2021 EDELMAN AWARD CEREMONY

Recognizing Distinction in the Practice of Analytics, Operations Research, and Management Science

OR

2021 EDELMAN
AWARD CEREMONY

FOR DISTINCTION IN PRACTICE

FRANZ EDELMAN AWARD

Achievement in Advanced Analytics,
Operations Research, & Management Science

Emphasizing Beneficial Impact

DANIEL H. WAGNER PRIZE

Excellence in Operations Research Practice

Emphasizing Innovative
Methods and Clear Exposition

UPS GEORGE D. SMITH PRIZE

Strengthening Ties Between
Academia & Industry

Emphasizing Effective Academic Preparation

INFORMS PRIZE

Sustained Integration of Operations Research

Emphasizing Long-Term,
Multiproject Success

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CO-HOST OF CEREMONY

Dionne Aleman, University of Toronto

In her first year as a PhD student at the University of Florida, Dionne Aleman attended her first INFORMS meeting, the 2003 INFORMS Annual Meeting in Atlanta, only a six-hour drive from UF in Gainesville. She and a couple friends from the UF Department of Industrial and Systems Engineering turned the conference into a road trip to remember, making new friends and memories at INFORMS. Eighteen years later, Dionne remains an enthusiastic member of INFORMS who wants to help all members enjoy and gain as much value from their involvement with INFORMS as she has.

Dionne's first service to INFORMS was as a session chair at the 2006 Annual Meeting, then invited session organizer in 2007, and treasurer of the Health Applications Section (HAS) in 2008. These opportunities gave Dionne a passion for connecting researchers and educators to elevate their work. She has since served as chair of HAS, overseeing its promotion from Section to Society; president of the Public Sector OR Section; president of the Junior Faculty Interest Group; chair of INFORM-ED (Forum on Education); and *TutORials* co-chair. She currently serves on the Committee on Teaching and Learning. In 2016, Dionne was awarded the Volunteer Service Award, Distinguished Level, "to recognize exceptional volunteer service to INFORMS."

Within Canada, Dionne is a two-term past president of the Canadian Operational Research Society (CORS/SCRO), where she also served as CORS Council Secretary and Secretary of the Health Care Operations Research Special Interest Group. In 2019, she was awarded the Eldon Gunn Service Award for "outstanding contributions of time and service to the Society."

Dionne holds BSc, MSc, and PhD degrees from the UF Department of Industrial and Systems Engineering, which is unsurprising as she comes from a family of Gators, many of whom are industrial engineers. However, she is the only one who has earned a PhD. She is now an associate professor in the Department of Mechanical & Industrial Engineering at the University of Toronto, with appointments in the Institute of Health Policy, Management and Evaluation; Institute for Pandemics; and the University Health Network Techna Institute. Dionne is also co-lead for the Toronto-Manchester Joint Translational Centre for Digital Health and is a member of the Public Health Agency of Canada's external experts COVID-19 modeling group.

Her research focuses on the application of O.R. to medical and healthcare systems to improve the quality, timeliness, and efficiency of care. This research includes using optimization, simulation, machine learning, and graph theory to solve problems in pandemic modeling, radiation therapy, hospital scheduling, and organ transplant matching. This research has been supported by NSERC, CIHR, CFI, ORF, and NSF.

In her spare time, Dionne enjoys watching football (Go Gators, Go Dolphins!) and baseball (Go Blue Jays!) and playing tennis. She would be remiss for not acknowledging that her career has been made possible by the unwavering support and patience of her much smarter, more likeable wife, Nancy.

CO-HOST OF CEREMONY

Zahir Balaporia, CAP, FICO Xpress Optimization

Zahir's engagement with INFORMS started in the late 1990s as conference attendee and occasional presenter. The 2001 INFORMS Practice Conference (now Analytics Conference) is where he truly fell in love with the event, thanks to its focused emphasis on the deployment of solutions in practice. Presenters across a diverse set of organizations shared successes and challenges, which as a young practitioner challenged with implementing complex models, was the best group therapy he could have asked for.

After graduate school, Zahir started his career in manufacturing, leading projects for process improvement, building optimization models for production sequencing, and building simulation models for capacity sizing and capital investments. He then joined Schneider, a $4B+ transportation and logistics company, where he spent the next 19 years working in a variety of challenging and fulfilling roles. His teams specialized in the application of advanced analytics for decision support across the enterprise in areas such as network planning, supply chain design, vehicle routing, predictive risk, and driver assignment. In 2006, Zahir was part of the Engineering and Research team at Schneider National that was awarded the INFORMS Prize.

In 2015, Zahir joined FICO's Xpress Optimization team where he supports FICO's customers in North America, South America, and Europe. With more than 25 years of experience developing and deploying advanced analytics solutions, Zahir has been instrumental in FICO's growth across supply chain, transportation, logistics, and manufacturing. He also specializes in change management associated with deploying advanced analytics, which focuses on combining FICO's leading technology with solution design ideas that lead to strong solutions adoption by decision makers.

His work has been profiled in the books "Only Humans Need Apply – Winners and Losers in the Age of Smart Machines" by Davenport and Kirby and "The New Know" by Thornton May. Zahir has a BS in computer engineering from Clarkson University, an MS in industrial engineering from Purdue University, and an MS in system dynamics from Worcester Polytechnique Institute.

Zahir has actively volunteered with INFORMS since 2007, primarily on the Analytics Conference committee as track chair/co-chair. He was the Analytics Conference chair in 2009 and co-chairs the Analytics Leadership track. He was president of the Analytics Section (now Society) in 2012 and co-founded the Executive Forum at the Business Analytics Conference. While he is very proud of his volunteer contributions, he is especially proud of being a co-founder of The Algorhythmics, the unofficial INFORMS band.

In his spare time, Zahir enjoys playing music, golfing, and traveling with his wife Meherrnaz and their two wonderful children. He continues to maintain his unbroken attendance streak at the Business Analytics Conference, which started in 2001, and hopes to keep it going for many years to come.

ANALYTICS AND OPERATIONS RESEARCH TODAY

2021 EDELMAN PROGRAM NOTES

By Stephen Graves, INFORMS President

I t is my pleasure to welcome you to the 2021 Edelman Award Ceremony to recognize and celebrate how members in our community are saving lives, saving money, and solving some of the world's most challenging problems with operations research (O.R.) and analytics.

Thank you for joining me and the rest of the INFORMS community as we celebrate this year's recipients of four of INFORMS' most esteemed awards: *Daniel H. Wagner Prize for Excellence in Operations Research Practice; UPS George D. Smith Prize; INFORMS Prize;* and the *Franz Edelman Award for Achievement in Advanced Analytics, Operations Research, and Management Science.*

The hard work and incredible contributions of this year's finalists not only showcase to the rest of the world the transformative power of O.R. and analytics but serve to guide and inspire the next generation of O.R. and analytics researchers and professionals. These contributions, and the dedication and hard work of our finalist teams, are the culmination of years of hard work and represent a dedication to the highest levels of excellence.

Daniel H. Wagner Prize for Excellence in Operations Research Practice

For the past 20 years, the Daniel H. Wagner Prize has recognized strong mathematics applied to practical problems that not only have a significant impact in application, but are communicated with clean, intelligent writing.

In 2020, the Wagner Prize was presented to a team of researcher's from The Pennsylvania State University, The University of Texas at Austin, and the University of British Columbia for their contribution to increasing efficiency in product planning and supply in agribusiness.

Focusing on the commercial seed corn business, the researchers work, "Distribution Estimation and Efficient Optimization for Portfolio Management in Agribusiness: Analytical Developments and Benefits," identified unique, cutting-edge applications of O.R. and analytics to improve the distribution and performance of crops, realizing both monetary and nonmonetary benefits.

UPS George D. Smith Prize

Each year, the INFORMS UPS George D. Smith Prize recognizes universities that develop and maintain a strong relationship between their students and industry partners to help better prepare the next generation of O.R. and analytics practitioners.

The award is named in honor of the late UPS chief executive officer, and the Smith Prize finalists are selected from among the leading O.R. and analytics programs at universities around the world.

This year, the finalists are: University of Illinois Urbana-Champaign, Gies College of Business; University of Iowa, Department of Business Analytics; and University of Minnesota, Information & Decision Sciences Department at the Carlson School of Management.

INFORMS Prize

The INFORMS Prize is presented each year to organizations with a strong commitment to and effective integration of O.R. and analytics into its decision-making process, maintaining multiple initiatives with lasting impacts over time.

Over the years, the INFORMS Prize has been presented to leading organizations including UPS, Booz Allen Hamilton, BNSF Railway, Walt Disney Company, U.S. Air Force, General Motors, Intel, HP, IBM, Ford, Procter & Gamble, and GE Research.

Amazon has been selected as the recipient of the 2021 INFORMS Prize, for their dedication and commitment to maintain a dynamic O.R. and analytics program over several decades.

Franz Edelman Award for Achievement in Advanced Analytics, Operations Research, and Management Science

The world's most prestigious award for achievement in the practice of O.R. and advanced analytics, the Franz Edelman Award annually recognizes organizations whose applications of O.R. and analytics have transformed the world around us.

This year's finalists have made revolutionary contributions in robotics, cruise industry pricing and booking, railway planning and productivity, IT system sustainability, corporate decision making, and retail inventory operations.

The 2021 Franz Edelman Award finalists are Alibaba, JD.com, Lenovo, Memorial Sloan Kettering, OCP, and The United Nations World Food Programme.

A pioneering retail model enables the delivery of **Alibaba's** e-commerce and grocery products to customers through its logistics networks in 30 minutes to two hours from the time their order was placed. A vehicle routing algorithm was designed to optimize warehouse order picking operations and delivery routes. The algorithms are built on large neighborhood searches and deep reinforcement learning and can achieve near optimal performance under tight computational time limitations.

Ten years ago, **JD.com** pioneered same-day delivery as a standard service in China. By building automated warehouses, JD.com uses analytics to improve warehouse efficiency, while maintaining the balance between urgently growing demand and high-quality service. These agile warehouse systems enable JD.com to handle peak sales seasons (when order volume can increase as much as 10 times the normal volume), reduce storage costs by 50%, and realize hundreds of millions of dollars insavings.

In an increasingly competitive world, **Lenovo's** in-house manufacturing facilities have cemented its leadership in the PC, smartphone, and data center industries. Lenovo uses a revolutionary AI-enabled production planning and scheduling system to maintain efficiency while balancing increasing complexity and an ever-growing product portfolio. This system has significantly improved utilization and customer fulfillment rates while simultaneously increasing production volumes. In particular, at Lenovo's largest PC factory, production efficiency has increased by 18% leading to higher profitability and improved customer experience.

Of the roughly 18 million new cancer cases diagnosed each year, half will be treated with radiotherapy that uses customized penetrating radiation beams to attack and defeat cancer cells without harming the surrounding healthy tissue. Using advanced optimization tools, **Memorial Sloan Kettering** has greatly improved the radiotherapy treatment planning process, treating more than 3,000 patients to date, with a much broader impact on patient care.

As the world's largest phosphate processing and exporting group, **OCP** employs optimization models to enhance production, marketing, and logistical processes. Last year, these tools helped OCP realize incremental annual profits of ~$400 million. In addition, this focus on optimization has led to innovation and entrepreneurship becoming core pillars to OCP's culture and led to the development of the Mohammed VI Polytechnic University in Morocco, at which analytics plays a central role.

The leading global humanitarian organization and 2020 Nobel Peace Prize Laureate, **The United Nations World Food Programme** (WFP), leverages analytics to deliver food assistance in emergencies and works within communities to improve nutrition and build resilience. In 2020 alone, WFP provided assistance to nearly 100 million people across 88 countries. Using analytics, WFP manages a large and complex humanitarian operation to reach more people, respond to emergencies faster, and realize significant savings all while supporting and empowering communities.

Thank you for joining us for this special virtual Edelman Award Ceremony. While this past year has been marked with challenges, it has also served as a global reminder to the power and impact of O.R. and analytics around the world. And contributions like those of our finalist teams make a huge impact, as all of us at INFORMS – members, staff, leadership, volunteers, and more – continue to spread the word of the many incredible ways that O.R. and analytics are saving lives, saving money, and solving problems.

ENRICHING THE LIVES OF EVERY PERSON ON EARTH

Reflections on Winning the 2020 Franz Edelman Award
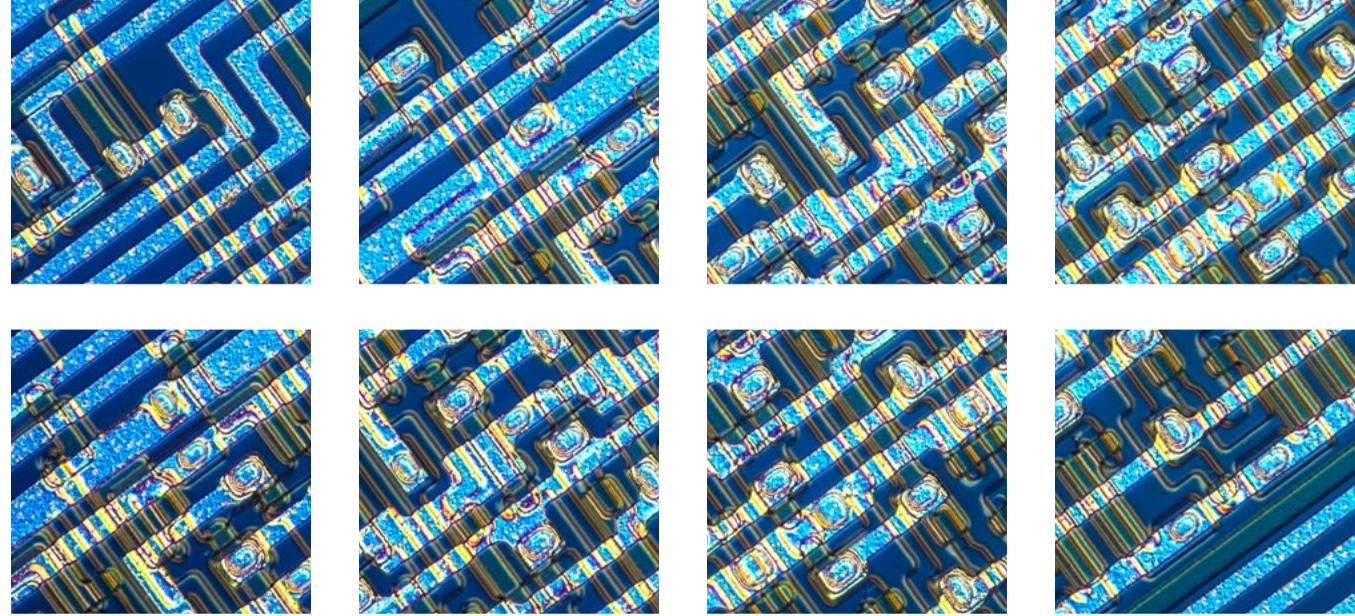**By Kalani Ching, Intel**

Intel put the "silicon" in Silicon Valley, and today our technology remains at the core of the most exciting, life-changing innovations on the planet. For more than 50 years, Intel and its people have had a profound influence on society. More than 110,000 Intel employees are shaping the future with computing and connectivity technologies. Together, we address the world's greatest challenges as well as helping secure, power, and connect billions of devices in a connected world – from the cloud to the network to the edge and everything in between.

Intel has been on a journey to redefine its position in the industry: from CPU to XPU, multi-architecture company; from a silicon focus to a platform focus including silicon, software, and services; and from a traditional integrated device manufacturer (IDM) to a modern, even more flexible IDM. Intel maintains an urgent focus on execution to deliver a predictable cadence of leadership products to its customers. We leverage manufacturing expertise, vast intellectual property (IP), and engineering innovations that give Intel increased flexibility to design and manufacture products in ways our competitors can't match. Leading in the future means living up to our stated purpose: to create world-changing technology that enriches the lives of every person on Earth.

Intel holds a strong position in the semiconductor industry as one the few remaining IDMs. Most semiconductor companies are "fabless," which means they design their own products but do not own manufacturing operations. Other companies in the industry focus only on manufacturing, building the products designed by the fabless companies. Intel is one of the few companies that both designs and manufactures its products. At any given point in time, Intel is delivering hundreds of different products to its customer base through its large and complex supply chain, while simultaneously designing the next generation of products to meet its global customers' needs.

The work featured in the 2020 Franz Edelman Competition first began at Intel in 2009 with the introduction of its Master Production Scheduling solution utilizing operations research and optimization techniques. The initial solution was an enormous improvement over the existing manual, spreadsheet-based planning systems. However, the greatest value of the work was derived from the flexibility and agility of the team to continuously improve and transform Intel's advanced analytics capabilities to stay in lockstep with our transformation as a technology company. No doubt, Intel's technology innovations drive an ever-increasing complexity of our product architecture, manufacturing process, and supply chain.

Today's solution has evolved to incorporate advanced analytics to optimize global planning at Intel, across both product and manufacturing vectors. Our approach integrates the generation and optimization of product design alternatives (using genetic algorithms and device physics simulation) with large-scale supply chain planning (using problem decomposition and mixed-integer programming) to deliver more output within existing capacity. This corporate-wide capability is fast and effective, enabling analysis of many more business scenarios in much less time than previous solutions. The capability provides substantially faster response time to customers.

These advanced analytics solutions set the direction on key product architecture design decisions across multiple products and business units and are vital to the improved supply chain planning decisions performed on a daily, weekly, and monthly basis across Intel's worldwide manufacturing network. Intel also realized several organizational benefits. One is the enablement of personnel on the front lines of product design and supply chain planning to make faster, better, more integrated decisions. Another gives senior management new insights and abilities to influence decisions impacting go-to-market strategies.

Finally, our success provides proof of the power of applying advanced analytics to Intel business problems for all teams inside Intel as well as across the advanced analytics community. Despite many challenges throughout the years, our users and our management have transitioned from skeptics to believers and, finally, to champions. Especially in the current market environment when the global semiconductor industry is experiencing very high demand and severe capacity constraints, our capability is fully leveraged, enabling Intel to maximize output to customers while minimizing costs.

Intel is honored to be the 2020 Franz Edelman Award winner and proud of the featured work. This recognition is for the entire team working to deliver the solutions that drive the most important decisions for Intel. We also share this award with our mentors, coaches, and extended members of the Intel team who provided support and assistance throughout our Edelman journey to share our powerful story.

We deeply appreciate INFORMS and the entire community of operations research and analytics professionals who are transforming the world. Intel is delighted to add the Edelman Award to its mantle beside the earned Wagner Prize and INFORMS Prize, thereby completing our INFORMS "trifecta." Together, these awards demonstrate the power of advanced analytics at Intel, and its fundamental importance in our ability to deliver the technology leadership and reliable, top quality products the world needs and expects.

OPERATIONS RESEARCH: BILLIONS AND BILLIONS OF BENEFITS!

By Jeffrey M. Alden, General Motors Analytics Research

More than $336 billion U.S. dollars of impact! That's impressive! How were they estimated? How broad is the impact? Is there more? Since 1974, Edelman Competition finalists publish their project accomplishments in the *INFORMS Journal on Applied Analytics*. In reviewing the 289 articles, their cumulative monetary impact was estimated using the following guidelines:

- Be objective and make conservative assumptions.

- Include reported impact plus at most two more years of anticipated impact.

- Include only one year of enormous impact (tens of billions) to downplay the huge size and budget of some organizations.

- Ignore relative impact even though saving $10 million for a small company may be more impressive than saving $100 million for a large company.
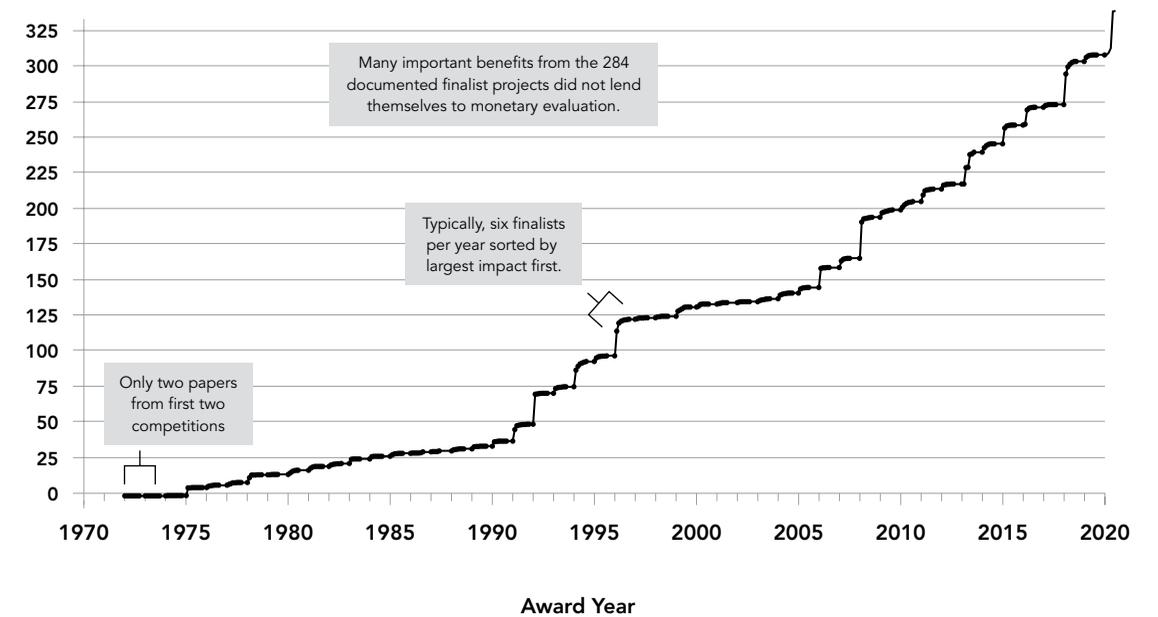
These conservative guidelines exclude important yet difficult-to-quantify reported benefits, such as improvements in legal dispute resolution, cancer treatments, airline safety, epidemic disease control, organizational structure, on-time railways, space shuttle heat shielding, and water quality. For example, there are more than 20 finalist papers with significant life and health benefits. Most are difficult to quantify, however, a CDC project on (future) U.S. epidemics expects annual savings of 6,000 lives valued at $12B[1] and one U.S. Army project estimates 4,500 avoided casualties by reducing requirements for helicopter and ground-convoy movements.[2]

Nearly all finalist papers report nonmonetary benefits and tout them as longer lasting by establishing, for example, ongoing practices and organizational changes that improve health, safety, cooperation, decision making, timeliness, and job satisfaction. Reported monetary benefits understate the full impact of the Edelman finalist projects that are also saving lives and solving societal problems.

Another important indication of the influence of operations research (O.R.) is the impressive breadth of applications. Edelman finalists represent 143 different application areas including aviation (safety, traffic), banking, canal operations, communications (broadband, broadcasting, radio spectrum), consumer products, crowd control, cruise lines, delivery (express, truck), defense (Air Force, Army), education, financial (contract bidding, credit card, fraud, investment, pension, settlement), fire protection, forestry, healthcare (blood collection, cancer, diagnosis, disease control, elderly, hospital, medical displays, pharmaceutical, surgery), hotel management, energy production and distribution (coal, gas, electric, nuclear, oil, wind), land use, manufacturing (electronics, food, paper, seeds, steel, tires, vehicles), marketing, mining, printing, sanitation, security (airport, police), senior housing, social networks, sports, tax collection, transportation (airline, highway, railway, rental, outer space,

Benefits more than $336 Billion from Edelman Finalist Projects 1972–2020
(Conservatively quantified benefits. Realized plus at most 2 years anticipated, in 2020 U.S. dollars)

Many important benefits from the 284 documented finalist projects did not lend themselves to monetary evaluation.

Typically, six finalists per year sorted by largest impact first.

Only two papers from first two competitions

Award Year

school bus), treasure hunting, waste management, water (flood, flow, resources, quality), and weapons dismantlement. The list goes on and on! In fact, 742 organizations[3] from business, government, and academia are recognized and honored as supporting or benefiting from finalist projects.

This is just the "tip of the iceberg" because the Edelman Competition only captures those O.R. professionals choosing to compete! The 1,405 Edelman finalist authors[4] represent only 10% of the current INFORMS membership. Undoubtedly, there is a vast number of projects with significant impact that did not compete due to confidentiality, lack of internal support to compete (e.g., no one thought of it, too busy, no management support, inadequate documentation), or the team was simply unaware of the competition. The impact is immense! O.R. professionals should be proud of their profession – you can say "hundreds of billions" when asked about the value of O.R.!

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[1] For CDC: 6,000 lives/year ≈ 314M U.S. population * 5% epidemic penetration * 10% die under current practices * (1%-80% fatality reduction under improved practices) * 1 epidemic per 200 years. Value of quality year of life in U.S. is $2M/average life ≈ $50K/year (a standard value) * 78 years life expectancy * 50% average life lived. Total expected annual impact is $12B = 6,000 * $2M. See "Advancing Public Health and Medical Preparedness with Operations Research," *Interfaces*, Vol. 43, No. 1 (note Figure 6). Numbers are reasonable values offered by the author.

[2] "Bayesian Networks for Combat Equipment Diagnostics," *Interfaces*, Vol. 47, No. 1.

[3] Some organizations and contestants have competed multiple times and are counted more than once.

[4] Interesting how the average number of authors per paper has grown from 1.8 over first 10 award years (1974–1982) to 8.2 in the last 10 award years (2010–2019). Linear regression gives 0.17 annual growth in average authors per paper with $R^2 = 0.80$.

FRANZ EDELMAN AWARD

RECOGNIZING AND REWARDING REAL ACHIEVEMENT IN O.R. AND ANALYTICS

The Franz Edelman Award Competition is administered by the Practice Section of INFORMS

For almost 50 years, the international Franz Edelman Competition has shined a spotlight on the most outstanding real-world applications of operations research (O.R.) and analytics that are transforming our approach to some of the world's most complex problems. Every year, organizations from around the world – both large and small, profit and nonprofit, business and governmental, private and public – compete for the Edelman Award. All selected finalists have realized substantial benefits that range from life-saving medical advancements to millions in cost savings and efficiency gains, all from the practical application of advanced methods of O.R. and analytics.

Rich with insightful research, the abstracts from finalist papers are shared in *INFORMS Journal on Applied Analytics*. In addition, full-text versions and video of the competition presentations are available online.

The history of the Edelman Award predates that of INFORMS. In 1972, The Institute of Management Sciences (TIMS), together with its College on the Practice of Management Science (CPMS), created the competition. In 1986, the award was renamed in honor of one of the earliest industry practitioners of O.R. in North America, Franz Edelman. When TIMS merged with the Operations Research Society of America in 1995 to create INFORMS, the Edelman Award became the flagship event in a growing awards program.

Born in Germany not long before Hitler came to power, Franz Edelman overcame significant adversity at a young age. After fleeing the Nazi regime as a teenager in the late 1930s, Franz Edelman found himself in England, where his alien status resulted in internment, and an interlude of lumberjacking in Canada. After navigating these obstacles, he received his undergraduate education at McGill University, and later earned a Ph.D. in applied mathematics from Brown University. He then joined the RCA Corporation as an engineer concentrating on computational topics. Franz rapidly began to envision the extreme value of computer systems that could assist with management and business operations. By the early 1950s, this insight led him to establish RCA's legendary Operations Research Group, one of the first in a North American corporation.

As he continued in his advancement of the O.R. profession, Franz Edelman advocated that success in O.R. requires excellence in information technology (IT) – computer software, computer hardware, and communications. His passion for IT ultimately led him to his new role as vice president of Business Systems and Analysis for RCA, responsible for IT as well as O.R. These ideals are still very much present in our current focus on "analytics" and "business intelligence," where strong analysis combines with strong IT.

After 30 years of service to RCA, Franz Edelman retired and formed Edelman Associates, an O.R. consulting firm. Throughout his career, Franz's commitment to advancing O.R. and his positive influence on others enhanced his legacy as a leader in the field of O.R. practice. Following his death, the Franz Edelman Award was named in his honor and continues to advance the O.R. practice to which he contributed so much.

THE FINEST STEP FORWARD: JOURNEY TO THE FRANZ EDELMAN AWARD

Every year, the recipient of the Franz Edelman Award for Achievement in Advanced Analytics, Operations Research, and Management Science is selected from a pool of incredibly accomplished finalist teams, representing leading organizations from around the world. The finalist projects are the result of years of research, hard work, and collaboration for a transformative impact for each organization. The selection process at INFORMS also begins long before the award is ever presented.

After issuing a call for entries, INFORMS often receives more than two dozen submissions from organizations with a summary illustrating a practical operations research (O.R.) application in which the results had significant, verifiable, and quantifiable impact for the organization.

The Franz Edelman Award Committee is comprised of nearly three dozen O.R. practitioners and academics from leading O.R. programs, including IBM, SAS, General Motors, Hewlett-Packard, Boeing, General Electric, UPS, Duke University, Virginia Tech, and more. By November of each year, this committee will have narrowed the applicant field to a group of semifinalists, and by the end of each year, six are recognized as Edelman Award finalists.

Prior to being named finalists, each entry is carefully reviewed by a team of verifiers who work with the relevant stakeholders to validate the details of each award entry. The verifiers thoroughly examine the O.R. work presented in the assigned entry summary, as well as its potential impact, and convey this information to the rest of the selection committee. The verifiers communicate directly with the entrant's O.R. team, the users of the work, and client management. Verification is a crucial step in the competition as it ensures that only the highest-quality O.R. will be represented in the Edelman Award Competition. All verifiers follow detailed written guidelines and sample verification reports to ensure a thorough process that is identical for each award entry.

Once the Edelman Award Committee has announced the six entries that will advance to the finals, each finalist prepares a journal-quality paper and a 40-minute presentation that will be held during the INFORMS Conference on Business Analytics and Operations Research (held virtually in 2020 and 2021 due to the ongoing COVID-19 pandemic). A team of experienced coaches is assigned to each finalist team to guide them throughout each step of the process, and help ensure that the team's paper and presentation will convey the significance and monumental impact of the work to the panel of judges.

As the INFORMS Conference on Business Analytics and Operations Research approaches, the finalist teams prepare for the final stage of the competition. The finalist papers are presented to the judges, who then begin the long review process. Each judge independently studies the papers and provides input to a group discussion. The finalists are assigned a focal point judge who conveys valuable feedback from the judging committee to the finalist coaches. This feedback helps each team identify areas with potential for clarification or improvement prior to the final presentation, which takes place on the second day of the INFORMS Business Analytics Conference.

On the day of the competition, each team conducts a 40-minute presentation, followed by a 10-minute period of questioning by the judges. This year's presentations were conducted virtually, as was the judging. As they assess each presentation, the judges follow a strict set of guidelines, including the importance of the application, the novelty and portability of the technical solution, the quality and effectiveness of the implementation, and the total impact of the project in both quantitative and qualitative terms. Once the final presentation is complete, the judges carefully review all that they have heard and seen, until they unanimously agree on which finalist team best exemplifies the ideals and standards of the Franz Edelman Award and its legacy that represents almost 50 years of O.R. and analytics excellence.

Following the competition, the incredible achievements of all the finalists are showcased in the January/February issue of the *INFORMS Journal on Applied Analytics*, which is dedicated to improving the practical application of O.R. to decisions and policies in today's organizations and industries. In addition to being presented virtually at this year's conference, the competition is recorded and all presentations are made available via streaming video shortly after the end of the INFORMS Business Analytics Conference. During the INFORMS Annual Meeting in the fall, which attracts more than 7,000 O.R. and analytics professionals, academics, and students from around the world, the first-place team shares a keynote address, while the other finalists will again be invited to reprise their work to share during a meeting session.

EDELMAN FIRST-PLACE AWARD RECIPIENTS

2020 Intel Corporation
"Intel Realizes $25 Billion by Applying Advanced Analytics from Product Architecture Design through Supply Chain Planning"

2019 Louisville Metropolitan Sewer District
"Analytics & Optimization Reduce Sewage Overflows to Protect Community Waterways in Kentucky"

2018 Federal Communications Commission (FCC)
"Unlocking the Beachfront Using Operations Research to Repurpose Wireless Spectrum"

2017 Holiday Retirement
"Revenue Managemen Provides Double Digit Revenue Lift for Holiday Retirement"

2016 UPS
"UPS On-Road Integrated Optimization and Navigation (ORION) Project"

2015 Syngenta
"Good Growth through Advanced Analytics"

2014 U.S. Centers for Disease Control
"Eradicating Polio Using Better Decision Models"

2013 Delta Programme Commissioner
"Economically Efficient Flood Standards to Protect the Netherlands Against Flooding"

2012 TNT Express
"Supply Chain-Wide Optimization at TNT Express"

2011 MISO
"MISO Applies Operations Research to Energy Ancillary Services Markets, Unlocking Billions in Savings"

2010 Indeval
"Mexican Financial Markets Benefit from Novel Application of Operations Research"

2009 Hewlett-Packard
"HP Transforms Product Portfolio Management with Operations Research"

2008 Netherlands Railways
"The New Dutch Timetable: The O.R. Revolution"

2007 Memorial Sloan Kettering Cancer Center
"Operations Research Advances Cancer Therapeutics"

2006 Warner Robins Air Logistics Center
"Warner Robins Air Logistics Center Streamlines Aircraft Repair & Overhaul"

2005 General Motors
"Increasing Production Throughput at General Motors"

2004 Motorola, Inc.
"Reinventing the Supplier Negotiation Process at Motorola"

2003 **Canadian Pacific Railway**
"Perfecting the Scheduled Railroad: Mode Driven Operating Plan Development"

2002 **Continental Airlines**
"A New Era for Crew Recovery at Continental Airlines"

2001 **Merrill Lynch, Inc.**
"Pricing Analysis for Merrill Lynch Integrated Choice"

2000 **Jeppesen Sanderson, Inc.**
"Flexible Planning and Technology Management at Jeppesen Sanderson, Inc."

1999 **IBM**
"Extended Enterprise Supply Chain Management at IBM Personal Systems Group and Other Divisions"

1998 **Bosques Arauco, S.A.**
"Use of O.R. Systems in the Chilean Forest Industries"

1997 **Societé Nationale des Chemins de Fer Français and Sabre Decision Technologies**
"Schedule Optimization at SNCF: From Conception to Day of Departure"

1996 **South African National Defense Force**
"Guns or Butter: Decision Support for Determining the Size and Shape of the South African National Defense Force"

1995 **Harris Corporation/Semiconductor Sector IMPReSS**
"IMPReSS: An Automated Production Planning and Delivery-Quotation System at Harris Corporation (Semiconductor Sector)"

1994 **Tata Iron & Steel Company, Ltd.**
"Strategic and Operational Management with Optimization at Tata Steel"

1993 **AT&T**
"AT&T's Telemarketing Site Selection System Offers Customer Support"

1992 **New Haven Health Department**
"Let the Needles Do the Talking! Evaluating the New Haven Needle Exchange"

1991 **American Airlines**
"Yield Management at American Airlines"

1990 **Health Care Financing Administration**
"Diagnosis Related Groups: Understanding Hospital Performance"

1989 **ABB Electric, Inc.**
"A Choice-Modeling Market Information System That Enabled ABB Electric to Expand Its Market Share"

1988 **City of San Francisco Police Department**
"A Break from Tradition for the San Francisco Police: Patrol Officer Scheduling Using an Optimization-Based Decision Support System"

1987 **Syntex Laboratories, Inc.**
"Sales Force Sizing and Deployment Using a Decision Calculus Model at Syntex Laboratories"

1986 **Southland Corporation (CITGO Petroleum Corporation Subsidiary)**
"The Successful Deployment of Management Science throughout CITGO Petroleum Corportation"

1985 **Weyerhaeuser Company**
"Weyerhaeuser Decision Simulator Improves Timber Profits"

1984 **Blue Bell, Inc. (dual)**
"Blue Bell Trims its Inventory"

1984 **The Netherlands Rijkswaterstaat & the RAND Corporation (dual)**
"Planning the Netherlands' Water Resources"

1983 **Air Products and Chemicals, Inc.**
"Improving the Distribution of Industrial Gases with an On-Line Computerized Routing and Scheduling Optimizer"

1982 **Arizona Department of Transportation**
"A Statewide Pavement Management System"

1981 **ANR Freight System**
"From Freight Flow and Cost Patterns to Greater Profitability and Better Service for a Motor Carrier"

1980 **Kelly-Springfield Tire Company**
"Coordinating Decisions for Increased Profits"

1979 **The Greater New York Blood Program**
"The Long Island Blood Distribution System as a Prototype for Regional Blood Management"

1978 **Cahill May Roberts, Ltd.**
"A Planning System for Facilities and Resources in Distribution Networks"

1977 **Syncrude Canada, Ltd.**
"Simulation of Tar Sands Mining Operations"

1976 **American Telephone & Telegraph**
"The Use of Management Science in Making a Corporate Policy Decision–Charging for Directory Assistance Service"

1975 **Xerox Corporation**
"Management Science's Impact on Service Strategy"

1974 **Canadian National Energy Board**
"Management Science in Energy Policy: The Trans Canada-Great Lakes Transmission Case"

1973 **The Babcock & Wilcox Company**
"Planning Nuclear Equipment Manufacturing"

1972 **The Pillsbury Corporation**

THE 2021 SELECTION COMMITTEE & VERIFIERS

We wish to thank the following individuals for their dedication and service as Selection Committee members and verifiers for this year's Edelman Award.

Each of the semifinalists is assigned a verifier who works behind the scenes, often with an associate verifier, to validate the claims made by their entry. A verifier's primary role is to understand an applicant's O.R. work and its impact in detail, and then convey this to the rest of the committee, both orally and in a written report. Verification is a crucial element of the competition because it ensures that only the highest-quality O.R. and analytics work with verified impact makes it to the Edelman Award finals.

- Carrie Beam, *Chair, Edelman Award; University of Arkansas*
- Layek Abdel-Malek, *NJIT*
- Jeffrey M. Alden, *General Motors Analytics Research, v*
- Sudharshana Apte, *Altria, v*
- Sharon Arroyo, *Boeing*
- Sudip Bhattacharjee, *University of Connecticut, v*
- Ann Bixby, *Aspen Technology, v*
- Paul Brooks, *Virginia Commonwealth University*
- Aaron Burciaga, CAP, *ECS, v*
- Carol DeZwarte, CAP, *Convoy Inc, v*
- Goutam Dutta, *Indian Institute of Management, v*
- Pooja Dewan, *OTIS Elevator Company*
- Gul Ege, *SAS Institute Inc., v*
- Michael Gorman, *University of Dayton*
- Genetha Gray, *Salesforce*
- Shailendra Jain, *Hewlett Packard Enterprise, Retired, v*
- Burcu B. Keskin, *University of Alabama, v*
- Don Kleinmuntz, *Kleinmuntz Associates*
- Margarit Khachatryan, *MagAnalytics, v*
- Russell P. Labe, CAP, *RPL Analytics Consulting, v*

- Tim Lowe, *University of Iowa*
- Polly Mitchell-Guthrie, *Kinaxis, v*
- Sven Müller, *Otto von Guericke University Magdeburg*
- Chanel Murray, *PNC, v*
- Ranganath Nuggehalli, CAP, *UPS*
- Kamran Paynabar, *Georgia Tech*
- Catherine Petersen, CAP, *Sapphire Digital, v*
- Patti Phillips, *ROI Institute, Inc., v*
- Sanjay Prasad, *IBM*
- Michael Prokle, *Fortune Brands GPG, v*
- Mikael Rönnqvist, *University of Laval, v*
- Cynthia Rudin, *Duke University, v*
- Harrison Schramm, CAP, *Group W, v*
- Onur Seref, *Virginia Tech*
- Zohar Strinka, *Analytics Strategies LLC, v*
- Kendra Taylor, *KEYfficiencies, v*
- Rajesh Tyagi, *GE Global Research, v*
- Andrés Weintraub, *Universidad de Chile*
- Xiaodi Zhu, CAP, *New Jersey City University, v*

"v" Indicates Verifiers

THE 2021 COACHES & JUDGES

We wish to thank the following individuals for their dedication and service as coaches and judges for this year's Edelman Award.

The role of the coach is to ensure each team's paper and presentation conveys the work in a manner that may be well understood by a general operations research audience. Often a coach is paired with an associate coach who lends another perspective to the process. The judges must work together, evaluating the evidence to determine which finalist is most deserving of the Franz Edelman Award for Achievement in Advanced Analytics, Operations Research, and Management Science. The award is for implemented work that has had significant, verified, and preferably quantified impact.

Franz Edelman Coaches

- Jeffrey M. Alden, *General Motors Analytics Research*
- Aaron Burciaga, CAP, *ECS*
- Goutam Dutta, *Indian Institute of Management*
- Gul Ege, *SAS*
- Chanel Murray, *PNC*
- Sanjay Prasad, *IBM*
- Michael Prokle, *Fortune Brands GPG*
- Mikael Rönnqvist, *University of Laval*
- Kendra Taylor, *KEYfficiencies*
- Rajesh Tyagi, *GE Global Research*
- Andrés Weintraub, *Universidad de Chile*
- Xiaodi Zhu, CAP, *New Jersey City University*

Franz Edelman Judges

- Carrie Beam, *Chair, Edelman Award; University of Arkansas*
- Ann Bixby, *Aspen Technology*
- Michael Gorman, *University of Dayton*
- Terry P. Harrison, CAP, *Penn State University*
- Shailendra Jain, *Hewlett Packard, Retired*
- Tim Lowe, *University of Iowa*
- Aly Megahed, *IBM*
- Harrison Schramm, CAP, *Group W*
- Kermit Threatte, *Shopify*

THE ANSWERS WE NEED ARE EVERYWHERE. JUST ASK THE DATA.

From protecting people from fraud to improving their health and public services, data can do amazing things. All it takes is the right questions and the latest in analytics from SAS. Because we believe everyone can make the world smarter, faster and kinder than it's ever been. We just have to ask the data. Follow your curiosity to sas.com/curiosity.

Curiosity Forever
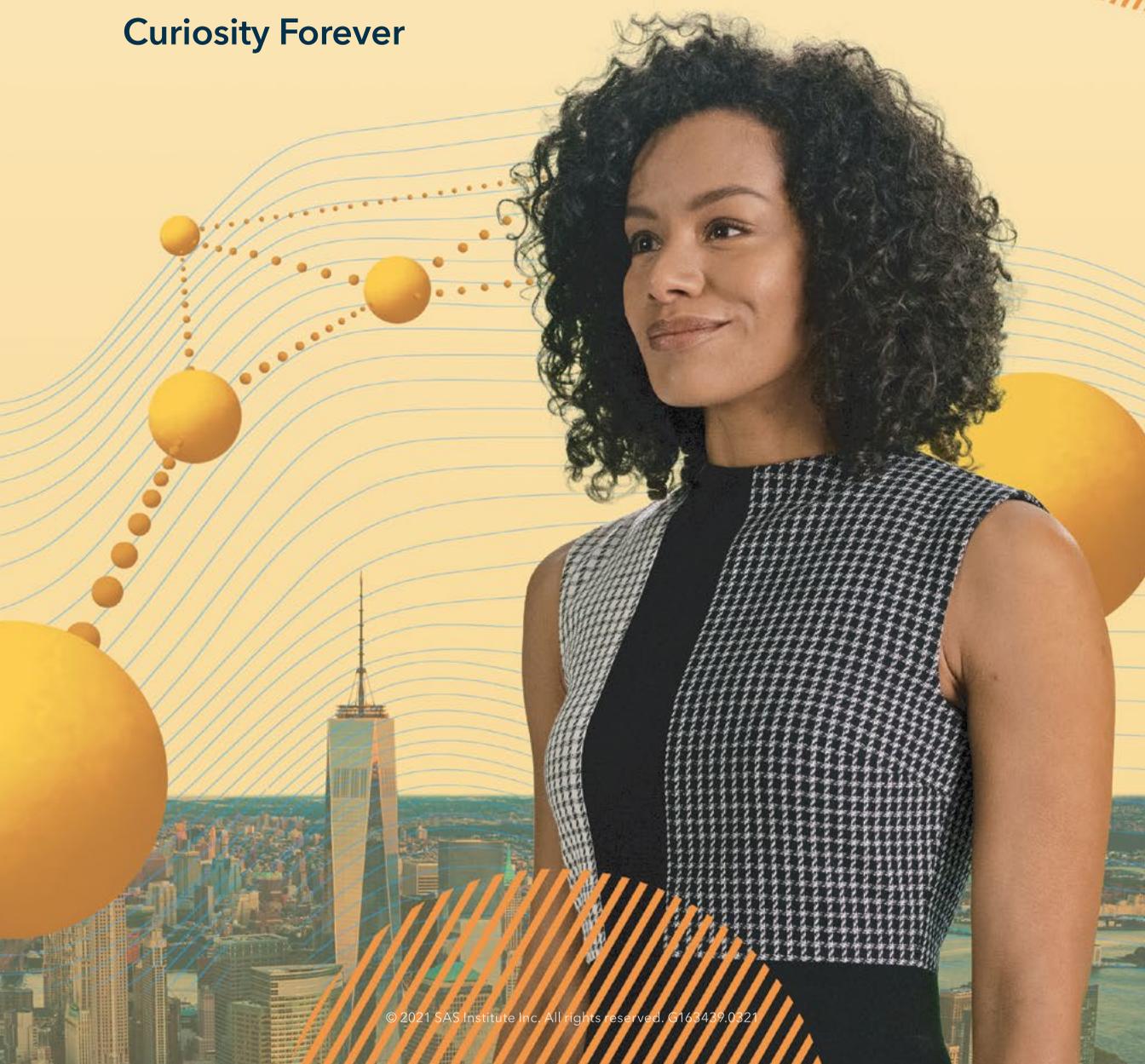
THE EDELMAN LAUREATES

The individuals who author Edelman finalist papers are deemed Franz Edelman Laureates.

Authors of finalist papers to be published in *INFORMS Journal on Applied Analytics*, are recognized as laureates and formally presented with the Franz Edelman Medal prior to the Edelman Award Ceremony.

Laureates are recognized for their significant contributions to work that was selected to represent the best applications in the world of analytical support for decision making. Laureates are expected to serve as role models and exemplify that challenges can be met and innovative applications of analytics can help every organization.

The Laureate recognition is distinct and separate from membership in the Franz Edelman Academy.

THE EDELMAN ACADEMY

Each year, participating organizations are inducted as members of the Franz Edelman Academy.

The primary client organization, or beneficiary of the finalist work, is inducted into the Edelman Academy at the Edelman Award Ceremony during the INFORMS Business Analytics Conference each year.

In addition, organizations that played a major role in the work, and therefore deserve academy membership, may also be inducted. The most common example would be an organization that provided the professionals who did the majority of the analytical work.

The membership of the Franz Edelman Academy represents 50 years of extraordinary contributions to society through the innovative application of operations research and advanced analytics.

THE 2021 FRANZ EDELMAN AWARD FINALISTS

Introduced in the pages that follow are the six finalists for the 2021 Franz Edelman Award.

Over the past several months these Edelman finalist teams, with guidance from their team coaches, have demonstrated to the Edelman selection committee that their work is among the finest examples of operations research and analytics practice in the world. One of these organizations will be recognized as the best in class, the first-place recipient of the 2021 Franz Edelman Award for their work to help save lives, save money, and solve problems.

A shortened summary of each of the 2021 finalist team's work is described in the following pages. Papers including the full project description will be published in the January/February 2022 issue of *INFORMS Journal on Applied Analytics* (formerly *Interfaces*). This journal, published by INFORMS, is dedicated to improving the practical application of operations research and advanced analytics in today's organizations and industries.

The finalists for the 2021 Edelman Award include the following:

- Alibaba
- JD.com
- Lenovo
- Memorial Sloan Kettering
- OCP
- The United Nations World Food Programme (WFP)
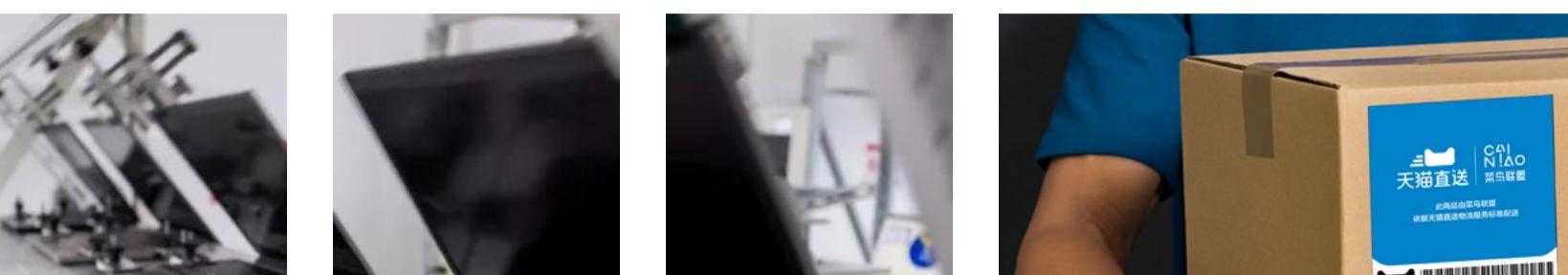
ALIBABA

Alibaba VRP Algorithms Have Enabled Its On-time Hour-level Delivery

In recent years, Alibaba has pioneered an integrated online and offline retailer where customers can place online orders of e-commerce and grocery products at its participating stores or restaurants and have them delivered in as short as 30 minutes or 2-4 hours. Depending on the customer segments and geographical locations, these services are provided through various businesses of Alibaba ecosystem, such as Freshippo, Taoxianda, Cainiao Network, Lazada, etc.

The delivery services enable their customers to order nearly everything, including fresh foods, raw or cooked, and OTC drugs on their mobile phones.

These service commitments indicate that as soon as orders are placed, decisions have to be made to 1) batch these orders and schedule picking routes of orders for pickers at warehouses or stores, and 2) optimize routes for motor drivers. There are varieties of routing

problems to be solved in the whole process or order fulfillment process. The stringent service commitment, coupled with urban transportation uncertainty and complicated picking operations in space-tight warehouses, have created significant challenges in developing solutions to these problems.

To solve these problems, the operations research community of Alibaba has developed its own vehicle routing problem (VRP) system. In addition to the reduced time and the resulting cost-saving benefits, the algorithm has brought several other intangible benefits.

It significantly frees up the time of algorithm developers, speeds up the business development, and becomes one of the key drivers behind the success of several business subsidiaries inside Alibaba — providing on-time and fast delivery service in a cost-efficient way is critical to stay competitive in the market, and by shortening the vehicles' traveling route, the carbon dioxide emissions are reduced, another effort highlighting our commitment to environment protection.

The system is built upon two approaches: an Adaptive Large Neighborhood Search (ALNS) Framework and a Learning-based Framework.

The former is based on the latest metaheuristics in the solution of VRPs, contains a rich pool of neighborhood search operators, supports almost all variants of VRPs, and allows the inclusion of additional objectives and constraints for expansion, and has consistently ranked the best among several VRP test cases.

The latter is the development of a deep-learning-based approach that trains neural network models offline to make almost instant online predictions of optimal solutions.

The algorithms have achieved near the vicinity of the best solutions for some VRP cases with a tiny fraction of the time and thus are used for practical online decision making.

To increase the transportability of the system, several efforts were made: First, a framework that allows extension through neighborhood operators is developed. An extendable domain-specific language is designed to implement user-defined constraints and objectives.

Second, a data-driven approach that allows self-learning VRP solutions based on real data is provided. It also incorporates optimization to generate offline training to derive models that could be used for online real-time decision making. Such an approach has been applied to develop the solution to address a variety of routing problems in milliseconds in real life.

ORGANIZATION

Alibaba

Founded in 1999, Alibaba enables businesses to transform the way they market, sell, and operate and improve their efficiencies. We provide the technology infrastructure and marketing reach to help merchants, brands, and other businesses to leverage the power of new technology to engage with their users and customers and operate in a more efficient way.

Our businesses are comprised of core commerce, cloud computing, digital media and entertainment, and innovation initiatives. An ecosystem has developed around our platforms and businesses that consists of consumers, merchants, brands, retailers, third-party service providers, strategic alliance partners, and other businesses.
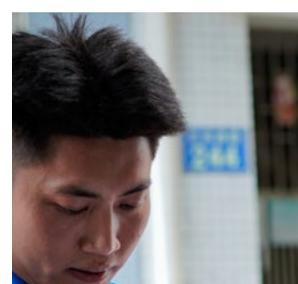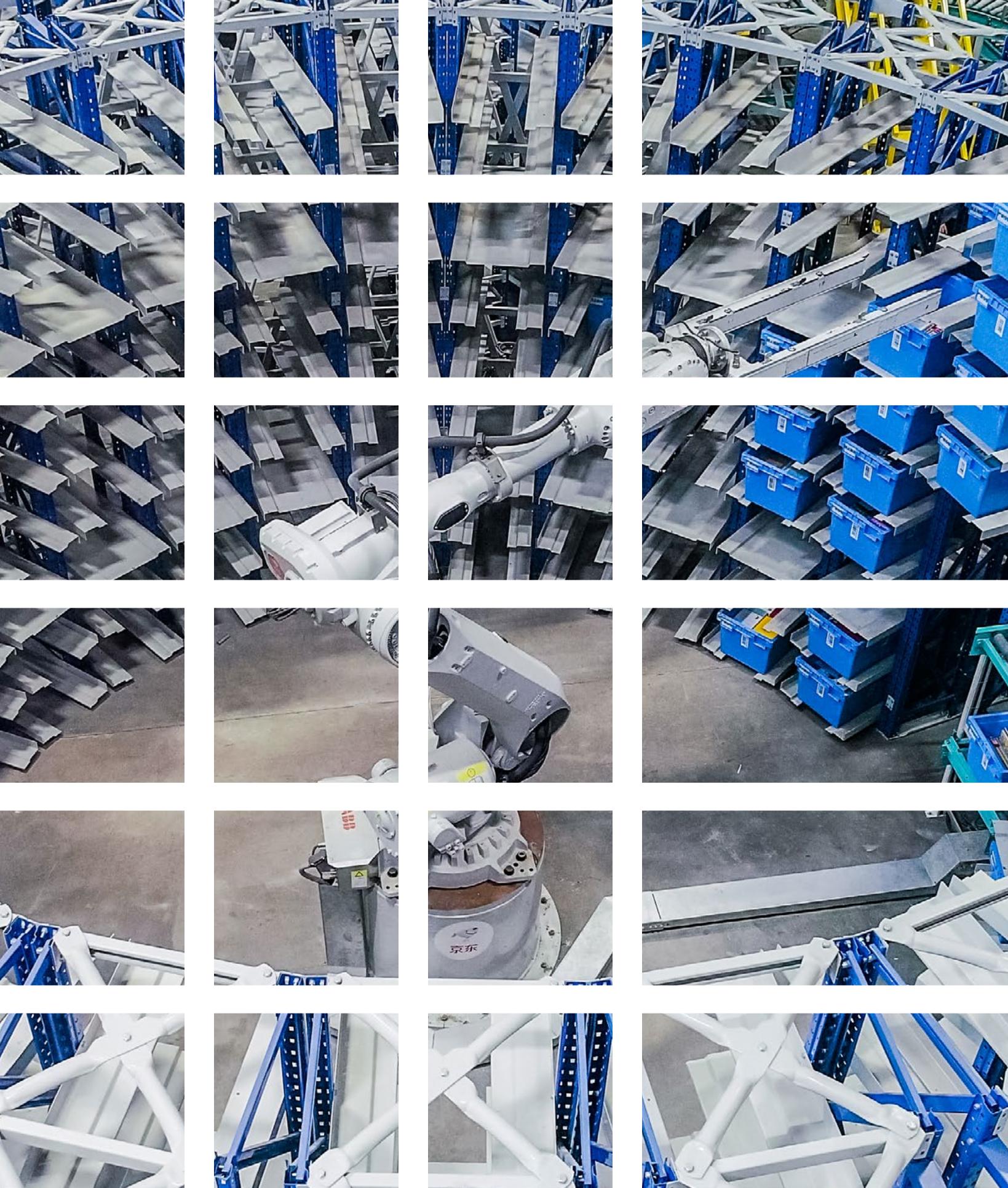
JD.COM

Operations Research Optimization Algorithms Drive Unmanned Warehouse Robots to Work

J D.com pioneered same-day delivery as a standard service in China's B2C e-commerce sector 10 years ago. As both demand and labor costs have increased dramatically since then, the company has faced an emerging challenge of how to cost-effectively meet growing demands while maintaining high-quality logistics services. In response, JD.com began to invest in unmanned warehouses in 2015.

One of the major challenges in an unmanned warehouse is the management and dispatching of automatic guided vehicles (AGVs). In a modern parts-to-picker automated warehouse system, AGVs pick up movable racks and transport inventory to workstations for picking.

A central question is how to effectively dispatch AGVs to racks and workstations in real time, to minimize the travel-distance and order-fulfillment time. The problem can be formulated as a large-scale integer program with millions

of decision variables and constraints. Moreover, it must be solved in real time. We tackle this problem via a Lagrangian relaxation together with cutting planes, and are able to find near-optimal dispatching decisions for hundreds of AGVs in seconds.

Optimization combined with modern robotics technology results in tremendous improvements in picking efficiency and warehouse space utilization. JD.com currently operates more than 900 warehouses with an area of approximately 21 million square meters.

JD.com's application of unmanned technologies is the most extensive in the field of e-commerce logistics in China. It has helped the company to lower the inventory turnover days to 33.3 despite the significant increase in the number of SKUs, and decrease fulfillment expense ratio to a world-leading level of 6.5%. In 2020, 90% of JD.com's first-party retail orders were delivered the same- or next-day after they were placed.

The agility of such unmanned technologies not only makes it possible for a single warehouse to handle more than 1.3 million orders per day during peak sales seasons, but also helped the company quickly respond to COVID-19 and ensure the rapid recovery of production capabilities. Moreover, before the deployment of unmanned warehouses, logistics workers across the industry had faced unprecedented pressure in the form of physical labor. For example, warehouse employees often manage heavy loads, causing serious joint problems; pickers walk the length of almost a marathon each day and workers in cold chain warehouses frequently transition between normal temperatures and -30°C. The unmanned warehouse technology has effectively improved working conditions.

JD.com began providing integrated technology services including both software and automation solutions to third parties in 2018. This opening up has demonstrated extraordinary results across industries such as FMCG, apparel, home appliances, home furniture, consumer electronics, automotive, and fresh produce. In 2020, JD.com's logistics business served more than 190,000 corporate customers.

JD.com's unmanned warehouse technology has received intense media coverage since its deployment. It was featured on the April 21, 2018, broadcast of China Central Television's nightly news program Xinwen Lianbo. This program is shown simultaneously by all local TV stations in mainland China, making it one of the world's most-watched programs. The warehouse has also been covered by leading international media outlets including *CNBC, Bloomberg*, *The Washington Post*, and others.

Furthermore, as a representative of contemporary Chinese science and technology, JD.com was also featured during the closing ceremony of the 2018 PyeongChang Winter Olympics in an 8-minute promotional video for the 2022 Winter Olympics, which will be held in Beijing.

ORGANIZATIONS

JD.com
JD.com is a leading technology-driven e-commerce company transforming to become the leading supply chain-based technology and service provider. The company's cutting-edge retail infrastructure seeks to enable consumers to buy whatever they want, whenever and wherever they want it.

The company has opened its technology and infrastructure to partners, brands, and other sectors, as part of its Retail as a Service offering to help drive productivity and innovation across a range of industries. JD.com is the largest retailer in China, a member of the NASDAQ100, and a Fortune Global 500 company.

### The Shanghai University of Finance and Economics
The Shanghai University of Finance and Economics (SUFE) is a top-ranked, world-renowned finance- and economics-oriented research university located in Shanghai, the People's Republic of China. As the oldest financial university in China, SUFE has enjoyed a reputation of being one of the best finance and economics universities in China for many years.

The University of Chicago Booth School of Business
The University of Chicago Booth School of Business is the graduate business school of the University of Chicago. Founded in 1898, Chicago Booth is the second-oldest business school in the U.S. and is associated with nine Nobel laureates in the Economic Sciences. Chicago Booth empowers bold thinkers and inquisitive minds to dig deeper, discover more, and shape the future.

The University of Southern California Viterbi School of Engineering
The University of Southern California Viterbi School of Engineering was founded in 1905. It is among the nation's highest in volume of research activity, with more than $135 million in external funding support. The Viterbi School of Engineering is currently ranked No. 9 in the United States by *U.S. News & World Report*, and is a hub for entrepreneurship that connects students from 64 countries.
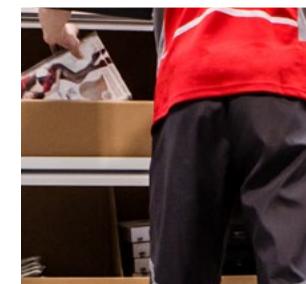
LENOVO

Reinforcement Learning Greatly Improves Production Efficiency in Large Manufacturing Plants

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L enovo is a global leader in the consumer electronics industry and production of smart devices, and is the largest PC maker in the world. Lenovo consistently strives to provide the highest quality and best experiences to all of its customers, which include end consumer, commercial, and small- to medium-sized businesses.

Each year, Lenovo provides global users with hundreds of millions of smart devices, including PCs, tablets, and smartphones. Lenovo accomplishes this intelligent transformation through technological innovations, not only in designing and building smart devices and infrastructures, but also in the daily operation and management of its massive supply chain and manufacturing system.

Hefei Electronics Technology (LCFC), a subsidiary of Lenovo, produced more than 34 million PCs in 2020, accounting for nearly half

of Lenovo's PC production. Due to the large scale and complex production system at LCFC, production scheduling is a critical process to optimize manufacturing efficiency and throughput. The primary task for the planning team in LCFC is taking batches of orders twice a day and making corresponding production schedules for the manufacturing plants through long hours of intensive communication and coordination. Job orders are assigned to each production line with the intent to fully utilize the capacity of each machine.

Below is an overview of the challenging demands associated with the manufacturing scheduling process:

- LCFC has four plants, containing 43 assembly lines in total.

- For each run of production scheduling, more than 6,000 production orders need to be scheduled, involving more than 200,000 laptops waiting for production.

- The products are categorized into more than 550 models with over 250,000 stock keeping units (SKUs).

- A task corresponding to a specific model can only be executed on a portion of the total production line set.

- Orders with an urgent due date need to be scheduled preferentially to reduce the chance of a violation, which directly impacts the customer fulfillment rate and cost of manufacturing.

In order to improve performance of production scheduling, reduce the workload of the planning team, and respond to the scheduling demand more quickly, the Lenovo Research team and LCFC jointly developed an advanced production

scheduling solution. Utilizing machine learning, artificial intelligence, and reinforcement learning, production scheduling in LCFC was modeled as a very large-scale combinatorial optimization problem with massive operational constraints.

A deep reinforcement machine learning model based on an encoder-decoder architecture was used with improved representation ability added by using a multilayer forward convolution into the encoder and a masking mechanism that enforces the operational constraints to the output of the model. Through powerful self-learning and computing capabilities, the solution improved multiple production indicators and obtained complete scheduling results within minutes instead of the hours it previously took.

The new solution has significantly increased the production efficiency of LCFC, reformed the management process to reduce the backlog of production orders, and improved fulfillment rate, which has led to higher profitability and a better customer experience. Since 2019, this solution helped Lenovo increase revenue by more than 4.6 billion USD in total.

Moreover, the analytics and operations research techniques in this project are not limited to just the production scheduling problem. This work is highly portable to other industrial planning and decision scenarios inside or outside of Lenovo, such as delivery routing and packing optimization, material requirements planning, and supply chain optimization.

ORGANIZATIONS

Lenovo Group
Lenovo is a Fortune Global 500 company with more than 50 billion USD in revenue and 63,000 employees, operating in 180 markets around

the world. Focused on a bold vision to deliver smarter technology for all, Lenovo is developing world-changing technologies that create a more inclusive, trustworthy, and sustainable digital society. By designing, engineering, and building the world's most complete portfolio of smart devices and infrastructure, Lenovo is also leading an Intelligent Transformation – to create better experiences and opportunities for millions of customers around the world.

LCFC (Hefei) Electronics Technology (LCFC)
Founded in 2011, LCFC is Lenovo's subsidiary and the largest PC research, development, and manufacturing base plant. In 2020, LCFC realized total revenue of 14.38 billion USD with peak production over 190,000 units per day. For every eight new laptops sold worldwide, one of those comes from LCFC. So far, more than 150 million products have been shipped from LCFC cumulatively.
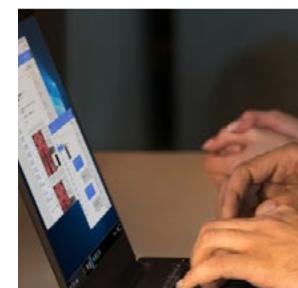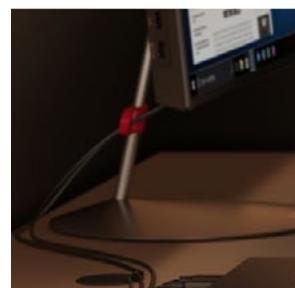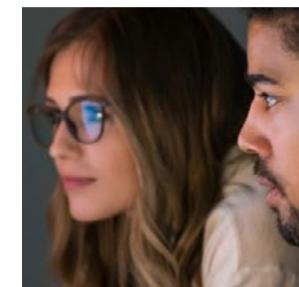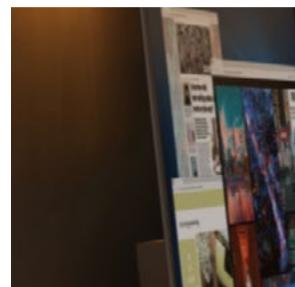
MEMORIAL SLOAN KETTERING

Automated and Clinically Optimal Radiotherapy Cancer Treatment Planning

Planning cancer treatments with radiation to sterilize cancer cells is a global problem. Every year, worldwide, there are about 18 million new cases of cancer, more than a third of which are treated with radiation.

Radiotherapy is the use of carefully chosen beams of high-energy radiation to sterilize cancer and is often given in conjunction with other types of treatment such as chemotherapy and/or surgery. The radiation is delivered directly into the affected area to kill cancerous cells without harming the surrounding healthy organs and tissue. The treatment is complex and very patient specific; it must be uniquely tailored for each patient.

Memorial Sloan Kettering Cancer Center (MSKCC) has developed and applied advanced optimization tools (e.g., hierarchical constrained optimization, convex approximation, Lagrangian

multipliers), along with careful modeling of the radiation delivery process, to provide better planning, faster, and cheaper radiotherapy treatment. The need for complex, high-dimensional constrained optimization in cancer care is clear, because each cancer patient is unique in terms of the shape and location of the tumor and radiation-sensitive surrounding healthy tissues.

Radiation is delivered to the patient's body from various orientations. Each "intensity modulated" radiation treatment requires customization of radiation intensity maps of delivered beams to kill cancerous cells without causing excessive harm to nearby normal organs and tissues. Finding these patient-specific settings, correctly prioritizing different dose goals to disease, and achieving the desired avoidance to multiple normal tissues, is a complex and labor-intensive task that must be achieved in a limited time.

Most current planning optimization methods either rely on the radiotherapy planners' experience and skill to guide these tradeoffs or seek to create a plan based on characteristics of past acceptable plans.

The Approach
MSKCC formulated this problem as a hierarchical constrained optimization problem to better capture the underlying clinical philosophy of controlling acceptable dose tradeoffs within the plan: some dose goals are more important than other goals. For example, delivering adequate tumoricidal dose to mouth cancer may be considered more important than avoiding a reduction in salivary function.

For each patient, the delivery machine parameters are optimized by solving two large-scale sequential constrained optimization problems. The first-level optimization problem guarantees adequate radiation dose to the tumor; the second-level optimization problem

minimizes the radiation to critical healthy organs. Excessive radiation dose to healthy organs exceeding tissue tolerances is strictly prohibited in each optimization problem using constraints. The resultant optimization problems are large and nonconvex with hundreds of thousands of variables and constraints.

To allow quick patient access and solve the optimization problems in a clinically reasonable time frame, the team leveraged multiple advanced optimization tools (e.g., convex approximation, Lagrangian multipliers, and sequential convex programming) to reduce typical computational time to 1-2 hours while also maximizing patient plan quality.

Clinical Implementation
Memorial Sloan Kettering Cancer Center has clinically implemented this complex optimization technique, internally referred to as ECHO (Expedited Constrained Hierarchical Optimization). The technique was validated before clinical implementation, with extensive retrospective comparison studies comparing automated ECHO plans with the manually generated plans produced by experienced planners. Extensive work was also done to improve the dosimetric modeling, ensuring that the optimization problem solution is close to the dose distribution as delivered by the treatment machine.

The team demonstrated that ECHO plans have a consistent high quality, and in general provide better tumor irradiation, and reduced radiation dose to the key healthy organs, and are thus expected to improve outcomes. In addition, ECHO results in improved clinical workflow and shorter times between simulation and treatment (from 5 days to 4 days).

More than 3,000 patients have benefited thus far from ECHO radiotherapy treatments. Benefits

to MSKCC and their patients include: 1) a streamlined and more efficient workflow (e.g., increased capacity); 2) reduced planning effort; 3) improved plan quality; 4) greater planning consistency; and 5) expedited treatments for numerous patients in severe pain and in urgent need of treatment. The ECHO system has been commissioned clinically for several disease sites (prostate, lung, paraspinal, oligometastatic, and head and neck), and will be expanded to the great majority of all radiotherapy treatment planning at MSKCC in the next two years.

The ECHO system will ultimately be explored as a way to impact patient care more broadly, most likely with a commercial partner, including in resource-constrained countries where access to highly skilled radiotherapy planners is very limited and cost-efficient resource utilization is a must to be able to meet the cancer treatment need.

ORGANIZATION

Memorial Sloan Kettering Cancer Center
Memorial Sloan Kettering Cancer Center (MSKCC), located in New York City and the surrounding region, is the largest and oldest private cancer center in the world. MSKCC is regarded as one of the world's leading cancer centers delivering patient care, conducting research, and training the next generation of cancer caregivers and researchers. MSKCC annually treats more than 12,000 patients with radiotherapy.

Each year MSKCC trains more than 3,000 medical students, residents, postdoctoral researchers, PhD and MD-PhD candidates. According to *U.S. News & World Report*, MSKCC has ranked as one of the top two hospitals for cancer care in the country for more than 30 years.
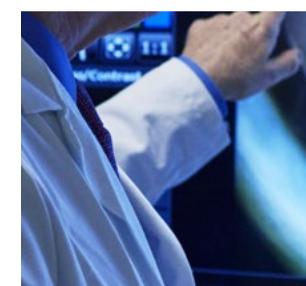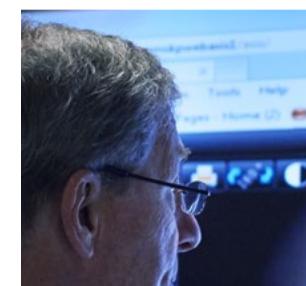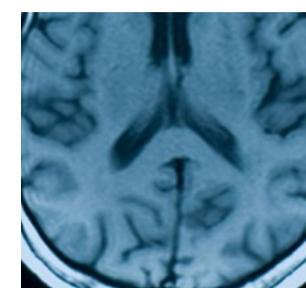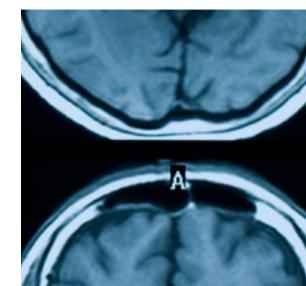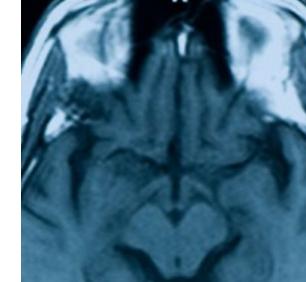
OCP

Global Food Security: Transforming OCP through Analytics

Humanity relies on cultivated lands to feed itself and thrive. Fertilizers are responsible for 30%-50% of food production and phosphate is an essential and non-substitutable component of fertilizers. OCP, based in Northern Africa, is the world's largest phosphate mining and processing company with a worldwide reach and a diversified product portfolio, and therefore plays a critical role in global food security. Its supply chain is large and complex, and running it involves many key decisions along the value chain.

OCP extracts about 40 million tons of rock per year from more than eight mining sites, with each site delivering up to 10 different grades of raw ore. These different grades may undergo physical processing and blending before either being exported or further processed into nine grades of phosphoric acid or over 43 grades of fertilizers in more than 42 plants in multiple geographies. Managing such a complex supply chain is challenging due to the large number of decision

variables pertaining to extraction planning, rock beneficiation, blending, and chemical processing allocation. All of these operational decisions need to be adjusted to the sales opportunities that arise globally.

Over the last decade, OCP in collaboration with Dynamic Ideas, an analytics consulting company based in Massachusetts, developed a mixed-integer, multiperiod optimization model to holistically optimize the entire production, sales, and supply chain of OCP: from the mines, to physical treatments, to chemical facilities, to inventory facilities and the port for global distribution.

This model brings together all major operational decisions of the company into the same decision platform, enabling all managers to collaborate in order to maximize the overall profit. It currently runs at different time horizons, ad hoc, monthly, quarterly, annually and multi-annually depending on the nature of decisions to be made.

The development of the model has been used to transform the processes of the company toward more cooperation, transparency, and alignment on common objectives. It contributed significantly to breaking the silos within the organization, educating managers on the interdependency of their actions, and materially affected the culture of the company to promote innovation collaboration and entrepreneurship. In turn, this led to the development of a new university (UMP6) in Morocco in 2017, in which analytics play a central role, and a very successful executive education class at MIT.

The optimization model is responsible for an EBITDA improvement year-on-year in excess of 20%, amounting to more than $2.3 billion for the period 2015-2020. (EBITDA stands for earnings before interest, taxes, depreciation, and amortization and is a metric used to evaluate a company's operating performance.)

It can be seen as a proxy for cash flow from the entire company's operations.) The incremental profitability has fueled OCP's financing capacity.

OCP is consequently delivering a $20 billion in capital expenditures (CAPEX) program. The first phase of the CAPEX program led to doubling OCP's mining capacity and tripling fertilizer production capacity, resulting in OCP bringing an additional 8 million tons of fertilizers production capacity in the last decade. The model further enabled OCP to produce customized fertilizers that helped achieve materially improved agricultural yields, hence food production, especially in Africa. The increased production of fertilizers and availability of customized fertilizers have significantly contributed toward global food security.

ORGANIZATIONS

OCP

The OCP Group (formerly Office Chérifien des Phosphates) is a Moroccan-based phosphate rock miner, phosphoric acid manufacturer, and phosphate fertilizer producer and exporter. Founded in 1920, the company has grown into the largest phosphate mining and processing company in the world and is responsible for 31% of phosphates global trade, an element that is key to global food security as it is an essential and non-substitutable component of fertilizers. OCP has access to more than 70% of the world's phosphate rock reserves. The group employs nearly 20,000 people in Morocco and a number of international subsidiaries. In 2018, its revenues amounted to $6 billion, which represented 5% of the GDP (gross domestic product) of Morocco.

In 2006, OCP was in such financial distress that it was seeking massive cash injection just to survive. OCP was holding a $3.8 billion long-term liability and had achieved mostly negative net income since

1999. The company was focused on maximizing the volume of rock extracted, which produced poor financial performance and limited its growth capacity to address growing food demand.

A new team led by Dr. Mostafa Terrab, chairman and CEO, took leadership of the company in 2006 with the mandate to change the strategy, address the financial situation of the organization, change the operating processes, deal with internal politics, and more importantly transform the culture of the organization.

OCP is unrecognizable today. The company is now highly profitable ($2 billion EBITDA in 2020 while prices of fertilizers were near the bottom of the price cycle), its culture is oriented toward serving its end-customers while optimizing value-leveraging sales and strong operations departments collaboratively.

Dynamic Ideas

Dynamic Ideas is a Massachusetts-based analytics consulting company founded in 1999. Several of the senior members of the Dynamic Ideas team were trained in operations research at Massachusetts Institute of Technology. The company has extensive expertise in optimization and analytics. Its clientele includes several major global companies including OCP.
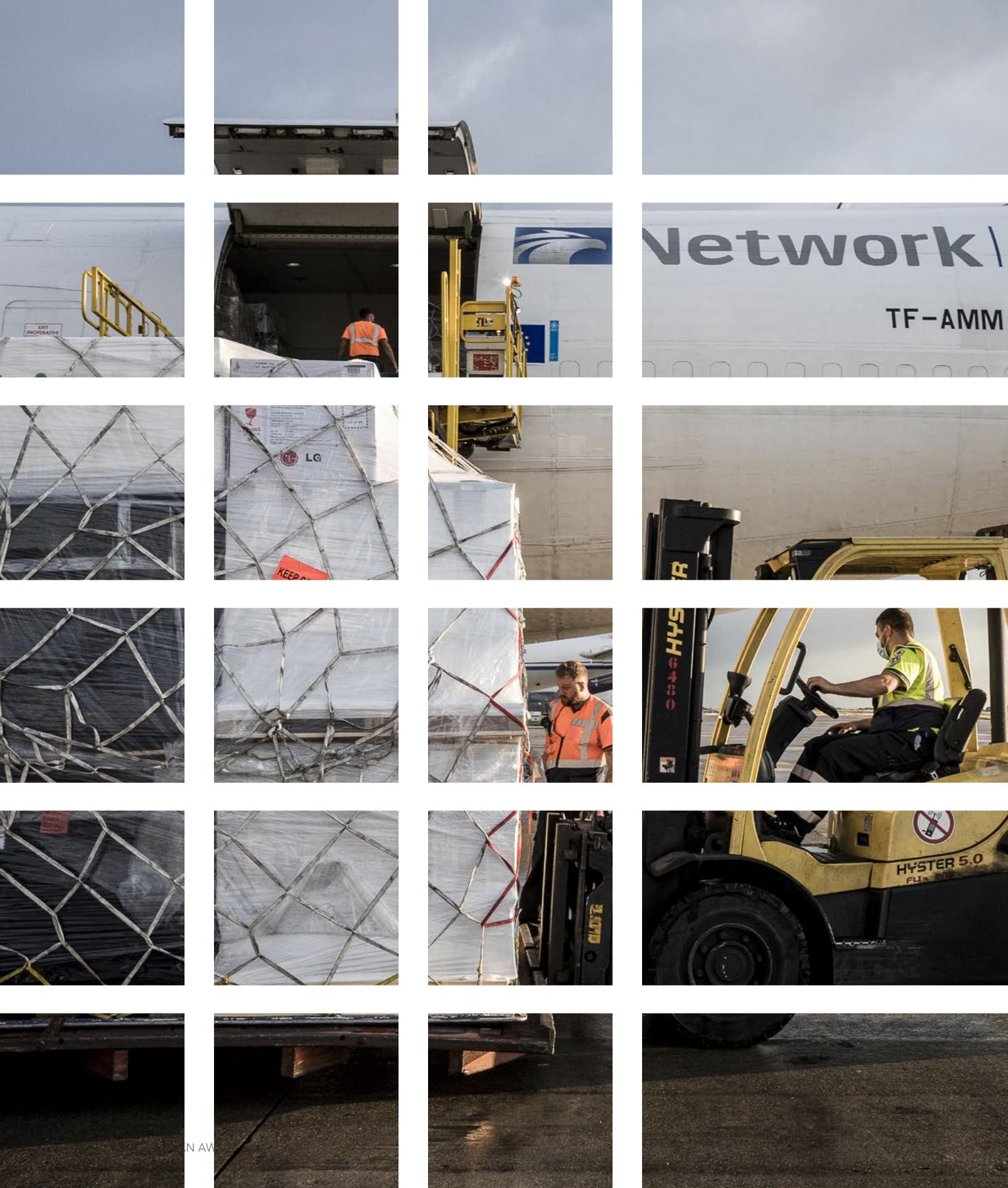
UNITED NATIONS WORLD FOOD PROGRAMME

Toward Zero Hunger with Analytics

Today, nearly 690 million people regularly go to bed hungry. This means 1 in 11 people do not have access to enough food – a situation exacerbated further by the ongoing COVID-19 pandemic. One of the key players addressing this issue is the United Nations World Food Programme (WFP), the world's largest humanitarian organization fighting hunger worldwide and winner of the 2020 Nobel Peace Prize. In 2019, WFP procured and distributed 4.2 million metric tons of food and provided U.S. $2.1 billion in cash-based transfers to 97.1 million beneficiaries across 88 countries.

Humanitarian operations are complex to manage by nature, as they seek to address multifaceted problems with limited resources in unstable operational environments. Planning and managing the entire supply chain of WFP assistance comes with many unique challenges: from high demand volatility to funding restrictions and from security

and access limitations to data inconsistencies. As needs evolve and new information comes in, it is critical to continually monitor and understand each operation, quickly adapt and re-evaluate plans, optimize the use of limited resources, and anticipate what is expected to happen next.

To that end, WFP has been embracing the power of analytics. Engineers and mathematicians have taken a leading role in supporting complex operations, using analytics as an enabler to strengthen the integration between functional areas, augment visibility on WFP operations, and find concrete ways to maximize their efficiency and effectiveness.

Working closely with its partners in academia (Tilburg University and Georgia Institute of Technology) and the private sector (Palantir, UPS, and Takeda), WFP has been developing a variety of tools ranging from automated dashboards (bringing together descriptive and predictive analytics) to decision support systems (such as control towers and optimization models). This coordinated, proactive, and data-driven approach to managing humanitarian operations has resulted in a wide range of benefits.

In South Sudan, this approach has been used to optimize food arrivals through international corridors (Sudan, Ethiopia, Kenya, and Uganda)

and redesign the logistics network, improving access to hard-to-reach locations and reducing the need for costly airdrops. This has resulted in better utilization of the riverine network, earlier availability of donor funding, and more than U.S. $100 million in savings. Moreover, this approach led to the reopening of a barge supply line between Sudan and South Sudan for the first time since 2011, contributing to peace-building activities and economic development across the region.

In Iraq, analytics helped identify more cost-effective food baskets. Simultaneously optimizing the composition of the ration and the supply chain strategy reduced monthly operational costs by 12% without compromising the nutritional performance of the basket. This optimized ration was distributed for more than two years, resulting in more than U.S. $25 million in savings.

For the COVID-19 response, analytics supported senior management in decision making for global operations, evaluating contingency scenarios and prioritizing scarce resources such as funds, staff, and key commodities. Additionally, a Control Tower was built to support WFP's Common Services, which allow other organizations and partners to leverage WFP's supply chain network to move life-saving health cargo anywhere in the world. This allowed for the transportation of 100,000 m³ (cubic meters) of cargo to more

than 150 countries during a period of extensive lockdowns and access constraints.

Significant investments over the last decade have put planning and optimization at the forefront of tackling emergencies at WFP. A data-driven approach to managing operations has gradually become the norm and has culminated in the creation of a supply chain planning unit and more than U.S. $150 million in savings – enough to support two million food insecure people for an entire year. The developed tools provide end-to-end decision support for each WFP operation, making it possible to rapidly identify the most efficient and effective course of action.

Through analytics, decision makers are now equipped with the insights they need to manage their operation in the best way, thereby saving and changing the lives of millions and bringing the world one step closer to "Zero Hunger."

ORGANIZATIONS

U.N. World Food Programme

The U.N. World Food Programme (WFP) is a frontline humanitarian organization saving lives and changing lives, delivering food assistance in emergencies, and working with communities to

improve nutrition and build resilience. For its efforts to combat hunger, contribute to bettering conditions for peace in conflict-affected areas and for acting as a driving force to prevent the use of hunger as a weapon of war and conflict, WFP was awarded the Nobel Peace Prize in 2020.

On any given day, WFP has 5,600 trucks, 30 ships, and nearly 100 planes on the move, delivering food and other life-saving assistance to those in most need. Every year, it distributes more than 15 billion rations at an estimated average cost per ration of U.S. $0.61. These numbers lie at the roots of WFP's unparalleled reputation as an emergency responder, one that gets the job done quickly at scale in the most difficult environments. In 2019, WFP assisted 97 million people in 88 countries.

Two-thirds of WFP's work is in conflict-affected countries where people are three times more likely to be undernourished than those living in countries without conflict. In emergencies, WFP is often first on the scene, providing food assistance to the victims of war, civil conflict, drought, floods, earthquakes, hurricanes, crop failures, and natural disasters. When the emergency subsides, WFP helps communities rebuild shattered lives and livelihoods. In addition, WFP works to strengthen the resilience of people and communities affected by protracted crises by applying a development lens in its humanitarian response.

THE WAGNER PRIZE

DANIEL H. WAGNER PRIZE HISTORY

For Excellence in the Practice of Advanced Analytics & Operations Research

T he Wagner Prize is awarded annually in honor of the late Dr. Daniel H. Wagner. During his years as president and principal owner of Daniel H. Wagner Associates, Dr. Wagner brought many high-quality mathematicians into the operations research community. This led to significant advances in the firm's fields of endeavor and delivery of significant applications to the Navy, Coast Guard, and other clients. Many of the applications are still in service today.

Dr. Wagner earned his PhD in mathematics from Brown University in 1951. His dissertation, "On Free Products of Groups," was published in 1957 in the *Transactions of the American Mathematical Society*. Dr. Wagner joined the Navy's Operations Evaluation Group at the Pentagon, working on operations research for naval warfare. He worked there until 1956, with a one-year leave of absence for postdoctoral research on free algebras at MIT.

Dr. Wagner then joined the Burroughs Research Center, where he directed a group of mathematicians performing analysis for the development of digital computers.

In 1957, Dr. Wagner and John D. Kettelle formed the partnership of Kettelle and Wagner, which was dissolved in 1963. That same year, he formed a new company, Daniel H. Wagner Associates, Inc. This company applied itself to cutting-edge work in the mathematics of naval tactics, especially antisubmarine warfare, detection theory, and search planning.

After retirement from the firm he founded, Dr. Wagner held various teaching and research positions with the U.S. Naval Postgraduate School and the U.S. Naval Academy.

Dr. Daniel H. Wagner was a member of INFORMS/ORSA for more than 40 years. He passed away in March 1997.

2020 Wagner Prize Committee (*Nonvoting Member*)

- Mary Helander, *Chair, Wagner Prize; Syracuse University*
- Margret Bjarnadottir, *University of Maryland*
- William J. Browning, *Applied Mathematics, Inc.*
- C. Allen Butler, *Wagner Associates*
- Jim Cochran, *University of Alabama*
- Brian Eck, *Google Inc.*
- Pavithra Harsha, *IBM Research*
- Lawrence D. Stone, *Metron Inc.*
- Rahul Swamy, *University of Illinois Urbana-Champaign**
- Emily Tucker, *University of Michigan*

2020 WAGNER PRIZE FINALISTS

The 2020 Wagner Prize competition took place at the Virtual 2020 INFORMS Annual Meeting. Five teams gave presentations to the INFORMS Practice Section judging committee seeking to demonstrate that the quality of their analysis in a real-world application qualifies them to win this award for outstanding practice of operations research and advanced analytics. The judging committee announced the winner during the Annual Meeting, and the winning team of the Daniel H. Wagner Prize will reprise their presentation during the Virtual 2021 INFORMS Business Analytics Conference.

Dr. Wagner strove for strong mathematics applied to practical problems, supported by clear and intelligible writing. This prize recognizes those principles by emphasizing good quality writing, strong analytical content, and verifiable practice successes within analytics and operations research.

All finalists' presentations can be viewed at the INFORMS Video Library. A special issue of *INFORMS Journal on Applied Analytics* (formerly *Interfaces*) will publish the winning paper along with those of the other four finalists listed below:

A Boost for Urban Sustainability: Optimizing Electric Transit Bus Networks in Rotterdam

- Ayman Abdelwahed, Pieter Van den Berg, Tobias Brandt, & Wolfgang Ketter, *Erasmus University Rotterdam*
- Judith Mulder, *RET*

Driver Positioning and Incentive Budgeting with an Escrow Mechanism for Ridesharing Platforms

- Davide Crapis & Hao Yi Ong, *Lyft*
- Daniel Freund, *Massachusetts Institute of Technology*

Formulation Matters: Reciprocating Integer Programming for Birchbox Product Assortment

- Irvin Lustig, CAP, Patricia Randall, & Robert Randall, *Princeton Consultants*

Scheduling the Main Professional Soccer League of Argentina

- Mario Guajardo, *NHH Norwegian School of Economics*
- Guillermo Durán & Facundo Gutiérrez, *University of Buenos Aires*
- Javier Marenco, *University of General Sarmiento*
- Denis Sauré & Gonzalo Zamorano, *University of Chile*

2020 WAGNER PRIZE WINNER

The 2020 Daniel H. Wagner Prize for Excellence in the Practice of Advanced Analytics and Operations Research first place winners are Saurabh Bansal from The Pennsylvania State University, Genaro J. Gutierrez from The University of Texas at Austin, and Mahesh Nagarajan from University of British Columbia.

Theory-driven Practical Approach to Integrate R&D and Production Planning for Portfolio Management in Agribusiness

- Saurabh Bansal, *The Pennsylvania State University*
- Genaro J. Gutierrez, *The University of Texas at Austin*
- Mahesh Nagarajan, *University of British Columbia*

The award winning paper, "Theory-driven Practical Approach to Integrate R&D and Production Planning for Portfolio Management in Agribusiness," describes agribusiness firms with an eye toward increasing population and evolving weather patterns, investing heavily into developing new varieties of staple crops that can provide higher yields and are robust to weather fluctuations.

The team worked with Dow Agrosciences (now Corteva) over a period of five years to manage its seed corn portfolio, which includes several hundred seeds that cater to specific regions in the continental U.S. and is valued at more than $1 billion.

The effort had two interacting parts: (1) developing a decision analytic theory to estimate the production yield distributions for new seed varieties from discrete quantile judgments provided by plant biology experts, and (2) developing an optimization protocol to determine Dow's annual production plan for the seed portfolio with a flexibility of backup production in South America, under production yield and demand uncertainty. The first part was needed due to the sparsity of the yield data available during the research and development (R&D) process for new seeds.

It was owned by the R&D function at the firm and provided yield probability distributions as inputs to the optimization protocol of the second part, which was owned by the production function. This optimization protocol navigated several hundred uncertainties in yields and demands for the seeds in the portfolio to determine the area that Dow should use in North America and South America for growing each seed.

The results of the optimization problem informed the R&D function about the attractiveness of specific future varieties and helped structure its research pipeline. The team developed new theoretical results for both parts that were also easy to implement in the industrial environment at Dow. The implementation of the developed theory led to significant monetary and managerial benefits at Dow and underscores the importance of human elements of decision making at firms.

UPS GEORGE D. SMITH PRIZE

UPS GEORGE D. SMITH PRIZE HISTORY

T he UPS George D. Smith Prize is awarded to an academic department or program for effective and innovative preparation of students to be good practitioners of operations research, management science, or analytics. It is accompanied by a $10,000 cash award. The prize committee is pleased to announce the 2021 finalists:

- Gies College of Business,
  University of Illinois Urbana-Champaign

- Department of Information & Decision Sciences at the Carlson School of Management,
  University of Minnesota

- Department of Business Analytics,
  University of Iowa

The UPS George D. Smith Prize is an exciting award created in the spirit of strengthening ties between industry and the schools of higher education that graduate young practitioners of operations research (O.R.). This prize has been named in honor of the late UPS chief executive officer who was a patron of operations researchers at the leading Fortune 500 corporation. George D. Smith was the second CEO of UPS, holding the position from 1962 to 1972. He joined UPS as an accountant in 1925 and at some point in his long and illustrious career held almost every functional title within the company.

While his background was steeped in finance, George Smith had a keen engineering mind. In the late 1940s, after learning about O.R., Smith realized that intuition alone would not be enough to help UPS master the many issues it faced as it grew in size from a regional to nationwide carrier. Smith recognized O.R. as an engineering approach to making decisions, and started advocating the use of O.R. concepts at UPS. Quantitative analysis became the bedrock on which the UPS engineering function was built. Because of Smith's vision, UPS now employs thousands of engineers whose focus is efficiency, sustainability, and service.

He was a strong believer in investing in our younger generation. For him, nurturing them was the key to sustained prosperity. This prize embodies Smith's beliefs: to recognize the importance of O.R. in practice, and ensure that members of our younger generation get proper exposure to its value, and in turn benefit society.

2021 UPS Smith Prize Committee

- Robert Dell, *Chair, Smith Prize; Naval Postgraduate School*

- Andrew Armacost, *University of North Dakota*

- Jill Hardin Wilson, *Northwestern University*

- Patricia Randall, *Princeton Consultants*

- Anne Robinson, *Kinaxis*

- Andrew Wasser, *Carnegie Mellon University*

- Haining Yu, *Amazon*

2021 SMITH PRIZE COMPETITION

Since the earliest days of operations research (O.R.) and analytics, to support the developing technology and research, it became increasingly important to prepare young O.R. and analytics professionals to further the growing impact of these fields. The UPS George D. Smith Prize recognizes the importance of a strong partnership between industry and academia in preparing students to be effective practitioners. The diversity, quality, and innovation of this year's finalists presented the committee with an encouraging and exciting glimpse of the future of the profession.

"As we grow in size, our problems increase geometrically. Without operational research, we would be analyzing our problems intuitively only, and we would miss many opportunities to get maximum efficiency out of our operation." – George D. Smith

SMITH PRIZE PAST WINNERS

2020 Smith School of Business
Queen's University

2019 Department of Operations, Business Analytics, and Information Systems
University of Cincinnati

2018 Haslam College of Business MSBA
University of Tennessee

2017 Operations Research Program
United States Air Force Academy

2016 H. John Heinz III College of Information Systems and Public Policy
Carnegie Mellon University

2015 Sauder School of Business
University of British Columbia - Center for Operations Excellence

2014 Leaders for Global Operations
Massachusetts Institute of Technology
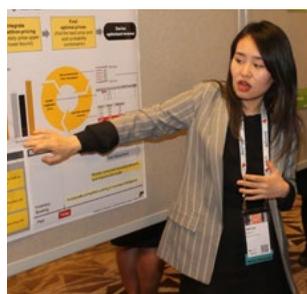
2013 Department of Operations Research
Naval Postgraduate School

2012 Tauber Institute for Global Operations
University of Michigan

Excellence in Analytics

Gies College of Business has reinvented business education by integrating data analytics across the curriculum to ensure every Gies Business student is trained in operations and analytics. At Gies, students develop a data science mindset that drives the world of information systems, operations, supply chain, and analytics forward. It is a purposeful endeavor that accelerates the learning curve—for our students and for the future of business.

Reimagining the data analytics curriculum

Approximately 800 undergraduate students take operations and analytics as part of their core curriculum. Gies' graduate programs offer more than 25 courses in analytics, and in Fall 2021 the College will launch an MS in Business Analytics. This is in addition to the one-year MSTM, which focuses on leveraging business and technology—and our online MBA (iMBA), which offers a business data analytics concentration. Doctoral students learn analytical and empirical methods, applying business analytics and machine learning to a variety of business issues.

Gies benefits from extensive interactions with industry stakeholders to provide our students with experiential learning opportunities so they can cultivate tools to stay ahead of current trends. Students have opportunities to work on industry-sponsored projects in practicum courses to solve challenges such as developing risk metrics and forecasting demand with the latest cognitive technologies.

Our partnerships go well beyond hands-on learning for our students. We have developed the University of Illinois-Deloitte Foundation Center for Business Analytics to provide leading-edge ideas and curriculum materials that aim to revolutionize how schools teach business analytics to future professionals. To date, the Center has released four courses that are free and available to the public.

Interdisciplinary team of faculty experts

Gies faculty use a variety of data analytics techniques to test new ideas that are changing business and society. Faculty work together on projects and grants in an environment where interdisciplinary research is highly encouraged.

Learn more at the Gies Business IOSA page

Gies College of Business
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

A PIONEER
Looks to the Future

Widely considered to be a birthplace of the discipline, the University of Minnesota's **Carlson School of Management** has been at the forefront of management information systems research and education for more than 50 years.

Today the school's **Information and Decision Sciences** department continues that tradition with business analytics programs that prepare students to become technically-skilled, business-savvy leaders for a data-driven world.

#2	#5	#8
in the world for publications in top information systems journals	Information Systems Programs	Masters in Business Analytics in the U.S.
AIS Research Rankings 2016-2020	*U.S. News and World Report 2021*	*QS World University Ranking 2021*

IN DEMAND

Our M.S. in Business Analytics graduates go on to careers at Amazon, Capital One, Ford, McKinsey & Company, and other top companies. Placement rates for our graduates for the last six years:

100% 2015	**100%** 2016
99% 2017	**100%** 2018
98% 2019	**94%** 2020

CONNECTED TO INDUSTRY

Best Buy, Target, Medtronic, 3M, Land O'Lakes, and Optum are just some of the companies that partner with us on:

EXPERIENTIAL LEARNING
for students in the
Carlson Analytics Lab

RESEARCH SUPPORT
for faculty in the
MIS Research Center

INNOVATION & COLLABORATION
through events and custom
executive education

CARLSON SCHOOL
OF MANAGEMENT
UNIVERSITY OF MINNESOTA

carlsonschool.umn.edu

Department of Business Analytics

The Department of Business Analytics has emerged as a thought leader in business education and research.

Our programs offer students a technical degree, covering important topics such as database management, information visualization, big data, and optimization modeling in our courses. We keep our curriculum for all programs up to date by incorporating feedback from our Tippie Analytics Cooperative Advisory Council, representing important employers in the field, in our major curriculum decisions. We offer students a degree that prepares them for the real world by requiring all students in our undergraduate and graduate programs to participate in capstone projects with companies. We also offer students the ability to distinguish themselves by being good communicators, with an emphasis on writing and presentation skills woven throughout our courses. Our programs value and promote diversity.

The Department of Business Analytics offers experts in:

▶ Data science
▶ Social network analysis
▶ Machine learning
▶ Optimization
▶ Statistics
▶ Transportation
▶ Supply chain management

Academic Programs

Undergraduate degree in Business Analytics and Information Systems

Graduate Certificate in Business Analytics

Part-time Master's Degree in Business Analytics

Full-time Master's Degree in Business Analytics

PhD in Business Analytics

More Information

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📷 @tippieanalytics

Congratulations to all
2021 Edelman Award finalists.

Kinaxis. Empowering confident supply chain planning decisions.

kinaxis®
KNOW SOONER. ACT FASTER.

INFORMS PRIZE

INFORMS PRIZE HISTORY

T he INFORMS Prize has been honored during the Edelman Award Ceremony for 14 years. While the Edelman Award and the Wagner Prize recognize single projects that demonstrate outstanding accomplishments in O.R. practice, the INFORMS Prize complements them by recognizing long-term, multiproject achievements. The INFORMS Prize is awarded annually to recognize effective integration of O.R. into organizational decision making. It is awarded to an organization that has repeatedly applied the principles of advanced analytics in beneficial and long-lasting ways.

2021 INFORMS Prize Committee

- Erica Klampfl, *Chair, INFORMS Prize; Ford*
- Bill Cook, *University of Waterloo*
- Steve Dirkse, *GAMS*
- Bryan Flietstra, *Steelcase*
- Stefan E. Karisch, *Boeing*
- Kathy Lange, *SAS*
- Sanjay Saigal, *University of California, Davis*

INFORMS PRIZE WINNERS

2021 Amazon

2020 UPS

2019 Booz Allen Hamilton

2018 BNSF Railway

2017 The Walt Disney Company & U.S. Air Force

2016 General Motors

2015 Chevron

2014 Mayo Clinic

2013 Ford Motor Company

2012 Memorial Sloan Kettering Cancer Center

2011 Sasol

2010 Jeppesen

2009 Intel Decision Technologies Group

2008 GE Global Research Risk & Value Management Laboratory

2006 Schneider National, Inc.

2005 Air Products & Chemicals, Inc.

2004 Procter & Gamble

2003 UPS

2002 Hewlett-Packard

1999 IBM

1998 Lucent Technologies

1997 Merrill Lynch Private Client Group

1996 Pfizer Inc

1995 Bellcore

1994 AT&T and US West Technologies

1993 New York City Office of Management and Budget & United Airlines

1992 San Miguel Corporation

1991 American Airlines & Federal Express

Notes: Prior to 1995, the award was called the ORSA Prize. No prize recipients were chosen in 2000, 2001, and 2007.

INFORMS PRIZE CRITERIA

The INFORMS Prize selection committee is comprised of six members as well as the past committee chair, consisting of practitioners and academics, providing a broad representation of the operations research community.

Variety of Advanced Analytics and O.R. Applications.
Implementations in diverse applications, using a wide set of methods, led to greater opportunities to improve organizational performance.

Strategic Advantage for the Organization.
Analytics and O.R. permeate the parent organization's operations and are considered integral and a source of strategic advantage.

Large Impact.
Over the years the total amount of beneficial impact on the organization has been substantial. This impact was delivered through some one-time and some recurring projects; its amount could be described sometimes by numerical measures and sometimes by statements without numbers.

Model for Success.
The organization provides an excellent example of successful analytics and O.R. practice for others to follow. An important reason for success has been to contribute in a variety of basic functions; for instance, in a business organization these functions likely will include finance, marketing, production, and planning.

Top-Management Endorsements.
Strong submissions include personally written endorsements from top-level executives.

High-Quality Application.
The best applications are well written. And they are complete, with all supporting references and endorsements included.

2021 INFORMS PRIZE WINNER

The 2021 INFORMS Prize for Sustained Integration of Operations Research first place winner is Amazon. Amazon is guided by four principles: customer obsession rather than competitor focus; passion for invention; commitment to operational excellence; and long-term thinking. Some of the products and services pioneered by Amazon include: customer reviews, 1-Click shopping, personalized recommendations, Prime, Fulfillment by Amazon, AWS, Kindle Direct Publishing, Kindle, Fire tablets, Fire TV, Amazon Echo, and Alexa.

From the beginning, operations research (O.R.) and analytics have been critical to Amazon's success: Initial mathematical modeling initiatives focused on topology, the location of fulfillment centers (FCs) and improving the throughput of these facilities. As the number of FCs increased, Amazon focused its analytical horsepower on how to optimize the storage of inventory within the FCs, distribute inventory throughout the fulfillment network, optimize labor for all seasons, and how to "pick" more effectively. The introduction of new business initiatives such as robotics, web services, retail and physical stores has opened new avenues for the application of optimization, machine learning, and analytics to increase efficiency across all aspects of the business including the design and operation of one of the world's largest delivery networks.

Today, the middle mile ground and air transportation network represents one of the fastest growing logistics areas within Amazon. The ground network moves tens of millions of packages a week worldwide, operating hundreds of thousands of truckloads and thousands of air cargo flights each week. The scale and combinatorial nature of the delivery operation challenges Amazon to design, build, and operate robust transportation networks that minimize the overall operational cost while meeting customer promises and providing a good experience for Amazon employees. The Middle-Mile Planning, Research, and Optimization Sciences (mmPROS) team is central to this goal and charged with developing an evolving innovative suite of decision support and optimization tools to facilitate the design of efficient air and ground transport networks, optimize the flow of packages within the network to efficiently align network capacity and shipment demand, and effectively utilize scarce resources, such as aircraft, trucks, and rail services.

The innovative tools developed to design and operate these networks rely heavily on mathematical optimization models and algorithms, machine learning, stochastic modeling and simulation, metaheuristics, and advanced analytics. Focus areas include surface research science, air science and tech, and pricing and yield management. These cutting-edge models and algorithms have helped to significantly reduce air and ground shipping costs while completely changing how carriers discover and book loads with Amazon through mobile apps using automated, dynamic pricing offers.

INFORMS

ABOUT INFORMS

The Institute for Operations Research and the Management Sciences

F rom increased efficiency in business processes that leads to millions in savings, to lifesaving advancements in medical treatments, to revolutionized transportation and delivery systems, analytics and operations research (O.R.) are truly saving lives, saving money, and solving problems. At the heart of this growing field is INFORMS, the leading professional society for a vibrant community of nearly 12,000 operations research and analytics professionals, academics, and students, representing more than 82 countries around the world, whose impact on the economy and society has been and continues to be nothing short of remarkable.

INFORMS promotes best practices and advances in analytics and O.R. We are dedicated to encouraging, facilitating, and awarding excellence in our membership. Formed in 1995 when the Operations Research Society of America (ORSA) and The Institute of Management Sciences (TIMS) merged, INFORMS strives to provide opportunities of inspiration and collaboration among our members, fostering the life-changing ideas of the O.R. and analytics leaders of the future.

During the COVID-19 pandemic, INFORMS pivoted to transform both its Annual Meeting and Analytics Conference from in-person events featuring thousands of attendees, to fully virtual platforms that welcomed members of the O.R. and analytics community from around the globe to interact and collaborate as well as celebrate the individuals and organizations making global impacts. In addition ,the growing INFORMS advocacy program leverages the expertise of our members to provide policymakers in Washington, D.C., with valuable insight regarding the importance of data-driven decision making.

INFORMS publishes 17 scholarly, peer-reviewed journals, more than one-third of which are featured on the *Financial Times* list of 50 top academic journals, highlighting the latest O.R. and analytics methods and applications. In addition, our continuing education and Certified Analytics Professional (CAP®) and Associate CAP (aCAP) certification programs provide opportunities for professional advancement at every career stage. With 22% of Fortune 100 companies now employing CAP certified analytics and O.R. professionals, these certifications enable industry leaders to identify and employ top talent.

INFORMS provides many resources to organizations of all sizes seeking information on the benefits of analytics, connecting them with the latest research and discoveries, as well as analytic and operational research professionals with the expertise they require. In addition, within our membership are smaller specialized subdivisions that are dedicated to a common theme or technical interest, many of which directly pertain to analytics and operations research applications for industry. Our members are embracing complex problems and unlocking the valuable data needed to enhance decision-making processes and improve day-to-day operations in almost every industry sector.

INFORMS would like to congratulate and thank the 2021 Franz Edelman Award finalists, both for their incredible contributions today, as well as inspiring the great discoveries and advancements of tomorrow.

ADVANCING THE PRACTICE OF O.R. & ADVANCED ANALYTICS

By Srinivas Bollapragada
President, INFORMS Section on Practice

Tonight we celebrate outstanding achievements in operations research and advanced analytics. This Award Ceremony and the competitions for the Edelman Award, Wagner Prize, and UPS George D. Smith Prize are all conducted by volunteers of the INFORMS Section on Practice. Details on these competitions are described in this program book.

The focus of our Section is on promoting the practice of operations research and advanced analytics through the stewardship of competitions dedicated to highlighting the best practices of our profession. We also organize a set of practice-related presentations at the INFORMS Annual Meeting in the fall and publish biannual newsletters for Section members.

Recently, we started organizing monthly webinars to bring awareness of the value of applying analytics to real-world problems, and monthly happy hours to promote networking, especially during this pandemic when many of us are working from home. Please visit the Practice Section website at connect.informs.org/practice for more information on the Section and all of its activities.

We invite you to join our exceptional group of volunteers who are dedicated to improving the world by using operations research and analytics to save lives, save money, and solve problems. Our volunteers are from many different organizations in industry, academia, and government, and they have different perspectives to share. Collaborating and networking with this group while contributing to the advancement of our profession is stimulating and rewarding.

If you are interested in volunteering with the INFORMS Section on Practice, please send an email to me at: bollapragada@ge.com.

CALL FOR INFORMS AWARD SUBMISSIONS

Descriptions of INFORMS awards and prizes, and submission deadlines listed here.

Daniel H. Wagner Prize
Excellence in Operations Research Practice

The Daniel H. Wagner Prize emphasizes the quality and coherence of the analysis used in practice. This prize recognizes those principles by emphasizing good writing, strong analytical content, and verifiable practice successes.

2021 Submission Deadline: Sunday, May 2, 2021

Franz Edelman Award
Achievement in Advanced Analytics, Operations Research, & Management Science

The purpose of the Franz Edelman Competition is to bring forward, recognize, and reward outstanding examples of impactful O.R., management science, and advanced analytics practice in the world.

2022 Submission Deadline: Wednesday, December 1, 2021

UPS George D. Smith Prize
Strengthening Ties Between Academia & Industry

The UPS George D. Smith Prize is awarded to an academic department or program for effective and innovative preparation of students to be good practitioners of operations research, management science, or analytics.

**2022 Submission Deadline: Sunday, October 31, 2021**

INFORMS Prize
Sustained Integration of Operations Research

The INFORMS Prize is awarded for effective integration of advanced analytics and OR/MS in an organization. The award is to be given to an organization that has repeatedly applied the principles of advanced analytics and OR/MS in pioneering, varied, novel, and lasting ways.

2022 Submission Deadline: Wednesday, December 1, 2021
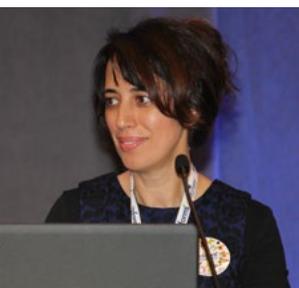
FEW INDUSTRIES ARE AS RELEVANT TO HUMANITY – AND COMPLEX – AS AGRICULTURE

Data analytics is helping address the challenges facing food production.

10 BILLION
GLOBAL POPULATION BY 2050

200,000 DAILY
POPULATION GROWTH

70% GREATER
DEMAND FOR FOOD BY 2050

FINITE ARABLE LAND AND WATER

At Syngenta, we're harnessing the power of data analytics to develop higher-yielding, more resilient seeds – and digital tools to help farmers make better decisions about their crops.

Embracing the innovative spirit, talent and purpose within the INFORMS community, Syngenta is proud to celebrate the class of 2021 Franz Edelman Award finalists.

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Decision Management

Introducing the FICO "Optimizing Success" Program

A reported 85% of advanced analytics projects fail to reach successful deployment, due to disconnects between model builders and business users. That's why thousands of companies trust FICO Xpress Optimization – which includes Xpress Insight, Solver, Mosel, Workbench, and Decision Optimizer – for their most demanding challenges. With Xpress Optimization, data scientists and business users can collaboratively build, deploy, and execute the type of analytically-powered applications that will enable their firms to transcend the competition.

To help every business enjoy this degree of cross-organizational synergy, FICO created the new "Optimizing Success" program. The Optimizing Success program makes it easier than ever for users of other optimization products – such as IBM's ILOG CPLEX Optimization Studio, Gurobi Optimizer, and SAS Optimization – to migrate to Xpress and achieve an entirely new level of project success.

Under The Optimizing Success Program, New Users Can Receive:

- Free model benchmarking, to compare their current model performance with Xpress 8.11
- One free Xpress-Insight based proof-of-concept application to enable business users to run models as a web application (limited availability)
- Free model conversion from your existing solver API to FICO Xpress, up to 2,500 lines of code
- Free model conversion from your math modeling language to FICO Xpress Mosel, up to 1,500 lines of code. This typically results in a 2-10x matrix generation speedup.
- A discount on start-up professional services, such as complex application migration to FICO Xpress Mosel or Xpress Solver API (Python, Java, .NET, C/C++, R, etc)
- A free community license version of Xpress Insight for a single user/developer
- Free membership in the FICO Optimization Community, free access to online training tutorials, and discounts on customized training courses if needed
- Weekly Xpress office hours, open to all FICO Xpress customers

Why Switch to FICO Xpress Optimization?

FICO has been a leader in optimization for nearly 40 years and continues strong investments in solver performance and R&D. We have a growing, dedicated team of modeling and solver experts, including several hired from IBM just recently, who can help you get the best out of Xpress. We work very closely with our users, and our products are second-to-none in terms of performance, features, functionality, and productivity:

- Xpress Solver offers the widest breadth of fast and reliable solvers, the highest degree of reproducibility of results (independent of the platform), and several solution robustness features, including solution refiner, iterative refinement, MIP Solution Refiner, machine learning for scaling, and diagnostics for numerical issues.

- Xpress Mosel is our expressive and intuitive language for formulating mathematical models and writing complex programming logic. Users can implement advanced Solver functionality, such as callbacks, entirely from within in the Mosel language. Mosel also provides modules that enable distributed computing, and with the help of the Mosel Native Interface, users can define reusable components such as new types, subroutines, IO drivers, and more.

- Xpress Insight empowers business users with the ability to conduct what-if scenario analysis and collaborate with peers for optimal results. Users can also rapidly create powerful, effective, enterprise-ready analytic and optimization applications faster than ever before.

Success awaits you!

If you are ready to drive the business results of your optimization efforts to new heights, visit our Optimizing Success page today!

Learn more

FICO

ACCOLADES

PAST EDELMAN LAUREATES *(*Indicates Member of Winning Team)*

2020
Kamilia Ahmadi
Justin Beck
Jasmina Bogojeska
Ralf Borndörfer
Yixian Chen
Kalani Ching*
Thomas Eßer
Patrick Frankenberger
Ioana Giurgiu
John Harvey
John Heiney*
Andreas Huck
Dan Iliescu
Viresh Jivane
Christoph Jobmann
Kristina Kaylen
Karl Kempf*
Boris Krostitz
Ryan Lovrien*
Nate Lyman
Nicholas Mason*
Prakhar Mehrota
Pratik Mital
Kai Mohrhagen
Philipp Nagl
Irfan Ovacik*
Linsey Pang
Scott Pleiman
Evan Rash*
Markus Reuther
Tony Romero*
Corrado Sala
Nitin Kishore Sai Samala
Nandini Sarkar*
Thilo Schang
Hanno Schülldorf
Peter Schütz
Shamin Shirodkar*
Monika Shrivastav
George Stark
Tobias Therolf
Harry Travis*
Melinda Urban
Peter Vermeulen

Kerstin Waas
Steffen Weider
Dorothea Wiesmann
Norman Wilken
Wei Xie
Zhenying Zhao*

2019
Angela Akridge*
Shubhi Asthana
John Beaver
Francisco Bernal Lozano
Dimitris Bertsimas
Maja Daczkowska
Arthur Delarue
William Eger
Veronica Elvira Olalla
Martina Fischetti
Olivier Fradet*
Sandeep Gopisetty
Francois Grondin*
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Yuting Jia
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Sebastien Martin
Aly Megahed
Wolffie Miller*
Michele Monaci
Taiga Nakamura
Jay Nanduri
Anand Oka
David Pisinger
Martin Pleau*
David Rios
Michael Rose
Jesper Runge Kristoffersen
Leslie Shoemaker*
Mark Smith
Diana Tao*
Yung Wen Liu

2018
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José Antonio Carbajal, CAP

Wes Chaar
Steven Charbonneau*
James Andrew Costa*
Anthony Coudert*
Umberto Dellepiane
Tianhu Deng
Melissa Dunford*
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Alexandre Fréchette*
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Jingkuan Han
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Karl Kempf
Jean L. Kiddoo*
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Brian Smith*
Rudy Sultana*
Michael Trick*
Brian Wieland
Sean Willems
Peter Williams
Madolin K. Witte

Mengying Xue
Junchi Ye
Yanfang Zhao
Zhongde Zhao
Shuhui Zhou

2017
Brandon Allen
Johanna Amaya
Felipe Aros-Vera
Turgay Ayer
Jeff Ban
Jerod Bieringer
Peter Boggis
Srinivas Bollapragada
Robert Boute
Sylvie Bouffard
Jay Brantley
Matthew Brom
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Mary Deck
Kristof Deneire
Sheila Donahoe*
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Sandra Fleming
Marc Garbiras
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Loskesh Kalahsthi
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Ahmet Kuyumcu*
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Michael Marsico
Susan McSherry
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Heath Morgan
Melanie Murray*
Kaan Ozbay
Zeynep Ozkaynak
Giampaolo Orrigo

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Asheque Rahman
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Mason Samuels
Iván Sanchez-Diaz
Mark Simon
Michael A. Silas
Caesar Singh
Erdem Telatar
Charlie Turnipseed
Maud Van den Broeke
Roshan J. Vengazhiyil
Cara Wang
Andrew Weeks
Chelsea C. White III
Scott Wills
Jeffrey Wojtowicz
Shamim Wu*
Xia Yang
Utku Yildirim*
Chenxi Zeng
Can Zhang

2016
David Aebischer
Fernando Alarcón
William Aldrich
Bradford Alex Baker
Brian Blank
Stefan Conrady
Guillermo Duran
Michael Kevin Geraghty
Gnanadeeban Gnanapandithan
Michael Grimes
Mario Guajardo
Song He
Amanda B. Hepler
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Katherine Lajoie
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Jack Levis*
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Luis Reinoso
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Anthony Tasso
Joseph A. Tatman
Jessica Tisch
Andrew Vatterott
John Vatterott
Rodolfo Villalba
Andrés Weintraub
Jeff Winters*
Darrin L. Whaley
Rodrigo Wolf-Yadlin
Gonzalo Zamorano

2015
Habib Z. Al Abideen
Brian Alford
Tovey Bachman
David Basset
Aaron K. Baughman
Richard Bogdany
Joseph Byrum*
Robert W. Carroll
Kristen M. Cheman
David Culhane*
Jeffrey Curtis
Craig Davis*
Scott Davis
Greg Doonan
Tracy Doubler*
Shatiel Edwards
David Foster*

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Ferrari Griarte
Meggen Gullo
Knut Haase
Benjie Harrison
Andrew Hazlewood
Dirk Helbing
Stephen Henry
Scott Johnson
Matthew Hoffman
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Craig Lawton
Ni Li
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Stephen Mack*
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Cameron McAvoy
Michael McCarthy
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Ronald Mowers*
Frank Muldoon
Jeet Mukherjee
Sven Müller
Brian O'Connell
Herbie Pearthree
Roy Rice
Liliana Shelton
Sandy Sun
Gerald Teper
Clay Upton
Pamela J. Williams
Liang Xu
Xiaochuan Zhang
Kailai Zhou
Chris Zinselmeier*

2014
Ross Anderson
Itai Ashlagi
Hany Atallah
Kristen Baker
Abel Chan
Stephen Cochi*
Radboud Duintjer Tebbens*
Peter Ferris
Chris Forbes
Joseph Forbes

Michael Forbes
David Gamarnik
Ashish Goel
Pankaj Gupta
Siva Gurumurthy
Leon Haley
John Haupert
Zengjian Hu
Paul Kennedy
Eva K. Lee
Joshua Morrison
Edmond Mount
Mark Pallansch*
Eleanor Post
John Putz
Michael Rees
Alvin Roth
Aneesh Sharma
John Sirois
Tayfun Sönmez
Yohan Sutjandra
Calvin Thomas
Kimberly Thompson*
Utku Ünver
Dong Wang
Steven Wassilak*
Michael Wright
Daniel Wu

2013
Carlijin Bak*
Tejinder Kaur Bimbraw
Brett Bonner
Ruud Brekelmans*
Graeme Case
K. Chandrasekhar
Lijun Chen
Zhi-Long Chen
Parag Chitalia
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Yan Liu
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Rohit Saksena
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Craig Stenstrom
Karthik Subbian
Sumathi Subramanian
Lixin Tang
Pieter Vermeer*
David Wagnon
Gongshu Wang
Takashi Yonezawa
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Xinhui Zhang

2012
Ahmar Abdullah
Suresh Acharya
Sofia Archontaki
Bernard A. Benecke
Greg Burel
Arnab Chakraborty
Kyle Christianson
Frederic Deschamps
John Dimotikalis
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Phillip Finch

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Iraklis Lazakis
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Ritwik Sinha
Girish Srinivasan
Suresh Subramanian
Rohit Tandon
Osman Turan
James Van Sistine
Orestis Varelas
Takis Varelas

2011
Naoki Abe
Fernando Alarcon
Gary F. Anderson
Gustavo Angulo
Alex Beiza
James J. Bennett
Cristian Berner
Brian Carlson*
Jaime Catalan
Yonghong Chen*
Brent R. Cooley
Kenneth Cooper
Jin Dong
Xing Dong Zhang
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Timothy Gardinier
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Guillermo Gonzalez
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Sergio Hurtado
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Kevin Larson*
Gregory Lee
Guo Li Jie
Xingwang Ma*
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Gerard Miller
Mauricio Naveas
Andres Neely
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Matthew Tackett*
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Vince P. Thomas
Fernado Valenzuela
Jie Wan
Melissa Weatherwax
Andres Weintraub
Ming Xie
Jun Yin Wen*
Daniel Yung
Eugene Zak*
Bin Zhang

2010
Gerkotze Bonthuys
Ebert Cawood
Jay Cunningham
Miguel de Lascurain*
Luis de los Santos*
Esmi Dreyer
Ingrid Farasyn
Andrea Feunekes
Ugo Feunekes
Marc Fischer
Michele Fisher, CAP
Tjark Freundt

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Johan Janse van Rensburg
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Joel I. Kahn
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David Fernando Muñoz, CAP*
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Hylton Robinson
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Gerrit Streicher
William Tarlton
Hentie van den Berg
Anette van der Merwe
Wim Van de Velde
Lorraine van Deventer
Jaime Villaseñor*
Glenn Wegryn, CAP
Sean P. Willems
Cecile Wykes

2009
Dharma Acharya
Jason Amaral*
Dirk Beyer*
Ann Brecht*
Matt Callahan
Brian Cargille*
Felipe Caro
Russ Chadinha*
Kathy Chou*
Matt Collins
Juan Correa
José Manuel Corredoira
Prashant Dave
Gavin DeNyse*
Miguel Díaz
Alexey Ershov

Graeme Everett
Qi Feng*
Chris Fry*
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Rune Gjessing
Michael F. Gorman
Sharon Hormby
Shailendra Jain*
Shiva Kumar
Rick Lawrence
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Marcos Montes
Julia Morrison
Thomas Olavson*
Cookie Padovani*
Claudia Perlich
Andy Philpott
Sesh Raj*
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Saharon Rosset
David Sellers
Kurt Sunderbruch*
Robert Tarjan*
Timothy Tenca
Kjetil Vatn
Krishna Venkatraman*
Julie Ward*
Joseph Woods*
Bin Zhang*
Jing Zhou*

2008
Erwin Abbink*
Terra Baranowski
Jonathan Berry
Erik Boman
Michael Brennan
Robert Carr
Lorne Cass
Michael Cirillo
Maria Delbom
Charles B. Duke
Helga Einarsdottir
Mats Eklund
Patrik Eveborn
Pieter-Jan Fioole*
Matteo Fischetti*
Marte Fodstad

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William Hart
Lars Hellemo
Jonathan Herrmann
Ken Howard
Dennis Huisman*
Robert Janke
Leo Kroon*
Miro Lehky
Vaughn Lowe
Gábor Maróti*
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Regan Murray
James Oiesen
Cynthia Phillips
Cyndi Quan-Trotter
Sudhendu Rai
Lee Ann Riesen
Frode Rømo
Mikael Rönnqvist
Thomas Scheermesser
Lex Schrijver*
Adri Steenbeek*
Ved Sud
Midori Tanino
Thomas Taxon
Asgeir Tomasgard
James Uber
Jean-Paul Watson
James Wetherly
Roelof Ybema*

2007
Corne Aantjes
Deirdre Borrego
Dwight Branvold
Vinayak Deshpande
Kent Everingham
Matt Gaskins
Jerry Hwang
Tim Hyatt
Irina Ionova
Ananth Iyer
Michael Jacks
Goos Kant
Alexei Khavaev
Eva K. Lee*
Patty Mackenroth
Venu Nagali

Gary Polaski
Mark Pridgen
Frederick C. Riedlin
David Sanghera
Patrick Scholler
William V. Shearin
Michael A. Shirk
Greg Shoemaker
Jorge Silva-Risso
Tim Thurston
Marco Zaider*

2006
William Best*
Raymond H. Bittel
Richard Carnevale
Sridhar Chandrasekaran*
Louis Cox, Jr.
Ross Darrow
Stéphane Dauzère-Pérès
John Elieson
Christoper A. Forgie
Dirk Guenther
Kjetil Haugen
Ulrich Koester
William H. Lee
Per Olav Myrstad
John J. Nestor
Atle Nordli
Asmund Olstad
Robert M. Peterson
Douglas Popken
B.V. Rao
Alf Reistad
Barry C. Smith
Mandyam Srinivasan*
Geir Teistklub
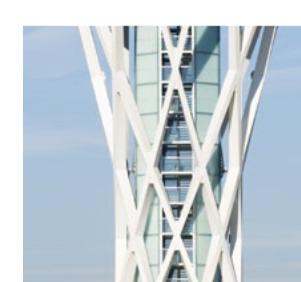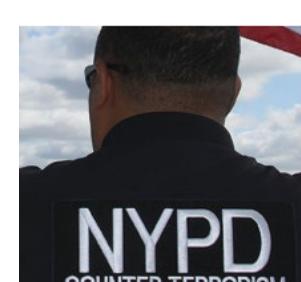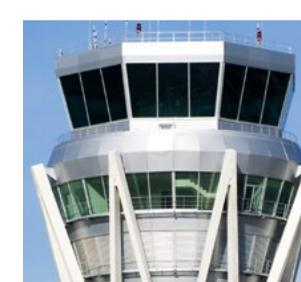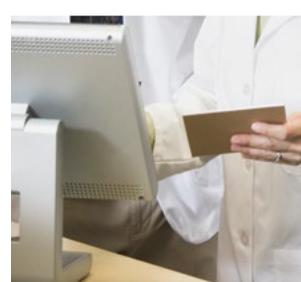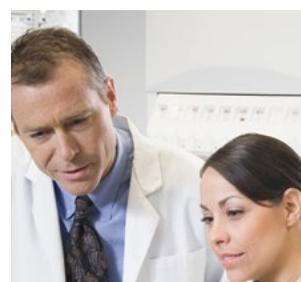Russell Wooten
Faker Zouaoui

2005
Jeffrey Alden*
Dennis Begg
D.A. Beis
Ann Bixby
Lawrence Burns*
Michael Concordia
Theodore Costy*
Brian Downs, CAP
Toshiharu Hasegawa

Rick Hughes
Richard Hutton*
Craig Jackson*
Jim Jacobs
David Kim*
Kevin Kohls*
David Levine
P. Loucopoulos
Paul Martyn
Jonathan Owen, CAP*
Y. Pyrgiotis
Tuomas Sandholm
Mihiro Sasaki
Katsushige Sawaki
Mike Self
Atsuo Suzuki
Mark Turnquist*
David Vander Veen*
K.G. Zografos

2004
Martin Barkman
John C. Butler
Alexander Chebeskov
Herman Chiu
Mathieu Clerkx
Ton de Kok
Jacques Desrosiers
Yvan Dumas
James Dyer
Thomas A. Edmunds
Rob Harlan*
Richard Hicks
Fred Janssen
Jianmin Jia
Mike Kanaley
Joshua Kanner*
Alev Kaya, CAP
Byung-In Kim
Seongbae Kim
Bob Kraas
Benoit Lacroix
Kam-Keung Lai
Edmond Leung
Jiyin Liu
Yong Liu
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Sean Marshall
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Chris Milligan

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Robert Pruneau
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Quentin Samelson*
Avner Schneur*
Rina Schneur*
James Smith
Ron Sorensen
François Soumis
Sridhar Tayur
Loren Troyer
Mitchell Tseng
Jan van Doremalen
Erik van Wachem
Yat-Wah Wan
Elan Yaniv

2003
Kirk Abbott
Surain Adyanthaya
Vedat Akgun
Andrew P. Armacost
Mordecai Avriel
Cynthia Barnhart
Corey Billington
Chris Born
E. Andrew Boyd
Gianpaolo Callioni
Monica Carbajal
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John Fallis*
Edward Feitzinger
Chyi-Fu Hong
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Curtis Keller
Jason Kuehn*
Jin Liu
Ronit Meiri
Marc Meketon*
Wayne New
Avi Peretz

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Tom Rieger
John Ruark
Robert Slavens
Pat Smith
Jerry Trimarco
Carl Van Dyke*
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Keith A. Ware
Trace White
Sean P. Willems
Alysia M. Wilson
Bert Winemiller
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2002
Chae An
Michael Argüello*
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Burçin Bozkaya
Buyang Cao
Andrew Davenport
Ralf Elsner
Wolfang Hall
Gail Hohner
Arnd Huchzermeier
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Greg Kegler
Gilles Kern
Jospeh Knolmajer
Manfred Krafft
Ho Soo Lee
Thierry Lemoine
Timothy Lowe
Sandra McCowan*
Ed Ng
Alain Patchong
Grant Reid
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Rodney Traub
Anna White*
Gang Yu*

2001
Stuart Altschuler*
Rick Ayer
Vince Barabba

Donna Batavia*
Jeff Bennett*
Srinivas Bollapragada
Robert Butchers
José Vicente Caixeta-Filho
Hong Chen
Fred Cooke
Antonio de Pádua Wagemaker
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Gregory Hoscheit
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Mark Humphresville
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James Knowles
Russell P. Labe, CAP*
Robert Leachman
Bonnie Liao*
Vincent Lin
Kevin Lyman
Raj Nigam*
Je Oh*
Mark Paich
Greg Parlier
Mary Phillips
Nick Pudar
Surya Sahoo
Michael Scholes
Jim Smith
Jan Maarten van Swaay Neto

2000
Eric Bibelnieks
Mark Bullock
E. Rod Butchers
Deb Campbell
Kan Chang
Kenneth Chelst
Harlan Crowder
Paul R. Day
Randy Erdahl
Andrew P. Goldie
Michael Haydock
Ken Howard
Doug Johnson
Elena Katok*
Jeffrey Lockledge
Peter Lyon

Jeff A. Meyer
Demetrios Mihailidis
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Rick Oiesen
Robert Orzell
Alex Przebienda
Robert Rice
David Ryan
Amanda Scott
Laura Shisler
John Sidelko
Midori Tanino
William Tarantino*
Ralph Tiedeman*
Chris Wallace
Michael Wambsganss

1999
Rob Allan*
Ken Ambs
James Angelo
Nader Azarmi
Sugato Bagchi*
Steve Buckley*
Rony Cremmery
Sebastian Cwilich
Mei Deng
Nicolas De Schuyter
Markus Ettl*
Gordon Gould
Ron Holcomb
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Richard Hopson
David Houck
John Hudson
Dean Jones
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Lisa Koenig
Marc Lambrecht
David Lesaint
Grace Lin*
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Clive Morgan
Charles Muir
John Mulvey
Bret Naccarato*
George Pfeil

Shahram Taj
Mark Turnquist
Nico Vandaele
Christos Voudouris
Dicky Yan
David Yao*

1998
Henry Alden
Dean P. Angelides
Franz Behlau
Dimitris Bertsimas
Buyang Cao
James Causby
Christopher Darnell
Rafael Epstein*
Matthew J. Etzenhouser
L. Russell Fletcher
Corrie Heynen
Scott P. Holmen
R. Jaikumar
Ralph Kaiser
Albert Kuttner
Ramiro Morales*
Frederic Murphy
Murthy Murrageda
Kumar Rajaram
Jorge Seron*
Robert Soucy
Raymond Taylor
Izaak van de Wege
Franz van Esch
Michael Vasu
Don Weigel
Andrés Weintraub*
Steven Welch

1997
Nejib Ben-Kheder*
Paul Brinkley
Mitchell Burman
W. David Carr
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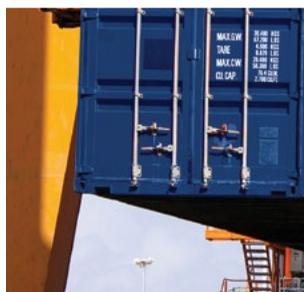Robert Cutler
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T ogether, these awards demonstrate the power of advanced analytics at Intel, and its fundamental importance in our ability to deliver the technology leadership and reliable, top quality products the world needs and expects.

— Kalani Ching, Intel