brings us to the core idea: using generative AI as a recursive thinking partner.

Generative AI as a Recursive Thinking Partner

Much of the scientific revolution was born in conversation, often in the coffeehouses of 17th- and 18th-century Europe. These spaces brought together disciplined thinkers from across domains – scientists, philosophers, mathematicians, and engineers – to both refine ideas and confront them from different angles. A physicist might challenge a poet's framing. A logician might disrupt a strategist's assumptions. Their friction wasn't a flaw – it was the sharpening stone. Recursion with diverse minds made ideas stronger.

Unlike today's solitary, monotopic prompting, their conversations were recursive by design: structured loops of tension, contrast and refinement. Through these recursive dialogues, insights were sharpened like steel folded by an expert swordsmith, over and over until strong, elegant and clear. Those sharpened exchanges became the intellectual forge that helped shape modern science and systems thinking as we know them.

Today, we have something those thinkers never imagined: a thinking partner that's always available, trained on vast amounts of global knowledge and capable of instant feedback. The question is whether generative AI can play the role those coffeehouse collaborators once did – helping us iterate, clarify and strengthen our ideas in real time.

The answer, in part, is yes [1]. In a 2023 *Harvard Business Review* (*HBR*) study, MBA students were asked to develop strategic plans. Those who used generative AI merely to produce content performed modestly. But those who used it to loop – question, refine, test and revise – produced higher-quality work with deeper insight and more originality. These students didn't just ask AI for ideas; they used it to challenge their assumptions, test logic flows and refine their strategies iteratively.

The key insight wasn't that AI produced better ideas – rather, structured looping with AI led to better thinking. When used this way, generative AI becomes a powerful accelerant for insight.

The Aristotelian Insight Loop

To better understand this recursive model, it helps to look back (roughly 2,500 years) to the birth of structured thinking in ancient Greece.

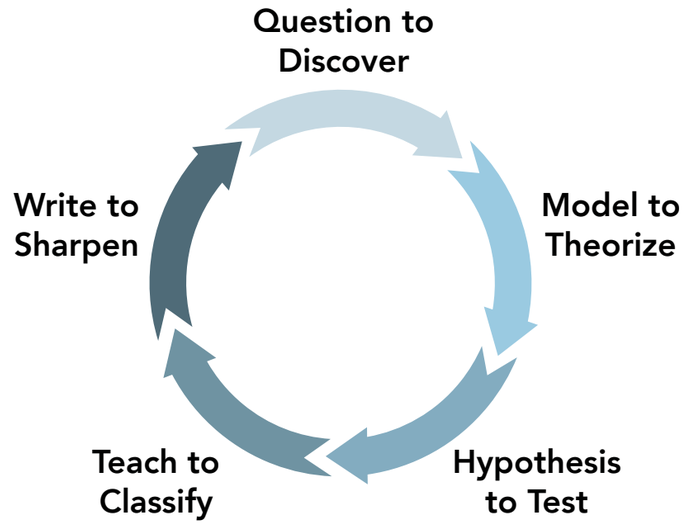


FIGURE 1: The Aristotelian Insight Loop.

That's where we find the foundation of the looped reasoning process that still shapes science, strategy and modern decision-making.

Socrates taught us to surface assumptions through disciplined questioning. His student, Plato, introduced conceptual modeling and abstraction, tools for structuring complexity. Plato's student, Aristotle, brought it all together: testing ideas against observation, teaching them in dialogue and preserving them in structured writing.

Together, they created a recursive framework for deep insight (see Figure 1). This five-part method of structured reasoning helped lay the foundation for science and systematic thought and became the intellectual engine that powered everything from classical philosophy to the Enlightenment and modern analytics.

1. Question to Discover

Socrates believed wisdom began with recognizing what we didn't yet understand. His method of inquiry (now called the Socratic Method) was more about surfacing untested assumptions than winning arguments. Today, this first stage mirrors how analysts define business problems or identify missing data, often using techniques like the Five Whys to uncover underlying causes. As with the Socratic Method, the goal is not vague complaints but sharp, humble curiosity. Modern learning science confirms that recognizing our own knowledge gaps – what psychologists call epistemic curiosity and metacognitive awareness – is a gateway to deeper learning and structured insight.

But in analytics and decision science, fluency is not the same as rigor.

2. Model to Theorize

Plato's legacy was abstraction. He built frameworks to explain justice, ethics and reality – conceptual models that gave shape to invisible patterns. In analytics, this step is just as crucial. Once we know what we don't understand, we start sketching possibilities: influence diagrams, simulations, structured hypotheses. For instance, a supply chain analyst might model how weather disruptions affect inventory variability. We move from loose ideas to frameworks that help us make sense of complexity so that we can test them.

3. Hypothesize to Test

Aristotle's genius was rigor. He didn't stop at theory; he insisted ideas be tested. Observed. Measured. This is the foundation of modern analytics: the scientific method, causal inference, model validation. If questioning is humility and modeling is creativity, then testing is accountability. This principle (now known as falsifiability) became central to the scientific method, as formalized by philosopher Karl Popper. In this stage, we ask: Does our model work? Can it be falsified? What does the data say?

4. Teach to Clarify

Aristotle didn't gather students to pass down finished truths – he brought them together to pursue truth through tension, dialogue and disciplined disagreement. His school, the Lyceum, was closer to a boxing ring than a lecture hall, where ideas were tested, countered and refined through intellectual sparring. Teaching meant confronting contradictions and clarifying what could not yet be fully explained. In this context, teaching wasn't the end of knowing – it was how knowing happened. Teaching is recursive: As we explain something to others, we expose the gaps in our own logic. For analysts, this happens in design reviews, stakeholder briefings or team walkthroughs. Teaching forces clarity, disciplines intuition and turns complexity into structure.

> AI doesn't replace structured thinking – it enhances it. It turns good thinking into better systems, and helps better systems lead to smarter outcomes.

5. Write to Sharpen

Aristotle wrote extensively, not to summarize, but to synthesize. Not as an afterthought, but as a final crucible for thinking. In analytics, writing does the same. Whether in reports, dashboards, executive summaries or even annotated code and model recommendations, we sharpen ideas through articulation. We carefully weigh our words to reduce ambiguity and preserve what matters most. Unlike the quick give-and-take of spoken conversation, writing formalizes ideas into shareable, inspectable forms – moving from shallow dialogue to structured insight. It enables others to think deeply with us, critique, refine and build upon our ideas. Through peer review, formal analysis and collaborative recursion, writing transforms isolated insight into collective progress – pushing ideas and decisions forward, making them better, stronger and ultimately, smarter.

This five-part loop, rooted in ancient insight, became the backbone of science, strategy and structured decision-making. Its power lies in recursion: Each pass clarifies assumptions, strengthens logic and improves decisions. Now, with generative AI, the same loop can be scaled and accelerated.

AI²: Accelerating the Aristotelian Insight Loop

AI^2 is the term we use for Aristotelian Insight amplified by Artificial Intelligence. It describes how the Aristotelian Insight Loop can be accelerated and democratized by generative AI, bringing structured reasoning to more people, quicker.

Today, AI enables us to engage with this loop at unprecedented speed and depth. What once required years of scholarly mentorship, handwritten drafts and painstaking debate can now be simulated, iterated and refined in hours or even minutes. AI doesn't change the structure of the loop; it accelerates its cycle, expands access and deepens its application. AI delivers near-infinite speed and scope, personalized to your needs in real time. Instead of waiting for feedback or access to mentors, learners can instantly engage with the exact concepts they need – tailored to their stage in the loop and their depth of understanding.

Used intentionally, AI becomes a recursive thinking partner: immediate, individualized and always available. It invites more people into deeper thinking and gives every learner a partner for structured cognition. AI also opens the door to cross-disciplinary insight, connecting ideas from different fields through structured reasoning. Many of history's greatest breakthroughs emerged this way, and generative AI makes that kind of lateral synthesis more accessible than ever.

As the earlier MBA student example from *HBR* shows [1], using AI recursively led to strategic plans that were both faster and more original than those produced through traditional methods.

AI now supports every phase of the loop:

- Questioning with deeper context and broader perspective
- Modeling with system maps and simulated environments
- Testing with access to global research and data
- Teaching through continuous feedback from AI dialogue
- Writing with real-time refinement and structure

Not every use of AI requires this depth. For operational summaries, basic reporting or task automation, generative AI can save time and streamline workflows. But when solving ambiguous problems, designing strategy or building models that influence real-world decisions, depth matters. In these moments, recursive structure is essential.

When used this way, in addition to accelerating cognition, AI^2 reinforces accountability. By walking through each phase of the Insight Loop, analysts build stronger, more traceable models. The structure encourages transparency in how assumptions are formed, tested and communicated, making decisions easier to defend and harder to obscure. In an era of black-box AI, recursive clarity becomes an ethical strength.

AI doesn't replace structured thinking – it enhances it. It turns good thinking into better systems, and helps better systems lead to smarter outcomes.

Toward the Era of AI^2

The recursive loop that once defined scholarship now defines scalable intelligence. With AI, structured thinking is no longer slow or exclusive – it's accelerated, personalized and democratized.

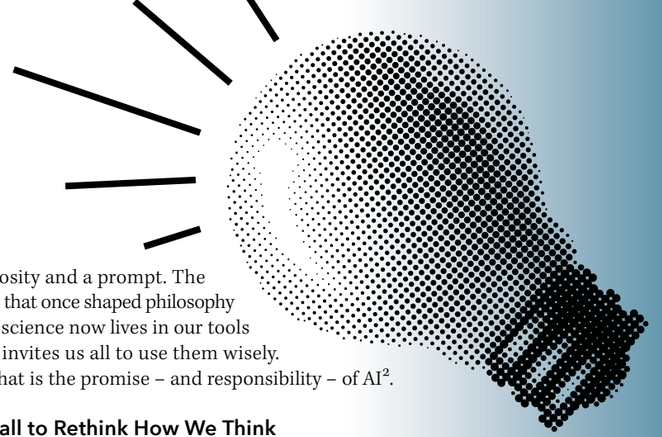
In analytics, that means transforming how we question, model, test, explain and communicate. Analysts can now surface assumptions faster, refine models more thoroughly and write with clarity in real time. What once took weeks of iteration can now happen in hours without compromising rigor.

These recursive capacities directly map onto the INFORMS Analytics Framework – from business problem framing to solution deployment (informs.org/IAF). Analysts use the loop to refine ambiguous problem statements, simulate dynamic systems, validate models with real data, and communicate insights across technical and nontechnical teams. Whether you're diagnosing root causes in a supply chain or explaining model drift to executives, AI used recursively supports structure, clarity and collaboration. It strengthens both what we deliver and how we think.

For teams, AI^2 amplifies collaboration and consistency. Structured loops allow shared understanding and make decisions more transparent. For leaders, it sharpens synthesis and supports faster insight-to-action.

Beyond analytics, the implications are even greater. AI^2 can compress the time it takes to master complex domains, enabling faster fluency for learners at every level. Experts can also gain leverage – extending insight across disciplines, sharpening systems and accelerating innovation.

Most importantly, structured thinking becomes accessible. What was once confined to universities or research labs is now available to anyone with curiosity and a prompt. The loop that once shaped philosophy and science now lives in our tools and invites us all to use them wisely.



That is the promise – and responsibility – of AI^2.

A Call to Rethink How We Think

In the age of AI, in which anything that has ever been discovered is instantly knowable, knowledge alone is no longer a national advantage. The future will be won not by those who know the most but by those who can think the deepest – those who can sort signal from noise, wrestle with complexity and decisively act on what matters.

This shift requires us to rethink how we learn, teach and live. Our schools were built for delivery, institutions for scale. But the future demands discernment, clarity, recursion and moral courage, and that we stop outsourcing our thinking – and start sharpening it.

This is why AI^2 is more than a framework. In a world flooded with information but starved for discernment, it's a blueprint for survival. It revives the ethos of the Lyceum as a truth-forging arena. A place where education is not passive absorption but active confrontation. Where students and analysts alike learn to fight for clarity, sharpen their logic through tension and build shared understanding under pressure.

We don't need more answers; we need better questions and more resilient minds. AI gives us information. Only structured, recursive thinking gives us insight, wisdom and direction. That is the muscle we must build as a people and the future we must teach into being.

A nation that thinks deeply will not be easily misled. A society that teaches its people to fight for truth will not be easily undone.

This is the moment to choose depth over convenience and to think like our future depends on it – because it does. If you're an analyst, start using AI to reason better. If you're a leader or educator, build systems that reward clarity, not just output.

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A VOTE OF NO CONFIDENCE

BY NOAH HIBBLER, NATALIE M. SCALA AND JOSH DEHLINGER

FREE AND FAIR ELECTIONS ARE A HALLMARK OF A HEALTHY democracy. Not only must the outcome be legitimate, but also, the citizens of the democracy must have confidence and belief in the integrity of the election. Three factors influence public confidence in electoral processes: voter education efforts, hierarchical levels of government and the postelection "winner effect" [1-4]. But what about the technical assurances built into current voting systems? How do they shape perceptions of fairness and accuracy?

Election systems and hardware are considered critical infrastructure in U.S. elections – assets, systems and networks that deliver essential services to society. Because of this, protecting and managing risks through information assurance is of heightened interest. The scope of information assurance has recently evolved to encompass broader concerns related to cybersecurity and information security. However, the five pillars of information assurance – confidentiality, integrity, availability, nonrepudiation and authentication – are still relevant when maintaining the integrity, secrecy, accessibility and verifiability of cast ballots [5].

In theory, these pillars work together to foster trust: Confidentiality ensures voter privacy, integrity prevents tampering, availability guarantees access, nonrepudiation provides proof of submission and authentication confirms voter identity. However, in practice, election systems face adversarial interference and meddling threats, and the states and localities that administer elections are doing so with limited budgets and aging equipment. Thus, a key question emerges when considering the next generation of election systems: Which information security pillars matter most to voters? To our knowledge, no study examines voter confidence in the U.S. election system and its ability to deliver fundamental information security.

To begin answering this question, we distributed a survey to more than 700 state and local election officials (EOs) from seven swing states, two blue states and one red state. We expect EOs to receive authentic feedback from voters because they are the front-line government election representative. Results from this early investigation reveal a clear perceived voter priority hierarchy, with voters valuing integrity and nonrepudiation the most. Confidentiality is the least valued pillar.

Voter Confidence in the Literature

Educational campaigns by EOs, proximity to the level of government and the "winner effect" significantly influence voter confidence in electoral processes. Suttmann-Lea and Merivaki (2023) and Merivaki et al. (2025) demonstrate that educational campaigns were effective at enhancing voter trust during the 2020 and 2022 elections; targeted communication efforts improved confidence among skeptical voters and increased ballot acceptance rates [1, 6]. Atkeson et al. (2015) and Wolak and Palus (2010) indicate that voter confidence exhibits a hierarchical pattern, with highest trust placed in local elections and progressively decreasing confidence at state and national levels, a pattern consistent with broader government trust trends since the 1960s [2, 3]. Finally, the "winner effect" plays a crucial role – voters whose preferred candidates won typically report higher confidence in electoral systems after elections [4, 7]. Voters typically express greater confidence in local vote counting than in state-level processes and greater confidence in state processes than in national ones [1, 2].

Five Pillars of Information Assurance

Information assurance, protecting information assets with combinations of physical, administrative and technical controls, has been a key practice of risk management, especially within government and military contexts, since the early 2000s. As threat landscapes and technology evolved, information assurance broadened into information security, which better reflects the need to protect data across digital environments, adversarial threat landscapes and emerging technologies. However, the traditional definition of information assurance adds methods for accountability by considering nonrepudiation and authentication; information security does not.

Therefore, the five pillars of information assurance are still relevant to critical infrastructure and election systems risk management. Although the field evolved, all fundamental risk assurances cannot be ignored. In particular:

- **Confidentiality** is the quality or state of being private or secret. An example of confidentiality in an election is secret ballots or privacy envelopes for mail-in ballots. Violations of privacy could reveal who an individual cast a ballot for and put them at risk of personal or professional reprisal, especially in a politically charged culture [8].
- **Integrity** is the quality or state of being complete or undivided. An example of integrity in an election is ballots not being changed or altered while being cast or counted. Violations of ballot integrity could result in a ballot not being counted as cast or not being counted at all.
- **Availability** is the quality or state of being accessible, suitable and ready for use. Some examples of availability for voters in an election include Americans with Disabilities Act compliance, as well as convenient proximity of designated polling locations to work or home, polling location hours and ballot casting methods. Violations of availability can result in the inability of voters to cast a ballot or receive results in a timely manner.
- **Nonrepudiation** refers to the inability to deny having taken an action. Some examples of nonrepudiation in elections are verification that a vote by mail ballot was picked up from a drop box or received by the polling center. Violations of nonrepudiation can result in distrust in the election system.
- **Authentication** is the act or process of proving that something is real, true or genuine. Some examples of authentication in elections are signature verification on ballots and identity verification at the polling place. Violations in authentication can result in voter fraud.

There are currently no voting systems that deliver perfect protection across all five pillars, yet each pillar is critically important [9]. As the current equipment ages and the more digitally fluent Generations Z and Alpha enter the electorate, the need emerges to align continued security designs with voter expectations while maintaining and building both confidence and trust.

Methodology

For this preliminary study, we sent a survey by email during spring 2025 to a random sample of EOs from states that listed employee email addresses online. Additionally, a link was provided to academic researchers in elections security to share with their government contacts. The survey was anonymous, managed via Qualtrics and reviewed by the institutional review board at Towson University. Questions in the survey included demographic data about the state and estimated population density of the communities served by each EO. Eliciting Likert scale and open-ended responses, we presented questions related to the five pillars with a section for the EO to rank the pillars in perceived order of importance to their county or locality. We also queried whether voters had expressed concerns about any pillar during the 2024 U.S. presidential election, or whether the EOs themselves had any concerns with their election equipment and/or administration processes. The response rate was 6.32% (48/759). No question in the survey had a forced response, which resulted in a usable answer $n \in \{23, \ldots, 28\}$ for each question after data cleaning.

There are currently no voting systems that deliver perfect protection across all five pillars, yet each pillar is critically important.

FIGURE 1: Voter perception of importance, as communicated to EOs.

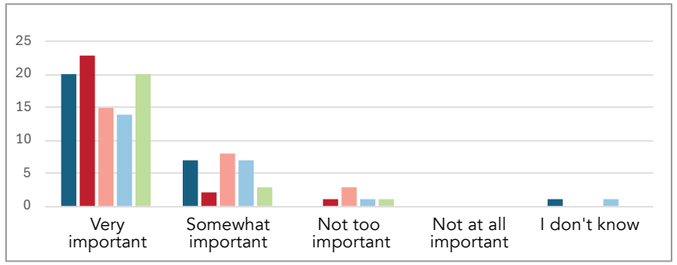


FIGURE 2: Voter perceptions of confidence in methods and technologies, as communicated to EOs.

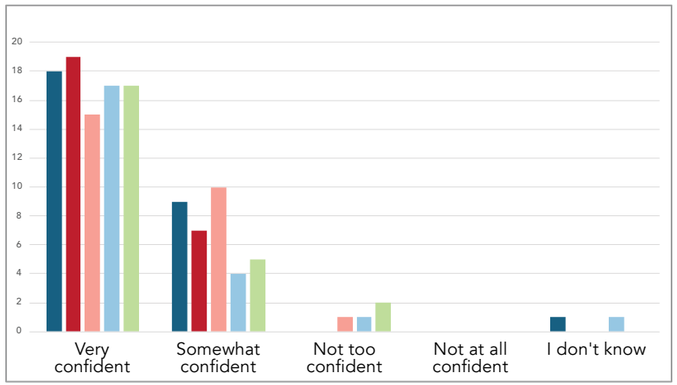
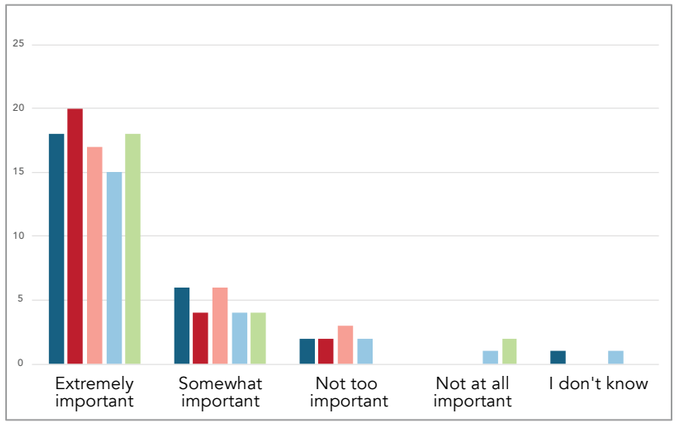


FIGURE 3: Voter perceptions of the impact of technology on trust, as communicated to EOs.



Results

Figures 1, 2 and 3 present histograms of EO responses for the five pillars and their perceived importance, confidence in implementation, and impact on voter trust. Each of the pillars was broadly rated highly for these attributes. For every pillar, pairwise Fisher's exact tests are not significant ($p > 0.30$ for all tests), indicating that no difference exists between the pillars themselves in terms of importance. This suggests uniform high ratings rather than differentiated priorities. That being said, it is possible that voters simply may not care about information security or don't communicate their concerns to an EO. The current political and cultural environment in the U.S. may be directly or indirectly driving voters to express their preferences online via social media. Furthermore, the five pillars have not been directly in the national discourse, so voters may not be framing their views in terms of these structured definitions. Future research is needed to tie online posts and colloquial narratives to the pillars, contextualizing voter sentiment.

The data tells a more interesting story when we consider ranking the pillars. For this, we apply a modified Borda count, assigning 1-5 points per pillar. Borda counts can be used as a method of rank choice but have been subject to criticism in the literature for potential tactical manipulation. However, this is a small sample size in an early study, and value function elicitation or utility was outside the scope of our survey. Borda counts have support for use with partial voting, which are appropriate for this data, as many of our survey responses were incomplete [10]. Figure 4 presents the Borda counts for the five pillars; integrity has the highest count at 69, followed closely by nonrepudiation. This implies that, from the EO perspective, voters find all pillars highly valuable and important. Confidentiality scored lowest, but not at minimum count, suggesting voters view all pillars as important, with subtle distinctions.

Although the Fisher's exact tests showed no statistically significant differences between the information assurance pillars, the Borda count showed a preference for integrity over the others. This may be because, as a respondent provided in free response, "voters think each item is equally important and of utmost importance." All pillars of information assurance are inarguably important. However, not all voting technologies fulfill the qualities of each pillar in practice, and the survey results demonstrate that voters do not value them equally. We need to understand which pillars voters value most so EOs can invest in election technologies that best support the qualities of those pillars.

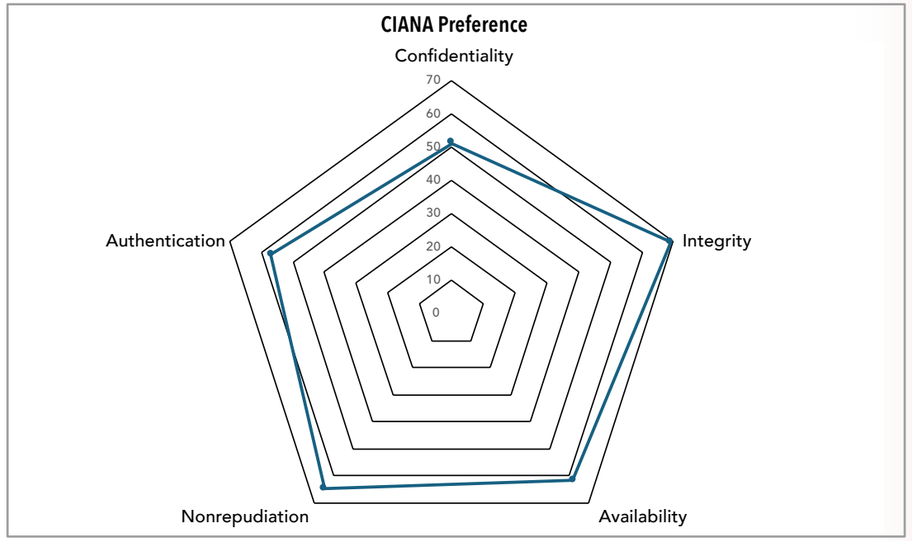


FIGURE 4: Borda counts for the five pillars.

The low ranking of confidentiality suggests a "privacy paradox," in which individuals profess concern for data privacy but trade it for perceived benefits or convenience [11, 12]. This underscores the need for election systems that visibly demonstrate vote accuracy and verifiability, coupled with straightforward communication that demystifies technical trade-offs. In electoral settings, public demand for transparency and verifiability often overrides theoretical desires for secrecy, shaped by social norms and declining expectations of privacy in an online age [13, 14]. These suggestions may inform EOs when planning voter education and outreach efforts.

Comments in the free-response section of the survey referenced nonrepudiation and integrity. Multiple EOs mentioned that voters raised concerns regarding integrity, which were assuaged by on-the-spot voter education, a method shown to be effective [1, 15]. Other comments were more overt, discussing multiple pillars in a single free-form response. For example, one EO wrote: "A few voters expressed disapproval of the concept of ballot secrecy, instead wanting concrete, later verifiable evidence of their vote being for who they wished to vote for and being able to track every ballot to a voter and to be able to record themselves and others within the polling place." Comments such as these suggested nonrepudiation, confidence and authentication concerns. The implied concern for accountability due to the high ranking of nonrepudiation and authentication indicated the desire for information assurance rather than mere information security.

Conclusions

We acknowledge this is very early work, utilizing a survey instrument predominately in the context of a student research project. That being said, what voters value and perceive to be important remains of concern, especially because strong, widely held beliefs in the integrity of an election are crucial for a functioning democracy. The data also suggests that voters and EOs may not truly understand the implications of and differences between the five pillars. Future work should validate these early findings as well as educate voters on information security principles that contribute to election integrity in the U.S.

Note: *References can be found online:* https://doi.org/10.1287/orms.2025.04.08.

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LEADING WITH PURPOSE: A CONVERSATION WITH THE 2026 INFORMS PRESIDENT

BY KARA TUCKER

WHEN THE INCOMING INFORMS PRESIDENT REFLECTS ON WHAT excites him most about stepping into the role, he doesn't start with strategy, budgets or the sweeping changes reshaping the fields of analytics, operations research (O.R.) and artificial intelligence (AI) (all of which are important). He starts with people.

After three years on the INFORMS Executive Committee – first as secretary and then as president-elect – Mark Lewis has gained a close-up view of what he considers the organization's greatest strength: a deeply committed staff and an equally dedicated volunteer community. "None of us are paid to do this work," he says. "We do it because we believe in INFORMS." That shared sense of purpose, he believes, is what enables the organization to tackle both its internal challenges and the rapid evolution of the broader scientific and technological landscape.

INFORMS will be entering 2026 on solid financial footing following the lingering impacts of the COVID-19 pandemic-era deficit. Lewis is candid about the strategic choice the organization made: Instead of gambling on short-term, high-risk revenue generators, INFORMS invested in a long-term, sustainable solution through its partnership with EBSCO. The agreement expands the global reach of INFORMS journals while also strengthening financial stability – two outcomes he sees as tightly intertwined. The long-term view, he notes, is what ensures that INFORMS remains positioned to serve members for decades to come.

But financial recovery is only one part of his vision. Much of Lewis' career – both within INFORMS and across academia and industry – has been defined by building community and expanding access, particularly for underrepresented groups. This year marks the 25th anniversary of the Minority Issues Forum (MIF), which he co-founded with four early-career colleagues. Their goal was simple but urgent: to create a supportive space for minority scholars and practitioners in a field in which many felt isolated. MIF has since grown into a vibrant, multigenerational community that continues to influence the culture and leadership pipeline of INFORMS. "It absolutely helped my career," Lewis reflects. "Having that support as a new faculty member made an enormous difference."

That experience shapes his approach to leadership today. Increasing diversity within INFORMS committees and volunteer roles is a priority, and he sees enormous potential in modernizing the new INFORMS Volunteer Management System – transforming it from a simple list into a tool that systematically surfaces emerging talent. This, he believes, is how INFORMS broadens participation and ensures that new voices contribute to its future.

Another theme that energizes Lewis is bridging the long-standing divide between academics and practitioners. His recent sabbatical as an Amazon Scholar illuminated the gap in a new way: Even researchers who consider themselves highly applied can remain distant from the operational realities industry faces. He sees two paths forward – creating more programs that immerse academics in industry settings and encouraging more faculty to engage directly with the INFORMS Analytics+ Conference. With federal research funding entering a period of greater uncertainty, the incentive for collaboration has never been stronger.

As AI and machine learning reshape global industries, Lewis is clear about the unique value INFORMS brings to the conversation. AI excels at rapid data processing, but O.R. provides the decision-making frameworks required to act responsibly on that information. From supply chains and healthcare to logistics and public policy, INFORMS members sit at the intersection of computation, optimization and societal impact. That, he says, is what "Smarter Decisions for a Better World" truly means.

For Lewis, leading INFORMS is not simply an administrative role – it is the next chapter in a career built on community, mentorship and a belief in the transformative power of O.R. The following Q&A offers an in-depth look at his vision for the year ahead.

Congratulations again on your election! Coming into your presidential year, what do you see as INFORMS' greatest strengths?

Thank you, and I'm really excited to be here. I've served on the Executive Committee for about four years – first as secretary (three years), then as president-elect – and I've had the privilege of working closely with our incredible staff. I always knew they were strong, but I didn't fully grasp just how dedicated they are to INFORMS' mission until I saw it up close. Our volunteers are another tremendous strength. None of us are paid to do this work; we do it because we believe deeply in INFORMS and in advancing the impact of our field. That passion is powerful.

Your predecessors have discussed the financial deficit created during the pandemic years. How will INFORMS continue its financial recovery and growth during your presidency?

First, we're already on the right path out of the deficit. There are essentially two ways to accelerate this: You can take a big financial bet that pays off quickly, or you can build a long-term revenue stream that grows steadily. INFORMS chose the second – our EBSCO agreement for journal aggregation and dissemination. This partnership not only provides direct revenue but, more importantly, expands global access to our journals, which increases reach and long-term value. That partnership has now officially begun, and I'm optimistic about the impact.

You've held a long list of volunteer roles and co-founded the INFORMS Minority Issues Forum (MIF). Tell us about starting that community and serving as its president more than once.

This year is actually our 25th anniversary, which is incredible. Five of us co-founded MIF: Bill Christian, Ilya Hicks, Maria Mayorga, Julie Ivy and myself. We were all early in our careers, and the idea grew out of a conversation I had with former INFORMS President John Birge.

Our goal was to create a supportive, inclusive space for people to gather, share experiences, and address issues unique to minority faculty and practitioners. Over 25 years, the community has flourished far beyond the original group – with tremendous support from members of all backgrounds. And yes, it absolutely helped my career. As a brand-new faculty member, having a community that understood and supported me made an enormous difference.

> None of us are paid to do this work. We do it because we believe in INFORMS.

One of your goals in your candidate statement was supporting minority and underrepresented groups. What concrete initiatives do you hope to launch or continue?

As secretary and president-elect, I worked to encourage broader representation on committees. One step was asking committee chairs to document

Mark Lewis speaks during the Student Awards Ceremony at the 2025 INFORMS Annual Meeting in Atlanta.

David Hunt passes the gavel to Mark Lewis during the 2025 INFORMS Annual Meeting.

how they expanded access and opportunities when forming their groups. I'm also excited about the Volunteer Management System. I'd love to see it become a true talent-matching tool – something that helps us identify members who haven't historically been invited into volunteer roles, whether they're women, veterans, Pride members, in a minority group or anyone simply less visible. It would expand opportunities for everyone – new voices, new perspectives and new volunteers.

You also mentioned the divide between academia and practice. How do you envision strengthening collaboration between those groups?

Last year, while on sabbatical, I served as an Amazon Scholar. That experience sharpened my understanding of the gap: Even researchers who see themselves as "applied" may still be a step removed from real implementation challenges. One solution is more programs like the Amazon Scholar model – bringing academics directly into industry environments.

The changing federal landscape will naturally push more academics toward industry engagement. But I also believe our evaluation metrics in academia can evolve. Impact shouldn't be measured only by publications. If a faculty member helps a company save millions of dollars or remain competitive in a way that benefits society, that's real impact. The Franz Edelman Competition is a great example. I attended the competition for the first time last year and was blown away. Those teams are absolute stars, and their work has extraordinary societal value.

You've also spoken about strengthening the INFORMS community. What does "sense of community" mean to you, and how can INFORMS reach less-connected members?

Community includes bridging the academic-practitioner divide, but also expanding globally. We have tremendous opportunities in Asia, Latin America and Africa, and we should deepen our ties to Europe as well. INFORMS may be incorporated in the U.S., but it's truly a global organization.

As for reaching less-connected members, we now have instant communication tools that didn't exist when INFORMS was founded. We're not leveraging them as effectively as we could. The harder part is ensuring we have people dedicated to this work – and that the whole organization recognizes its importance – but it's absolutely doable.

With AI and machine learning transforming nearly every field, how does INFORMS stay relevant in such a fast-moving landscape?

AI and O.R. are naturally connected, but computer science often dominates the conversation. O.R. brings something broader, especially around decision-making. Take supply chains: AI enables rapid data processing, but O.R. provides the optimization and decision frameworks needed to act on that data. The same applies in healthcare, drug development, logistics and more. There's still enormous opportunity for O.R. to shape smarter, more responsible applications of AI.

INFORMS' tagline is "Smarter Decisions for a Better World." How does that resonate with you?

I think of it in two parts. "Smarter decisions" means being data-informed and applying optimization – moving beyond analysis to action. "For a better world" reflects the incredible breadth of O.R. applications. Whether it's Amazon, public policy or a food bank, we have the tools to meaningfully improve people's lives. That's what drew me to the field in the first place.

What originally compelled you to join INFORMS?

I believe I attended my first conference around 1996 while working on my Ph.D. My advisors encouraged it, and I quickly realized I'd found my people.

My background was in mathematics and political science, so discovering O.R. felt like discovering the field where my skills and interests finally clicked. The problems are often easy to describe but hard to solve – the perfect combination. And even before MIF, I felt welcomed and supported.

Tell us more about your path and the mentors who shaped you.

I've been fortunate to have a long list of mentors, starting with the math faculty at my undergraduate institution, who created courses just so I could keep learning.

At Bell Labs, people like Martin Reiman, Bill Massey and Ward Whitt influenced my thesis direction. At Georgia Tech, my advisors Hayriye Ayhan and Bob Foley continued that support as well as my postdoc advisor Martin Puterman. Then there are countless INFORMS colleagues – some examples include John Birge, Brenda Dietrich, Candi Yano, Rhonda Righter and Shane Henderson – who have checked in on me and guided me over the years, even when we weren't working together directly. And, of course, my parents and family are my deepest inspiration.

What lessons from your mentors have stayed with you?

From my parents: always strive a little higher. If you earn a B, aim for an A next time. That mindset shaped my research career – solve a problem, then push further.

From my wife and children: humility. No matter how high you climb, to them you're just the person walking around the house in Crocs. It's grounding in the best way.

Lewis (right) facilitates a keynote panel during the 2025 INFORMS Annual Meeting.

With such roles as professor, former associate dean, researcher, father and now INFORMS president, how do you stay grounded?

I like to work out in the mornings – that helps center me. But more than anything, I often think: What would my father do? What would my mother want me to do? That keeps me aligned with my values, no matter how full life gets.

KARA TUCKER is editor of OR/MS Today.

Watch the full interview on INFORMS YouTube Channel!

INFORMS BOARD: **ELECTION RESULTS**

Wedad Elmaghraby, Dean's Chair of Operations Management of the Robert H. Smith School of Business at the University of Maryland, was elected by INFORMS membership as the president-elect of INFORMS. Elmaghraby will join the INFORMS Board of Directors as president-elect in January 2026 and will then serve as president and past president in 2027 and 2028, respectively.

Elmaghraby's research interests are at the interface of operations management, economics and behavioral decision-making. Her collaborations with faculty across economics, marketing, information systems, statistics, public policy and engineering reflect a strong appreciation for industry applications and interdisciplinary work. Elmaghraby's work spans healthcare, energy, procurement, online market design, pricing and sustainability.

Other elected members of the INFORMS Board resulting from the recent election include:

Secretary: Pelin Pekgun

Vice President, Chapters & Forums: Les Servi

Vice President, International Activities: Gina Galindo

Vice President, Marketing, Communications & Outreach: Tinglong Dai

Vice President, Membership & Professional Recognition: Anahita Khoiandi

Vice President, Practice: Pooja Dewan

Reminder! Candidate recommendations and expressions of interest for the INFORMS Elections to be held in 2026 to elect members of the 2027 Board of Directors are due January 16, 2026. Names received after that date may be considered. The nominating committee is scheduled to report its candidate slate by March 1, 2026. If you have any questions, please email nominations@informs.org.

STRENGTHENING ETHICAL STANDARDS IN SCHOLARLY PUBLISHING AT INFORMS

BY CHRISTOPHER S. TANG AND MATTHEW WALLS

INFORMS HAS LONG BEEN COMMITTED TO advancing research of the highest quality. With over 11,000 annual submissions across 17 journals, the vitality of our publishing program reflects both the ambition and creativity of our community. However, such growth brings with it a renewed responsibility: to ensure that the trust placed in our scholarship is never undermined by unethical practices.

To meet this challenge, INFORMS took the time to comprehensively rewrite its Publication Ethics policy (Publications Policies & Procedures Number 13.8, available at https://pubsonline.informs.org/publication-ethics). This revision, effective August 2025, reaffirms our commitment to **integrity, transparency** and **fairness** while introducing clear definitions, stronger safeguards and more robust procedures for addressing ethical violations.

Why the Policy Was Strengthened

Our earlier article, "Fostering Ethical Behavior in Academic Publishing: A Call for Self-Regulation" [1], emphasized the importance of self-regulation and the dangers of "publish or perish" pressures. These dynamics remain. However, as instances of plagiarism, redundant or parallel submissions, and data manipulation become increasingly sophisticated, our response must evolve accordingly.

Our updated policy ensures that INFORMS journals remain aligned with global standards – such as those of the Committee on Publication Ethics (COPE) [2] – while also addressing emerging challenges unique to today's publishing environment, including the use of generative artificial intelligence (AI).

Clearer Definitions of Ethical Breaches

The revised policy expands on the types of misconduct that undermine trust in scholarly publishing:

- **Concurrent or Multiple Publications:** Submitting or publishing "substantially similar" work in more than one venue without full disclosure is strictly prohibited.
- **Plagiarism and Self-Plagiarism:** Drawing on prior work, including one's own, requires full citation and disclosure. Unacknowledged text recycling undermines the transparency of scientific progress and is strictly prohibited.
- **Manipulation of Citations:** Artificially inflating references to particular authors or journals is unethical, as is relying on unverifiable references generated by AI tools.
- **Data Fabrication or Falsification:** Altering, inventing or misrepresenting results represents one of the gravest ethical violations.
- **Misrepresentation of Authorship:** Gift authorship, ghost authorship and failure to credit contributors are explicitly prohibited. These practices distort the scientific record by misallocating credit, undermining accountability and eroding trust in authorship as a marker of genuine scholarly contribution.

By clarifying these categories, the policy helps authors, reviewers and editors recognize and avoid pitfalls.

Addressing Emerging Challenges: Generative AI

A notable addition to the policy is guidance on the use of generative AI. While authors may use AI tools in preparing manuscripts, such tools cannot be listed as authors. All AI assistance – whether for text drafting, translation or data analysis – must be disclosed. This transparency ensures accountability and guards against hidden reliance on unverifiable sources.

Stronger Investigative and Adjudication Procedures

The new framework strengthens our structured process for investigating alleged violations:

- **Preliminary Review:** Editors-in-chief assess claims and provide accused authors the opportunity to respond.
- **Formal Review:** When warranted, a Publication Ethics Subcommittee, composed of impartial experts, conducts a thorough investigation.
- **Sanctions:** Depending on severity and recurrence, sanctions may range from paper rejection to lifetime bans on submissions to all INFORMS journals and, in extreme cases, notification of an author's institution.
- **Appeals and Author Rights:** Accused authors are assured due process, including timely notice, opportunity to respond, confidentiality and the right to appeal decisions.

These safeguards balance accountability with fairness, reinforcing both rigor and trust.

A Collective Responsibility

Whereas the revised policy strengthens institutional oversight, it also emphasizes the essential role of the community. Ethical publishing cannot be enforced by editors and committees alone. Every scholar must remain vigilant – reporting concerns, mentoring students in best practices and modeling integrity in their own work. As before, the principle of "See it, Say it, Sort it" applies: Self-regulation remains the first line of defense.

Looking Ahead

By updating the Publication Ethics policy, INFORMS has taken a decisive step to safeguard the credibility and integrity of our journals and reinforce the trust of our readership. These measures reflect international best practices, proactively address emerging challenges and uphold the high standards our field demands.

We invite all members of the INFORMS community to read and internalize the revised policy, guide students and colleagues in its principles, and help us foster a publishing culture in which integrity is not merely expected but actively championed.

Acknowledgment

In accordance with INFORMS' Publication Ethics policy, the authors acknowledge that ChatGPT was used to assist with initial drafting of this article. This work was conducted using a closed, subscription-based version of ChatGPT, which does not expose content to public training data. As with any AI-assisted work, disclosure ensures transparency; the authors remain fully responsible for the substance and accuracy of the article.

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MATTHEW WALLS (mwalls@informs.org) is the director of publications at INFORMS.

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THE INFORMS K-12 RESOURCE HUB: SCALABLE K-12 OUTREACH FOR A GLOBAL AUDIENCE

BY KENNETH E. MURPHY, FENGLIAN PAN, YIFENG WANG AND ZIHAN ZHANG

Images: Students present their posters in the K-12 Poster Competition during the 2025 INFORMS Annual Meeting in Atlanta.

THE INFORMS K-12 EDUCATION

Outreach and Networking Program is a new, platform-centered outreach initiative designed to make operations research, management science, industrial engineering (IE) and business analytics engaging, accessible and scalable for K-12 students around the world. Our vision is simply to provide a **flexible, sustainable, global platform** that can reach more students without the limitations of location or volunteer availability. This program is administered by the K-12 Committee, one of three subcommittees of the INFORMS Education Outreach Committee.

Launched in 2023, our program has already grown into a multipronged outreach platform, featuring the following.

1. **Webinar Series:** Our program has hosted five online webinars featuring speakers from Georgia Tech, University of Arizona, Pennsylvania State University, University of Massachusetts Amherst and Arizona State University. Two additional sessions are already planned. Each webinar highlights practical strategies, success stories and lessons learned in K-12 outreach, offering participants both inspiration and actionable ideas. The webinars draw a diverse audience of educators, outreach volunteers and INFORMS professionals who share a common interest in expanding STEM engagement. To maximize impact, each webinar is recorded and made available on our program website (www.informs-k12.com), ensuring that the content remains accessible to anyone interested in learning and contributing, regardless of time zone or schedule.
2. **In-person Panel Sessions at INFORMS Annual Meeting:** A cornerstone of our program since 2023, we have hosted a panel each year at the Annual Meeting, with the most recent at the 2025 INFORMS Annual Meeting in Atlanta. The face-to-face format fosters rich, real-time discussion and networking that cannot be fully replicated online. Participants engage directly with panelists, exchange ideas in the moment and build connections that often lead to future collaborations. These sessions have become a valuable space for energizing the INFORMS community around K-12 engagement and showcasing the breadth of outreach efforts happening across the community. After each session, we publish an article summarizing the key discussion points and results, helping to spread the ideas and words to an even broader audience.
3. **K-12 STEM Spark Poster Competition:** Expanding beyond our previous activities, which primarily focused on sharing outreach practices by college-level educators, our poster competition is designed to develop content directly focusing on high school students. We seek to develop content to reach younger learners sparking curiosity about OR/MS, IE and business analytics. The STEM Spark: INFORMS K-12 Poster Competition [1] is open to all INFORMS student members and focuses on showcasing their research in an accessible and engaging way for high school audiences. The goal is to inspire the next generation of educators and hone their skills in communicating and connecting with high school students by showing how OR/MS, IE and business analytics apply to real-world challenges. This, in turn, helps to build the next generation of analytical thinkers and strengthens the long-term STEM pipeline.
4. **Website Hub:** At the heart of the program is our K-12 Education Outreach and Networking Website – a growing online library of interactive and accessible materials that bring OR/MS and industrial analytics to life for younger audiences. The site aims to:
   - Capture and showcase K-12 activities organized within the INFORMS community.
   - Share high-quality resources that make complex ideas clear, fun and hands-on.
   - Connect people worldwide through lively forums and collaborative spaces.
   - Host interactive events that spark exploration, creativity and problem-solving.

   All materials are designed to be **accessible** and **flexible in use,** whether for outreach volunteers leading workshops; classroom teachers integrating OR/MS, IE and business analytics into lessons; or motivated students learning independently.

Looking ahead, the INFORMS K-12 Education Outreach and Networking Program seeks to increase its impact through a portfolio of innovative outreach initiatives. By combining online resources with the connection of in-person events, and directly engaging K-12 students, we are building a vibrant and sustainable pipeline for the next generation of problem-solvers. We invite all members of the INFORMS community to explore our resources, participate in upcoming activities and join us in inspiring curiosity, creativity and confidence in OR/MS, IE and business analytics for students everywhere.

KENNETH (KEN) MURPHY is an assistant professor of teaching at the Merage School of Business, University of California, Irvine. His courses include business capstone, predictive analytics, operations management and management science courses in executive, MBA, MS and undergraduate programs. His research spans scheduling, technology implementation and organizational effectiveness, in which he has published in leading operations and systems journals. His current interests include access and equity in OR/MS education, and digital transformation and optimization of university operations.

FENGLIAN PAN is an assistant professor in the Department of Industrial and Systems Engineering at UNC Charlotte. Her research lies at the intersection of statistics, optimization and simulation, with broad applications in complex systems reliability modeling, healthcare informatics and transportation optimization. Before joining UNC Charlotte, she earned her Ph.D. from the University of Arizona, where she was actively involved in the Arizona Summer Engineering Academy outreach program. She has experience leading both in-person and virtual camps that engage students through hands-on projects, interactive activities and real-world applications across engineering disciplines.

YIFENG WANG is a fourth-year Ph.D. candidate majoring in industrial engineering in the H. Milton Stewart School of Industrial and Systems Engineering at the Georgia Institute of Technology. His research focuses on physics/engineering-informed machine learning for quality control in advanced composite manufacturing and joining systems. Yifeng is actively involved in the academic community by engaging as a program manager to support multiparty communication and session organization in different events.

ZIHAN ZHANG is a Ph.D. candidate in industrial engineering at Georgia Tech. Her research focuses on tensor-based predictive modeling and process control for high-dimensional data. Since 2022, she has co-chaired the INFORMS Education Outreach Committee K-12 Subcommittee, organizing panel sessions at the INFORMS Annual Meeting to advance K-12 education and collaboration within the community. Actively engaged in the professional community, she has served as co-lead editor of *OR/MS Tomorrow* and president of the INFORMS Georgia Tech Student Chapter, which received the Student Chapter Annual Award – Summa Cum Laude under her leadership.

By combining online resources with the connection of in-person events, and directly engaging K-12 students, we are building a vibrant and sustainable pipeline for the next generation of problem-solvers.

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THE ANALYTICS BEHIND FAIRNESS: RETHINKING REVENUE SHARING IN COLLEGE BASEBALL

BY DOMINIC TOSO, COLLIN RADACK AND ZHAOHU (JONATHAN) FAN

A New Era in College Sports

On June 6, 2025, college sports changed forever. A landmark House v. NCAA settlement gave schools like Georgia Tech $20.5 million to allocate to their student-athletes each year. For the first time, athletic departments face a new question: *How do you divide millions of dollars fairly?*

Take baseball as an example. Benchmarked against Texas Tech University, our estimate is that the Georgia Tech baseball program will receive about $400,000. Should star players who excelled in previous seasons earn more? Should every athlete get the same amount? How do you build trust so players believe the process is fair and rooted in merit?

At Georgia Tech, we believe the solution is already in front of us: data. The same information that drives coaching decisions daily can also power a transparent, data-driven revenue sharing model for baseball.

For the first time, athletic departments face a new question: How do you divide millions of dollars fairly?

How Our Collaboration Began

Dominic Toso, a former Division I baseball player, has been passionate about applying data to solve challenges in baseball since completing his playing career at the University of Richmond in 2022. At Bucknell University, where he began his collegiate baseball career, Toso earned Patriot League Second Team All-Conference honors and was named a Collegiate Baseball Freshman All-American (2018) while maintaining dean's list standing and earning a spot on the Patriot League Academic Honor Roll. After transferring to Richmond, he became an Atlantic 10 First Team All-Conference selection (2022); was named to the All-ECAC Team, which recognizes top Division I players on the East Coast; and was a three-time Atlantic 10 Commissioner's Honor Roll honoree (2020-2022).

As a high-level hitter, Toso relied heavily on technologies such as Blast Motion, Rapsodo and Trackman to refine his swing. Working closely with Collin Radack – assistant coach at Richmond and former St. Louis Cardinals draft pick – Toso used data to identify inefficiencies and make targeted adjustments that maximized his performance.

After graduating, Toso joined EAB, an education-technology, services and research firm serving higher education, where he worked as a growth strategies initiative expert. There, he combined market research, Tableau dashboards and case studies to lead enrollment optimization strategies for institutional leaders – an experience that sharpened his understanding of how data can drive business decisions. At the same time, he coached at Ignite Baseball in Arlington, Va., where he learned how to apply technology-driven feedback from a coach's perspective to accelerate player development.

These combined experiences led Toso to approach Dr. Jonathan Fan, a faculty member at Georgia Tech's Scheller College of Business, whose research and teaching focus on data analytics. The two began meeting weekly outside of class to refine the foundations of the Player Growth Index (PGI), fueled by their shared passion for baseball and analytics. Recognizing the need for deeper baseball expertise, Toso invited Radack, his longtime mentor, to join. Radack's expertise in applying performance data to player development added a critical perspective and cemented a strong triple collaboration.

The Athlete's Perspective

As part of a Market Research Tools & Design course in summer 2025, an MBA student at Scheller College of Business interviewed a Georgia Tech athlete about the shift toward revenue sharing. The athlete believes the move toward revenue sharing is one of the most positive developments in college athletics. In his view, the system must be rooted in merit and performance, not hype or manipulation.

Turning Data into Decisions

To meet this challenge, we designed the PGI, a composite score that integrates multiple measures of player value into one metric. Think of it as a GPA for athletes: one number that captures the overall value of a student-athlete.

The PGI combines performance data from widely adopted technologies – such as Trackman, Rapsodo, Blast Motion and Qualisys – with in-game statistics most valued by MLB organizations, physical performance measurables, social media and name, image and likeness (NIL) metrics into a single composite score (0-100).

Every MLB organization already uses these tools to predict player success and support draft decisions. Although Georgia Tech baseball and other Division I programs rely on them daily, their potential to shape a fair revenue sharing framework remains untapped.

Voices from the Field

These technologies are the MLB's gold standard for evaluation. Radack explains:

"*Richmond Baseball uses a wide range of technology to support player development and in-game decision-making. On the hitting side, we utilize Blast, HitTrax, Trackman, Force Plate data and Vizual Edge to track swing data, batted ball metrics, zone recognition and visual training. For pitching, we rely on Trackman, high-speed cameras and arm care technology to monitor health, enhance development and refine pitch design. All of this data is also accessible to MLB scouts, which helps our players gain exposure and increases their chances of getting signed.*"

Radack relies heavily on advanced performance tools to elevate the Richmond baseball program. Since fully integrating data-driven training in 2022, he has turned Richmond's offense into one of the most consistent powerhouses in the Atlantic 10. Under his leadership as hitting coach, the Spiders led the league in batting average in 2022 and 2023 and ranked among the top four in nearly every offensive category in 2024, including home runs, doubles and slugging percentage. His ability to develop award-winning hitters such as Alden Mathes (19th-round draft pick of the Baltimore Orioles), Kyle Schmidt (33rd-round draft pick of the Minnesota Twins) and Brady O'Brien (undrafted free agent signed by the Seattle Mariners) has solidified Richmond as a perennial offensive force.

According to "Reshaping Baseball: The Impact of Analytics and Technology" [1], Rapsodo's sensor technology has dramatically changed how talent is evaluated in NCAA baseball. The authors state: "Rapsodo's affordable systems have democratized access to advanced analytics for mid-tier programs while bridging gaps between collegiate and professional levels" [1]. We believe we can leverage the same data used by MLB organizations to evaluate players' abilities and growth potential. These metrics form the foundation of the Player Growth Index. We expect that Georgia Tech's Athletic Department will leverage this data similar to how MLB organizations do, to justify player valuations.

The Four Pillars of PGI

1. **Advanced Player and On-field Performance:** Metrics such as exit velocity, bat speed, on-base percentage (OBP) and slugging percentage (SLG).
2. **Year-over-Year Development:** Growth over time (e.g., exit velocities, Wins Above Replacement (WAR), barrel percentage).
3. **NIL and Social Media Presence:** Followers, engagement rate, NIL earnings and deals signed.
4. **Physical Performance Metrics:** Mobility, strength and health metrics.

Each factor is scored on a 0-100 scale, weighted by importance and then combined into one PGI score. The result is a transparent framework any coach, administrator or player can understand and trust.

Why It Matters

At its core, revenue sharing is about trust and a system built on merit. Players want fairness, and administrators need transparency. While this example focuses on baseball, the framework can extend to any sport. With the right metrics, athletic departments like Georgia Tech's can enter this new era of athlete compensation with confidence, integrity and clarity.

The PGI will help Georgia Tech identify and reward players who deliver the greatest value to the program. It highlights athletes who not only contribute to wins but also boost attendance, ticket sales and revenue. This gives the athletic department a data-driven way to invest in players who strengthen the school's brand, maximize return on NIL dollars and fairly allocate resources to those creating the most impact.

DOMINIC TOSO (dtoso3@gatech.edu) is a first-year MBA student at Georgia Tech's Scheller College of Business, concentrating in Strategy & Innovation and Business Analytics. A former Division I baseball player, he was a Freshman All-American in 2019 at Bucknell University and earned additional accolades at the University of Richmond, where he served as team captain. He majored in PPEL (Politics, Philosophy, Economics, and Law) at Richmond.

COLLIN RADACK (cradack@richmond.edu) is an assistant coach for the University of Richmond Baseball program, former All-American at Hendrix College and MLB draft pick for the St. Louis Cardinals.

ZHAOHU (JONATHAN) FAN (jonathan.fan@scheller.gatech.edu) is a lecturer of information technology management at the Scheller College of Business, Georgia Tech.

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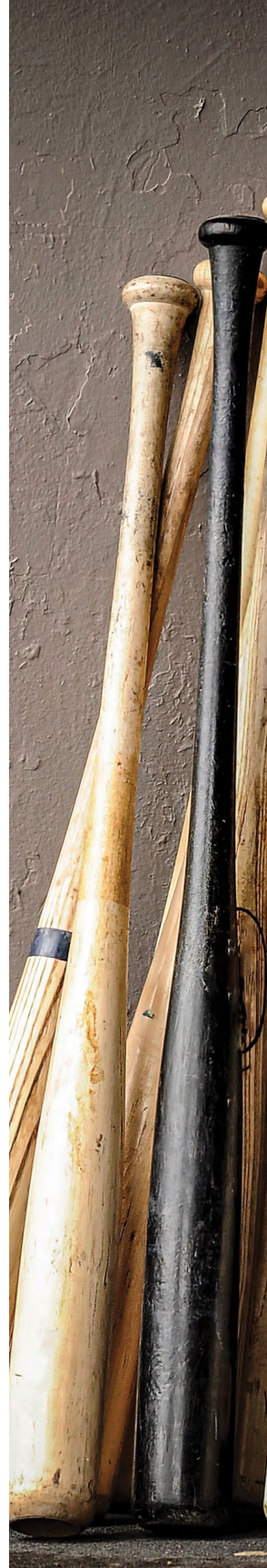


Robin Lougee speaks at the ECPN 20th anniversary celebration during the 2025 INFORMS Analytics+ Conference in Indianapolis.

INFORMS EARLY CAREER PROFESSIONALS' NETWORK (ECPN) TURNS 20!

BY ROBIN LOUGEE, SUBBU NARAYANASWAMY, QINGLIN DUAN AND HEATHER MOE

THE EARLY CAREER PROFESSIONALS' Network (ECPN) is INFORMS' premier program for supporting early-career practitioners launching careers in analytics, operations research and related fields in business, industry and government. Open to new or recent graduates of analytics, operations research or related programs, ECPN is a selective program designed for beginning professionals by experienced leaders. Participation in ECPN provides a means for budding practitioners to leverage the hard-won lessons of established analytics professionals, gain an edge by complementing their technical training with exposure to nontechnical career dimensions that can derail the best analytics talent, receive one-on-one coaching, and establish their professional identities through unparalleled face-to-face networking across industry sectors and career stages. Dating from the inauguration of its predecessor, the INFORMS Professional Colloquium (IPC) in 2005, the ECPN celebrated its 20th anniversary in 2025 – complete with cake and a special session, "Growing Together: Two Decades of ECPN Shaping Analytics Leaders," at the 2025 INFORMS Analytics+ Conference in Indianapolis, Ind.

Mission of the INFORMS ECPN

- Aid new and recent graduates to transition to successful and resilient real-world careers
- Foster professional identities by providing networking and mentorship opportunities with established practitioners and career-stage peers
- Facilitate the connection of early-career professionals with the practice community and resources available from INFORMS to support ongoing career growth
- Strengthen INFORMS by creating a pipeline of active members and future leaders who sustain and grow the larger INFORMS community

"*The INFORMS Professional Colloquium [now ECPN] is an all-around analytics experience. You are provided with the opportunity to interact with highly regarded experts in diverse fields of analytics, from groundbreaking research to managerial experts. Furthermore, the small size of the group gives you the chance to closely interact with speakers and have one-to-one sessions with a senior mentor, assigned based on your interest and experience. It provides a unique chance to meet and network with peers from the best analytics programs in the country and exchange ideas, questions and contacts.*"
– Jose Eduardo Oros, M.S., Pandora

Origins of ECPN

The ECPN was officially established in 2018 when the then-chair of the IPC, Alan Briggs, CAP-X, led the effort to merge the IPC with Early Career Connection (ECC), two events both held in conjunction with what is now the Analytics+ Conference, which addressed different early-career audiences.

> "The IPC was a one-day workshop to help the top practice-oriented O.R. graduate students successfully transition to life in industry. (Attendance by nomination only.) Today, only a small fraction of the M.S. students graduating from O.R.-related programs join INFORMS. The IPC aims to build connections between industry and academia by reaching out to students on the verge of becoming professionals, especially M.S.-level students. Based on the results of the long-running INFORMS Combined Colloquium for Ph.D. students, I believe that the networking opportunities and positive experience of IPC will lead to lasting associations with INFORMS and the rich community it serves. The IPC program focuses on skills for business success, with a mix of hands-on activities, presentations, panel discussions and networking events. IPC participants are automatically registered in the INFORMS Practice [Analytics+] Conference. The combination of the two programs gives attendees an array of perspectives and opportunities for exchange that is difficult to come by elsewhere. While the premise of the IPC is sound, its success depends on a student's ability to travel. Funding M.S.-level students to workshops is not a tradition in many schools or for many corporate sponsors. It is clear that we need to address this funding problem. The IPC is an opportunity for the O.R. community to invest in building the interface upon which the vitality of the profession depends."
>
> **– Richard Larson**

The ECC was established in 2013 as a revamping of the Young Researchers Connection (YRC), which was initiated by the late Richard E. Rosenthal for early-career academics [1]. The ECC was described as a special program of events geared to facilitate networking and introduce new perspectives into some of the most critical problems facing industry. The ECC included a special meet-and-greet reception before the Analytics Conference began, an introduction to the entire conference before the first plenary on Monday morning, and various meetups at meals and sessions throughout the meeting, giving participants the opportunity to touch base with one another, conference organizers, vendors and some leaders in the field. The ECC program was designed to help participants enjoy the conference and maximize its benefits. It was open to researchers from both academia and industry [1].

The IPC was established in 2005 by a committee spearheaded by Robin Lougee, building on a suggestion by Sanjay Saigal [2]. Then-president of INFORMS Richard Larson described the program in the quote above[3].

Strategic Partnership with the INFORMS Practice Section

In 2021, the INFORMS Practice Section and ECPN formed a strategic partnership plan. Since its inception as the IPC, the Practice Section has been a supporter and financial sponsor of the ECPN program. Given the shared goals of supporting and growing the practice community, nine opportunities were approved as a starting point to strengthen collaboration between ECPN and the Practice Section for their mutual benefit. Strategic items included:

- Create a standing position on the Practice Section Board for the ECPN chair.
- Invite the ECPN chair to give updates at the monthly Practice Section board meetings so that board members can provide assistance and guidance at key points.
- Establish a multiyear sponsorship to provide greater financial stability for the ECPN and reduce approval workloads for the Practice Section.
- Provide free one-year membership to the Practice Section for all current-year ECPN participants.

INFORMS ECPN Today

The ECPN continues to evolve and improve each year, based on feedback from participants and committee members. The workshop held on the Sunday of the Analytics+ Conference emphasizes experiential learning and connection through elements including:

- Coffee/tea with the 2025 INFORMS President
- Hands-on role-play exercise (introduced in the first IPC, it remains one of the program's most highly rated features)
- One-on-one speed mentoring
- Networking lunch
- Interactive elevator speech practice

What ECPN Attendees Find Most Valuable

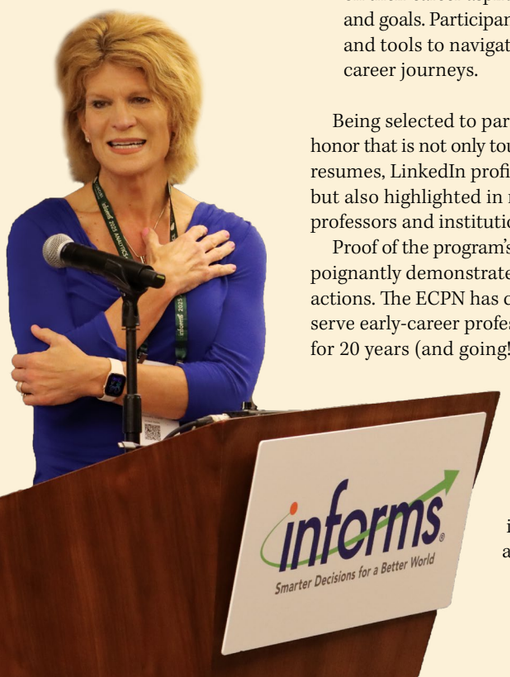
The ECPN has supported hundreds of early-career professionals, many of whom now hold leadership roles today. Alumni testimonials on the 2025 ECPN website highlight the program's impact in building confidence, networks and career clarity:

- Jose Eduardo Oros: Gained peer support and industry connections
- Yulia Vorotyntseva: Broadened career perspectives and made valuable connections
- Nitish Ghosal: Developed networking skills and gained career insights

Perspectives by four 2025 ECPN attendees, Uthman Kareem, Aashi Sharma, Jiaqi (Priscilla) Yang and Ziqi (April) Zhao, to appear in an upcoming issue of *OR/MS Tomorrow* shared five common themes.

- **Confidence and belonging.** ECPN helps participants feel more prepared, capable and empowered in their early careers. Participants leave the event feeling more validated, capable and part of a professional community.
- **Mentorship and networking.** ECPN fosters a supportive, inclusive community that reduces isolation and builds professional relationships. Strong personal connections with mentors and peers make a lasting impact.
- **Real-world exposure.** ECPN demystifies industry expectations and prepares participants to succeed in practice-oriented roles.
- **Interactive learning.** The experiential design and participatory format of ECPN fosters deeper understanding and skill development. Role-plays, mentoring and workshops offer engaging, hands-on growth experiences.
- **Career insight.** ECPN helps attendees reflect on their career aspirations and align their skills and goals. Participants gain clarity, inspiration and tools to navigate the next steps in their career journeys.

Julie Hunter speaks at the ECPN 20th anniversary celebration during the 2025 INFORMS Analytics+ Conference.



Being selected to participate in the ECPN is an honor that is not only touted by individuals on their resumes, LinkedIn profiles and other social media but also highlighted in materials by nominating professors and institutions.

Proof of the program's value is perhaps most poignantly demonstrated not in quotes but in actions. The ECPN has continued to evolve and serve early-career professionals consecutively for 20 years (and going!) thanks in large part to the passion of past participants who return as volunteers to share their time, energy and experience. For example, 2025 Co-chair Heather Moe is a past ECPN participant, as is the 2026 ECPN chair, Subbu Narayaswamy. The 2026 Analytics+ Conference chair, Zohar Strinka, CAP-X, is an ECPN alumni. 2025 Co-chair Qinglin Duan passionately embraced the mission after being inspired by ECPN alumni and 2013-2014 ECPN Chair Shrikant Jarugumilli.

2025 ECPN Committee

- Heather Moe (Esri), Co-chair
- Qinglin Duan (Bayer Crop Science), Co-chair
- Subbu Narayanaswamy (Wells Fargo)
- Kenza Choukry (IQS Research)
- Robin Lougee (INFORMS VP Practice)
- Anna Galloway (INFORMS Education & Industry Programs Coordinator)

We congratulate INFORMS and the ECPN for two decades of success. We thank all the participants, committee members and sponsors from the past 20 years and look forward to decades more of sharing insights and best practices with the early-career practitioner community.

If you are interested in attending the 2026 ECPN or know someone who could benefit from this unique opportunity, consider applying or nominating a candidate [4]. The 2026 ECPN will be held on Sunday, April 12, 2026, in conjunction with the 2026 INFORMS Analytics+ Conference at the Gaylord National Resort and Convention Center at National Harbor.

You can also sponsor a rising star. Travel costs are often a limiting factor for early-career attendees thinking of applying to the ECPN. If you would like to help support early-career professionals, visit https://tinyurl.com/supportECPN to donate. All of the funds raised at this site go directly to ECPN attendees to defray the cost of travel.

If you are interested in participating in, organizing or sponsoring the ECPN, please reach out to ecpn@mail.informs.org.

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QINGLIN DUAN is Lead Data Scientist at Bayer Crop Science and the 2025 ECPN Co-chair.

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THE INFORMS ANALYTICS FRAMEWORK™: A ROAD MAP FOR SUCCESS WITH ANALYTICS

BY IRV LUSTIG, CAP-X, AND JOHAN BOS-BEIJER

THE INFORMS ANALYTICS FRAMEWORK™ is a comprehensive structure designed to guide practitioners at any level through the entire life cycle of analytics initiatives, from initial business concept to sustained, value-delivering operations. It stands as a critical reminder that a successful analytics solution is much more than a well-written mathematical model or creative software solutions. The Framework provides repeatable practices and methods to avoid pitfalls and realize successful achievement. Exceptional, reliable and trustworthy analytics efforts require the incorporation of excellent communication across all team elements – engagement strategies, common understandable objectives, disciplined use of analytics and most importantly, clear agreed-upon problem (question) framing. A common theme throughout the Framework is the constant connection to the business objectives in activities within each domain.

Developed from the original 2013 Certified Analytics Professional (CAP®) Job Task Analysis, the Framework was substantially updated and rebranded in 2024 to support the full spectrum of modern analytics, from simple dashboards and machine learning (ML) to complex optimization and artificial intelligence (AI) initiatives. This Framework now serves as the foundation for the new three tiers of the CAP exam (Essentials, Pro and Expert) and is widely used in industry, public sector and academic settings to ensure that applications of analytics deliver genuine business impact value.

The Framework comprises seven sequential yet highly iterative domains. Uncovering issues in a later domain (such as the Data domain), or having to start in a different domain by necessity, often requires circling back to refine earlier domains (such as Business Problem Framing).

The Seven Domains of the INFORMS Analytics Framework

1. Business Problem Framing

Any application of analytics must begin with a clear, concise statement describing the business problem or question, not a technical one. The goal is to ensure that analytics is being applied to solve the right challenge for the organization.

- **Problem Statement and Stakeholder Identification:** Develop an initial statement of the problem or question, and identify all stakeholders, sponsors and beneficiaries who will be affected by or responsible for the solution.
- **Amenability Check:** Determine whether the problem or opportunity is truly amenable to an analytics solution. Many problems initially presented as analytics challenges are, in fact, solvable only by addressing underlying business process problems. If processes or data collection is inadequate, analytics must pause and be reevaluated until those issues are resolved.
- **Business Case Creation:** Refine the problem statement until it is clear and concise; then, develop a business case. This includes defining the cost of the solution (e.g., software licenses, cloud resources, database setup, data acquisition), expected benefits and organizational effects, including any changes required for the solution to be adopted and used.
- **Sponsor and Stakeholder Agreement:** Secure full agreement from sponsors and key stakeholders on the problem to be solved before any modeling work begins.

2. Analytics Problem Framing

This domain translates the agreed-upon business problem into an actionable analytical structure.

- **Reframing:** Convert the business problem statement into an analytics problem statement (e.g., "This is an optimization problem" or "This is a classification problem"). This is done at a business level, defining the constraints, decisions and objectives, but without writing any mathematical formulas or developing any software.
- **Drivers, Inputs and Assumptions:** Define, conceptually, the key drivers and inputs (e.g., fuel costs, traffic) that will inform the model and the required outputs. Clearly state any necessary assumptions (including realistic constraints) required to make the analytics applicable, because these may limit the scope of the solution.
- **Key Performance Measures and Baseline Performance:** Define the primary measures of success from an analytical standpoint (how success is measured with numbers or key indicators). Crucially, establish the baseline performance – the current measurable quality of decisions or processes that the new solution must surpass or present to demonstrate value.

- **Risk and Agreement:** Identify initial risks to the analytics effort (e.g., uncertainty about data availability, resource constraints) and secure stakeholder agreement on the analytics approach chosen to solve the business problem.

3. Data

Data preparation is the most time-consuming domain and, frequently, most of the effort in leveraging analytics to deliver business value. A data-first approach is essential because data quality issues can invalidate even the best models.

- **Needs, Sources and Management:** Determine the specific data needed to represent the conceptual drivers and inputs. Identify sources and their structure (tables, streaming, etc.). Develop a management plan for how data will evolve, whether it will be resident or transported for use, and how it will be maintained over time, as well as a plan for data accessibility controls.
- **Acquisition and Cleaning:** Acquire the data, including a robust test set. The bulk of the work involves cleaning, harmonizing, validating and ensuring consistency across all data points and tables.
- **Documentation:** Create a comprehensive data document listing all tables, columns, relationships, use constraints, owners and data assumptions. This serves as a vital reference for the entire team.
- **Iteration:** The findings from data analysis often expose initial flawed assumptions, requiring the team to loop back to update and validate the business and analytics problem statements.

4. Methodology Approach

With the problem defined and the data understood, the next step is selecting the appropriate analytics methodology.

- **Method Selection:** Determine the appropriate analytical techniques (e.g., linear programming, heuristics, specific machine learning algorithms) and select the best one based on available resources, team capabilities, policies and data.
- **Architecture and Technology Stack:** Define the solution technical architecture: how data will link to the model, where the solution will be deployed (e.g., cloud) and how updates will occur. Consider the environments in which the analytics solution will be developed, tested, operationalized (production) and backed up for disaster recovery. What kind of user interface is required? Then, select the specific technology stack.

5. Model Building and Evaluation

Although technically the core, this domain is often only 10%-15% of the total time spent when applying analytics.

- **Design and Structure:** Design and build one or more models. Sometimes, multiple models interact or are being compared. One best practice is to write out the mathematical representation of a model before developing any part of a software solution.
- **Validation and Trust:** Run the model, evaluate its performance against the analytics measures and get user feedback to ensure the solutions make sense. To establish trust, build user interfaces that allow business users to evaluate the solutions and provide feedback.
- **Documentation:** Write thorough documentation about the model's performance, assumptions, limitations and value.

6. Deployment

Deployment is a two-pronged effort with technical implementation and organizational adoption.

- **Technical Deployment:** Stand up the technical application, which may be an operational system running 24/7 (e.g., solving a problem every five minutes), real-time action indicators or a strategic report generator.
- **Business Deployment and Validation:** Deploy the new decision-making process into the business. This involves ensuring that people are trained on various aspects of the solution, which helps build trust and institutional knowledge in that solution. Obtain a business validation report and stakeholder agreement that the solution is meeting the needs of the business and is ready for use.
- **Implementation Support:** Analytics professionals must support the final implementation and testing to verify that the deployed solution is working correctly and that data is flowing reliably once it enters live production.

7. Solution Life Cycle Management

A successful solution requires perpetual care to continue delivering value.

- **Performance Tracking and Recalibration:** Continually track the solution's performance and whether it continues to deliver business value. Be ready to recalibrate models to prevent model drift as business constraints, data streams or external factors change over time.
- **Side Effects and Organizational Change:** Continuously validate the business case and manage the solution's side effects. Dynamic adaptability is critical to successful analytics.
- **Training and Documentation:** Support training activities for end users and ensure thorough knowledge transfer to internal teams. Maintain complete, up-to-date documentation so the solution remains supportable and evolves with the business.

Tasks of the INFORMS Analytics Framework

The team that created the new INFORMS Analytics Framework was also responsible for defining testing objectives for each of the three new levels of the CAP certification. These testing objectives are termed the "blueprints" for each level of the exam. Each of the testing objectives is associated with specific tasks within each of the domains. Whether as part of a specific analytics project or any other investigation into whether analytics is applicable to a business problem, these tasks, summarized above, should be considered to ensure analytics success. The Framework can become an essential component of operational excellence and the structure by which successful analytics efforts are approached and maintained. We recommend downloading the complete INFORMS Analytics Framework for a deeper dive into the specific details.

For more information about the INFORMS Analytics Framework, please visit informs.org/analyticsframework.

Acknowledgment

We would like to acknowledge the work of our colleagues who spent many hours in 2024 to define the detailed examination criteria in the blueprints that led to the new framework development. These colleagues are Shannon Browning, Arnie Greenland, Mehran Hojati, Thor Osborn, Zohar Strinka and Nick Ulmer (all CAP-X certified).

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THE INFORMS AMBASSADORS PROGRAM: A BRIEF HISTORY AND PERSPECTIVES FOR THE FUTURE

BY CHRYSAFIS VOGIATZIS AND BANAFSHEH BEZHAD

INFORMS: Smarter Decisions for a Better World

The world (in the form of our society), the environment around us and the systems we build have been the focus of INFORMS since its inception. INFORMS, as the premier professional society for operations research (O.R.) and the management sciences, has put societal good front and center in its mission throughout the years: A brief study of the current strategic plan immediately reveals its mission of "advancing and promoting the science and technology of decision making" to help create a more "just, prosperous, and sustainable world."

"World" is a key term here. INFORMS members, with their actions in the profession, at academic institutions and in governance, aim to improve the systems around us. Doing Good with Good O.R. is a competition that goes back to 2009 and celebrates the practice of operations research to help create a better world; Public and Societal Operations Research (PSOR) (formerly Public Sector Operations Research) is a section of INFORMS, also dating back to 2009, that has celebrated community O.R. and advancing theory and knowledge in decision-making for all humanity. The INFORMS Ambassador Program (formerly INFORMS DEI Ambassadors Program) is a more recent addition to this elite group of helping communities with the power of operations research. Established in 2019, and having its first cohort in 2020, the INFORMS Ambassadors Program has been a staple of improving the way we do things in the profession, industry, academia and INFORMS, creating communities of practice and new programs.

INFORMS Ambassadors Program

The program aims to provide funding, means and support to INFORMS members who have an idea about initiatives that improve our community outreach. This involves a diverse array of areas, including in the profession (in the workspace), in teaching and research within academic institutions (e.g., improving retention of students and creating more readily accessible and relevant materials), in the building of new communities and improvement of existing communities of practice, and, of course, in the improvement of INFORMS from within. The program is open to any INFORMS professional member, including staff, students, practitioners and academicians, and celebrates the unique capacities and capabilities that each set of members brings to the table. This is immediately visible from the wide variety of projects that have been supported throughout the years, which have brought together different groups with unique perspectives, building unique initiatives.

From a logistical perspective, the Ambassadors Program is announced in late October or early November every year through a call for proposals. The proposals are typically submitted by mid-December and are then evaluated by a panel of INFORMS members who are changed and rotated each year to ensure fairness. If awarded, projects can begin their work in January for one year. What types of projects are supported, and what makes them unique in our professional society?

A Retrospective of the INFORMS Ambassadors Program

Since 2020, the first cohort of the program, a whopping 58 projects have been supported by the Ambassadors Program. A classification of the programs performed by the former INFORMS Diversity, Equity, and Inclusion Committee (DEIC) found that a wide variety of topics were covered, and they can be broadly classified into the following categories:

1. Education and student outreach programs
2. Quantification and improvement of community outreach in academia and industry
3. Community building and empowerment
4. Research with a lens to fairness and justice
5. Professional development and mentorship programs
6. INFORMS organizational initiatives

The Ambassadors Program has led to the creation of new sections and forums within INFORMS; the celebration of research with a lens to helping and improving society through new awards; the creation of more accessible, relevant and modern teaching tools and materials; and improvement in how our professional society interacts with society at large. In only five years, the Ambassadors Program has had a lasting impact on INFORMS, creating a better, safer and smarter society for all of our members.

Among the first cohort of programs, the LGBTQ Community Building project set up the first steps for creating the INFORMS PRIDE Forum, a forum for all members of INFORMS who identify as LGBTQIA+ or allies. We also saw an INFORMS introspection with an analysis of INFORMS journals' editorial boards, an analytics journey to establishing how INFORMS can broaden the participation in editorial boards across all of its members. INFORMS en Español proposed and established a series of online seminar lectures for members who communicate in Spanish; seeing as the project coincided with the onset of COVID-19 and the transition to online education for many higher education institutions, this program attracted wide audiences and built numerous collaborations. The main focus of the 2020 cohort was serving populations and communities that have not always been as present in INFORMS, and it has remained a central pillar of the Ambassadors Program since then.

The next two years saw programs that built on their initial successes (broadening the PRIDE Forum and establishing programming at the INFORMS Annual Meeting, continuing the exploration of editorial board membership, reaching out to minority-serving institutions) and brought about a new set of programs focusing on accessibility within INFORMS, mentorship of groups that have not been traditionally well mentored (such as mid-career faculty) and new connections with local schools. For example, "To My Younger Self" established a mentoring workshop for women Ph.D. students and has remained a staple within INFORMS, increasing in popularity each year because of its outcomes and successes. We also established the first DEI Student Paper Competition, which received approximately 50 submissions annually and concluded in 2025.

In 2023 and 2024, alongside the traditional themes that the Ambassadors Program was becoming increasingly known for, we saw some newer initiatives aimed at establishing new pedagogy for OR/MS, new case studies and problems motivated by modern and culturally relevant issues, and even more K-12 outreach activities. We also continued to support programs that improved mentorship within and outside INFORMS (such as WELL INFORMED). The most recent cohort is no exception: Programs that advance belonging for OR/MS students in business and analytics, empowerment of student engagement and understanding of OR/MS, and advances in K-12 outreach were among the programs funded.

Future Avenues

INFORMS has a unique opportunity to build on the momentum: At a time when the society around us questions some of the initiatives that focus on community engagement and empowerment, we have a unique set of members that can help tie the outcomes of these programs to real-life improvements that can be felt by society at large. Operations research and the management sciences, in the form of modern decision-making, is a unique intersection of disciplines that also "talks" to modern societies because its stated goal is to improve their services and performance (healthcare and transportation, governance and justice, supply chain management and sustainability, etc.). As OR/MS and analytics practitioners, academicians, and advocates, we have a duty to continue promoting our tools and techniques for the improvement and empowerment of the communities around us.

Many INFORMS members have been participating in very useful conversations and actions within their environments and organizations that involve fostering an environment that values engagement and collaboration. These "best practices" that our members have been developing, refining and updating for years are invaluable to our community. Future Ambassadors will be asked to continue quantifying the "state of our profession" and how to best accommodate the INFORMS members of the future. Ambassadors will also be called upon to lead efforts to ensure everyone can access OR/MS tools and techniques, as well as the tools to succeed and thrive through mentorship and individualized guidance.

With the rise of artificial intelligence (AI) and its inherent interaction with OR/MS, we have another unique opportunity ahead to build communities that understand the advantages and disadvantages of AI in modern decision-making. INFORMS should not give away this leadership position and should build on more community outreach and education to improve the way that AI complements our societal systems. As modern higher education institutions broaden access to OR/MS education (i.e., more professional programs offered or better technology available for online learning), we have the responsibility to bring OR/MS to more students from widely different backgrounds and with widely different life experiences. Ensuring how to maintain academic excellence without compromising the student experience is a key part of community empowerment that future INFORMS Ambassadors will be called to address.

For more information about the INFORMS Ambassadors Program, visit https://connect.informs.org/informscommunity/ambassador-program.

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GOVERNMENT, INDUSTRY AND ACADEMIA COLLABORATION: VIRGINIA'S CCALS MODEL

BY THE HON. KAREN R. JACKSON

Meeting the Collaboration Challenge

For years, I have seen first-hand the untapped potential that exists when students, faculty, industry leaders and the public sector work closely together. During my time as Virginia's secretary of technology, I observed that while each group brought tremendous talent, resources and expertise to the table, too often they operated in parallel rather than in concert. Opportunities for multi-university teaming for students to apply their skills to real-world problems were limited. Industry sought innovation and early engagement with the future workforce but often struggled to navigate academic processes. Public agencies often sought affordable, accessible resources to provide insight into challenging problems, evaluate new technologies and markets, or advance policy goals. However, they lacked the sustained engagement to bring all the right voices together early in the process.

Closing these gaps has been a consistent theme throughout my career. I have worked to further opportunities for collaboration because I believe – and have repeatedly seen – that aligning these communities delivers better solutions, stronger talent pipelines and greater impact.

When I was invited to join the Commonwealth Center for Advanced Logistics Systems (CCALS), I already knew of their work. What I didn't fully appreciate at the time was the uniqueness of the CCALS model and the opportunities it creates. This is not just another research consortium – it is a deliberately designed collaboration engine that unites five universities, industry partners and public sector agencies to tackle projects of statewide and national significance.

Since joining CCALS, I have seen this model strengthened in meaningful ways. We established a business advisory council to deepen and formalize engagement with industry, ensuring that projects are informed not just by companies but also by individual experts who bring specialized perspectives. We expanded our partnerships with commonwealth agencies, including the Virginia Tobacco Region Revitalization Commission, Virginia Department of Aviation and the Virginia Economic Development Partnership, aligning our research with the Commonwealth's strategic priorities. We grew a portfolio of projects that blend technical innovation with market awareness and policy alignment, demonstrating that collaboration is not just possible – it is powerful.

Bridging the Gap Between Academia and Industry

CCALS represents a distinctly Virginian approach to solving complex, real-world challenges – one that blends academic research, industry insight and public sector strategy into a single, mission-driven effort. At its foundation are five leading universities (Virginia State University, Virginia Commonwealth University, Longwood University, Old Dominion University and the University of Virginia) working together to pool expertise, facilities and student talent.

Industry engagement comes through our business advisory council, which ensures that market realities and urgent challenges shape every project from the outset. Public agencies contribute both strategic priorities and policy context, helping align our work with infrastructure needs, workforce demands and regional development goals. CCALS serves as the bridge that connects these communities, creating a neutral space in which collaboration can flourish free of silos or competitive barriers. The result is a model that produces solutions that are technically sound, economically viable and socially beneficial.

Why Cross-Sector Collaboration Works

At CCALS, success stems from the way multiple perspectives are woven together. Universities contribute their research excellence, specialized facilities and a steady stream of students eager to put theory into practice. Industry brings market awareness, operational know-how and the urgency that comes from competing in global markets. Public agencies provide the strategic direction and policy frameworks that ensure solutions are aligned with the Commonwealth's long-term interests.

Because CCALS is not tied to a single campus, company or agency, it can act as a neutral convenor and trusted partner. This neutrality allows us to form multi-university teams that work seamlessly with industry and government, concentrating on shared goals rather than institutional boundaries. Together, these collaborations deliver outcomes that go beyond what any one entity could achieve on its own.

Projects with Impact

The strength of this model is best demonstrated through the projects we've undertaken. Each reflects the interplay of academic expertise, industry engagement and public sector priorities –and each has produced insights with broad implications.

One example is our work exploring hydrogen-hybrid applications in southern Virginia. Here, a multi-university team evaluated how hydrogen and hybrid systems could meet critical energy and transportation needs. The project did more than assess technical feasibility. It also examined market adoption, regulatory readiness and economic drivers, ensuring that recommendations were grounded in both engineering realities and the broader context in which adoption would occur.

Another project focused on baselining Virginia's logistics capabilities. By mapping current strengths, identifying bottlenecks and highlighting emerging opportunities, CCALS provided guidance that is now helping inform investments in infrastructure, workforce and technology. This work also gave state leaders a clearer picture of where resources could make the greatest impact.

Our research into securing supply chains demonstrated the importance of collaboration across sectors. By bringing together academic researchers, industry partners and public agencies, we identified vulnerabilities and proposed strategies for resilience that accounted not only for technical concerns but also policy considerations, trade dynamics and security regulations.

Finally, our efforts in unmanned systems and multimodal planning illustrate how emerging technologies must be developed alongside regulatory awareness. We examined how unmanned aerial vehicles and autonomous ground transport could improve safety and efficiency, while simultaneously considering the evolving frameworks that will govern their deployment.

In each of these cases, the collaborative model has ensured that research is not just theoretical but immediately relevant and actionable.

Reflections on Student Engagement and Learning Outcomes

Although the formal outcomes of CCALS' projects are measured in deliverables, reports and presentations, some of the most lasting results can be seen in the students who participated. Their experiences went far beyond classroom learning. Many developed a deeper understanding of local, state and federal geographic, economic and strategic priorities, gaining an appreciation for the distinct needs and opportunities of individual regions, organizations and agencies.

The students also came to see how the acceptance and advancement of technologies such as hydrogen is shaped not just by scientific possibility but also by economic forces, stakeholder needs, and the federal and state policy environments. They learned to weigh feasibility against impact, not only asking whether a particular technology could work but examining its potential "practical" benefits to industries, communities and economies. Just as importantly, they gained first-hand exposure to how policy frameworks at the federal, state and local levels influence the pace and direction of innovation and adoption.

For many students, this is their first experience working in a collaborative, interdisciplinary, outcome-driven environment that crossed institutional and sectoral lines. These "trial-by-fire" opportunities require students to communicate effectively (most of the multi-university projects are virtual), navigate competing priorities, face real deadlines and work through complex challenges. In doing so, they acquire "real-life" experiences and perspectives that will shape them – and perhaps their careers – for years to come.

Looking Ahead

As supply chains, energy systems and transportation networks become more interconnected and dependent on advanced technology, the need for policy-informed innovation will continue to grow. CCALS' collaborative, multi-university, nonprofit model is not simply a structure – it is a strategy for meeting these needs head-on.

By continuing to bridge academia, industry and the ever-evolving global policy ecosystem, we can accelerate innovation, strengthen resilience and prepare a workforce ready to lead in a rapidly changing world. The work done at CCALS is grounded in the principle that collaboration is not just beneficial – it is essential. Whether teams are helping to secure critical supply chains, exploring the potential of hydrogen-hybrid systems for next-gen aviation applications, modeling Virginia's role in the provisioning of sustainable/synthetic aviation fuels or baselining the state's logistics capabilities, CCALS remains committed to delivering solutions that matter.

Together, these collaborations deliver outcomes that go beyond what any one entity could achieve on its own.

THE HONORABLE KAREN R. JACKSON served as Virginia's Deputy Secretary of Technology from 2009-2014 and Secretary of Technology for the Commonwealth from 2014-2019. During her time in public service, she concentrated on advancing the development and adoption of technologies including broadband, autonomous systems, cloud computing, cybersecurity and data analytics. She also oversaw Virginia's IT infrastructure and was a staunch supporter of STEM programming.

Jackson currently serves as a senior fellow at the Commonwealth Center for Advanced Logistics Systems (CCALS), a state-funded (nonprofit), five-university consortium where she provides leadership on state government-related matters, relationship development, and emerging logistics technologies and applications such as optimization, autonomy, cyber, AI and supply chain resilience.

She holds a B.S. in business administration from Christopher Newport University and an MBA from William & Mary.

NAVIGATING THE INTERSECTION: A DATA SCIENTIST'S PERSPECTIVE ON INDUSTRY-ACADEMIC PARTNERSHIPS

THIS Q&A FEATURES AN INTERVIEW WITH Raghad Alkhawaldeh, a Ph.D. in industrial and systems engineering from Binghamton University with a robust academic foundation. Raghad's dissertation focused on innovative approaches to handle missing data in healthcare machine learning models and how that impacts moving models from theory to practice showcasing her commitment to impactful research. She has several years of experience in data science, significantly contributing to various fields, including healthcare, logistics and consumer goods. Currently serving as a senior data scientist at Procter & Gamble, Raghad is a leader of integrating artificial intelligence (AI) and machine learning to revolutionize consumer engagement and optimize marketing strategies. Her previous roles include leading data science projects at ChristianaCare Health Systems, where she improved patient care metrics through advanced predictive modeling. Raghad is passionate about mentoring the next generation of data professionals, actively engaging with students through her involvement in various speaking engagements at different universities. This interview dives into her career journey, insights on the data science landscape and advice for early-career professionals eager to make their mark in this dynamic field.

To start off, can you share some of the internships or research assistantships you have completed in the past? Was there one that stood out as particularly crucial to your career development?

Raghad Alkhawaldeh: Thank you for having me! Throughout my academic journey, I have had several internships and research assistantships that have shaped my professional path. One that stands out is my experience at ChristianaCare Health Systems, where I served as data scientist. At the time, I was studying for my Ph.D. (first year) in industrial and systems engineering. This role was pivotal because it gave me the opportunity to collaborate with individuals with varying professional backgrounds, and it allowed me to apply and enhance my technical skills in a real-world setting, working directly to improve patient care through data science.

Can you elaborate on your experience at ChristianaCare and the projects you worked on there?

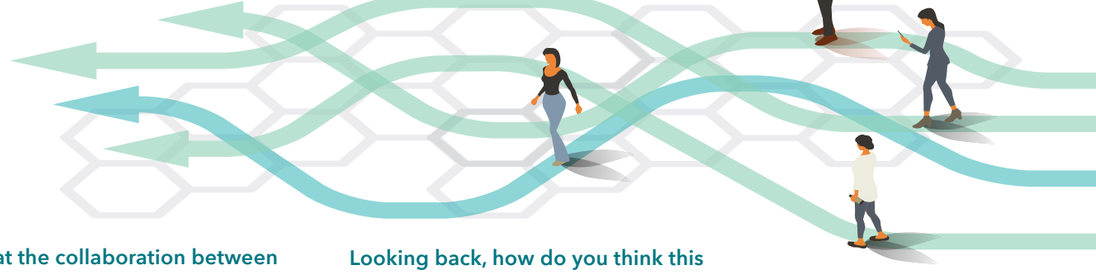
Raghad: Certainly! At ChristianaCare, I was involved in various projects aimed at enhancing patient outcomes through predictive modeling and data analytics. I was a team member of the Organizational Excellence department, and I collaborated with cross-functional teams to solve problems. A significant project I led was the development of a predictive model to reduce hospital readmissions for oncology patients. The goal was to proactively identify high-risk patients before their discharge and implement targeted interventions to mitigate readmission rates.

What inspired this project, and what were the main objectives?

Raghad: The main inspiration came from recognizing that readmissions are not only costly for the healthcare system but also distressing for patients and their families. The project aimed to enhance discharge planning and ensure a smooth transition from inpatient to outpatient care. By identifying high-risk patients, we could prioritize their needs and improve communication within the care team.

Can you tell us about the team that worked on this project and how you collaborated to achieve the project goals?

Raghad: The project was a collaborative effort involving a multidisciplinary team of oncology clinicians, data scientists and performance improvement experts. Each member brought unique expertise to the table, which was essential for the project's success. We held regular meetings to discuss data analysis results, share insights and refine our approach. Through our collaboration, we successfully developed and implemented the predictive model, which led to a reduction in readmission rates – from 34% to 24% for the overall patient population and from 45% to 29% for high-risk patients. Additionally, we improved communication strategies and discharge planning, which was crucial in ensuring that patients received the support they needed post discharge.



It seems that the collaboration between data scientists and healthcare professionals was crucial. How did this collaboration benefit both the hospital and your professional development?

Raghad: Absolutely, collaboration was key. For the hospital, utilizing data science techniques translated into identifying high-risk patients ahead of time to intervene and avoid readmissions, when possible, and it also resulted in efficient resource allocation and improved patient outcomes. Additionally, the clinicians on my team became familiar with how predictive models work, which helped them feel more comfortable discussing technical metrics such as confusion matrix metrics. For example, we would analyze false negatives together and ask questions like, "How can we better predict these patients next time?" This collaborative environment fostered a deeper understanding of the model's implications on patient care.

For me, it was an invaluable learning experience. I gained practical skills in applying theoretical concepts to real-world challenges. I enriched my experience in team leading and collaborating with multidisciplinary teams and, most importantly, gained the skill of interpreting machine learning models to nontechnical audiences. I also had the opportunity to mentor graduate student interns, which enhanced my leadership skills and deepened my understanding of the field.

What were some key learnings from this project?

Raghad: One of the most significant lessons was the importance of thinking beyond just model building. As a junior data scientist, I learned how to transition a model into operational use and integrate it into the workflows of clinicians. This aspect of implementation and change management is something I didn't fully grasp in grad school. Understanding the nuances of clinical workflows and how to ensure that a predictive model is effectively used in practice was crucial for the success of our project.

You mentioned that you mentored students as well. How did mentoring others influence your own learning and work experience?

Raghad: Mentoring helped reinforce my knowledge. Explaining complex concepts to interns required me to clarify my own understanding. Moreover, seeing their fresh perspectives on data analysis and problem-solving was energizing. It fostered a collaborative environment where ideas could be exchanged freely, leading to innovative solutions.

Looking back, how do you think this experience influenced your future career?

Raghad: This experience solidified my passion for applying data science in various fields. It has equipped me with the skills to bridge the gap between technical analysis and real-world applications. As I move forward in my career, I aim to continue leveraging data science to solve complex problems and drive innovation across diverse industries.

Do you have any advice for business leaders considering industrial-academic collaborations?

Raghad: Absolutely! I would advise business leaders to actively seek partnerships with academic institutions; these collaborations can foster innovation and bring fresh perspectives to problem-solving. It's essential to establish clear communication channels and shared goals between both parties to ensure that the collaboration is mutually beneficial. Engaging with academic researchers can provide access to cutting-edge methodologies and insights that can enhance business strategies and operations. Additionally, these collaborations can serve as a valuable recruitment tool, potentially leading to the hiring of the perfect candidate for a position, because businesses can identify and evaluate talented individuals while they are still in an academic setting.

As I move forward in my career, I aim to continue leveraging data science to solve complex problems and drive innovation across diverse industries.

Finally, what advice would you give to graduate students considering similar industrial-academic collaborations?

Raghad: I encourage them to seek out opportunities that align with their passions. Engaging with industry can provide practical insights that enhance academic research. Building strong relationships with professionals in the field can lead to collaborative projects that are mutually beneficial. Always be open to learning and adapting; the intersection of academia and industry is a dynamic space full of opportunities.

Thank you so much for sharing your experiences and insights, Raghad. Your work at ChristianaCare is a great example of how data science can make a tangible difference in healthcare.

Raghad: Thank you! It's been a pleasure discussing my journey and the impact of industry-academia collaboration.

THE WORLD IS NOT A LIST – IT'S A NETWORK: THE NETWORKED MINDSET

BY HASINI BALASURIYA

WHEN I BEGAN STUDYING OPERATIONS research (O.R), I thought of problems as lists, which have steps to complete, items to optimize and decisions to finalize. But working with networks has changed how I see the world. Now, I look for connections, flows and structures. This shift is not just technical. It is a different way of thinking about systems, people and decisions.

At its core, a network is a system of interconnected elements called nodes, which can be people, countries, machines or organizations. The relationships between the nodes are called edges, or links, representing interactions, flows or ties. Edges can be directed or undirected, weighted or unweighted, depending on the context. These simple components allow us to model incredibly complex phenomena: supply chains, social systems, terrorist cells, ecosystems, communication infrastructures and more.

Thinking in Edges, Not Just Nodes

What makes network models powerful is their ability to **reveal structure**, even when that structure is not obvious from individual parts. Instead of focusing on isolated decision variables, a network shows us how parts of a system relate to one another. This shift from entities to relationships is the basis of what I refer to as the networked mindset.

This perspective is grounded in decades of research. Mark Granovetter's classic paper "The Strength of Weak Ties" showed weak social connections: the low-frequency, low-trust relationships that often serve as bridges between otherwise disconnected groups [1]. That single insight changed how researchers understand information diffusion, job mobility and even social change. Building on this, Watts and Strogatz [2] developed the small-world network model, which formalized how real-world systems, such as power grids or friendship circles, combine local clustering with short average path lengths. In simpler terms, even in large systems, any two nodes can often be connected by surprisingly few steps. This "six degrees of separation" property is not random; it's a signature of complex and efficient yet robust network structures. A few long-range links, scattered strategically, make the entire network more navigable without destroying its local coherence.

But not all nodes are created equal. Some become disproportionately important. This leads to a third foundational insight: preferential attachment, a mechanism identified by Barabási and Albert [3] that explains how scale-free networks emerge. In these systems, most nodes have few links, but a few nodes, known as hubs, have an extremely high degree. These hubs aren't just convenient shortcuts; they shape the dynamics of the entire network. For example, removing a random node from the internet doesn't typically break it, but removing a central server can damage global connectivity. The same logic applies to global financial systems, global supply chains and influencer-driven marketing.

In my research on **link prediction for illicit trade networks**, this principle has real consequences. We are often more interested in hidden links than visible ones. A missing edge between two countries in a suspicious trade pattern may not signal absence but rather indicate a covert connection. This is especially true in criminal networks in which actors deliberately avoid detectable communication to evade surveillance [4]. Beyond just a description, network structure becomes a clue.

Network thinking also reframes more ordinary contexts. In academic collaboration, co-authorship networks map how ideas travel and cluster. Citation analyses show which ideas form intellectual hubs and which remain on the periphery [5]. These structures help explain why some research ideas thrive and others struggle to gain visibility. For students like me, and early-career researchers, recognizing these structures is also a way to navigate them. Building weak ties across disciplines or institutions can open opportunities that strong local ties cannot.

Networks in Everyday Systems

Network thinking is not limited to sociology or epidemiology. It is embedded in nearly every major application domain in OR/MS:

- **Supply chains:** Resiliency depends not just on inventory buffers but also on structural redundancy. Sparse, centralized supply networks are vulnerable to single points of failure. Modeling these as networks allows planners to identify critical suppliers and build adaptive capacity.
- **Healthcare systems:** Patient referrals, hospital transfers and disease progression can be analyzed as networks. Central hospitals in a care network may require greater resource buffers because of size and **network centrality.**
- **Transportation and logistics:** Route optimization problems implicitly rely on network structures. But delays and cascading failures are best understood with explicit network modeling.

Limitations of the Network Lens

Although the networked mindset is powerful, it is not without risks. Simplifying human systems into nodes and edges can mask complexity. Network models encode assumptions about who matters, what counts as a tie and what is measurable.

Data bias is a serious issue. If the data only reflects visible interactions, it may underrepresent marginalized actors. Moreover, networks show structure in addition to intention. Two nodes may be connected, but that does not mean they share goals or values. As researchers, we must remain aware of what our models omit.

Why Should We Learn This Mindset?

Students are often trained to optimize – to minimize cost or maximize efficiency. Network thinking adds another dimension: It emphasizes structure, resilience and flow. It helps us see both how systems work and who benefits and who is left out. Supply chains, healthcare access, disaster response and social equity problems all have network structures. By adopting a network-aware mindset, OR/MS students can design interventions that are efficient as well as robust and fair.

In network science, a system is rarely defined by a single decision or node. It is defined by how those nodes interact and what pathways emerge. This perspective pushes us to move beyond local optimization and ask harder questions: What structures are we reinforcing? Who is invisible in our models? What flows are we enabling or obstructing? In the end, how we model networks is not just a technical decision. It is a statement about what and who we choose to see.

> By adopting a network-aware mindset, OR/MS students can design interventions that are efficient as well as robust and fair.

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ELECTRIC AND/OR AUTONOMOUS? UNPACKING THE ROAD AHEAD FOR THE FUTURE OF MOBILITY

BY NANDAN KUMAR SINGH

THE AUTOMOTIVE INDUSTRY IS undergoing two transformative shifts: the move toward electrification in the form of electric vehicles (EVs) and the rise of autonomy in form of autonomous vehicles (AVs). While these revolutions are often discussed separately, their intersection raises important questions about technological dependencies, market dynamics and policy priorities. This article explores three key dimensions of that intersection: 1) whether the future of AVs is inherently electric; 2) whether autonomy will accelerate the decline of internal combustion engines (ICEs); and 3) whether transition, electrification or autonomy should come first. By examining technical synergies, business initiatives and regulatory landscapes, this article aims to offer a nuanced perspective on how these innovations may evolve not in isolation but in tandem.

Future of AVs Is Inherently Electric

The Society of Automotive Engineers (SAE) defines six levels of vehicle automation (see Figure 1). Levels 0 (no automation) to 2 (partial automation) fall under Advanced Driver Assistance Systems (ADAS), and Levels 3 (conditional automation) to 5 (full automation) are classified as Autonomous Driving (AD) [1]. As summarized in Table 1, automation from Level 0 to Level 2 has become a common feature across all vehicle types – i.e., ICE, hybrid and EV. However, when we move toward higher levels of automation (L3 and above), a clear disparity emerges. These AD features are primarily deployed in pilot or experimental settings and remain relatively rare in ICE vehicles. By contrast, they are becoming increasingly mainstream in EVs, while adoption in hybrids remains limited. This signals that the more advanced stages of autonomous driving (AD features) will evolve predominantly on EV platforms, rather than on ICE or hybrid platforms.

FIGURE 1: SAE J3016 Levels of Driving Automation (Source: Society of Automotive Engineers International, https://www.sae.org/blog/sae-j3016-update).

	SAE Level 0™	SAE Level 1™	SAE Level 2™	SAE Level 3™	SAE Level 4™	SAE Level 5™
What does the human in the driver's seat have to do?	You *are* driving whenever these driver support features are engaged – even if your feet are off the pedals and you are not steering			You *are not* driving when these automated driving features are engaged – even if you are seated in "the driver's seat"		
	You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety			When the feature requests, you must drive	These automated driving features will not require you to take over driving	
	These are driver support features			**These are automated driving features**		
What do these features do?	These features are limited to providing warnings and momentary assistance	These features provide steering OR brake/acceleration support to the driver	These features provide steering AND brake/acceleration support to the driver	These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met		This feature can drive the vehicle under all conditions
Example Features	automatic emergency braking blind spot warning lane departure warning	lane centering OR adaptive cruise control	lane centering AND adaptive cruise control at the same time	traffic jam chauffeur	local driverless taxi pedals/steering wheel may or may not be installed	same as Level 4, but feature can drive everywhere in all conditions

Will AVs Accelerate the Death of the ICE?

In mobility services such as ride-sharing platforms and robotaxis, autonomous driving is already being commercialized. By contrast, in the consumer vehicle segment, most automation offerings remain at Level 2, or at best Level 3+, which are still common across ICEs, hybrids and EVs. This divergence makes the regulatory and business context especially important. The way investments flow into these technologies, and the pace at which safety, liability and consumer acceptance are resolved, will shape whether advanced autonomy truly accelerates the decline of the ICE. What seems clearer is that only the most advanced features of AD (i.e., Level 3+) have the potential to act as a catalyst, and even then, the trajectory is unlikely to be straightforward. However, the regulation around the safety feature will have a significant role to play.

Which Should Come First: Electrification or Autonomy?

Although ADAS features (Levels 0-2) are now standard across ICE, hybrid and EV platforms, higher levels of autonomy (Levels 3-5) demand something more fundamental. The computational load, redundant systems and always-connected architectures required for autonomous driving align far more naturally with EV platforms than with ICE or hybrid drivetrains.

This creates an intriguing dynamic. Automakers may wish to treat autonomy as a standalone innovation, but in practice, AD capabilities cannot be scaled without electrification. Even if firms are hesitant to fully embrace EVs, customer demand for the safety, convenience and prestige of autonomous features could force their hand. In other words, autonomy itself may accelerate the industry's pivot toward electrification faster than regulation or fuel economics alone.

> In other words, autonomy itself may accelerate the industry's pivot toward electrification faster than regulation or fuel economics alone.

Electrification provides the enabling foundation; autonomy builds on it. Together, they redefine the trajectory of the industry. The real lesson for companies and policymakers is that these revolutions are not substitutes but complements. In that sense, electricity isn't just powering the car of the future but also fueling the path to autonomy.

TABLE 1: Automation features based on vehicle type.

VEHICAL TYPE	AUTOMATION LEVEL	
	Levels 0 to 2 (ADAS)	Levels 3 to 5 (AD)
Internal combustion engine (ICE)	**Common** Widely available in many petrol/diesel models (e.g., Ford F-150, Toyota Land Cruiser 300, BMW 5-Series, Audi A8) with adaptive cruise control, lane keeping assist, blind-spot monitoring and traffic jam assist.	**Rare/Experimental** Mostly research prototypes or retrofits (e.g., early Uber Ford Fusion hybrid prototypes, mining/construction AVs on diesel trucks). No mass-market ICE has Level 3+ systems.
Hybrid vehicle	**Common** Available on many hybrid models (e.g., Toyota Prius, Lexus RX Hybrid, Honda Accord Hybrid) with Level 2 features such as lane centering and adaptive cruise.	**Limited** Few examples: Honda Legend Hybrid (Japan, 2021) offered Level 3 "Traffic Jam Pilot" in a very limited run of 100 units.
Electric vehicle	**Common** Most modern EVs (e.g., Tesla Model 3/Y, Hyundai Ioniq 5) offer Level 2 driver-assist suites.	**Emerging Mainstream** Primary focus of current L3+ development (e.g., Mercedes EQS Drive Pilot, Honda "0" Series EVs, XPeng, Nio ET7, Cruise Origin, Zoox, Waymo).

Region	Level 0–2 (ADAS)	Level 3 (Conditional Automation)	Level 4 (High Automation)	Level 5 (Full Automation)
EU	**Mandatory:** AEB, ISA, ELKS, DDAW (phased 2022–29)	**Mandatory framework:** UN R157 ALKS on motorways	**Pilots only** under national approvals	Not regulated
U.K.	**Mandatory:** EU-style ADAS (safety law)	Framework under **Automated Vehicles Act 2024** (approvals expected soon)	**Pilots** allowed under AV Act regime	Not regulated
U.S.	**Partly mandatory:** AEB (FMVSS 127, 2024 rule); others voluntary	**Allowed** via FMVSS compliance or exemptions; not mandated	**Pilots** at state level (e.g., CA, AZ)	Not regulated
Japan	**Mandatory:** ADAS safety standards (e.g., AEB)	**Mandatory approval:** First Level 3 approved (Honda 2021)	**Allowed** (Level 4 in limited areas since 2023)	Not regulated
China	**Mandatory:** Some ADAS standards (e.g., AEB, LDW)	**Permits** for L3/4 city pilots (no national blanket law yet)	**Permits** in 20+ cities (Beijing, Shanghai, etc.)	Not regulated
India	**Not Mandatory:** (only voluntary Bharat NCAP star rating)	Draft: ADAS (e.g., ELKS) **mandatory for >8-seater buses from 2026**	Not yet	Not regulated

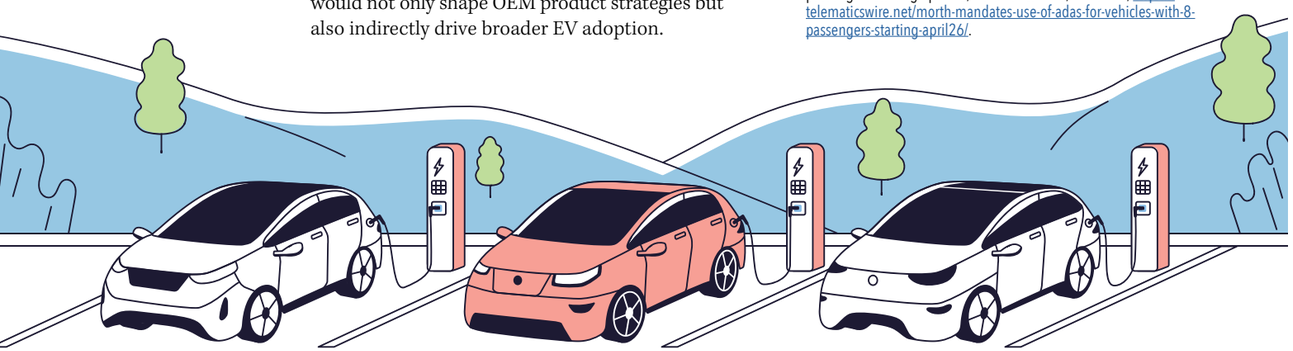
NOTE: AEB, Autonomous Emergency Braking (automatic braking if collision imminent); ALKS, Automated Lane Keeping System (hands-off driving in specific conditions; SAE Level 3); DDAW, Driver Drowsiness & Attention Warning (monitors driver alertness); DSSAD, Data Storage System for Automated Driving (black box for AV maneuvers); ELKS, Emergency Lane Keeping System (keeps vehicle in lane during danger); FMVSS, Federal Motor Vehicle Safety Standards (U.S. vehicle regulations); ISA, Intelligent Speed Assistance (warns/prevents exceeding speed limits); LDW, Lane Departure Warning (alerts driver if drifting out of lane); NCAP, New Car Assessment Program (consumer vehicle safety rating).

TABLE 2: Global regulation snapshot (by automation levels).

Regulation Across the Globe

Regulatory approaches to ADAS and higher levels of automation significantly vary across regions. As summarized in Table 2, mandatory ADAS requirements are concentrated in the EU, U.K., Japan, U.S. (limited to autonomous emergency breaking [AEB]) and partially China, whereas India and much of the Global South remain largely voluntary [2-6]. Regulation of Level 3-4 automation is tightly controlled through permits or specific approval frameworks, whereas Level 5 remains unregulated globally.

This variation has important implications. Once regulations evolve to make Level 3+ features mandatory, it could represent a tipping point for original equipment manufacturers (OEMs). To comply with the new requirements and leverage potential cost advantages of electrification, manufacturers may accelerate the transition from ICE to EV platforms. In turn, this regulatory push would not only shape OEM product strategies but also indirectly drive broader EV adoption.



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TEACHING THE META-PROBLEM MINDSET CAN EMPOWER A GENERATION OF CONFIDENT PROBLEM-SOLVERS

BY ZOHAR STRINKA, CAP-X

Author note: *Over the past several issues of* OR/MS Today, *I have shared the meta-problem mindset as a tool for solving better problems. In this final article in the series, we explore how teaching the framework can help students develop the skills they need to thrive in our rapidly changing world.*

WE RARELY TEACH REAL-WORLD PROBLEM-solving to students, yet it is the skill most likely to determine their future well-being and success (however you choose to define "success").

That same skill will also shape the future world that these students go on to build for us, our societies and our planet. It is our job to equip them for the task.

That was the mission that drove me to develop the meta-problem approach. I felt that there was something about the way I and other people in the OR/MS community solved problems that needed to be shared with the world.

I remember taking my first optimization course and learning about the objective function and constraints. I recognized the way I already thought and decided to pursue a Ph.D. in the field. Still, over the years, I've talked to plenty of people who don't see the world this way.

The act of choosing which problem to solve is something we do intuitively because of our training. But the magic of OR/MS is that, with the language of optimization, choosing which problem to solve becomes just another decision to optimize.

Eventually it clicked that the root of the skill gap lies in the way we teach students. We hand them neat and tidy problems with a correct answer. We tell them that by learning how to solve these designed problems using specific techniques, they'll learn the skills they need for their future. But not everyone learns how to generalize those lessons.

Decisions Shape Outcomes

The earlier students start focusing on decisions and how they connect to outcomes, the sooner they can take their problem-solving skills to the next level. This has the added benefit of creating a sense of agency.

Focusing on what they want from a situation is an empowering point of view. Jumping in with solutions when all someone wants is to be heard is frustrating for everyone.

I have three kids in middle and elementary school. I talk them through the creative process of choosing which problem to solve all the time. Kids get it. If they're fighting with a friend, you can focus on what outcomes they hope to achieve. If they are struggling with a topic, investigate what is standing in their way. If they don't like their teacher, talk about what decisions they could make to have the best possible outcomes – given the situation.

Adult students benefit from these same lessons. In college, one of my decisions each week was what process to use to finish my homework. I eventually noticed that as someone who sometimes picked the wrong method to try to solve a problem, I needed to take regular steps back to review where I was. My goal was to learn enough, get good-enough grades and not use up too much of my limited time on any one specific challenge.

Weigh the Trade-offs

Once you've made the shift to focus on decisions, you see the world differently.

However, decisions are rarely all happiness and sunshine. We have alternatives to choose between, each with their own pros and cons. When deciding which problem to solve, we need a good understanding of the path each option sets us down.

We tell [students] that by learning how to solve these designed problems using specific techniques, they'll learn the skills they need for their future. But not everyone learns how to generalize those lessons.

Students need to learn how the consequences of a choice flow from their decision of which problem to solve. Assumptions are also an important term to teach; I call them "guesses of what's true" when I'm talking to younger students.

People sometimes talk about problem framing to highlight how looking at problems differently can have surprising benefits. Seeing it as just a matter of perspective is a little too random for my tastes – how do you know which perspective will reveal a better option?

In contrast, the meta-problem approach entails a disciplined clarification of goals and a rigorous, structured exploration of the costs and benefits of each potential solution before ultimately deciding which problem to solve.

I encourage students to treat finding the best problem to solve as a chance to explore not only their options, but their preferences. While they might initially think they care about something specific, it can be fun and revealing to learn more about what they like or dislike.

Designing Good Problems

Deciding how to apply this idea to education is very much a research project. Still, there are some things that seem to work well while being an easy swap for parents and educators.

If your student is struggling with a dilemma, ask them what they're trying to get out of the situation. Instead of focusing on a single outcome, you can suggest some of the many competing objectives they might have in a situation. Then, you can discuss how they could pick the set of outcomes they like best.

Teaching students how to design good problems also gives them more fluency as problem-solvers. With younger kids, we let them try writing their own math problems. Then, you can discuss what makes a good fraction problem compared with just another whole-number division problem. For older students, you might explicitly talk through the clues that make one method more appropriate than another. This strengthens their understanding of the methods they're learning and of problem-solving.

Inevitably, when you have students solving problems together, they will get different answers. In my opinion, this is the best meta-problem learning opportunity there is. To get different answers, you need to solve different problems. If one student missed a step, you now know the consequences for the outcome (solution) of that slightly different version of the problem. I treat this discovery as a bonus challenge – one that may be harder but is also more rewarding than just solving the problem correctly the first time.

One other thing I have tried recently to save my students time and improve their understanding is not simply asking them to solve math or science problems. Instead, I ask them to describe which equations or methods they would use to solve the problem. This has been particularly valuable for college-level projects as I ask them to plan an analysis and then share why they crafted the plan they did. What outcomes do they expect to get? How might the systems they design change depending on what they learn?

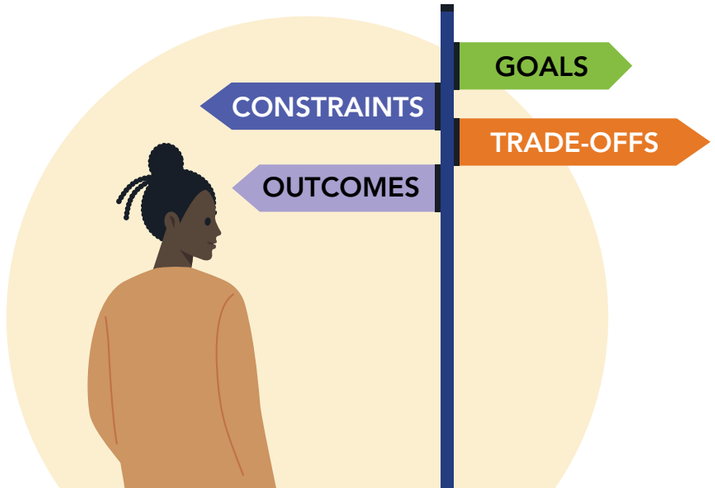
The Future is a Meta-problem

The ability to adapt in a rapidly changing world requires flexibility and openness.

If we want to do our students justice, we need to prepare them to live in that world. Fostering a mindset of curiosity and exploration related to problem-solving gives them a foundation to stand on. Build on that platform with specific skills to examine different problems and understand how they compare. Teach students to choose between their options based on the outcomes they hope to achieve.

I encourage each of you to adopt this mindset in your own lives and with your students. Making this change will help us create future generations of critical, adaptable and curious problem-solvers.

ZOHAR STRINKA, Ph.D., CAP-X, is a consultant focused on solving data and process problems for her clients in a variety of industries.



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