

ROUNDTABLE PROFILE

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Editor's note: This is another in a series of articles profiling members of the INFORMS Roundtable.

O.R. at General Electric Global Research Center



Aerial view of the GE Research Center in Niskayuna, N.Y.

Photo credit: Courtesy GE Global Research

GENERAL ELECTRIC GLOBAL RESEARCH CENTER (GEGR) HAS BEEN A CORNERSTONE OF GE TECHNOLOGY FOR MORE THAN 100 YEARS. It is one of the world's largest and most diverse industrial research labs with more than 2,500 researchers located at four multi-disciplinary facilities. Headquartered in Niskayuna, N.Y., GEGR has facilities in Bangalore, India; Shanghai, China; and Munich, Germany. GEGR delivers innovative, enabling technologies to GE's businesses that revolutionize the markets they serve. Examples of major breakthroughs over GEGR's history include the ductile tungsten that enabled the commercial incandescent lamp, portable medical X-ray, the first commercial U.S. jet engine, Lexan polycarbonate, man-made diamonds, MRI and digital X-ray. Home to two Nobel Prize winners, GEGR's mandate is to identify and perform the enabling R&D for the next-generation-plus of GE's products and services. A majority of the projects at GEGR are funded directly by GE's businesses.

Within GE Research there are 10 Global Technology organizations whose mandate is to focus global talent around synergistic themes. One of these organizations is the Computing & Decision Sciences Global Technology Group. Its mission is to find ways to acquire and transform data into actionable business knowledge, which enables GE to understand and deliver on its customers' needs.

This global organization has 150 scientists and engineers who apply their talents to developing sophisticated analytical tools and techniques to help GE find, capture and retain customer value. The organization is comprised of multiple labs that integrate expertise across several scientific disciplines including management science, operations research, artificial intelligence, statistics, sensor informatics, communication technologies, computational techniques and software architectures.

A majority of the OR/MS activity at GEGR is conducted in the Risk & Value Management Laboratory. This lab focuses on improving the operations of GE businesses using OR/MS technologies such as optimization, simulation and financial analysis, with the ultimate objective to improve the risk/return of GE and our customers. The lab has a world-class team of around 15 management scientists who in partnership with other researchers in the CDS organization have developed several novel

algorithms and implemented optimization-based systems, which have increased GE's bottom line by more than \$1 billion during the past decade. The OR/MS researchers at GE have impacted a number of GE businesses operating in diverse industries including finance, broadcasting, manufacturing, healthcare and transportation. Some of the lab's contributions are outlined below.

Finance: When Asian economies locked up in the late 1990s, GE and its partners injected liquidity and investment confidence through the purchase of distressed debt. GE Research developed a real option valuation framework to underwrite this distressed debt and optimization techniques to bid in order to optimize risk/return tradeoff. We developed underwriting algorithms and valuation methods of sufficient rigor that allowed us to invest in these assets.

GE Asset Management and Genworth Financial Inc. (an insurance company that GE spun off in 2004) use a novel, sequential linear programming algorithm that we developed to manage portfolios worth over \$100 billion. The algorithm generates an efficient frontier for large, real-world problems in a few minutes when compared with several days needed for generating sub-optimal solutions using prior techniques. We developed an analytical workflow and decision system capable of reducing the insurance policy underwriting times from around three weeks to a fraction of a sec-

All About the Roundtable

ond, while enhancing loss forecasting accuracy by more than 10 percent, which has led to properly priced risk.

Broadcasting: We developed a number of optimization-based sales systems that NBC-Universal currently uses to maximize its revenues and improve productivity. These systems implement algorithms to predict NBC-Universal's up-front sales market demand, automatically generate near-optimal sales plans and schedule commercials. Their use has improved sales operations by removing bottlenecks caused by manual development of sales plans, helped NBC-Universal to respond quickly to client requests and enabled it to make the most profitable use of its fixed advertising inventory. These systems improved sales-force productivity, reduced rework by more than 80 percent and improved customer satisfaction. They are now an integral and essential part of NBC's sales process.

Services: GE's manufacturing businesses derive a large portion of their revenues from services that they offer on their products. Contractual services agreements that GE offers allow its customers to shed maintenance and performance risks to GE, which is in a better position to bear those exposures. Our operations, computational finance and computer science researchers are building new models used to calculate the probable financial and performance outcomes, price contracts, manage the risk and find opportunities for design improvements.

We are now focusing on developing rigorous and consistent service engineering methodologies to design and deliver financial and

INFORMS has two types of members: individual and institutional. The latter (usually a company) joins by joining the INFORMS Roundtable and appointing as its representative the person in overall charge of O.R.

The Roundtable has been very active since its founding in 1982, with three meetings each year and much communication in between. It, its member institutions and its member representatives take a strong interest in how INFORMS serves the needs of practitioners, and have undertaken many initiatives and provided many services toward this end. These involve, for example, public awareness of O.R., both of the annual INFORMS conferences, continuing professional education, one of the prizes and various committees.

In addition, the Roundtable has an advisory responsibility to INFORMS. One bylaw states that it "... shall regularly share with INFORMS leadership its views, its suggested initiatives and its implementation plans on the important problems and opportunities facing operations research and the management sciences as a profession and on the ways in which INFORMS can deal proactively with those problems and opportunities ..." By tradition, it meets with the newly elected INFORMS president-elect each spring to discuss practice-related topics of interest to him or her, and with the entire INFORMS Board each fall to discuss topics of mutual concern.

The Roundtable membership comprises about 50 organizations. Further information is available at <http://roundtable.informs.org>.

This series of articles aims to share with the INFORMS membership at large some information and insights into how O.R. is carried on in practice today.

industrial services systemically, just as we have done for physical apparatus. In the future, we will move these lifecycle economic models directly into our original system design tools on equal footing with thermodynamics, fluidics and mechanics.

Graduating this year?

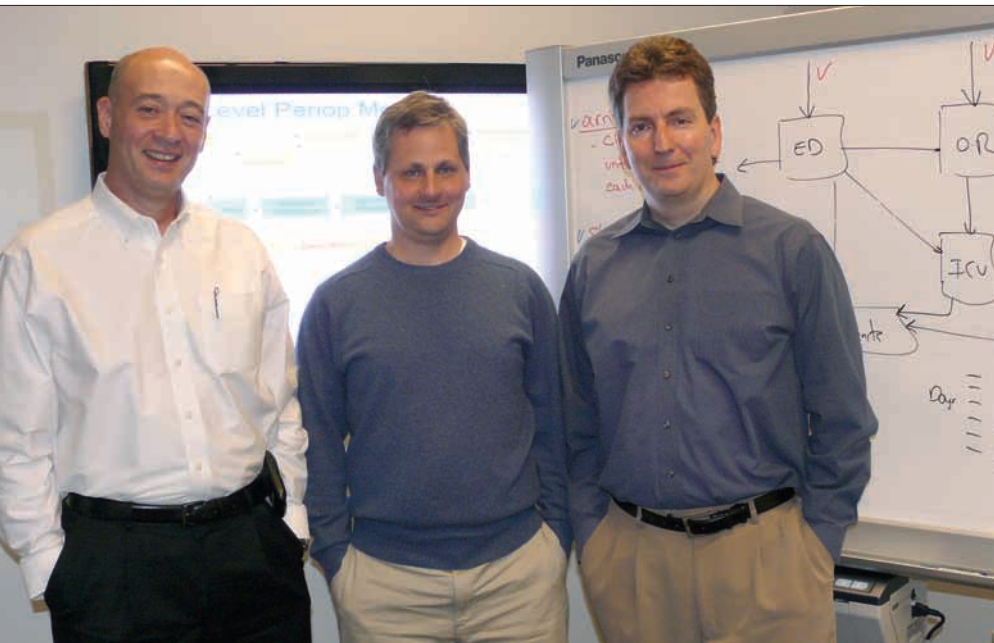
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Management scientists Kunter Akbay, Dave Toledano and John Ellis at GE Research help design the hospitals of the future.

Photo credit: Ricki D. Shapiro, GE Global Research

Healthcare: Across the developed world, aging populations put increasing demands on healthcare services, yet we do not observe a proportional increase in the number of care providers to serve the higher demand. In other words, we'll need to provide dramatically more healthcare, at the same or better quality, with fewer care providers and staff and proportionally less money to spend.

To get ahead of this dynamic, our scientists have built simulation-based design tools for the hospitals and care networks of the future. Going forward, we are adding algorithms into the real-time control of those healthcare delivery systems and enabling evidence-based clinical decisions. We are blurring the four walls of the hospital so that we can empower patients to live more vitally, longer and in preferred environments.

Management science is having a tremendous impact on GE because it is so relevant to how we perform for our customers.

Manufacturing and Supply Chain Management: We developed a decision support system to optimize the two-echelon global manufacturing supply chain for the high-performance polymers division of GE Plastics business, which was recently sold. This system uses a math-programming model to maximize contribution margin while taking into consideration product demands and prices, plant capacities, and production, distribution and raw material costs.

We developed and implemented a novel scheduling system that has increased throughput capacity of a plastics plant by 20 percent. We used a discrete-event simulation modeling approach to design the layout for a new factory that GE built for manufacturing side-by-side refrigerators in Mexico. We developed a sophisticated simula-

tion-based optimization algorithm that is used to determine the minimum number of spare parts inventory needed by airlines by location and SKU to achieve the required service levels with the minimum expenditure on spare parts inventory.

Transportation: We developed a sophisticated real-time optimization algorithm that generates detailed plans for moving trains in large integrated rail networks over a time horizon of eight to 12 hours. This algorithm results in increased average velocity of several miles per hour and is currently being beta tested at a major U.S. railroad. We have also developed an optimization algorithm for managing operations in a rail yard where incoming trains are disassembled and built into new trains.

We have shared some of this work with the operations research community through publications in journals such as Operations

Research, Interfaces and EJOR and presentations at numerous INFORMS conferences and at universities. INFORMS recognized our work with the INFORMS Prize in 2008 and several Edelman and Wagner finalist awards earlier.

In summary, management science is having a tremendous impact on GE because it is so relevant to how we perform for our customers. We have seen huge benefits when we apply these techniques to imagine, engineer and manage systems.

It only gets better from here. There are bigger problems where GE and its customers have a vested interest that we can help solve in the future. In financial services, we are going to focus on total capital management tools and the ability to design and deliver financial and industrial services systemically – just as we have done for phys-

ical apparatus. In the future, we hope to work on customizing NBC-Universal's content for precise "markets of one" where we are rewarded for delivering what viewers and advertisers want. Our customers require higher value, at lower risk, in a sustainable way. The needs are many and they will continue to grow. This is an exciting time for research in the area of operations research and management science at GE. **ORMS**

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