

GEORGIA INSTITUTE OF TECHNOLOGY

INDUSTRIAL & SYSTEMS ENGINEERING

The H. Milton Stewart School of ISyE Alumni Magazine

Fall 2015

ISyE:
Creative,
Analytical,
Engaged



The *Industrial & Systems Engineering* alumni magazine is published annually by the H. Milton Stewart School of Industrial & Systems Engineering at the Georgia Institute of Technology.

Vol. 8, No. 1 • Fall 2015

Barbara Christopher
Managing Editor

Shelley Wunder-Smith
Associate Editor

Lizzie Millman
Assistant Editor

Sarah Collins
Graphic Designer

Amy Zhen
Graphic Design
Student Assistant

H. Milton Stewart School
of Industrial & Systems
Engineering

Georgia Institute of
Technology

755 Ferst Drive
Atlanta, Georgia 30332-0205

PHONE:
404.385.3102

FAX:
404.894.2301

E-MAIL:
communications@isye.gatech.edu

WEB:
isye.gatech.edu

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On the front cover: ISyE School Chair Edwin Romeijn (credit: Gary Meek)

ISyE by the numbers



ISyE is the No. 1 program of its kind, as ranked by *U.S. News & World Report*.

25 Number of consecutive years the ISyE graduate program has been ranked No. 1

21 Number of consecutive years the ISyE undergraduate program has been ranked No. 1

Degrees Offered:

1 B.S. in IE degree

- With 5 concentrations in:
 - Economic and Financial Systems
 - General Industrial Engineering
 - Operations Research
 - Quality and Statistics
 - Supply Chain Engineering

9 Master's degrees

- Master of Science in Analytics
- Master of Science in Health Systems
- Master of Science in Industrial Engineering
- Master of Science in Operations Research
- Master of Science in Quantitative and Computational Finance
- Master of Science in Statistics
- Master of Science in Computational Science & Engineering
- Master of Science in Supply Chain Engineering
- Master of Science in International Logistics

5 Doctorate degrees

- Industrial Engineering with concentrations in:
 - Supply Chain Engineering
 - Statistics
 - Economic Decision Analysis
 - System Informatics and Control
- Operations Research
- Algorithms, Combinatorics, and Optimization
- Computational Science Engineering
- Bioinformatics

Fall 2015:

Enrollment

1,583 Undergraduates*	262 Masters	139 Doctoral
---------------------------------	-----------------------	------------------------

*includes co-op and study abroad students

52
Faculty Members

33
Staff Members

AY 2014-2015:

ISyE Degrees Awarded

345 **136** **25**
B.S. IE degrees M.S. degrees Ph.D. degrees

ISyE Degrees Awarded to Women

39% **33%** **22%**
B.S. IE degrees M.S. degrees Ph.D. degrees

647 Ph.D. students have graduated from ISyE since 1961.
Over half — **362** — have received a Ph.D. in the past 15 years.

Of the 345 B.S. IE degree recipients in 2014-2015...

- **14.5%** were underrepresented minorities (Hispanic or Latino, African-American or black, and bi-racial)
- **25.2%** completed their co-op
- **14.5%** graduated with honors
- **16.9%** participated in undergraduate research experience*
- **51.9%** participated in an internship*
- **37.6%** participated in study abroad*

The M.S. in Analytics program had a **100%** placement rate for summer 2015 graduates

\$67,130
average starting salary with a bachelor's degree in IE

4
President's Undergraduate Research Awards granted to IE students (AY 2014-2015)

Georgia Tech turned **130** years old on October 13, 2015

99%
of our B.S. IE students received job offers 2 months prior to graduation*

*self-reported

From Mission Possible to Endless Possibilities

by HANNAH CHEN, ISyE SOPHOMORE STUDENT

In 2013, during the summer before my senior year in high school, I attended Mission Possible, an ISyE program designed to introduce high school students to the field of industrial engineering. My dad earned his Ph.D. in industrial engineering at Purdue and encouraged me to try out this major. I Google-searched “Georgia Tech industrial engineering camps for high school students” and found Mission Possible. While it was only for five days, Mission Possible completely changed me from thinking, “Georgia Tech is a top engineering school” to “This is exactly where I belong.”

At the camp, we explored campus and received an overview of industrial engineering through hands-on activities and field trips. We interacted with professors and several current ISyE students. As a high school student, I really looked up to these incredibly intelligent and motivated people who were only a couple years older than me. This motivated me to push myself to the limit to achieve my goals.

One of the many people who stood out to me during Mission Possible was Stephanie Kalman, IE 2009 and MBA 2015. We walked across the street from campus to visit the Coca-Cola Company headquarters, where Kalman co-oped as an undergraduate and then joined full-time after she graduated. She gave us a presentation of what she did as an industrial engineer at Coca-Cola. I was inspired by her career path, and I knew that I had found the perfect school and major for me.



Above: Chen participating in Mission Possible's supply chain activity as a high school student. Below: Chen as an undergrad ISyE student.



I have finished my first year at ISyE and am now in my sophomore year. It has been an amazing experience so far. One of my favorite things about industrial engineering is its endless career possibilities and how it helps me build a mindset to make systems more efficient and effective for people in everyday life. While the program is not easy, Georgia Tech offers plenty of resources for students to succeed, such as the TA help desk, one-on-one tutoring, and group tutoring sessions. In only one year, my mind, my attitudes, and my social skills have all been challenged. Georgia Tech's ISyE program has given me new perspectives and many opportunities.

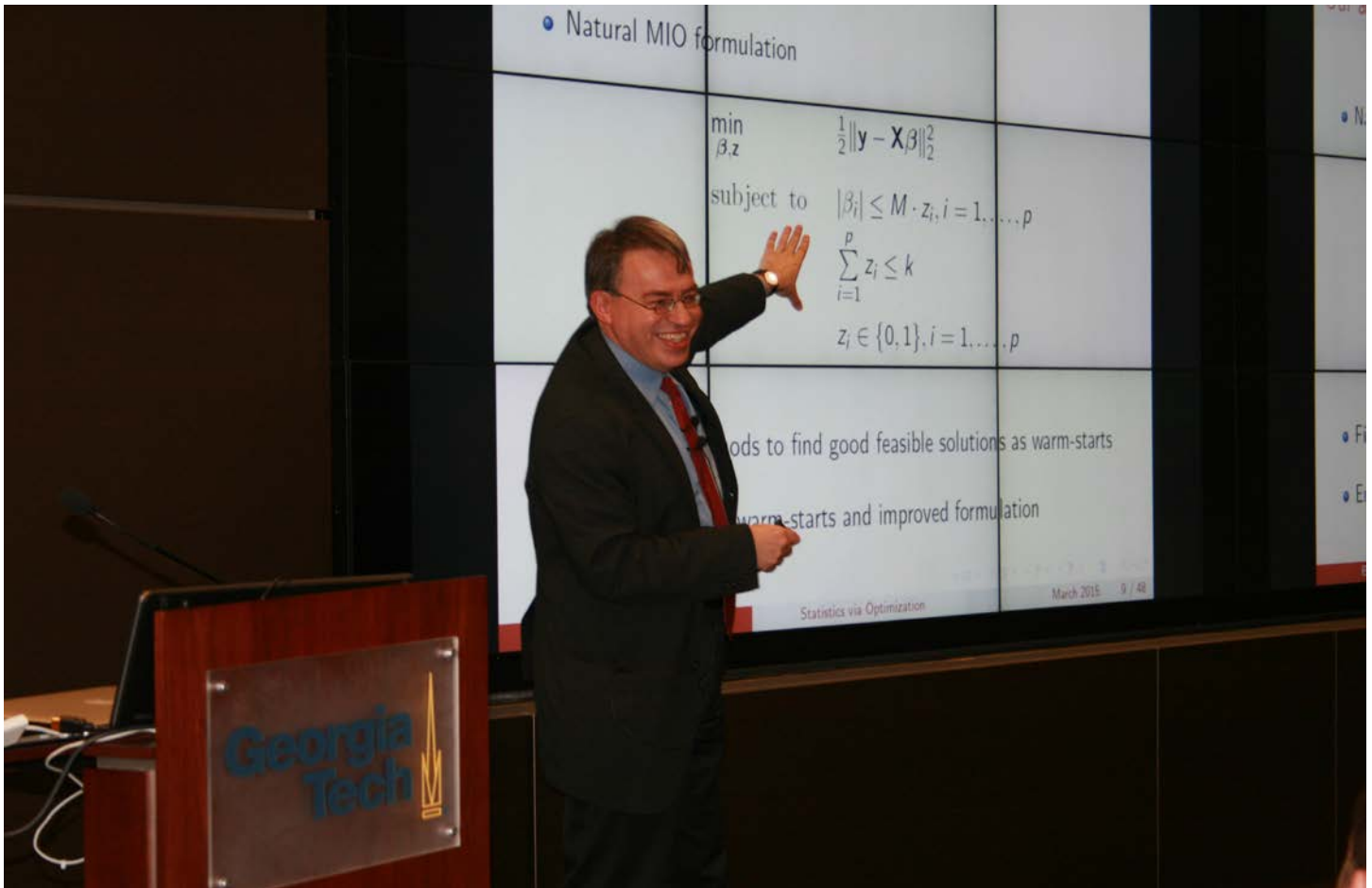
I have maintained contact with Kalman, keeping her in the loop about my freshman year and future plans. It is astounding how two years ago, during my first time at Georgia Tech, I was inspired to pursue an industrial engineering degree from visiting the Coca-Cola headquarters. Now I am very excited to have received a co-op offer at Coca-Cola, and I will start working there this fall for the next three alternating semesters.

I am very thankful to have attended Mission Possible and for its positive impact on me. I hope future high school participants take advantage of this program and have the same great experience I did or better. It's truly an honor to be at Georgia Tech, especially the No. 1-ranked school for industrial and systems engineering. ▪



If you know a high school student interested in attending Mission Possible, contact Dawn Strickland at dawn.strickland@isye.gatech.edu.
If you would like to sponsor a deserving student to attend the program, contact Nancy Sandlin at nancy.sandlin@isye.gatech.edu.

ISyE's Distinguished Lecture Series Provides Forum to Interact with Eminent Scholars in the Field



Dimitris Bertsimas spoke to a packed house in March. You can view the video at <http://b.gatech.edu/1xaZS4J>.

ISyE's Distinguished Lecture program promotes discussions on crucial issues in our field by bringing in leading scholars who engage and share their expertise with our faculty, students, and alumni.

In March, Dimitris Bertsimas, the 2015 ISyE Distinguished Scholarship Lecturer, presented an engaging dialogue to a standing-room only crowd. He discussed how to apply modern, first-order optimization methods to find feasible solutions for classical problems in statistics and mixed integer optimization to improve the solutions and prove optimality by finding matching lower bounds.

He focused on multivariate statistics and machine learning under a modern optimization lens. In his presentation, Bertsimas shared how key problems of classification and regression can naturally be written as optimization

problems. While continuous optimization approaches have had a significant impact in statistics, discrete optimization has played a very limited role, primarily based on the belief that mixed integer optimization models are computationally intractable. While such perceptions were accurate two decades ago, the field of discrete optimization has made very substantial progress.

Bertsimas is the Boeing Professor of Operations Research and the co-director of the Operations Research Center at MIT and has been with the MIT faculty since 1988. His research interests include optimization, statistics, and applied probability and their applications in health care, finance, operations management, and transportation. He received his M.S. and Ph.D. in applied mathematics and operations research from MIT in 1987 and 1988 respectively. ■

Field-testing in Rural Ethiopia a Portable Technology for Predicting Obstructed Labor Complications

In developing countries where access to obstetric care is limited, pregnancy complications can have a devastating outcome for both mother and child if not detected in a timely manner. Unfortunately, in low-resource settings such as rural regions of Ethiopia, pregnancy diagnostics that might present a significant improvement in pregnancy outcomes are not readily available to the general population, due to their high cost.

One of the most common preventable causes of fetal and maternal mortality is obstructed labor caused by the mismatch between baby size and maternal pelvis. A possible preventive approach to obstructed labor is early identification of high-risk patients for timely referral to a district hospital for medically assisted delivery or Caesarean section.

Sebastian Pokutta, Coca-Cola Assistant Professor in the Stewart School of Industrial & Systems Engineering (ISyE) at Georgia Tech, has been researching machine learning using 3-D scan technology. He has developed a working prototype to address detection problems in obstructed labor complications. The technology uses economical off-the-shelf sensors together with a low-cost workstation and screen. At a price point of less than \$1,500, this noninvasive and contact-free technology is magnitudes lower in cost than comparable technology.

Pokutta's scanner produces a large amount of 3-D streaming data. The measurement time is minimal, between five and 10 seconds, which results in minimal discomfort for the patient, compared to MRIs that require long exposure times. Moreover, this smart technology is easy to use and does not require highly skilled personnel to operate and interpret results.

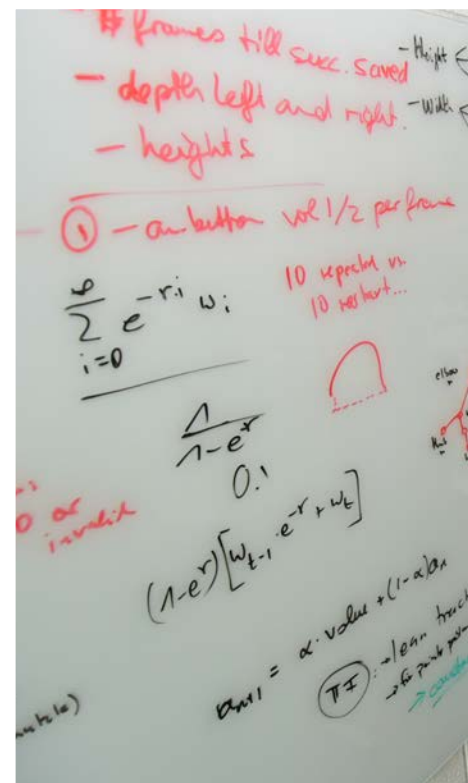
Pokutta — along with research team ISyE Ph.D. student Daniel Zink and Professors Brandon Dixon and Rudolph Gleason from the School of Mechanical Engineering — will use this technology to obtain skeletal tracking data to detect architectural and volumetric body features in real-time.

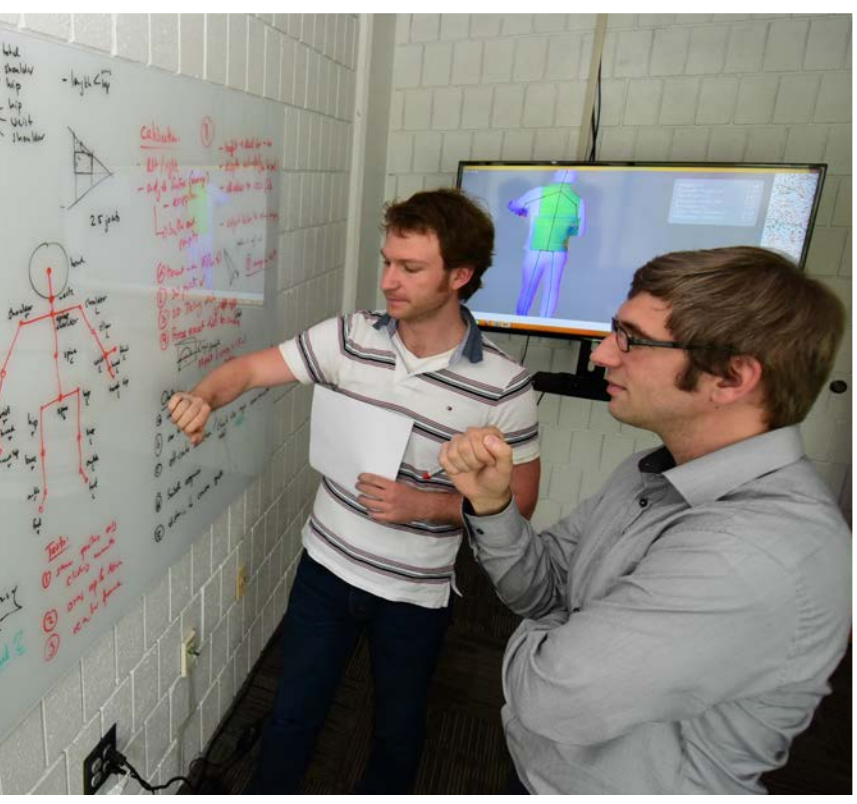
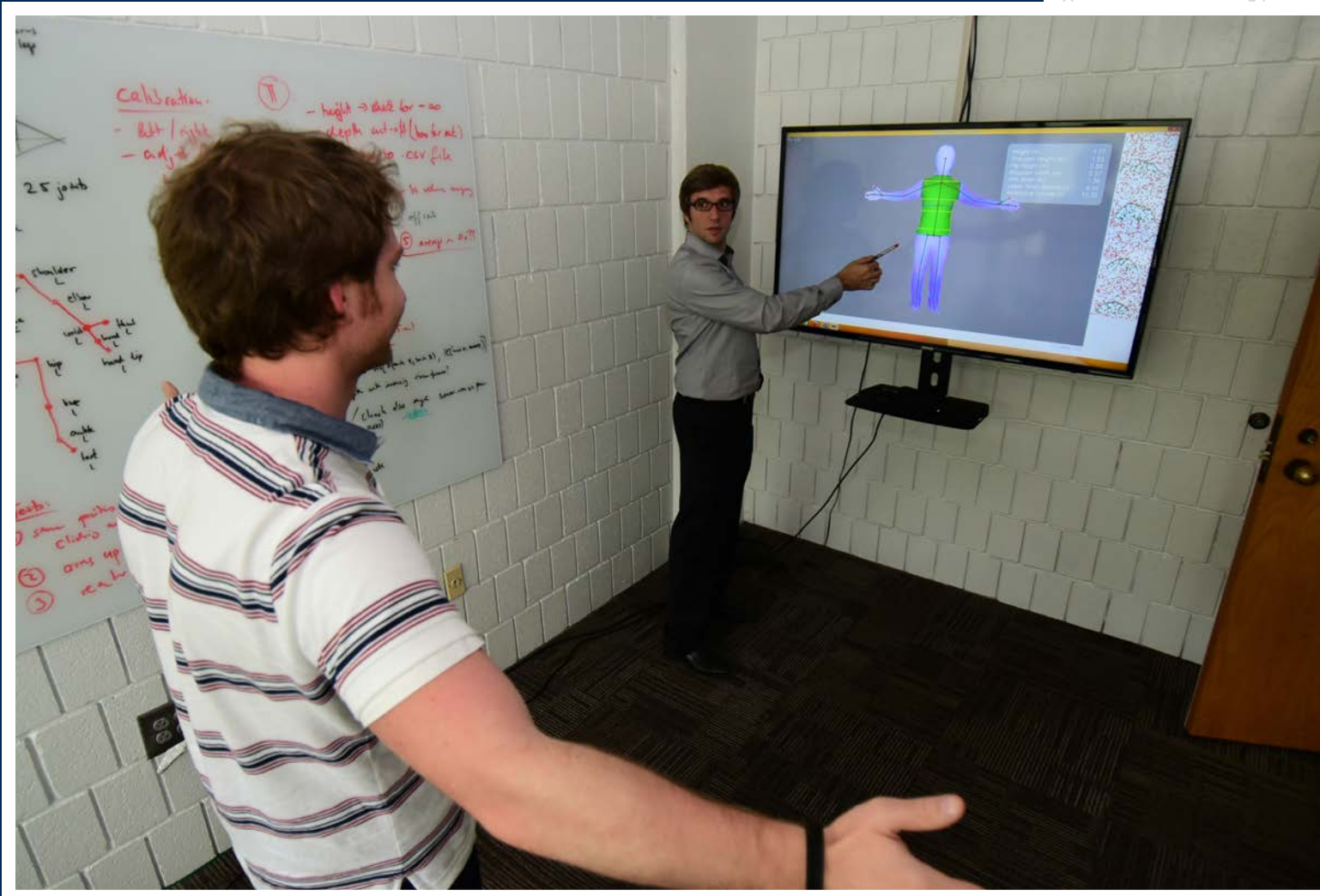
"Output will be a digital 3-D model of the patient, from which standard measurements such as body height, hip height, width, and circumference, waist height, width, and circumference, shoulder height and width, as well as more involved volumetric measures such as abdominal volume and shape are inferred and various measures can be derived," said Pokutta. "Based on these measurements, decisions can be made in advance to help ensure a safer delivery."

Currently, the technology is being field-tested in rural Ethiopia.

With minor modifications, this device has a broader application appeal, including monitoring for malnutrition to find out which food programs are working better, and diagnosing lymphedema, the chronic swelling of arms and legs of some cancer survivors.

The initial funding for this project, in the form of a seed grant from the George Family Foundation, defined the feasibility of the technology. In July 2015, the team won a seed grant challenge from Saving Lives at Birth: A Grand Challenge for Development, where they were one of 17 award nominees selected to receive funding from more than 750 submissions. This new funding will be used for the first clinical trial in Ethiopia, which began in September 2015. ■





Above: Sebastian Pokutta and ISyE Ph.D. student Daniel Zink demonstrate this smart low-cost device that has the ability to learn skeletal and anthropometric features from pregnant patients. The technology generates a 3-D reconstruction of the patient's body and extracts various linear and volumetric measurements from the body scans. The measurements are used to identify high-risk patients for obstructed delivery and to make recommendations for patient hospitalization.

Left: Zink and Pokutta discuss machine learning and signal processing algorithms and protocols that improve the device's volume-tracking abilities.



Senior Design Project Implemented, Makes Difference for Patients

ISyE's Senior Design course is designed to help undergraduate students kickstart their careers. During this intense semester-long course, ISyE students form teams to work with a business or organization on a specific issue. By addressing complex problems, students learn about project management, problem solving, team building, and get a chance to hone their professional communication skills.

No doubt, working on real-world problems adds value to a student's education, but when the project is actually implemented, the broader impact of the work is something worth talking about.

In one such case, a team of eight ISyE students, pictured on the next page with faculty advisor Pinar Keskinocak, worked with the Emory Winship Cancer Institute's Ambulatory Infusion Center (AIC) during the fall semester of 2014. AIC wanted to shorten the amount of time patients waited before being taken to their infusion chair, to help reduce stress and anxiety for their cancer patients. The ISyE team focused on identifying the causes of delays and finding practical ways to curtail them.

After interviewing and shadowing staff and patients, collecting data, and conducting time studies, the ISyE team proposed that improved workflow, increased ability to know where patients were located during the various phases of the treatments, and a better system to notify nurses when chairs were available would shorten patient wait times.



Winship Triage nurse using the Real-time Visibility Tool to seat a patient.

The team then developed a Real-time Visibility Tool, a web-based app that allows the Infusion Center to communicate with and notify each other throughout the steps of the process. They also developed a comprehensive simulation model with a user interface enabling them to modify flow and observe results as well as a list of recommendations to improve AIC's process flow.

AIC, impressed with the tool and recommendations, implemented the project.

"The impact of this [project] has been huge," said Catherine Parker RN, MSN, OCN, the unit director at the Infusion Center. "The development and implementation of the visibility tool has helped the triage RNs significantly by providing a technological solution for what was extremely manual and inefficient. The tool has also made it possible on extremely short-staffed days to utilize only one triage RN, which helped the overall staffing for the team by adding the second triage RN back to direct care. This is substantial for the staff and patient flow."

One of the implemented recommendations involved changes in the check-in process. Previously at check-in, paperwork was placed in a rack until one of the triage RNs could retrieve it. After implementing the ISyE team's recommendations, the front-desk staff member delivered the paperwork to the triage office immediately after patient check-in.

AIC patients have reported to AIC that wait times have decreased due to this change.

"The Real-time Visibility Tool created by the Georgia Tech students has been one of the best tools I have ever worked with here at Winship," said Claudia Giddings, RN. "As a triage nurse, it has cut down on time by more than 30-40 percent." ■

"The Real-time Visibility Tool created by the Georgia Tech students has been one of the best tools I have ever worked with here at Winship. As a triage nurse, it has cut down on time by more than 30-40 percent."

— Claudia Giddings, RN



Now Georgia Tech alumni, the Emory Winship Cancer Institute's Ambulatory Infusion Center Senior Design team won the Best of Senior Design Competition at ISyE for fall 2014. Their project was implemented and has made a difference for the center's patients.

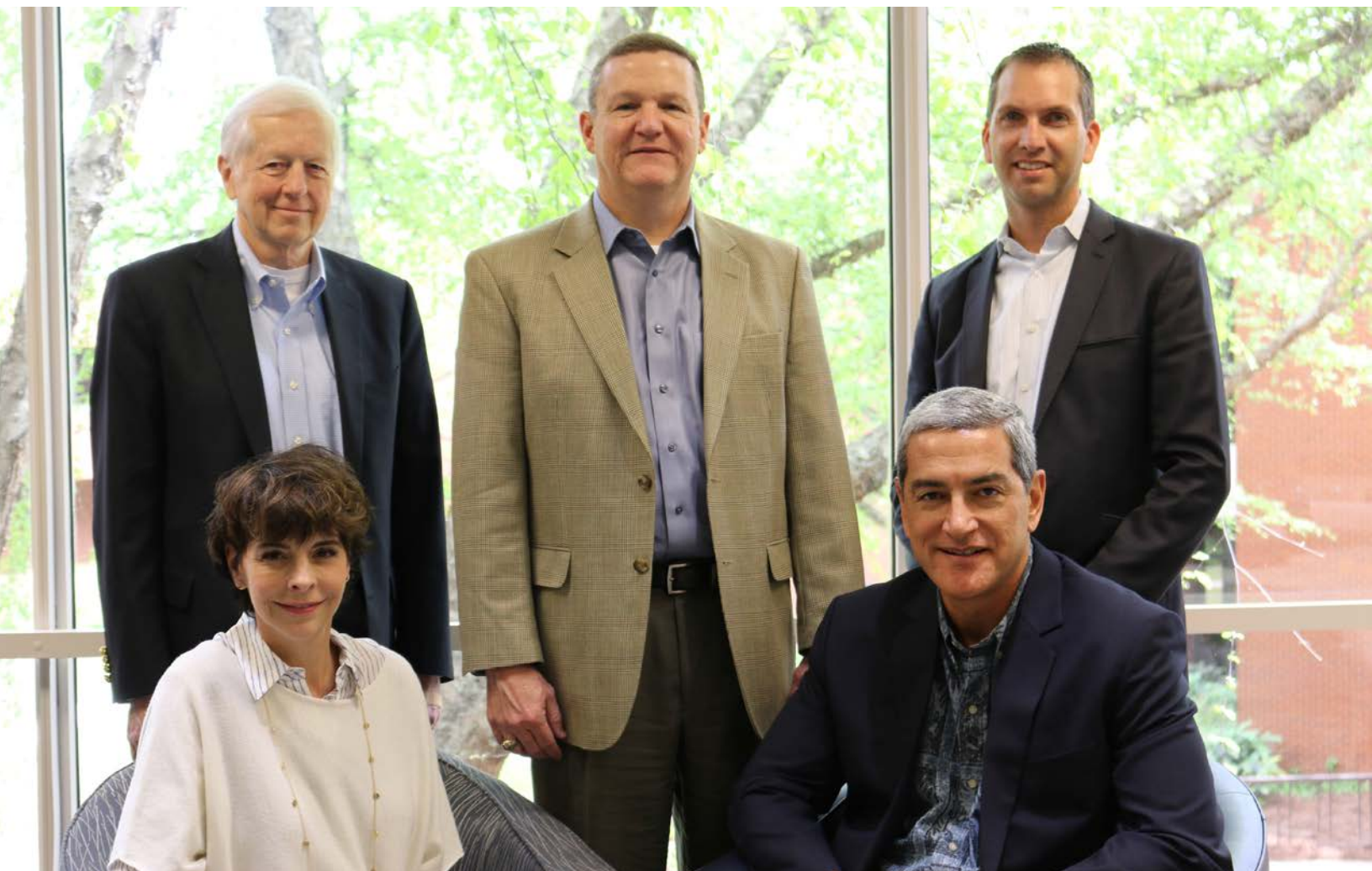
(L-R) James (Jimmy) Micali, IE 2014, Buyer at Intel; Emilie Wurmser, IE 2014, Technology Analyst at Accenture; Xiaoyang (Tony) Li, IE 2014, master's student in Financial Engineering at Columbia; Yunjie (Jack) Sun, IE 2015, Ph.D. student in Operations Research at Columbia; Sung Keun (Joseph) Baek, IE 2014, IT Business Analyst at Equifax; Mengnan (Mo) Shen, IE 2014, Software Developer at Capital One; Jisu (Jason) Park, IE 2014, master's student in Financial Engineering at Columbia; Pinar Keskinocak, William W. George Chair and ADVANCE Professor; and Allen Liu, IE 2015, Business Analyst at Liu & Associates

“Senior Design has made a real difference for me, and I consider it one of the most valuable experiences I had at ISyE... I began working as a software developer in July. Not having a computer science degree put me at a disadvantage when competing with CS students, but this project is what made me stand out. When I design a product, I think about it from the operation’s perspective, such as how to use technology to minimize cost, optimize process flow, and increase efficiency.”

— Mengnan (Mo) Shen

“Working on this Senior Design project with my teammates has been, by far, the most rewarding experience I have had at Georgia Tech. Not only did I get to apply a lot of the knowledge I acquired from my classes, but I learned to manage time effectively and work with strict deadlines. The best part was seeing our client’s reaction to our results and knowing that we have made a positive impact.”

— Emilie Wurmser



New Advisory Board Members Bring Fresh Insights and Expertise to ISyE

Reed Baker, IE 1985, **Michele Etheredge**, IE 1986, **John Marshall**, IE 1996, **Jim McClelland**, IE 1966, and **Major General (Ret.) Kelly McKeague**, IE 1981, MSIE 1987, joined the H. Milton Stewart School of Industrial & Systems Engineering Advisory Board in the spring of 2015. These five alumni are joining 15 other distinguished professionals and community leaders, serving as a sounding board for the School Chair in an advisory capacity as well as assisting with the School's development goals. Each member brings extensive industry knowledge and unique expertise to this role and will serve a four-year term (2015-2019).

Reed Baker is currently senior vice president and principal of Advantage Industrial Automation based in Atlanta, Georgia. Advantage Industrial Automation provides OEMs, industrial end-users, and system integrators with intelligent manufacturing solutions by adding value to the leading products in factory automation and controls. After graduating from ISyE, Baker's first position was with Square D Company (now Schneider Electric) as a field engineer. He is married to Angie Baker, IMGT 1985, and has two children currently attending Georgia Tech.

Michele Etheredge retired in 1998 after a successful career with CAPS Logistics and Frito-Lay as a project manager implementing supply chain solutions. Etheredge has also raised funds for Children's Healthcare of Atlanta and is currently assisting the Boy Scouts of America locally. She received her Georgia Tech degree with honors. She and her husband, Jimmy, IE 1985, have three children. Their oldest son is now a student in ISyE. They presently reside in Atlanta, Georgia, but enjoyed living in Surrey, England for six years.

John Marshall is the co-founder of AirWatch. Under his leadership, AirWatch became the largest enterprise mobility management provider in the world, with more than \$200 million in 2014 bookings. AirWatch has more than 18,000 customers, including four of the top five global Fortune companies. VMware acquired AirWatch for \$1.54 billion in 2014, the largest acquisition to-date for VMware. Marshall was named the 2013 Ernst & Young Entrepreneur of the Year for the Southeast and the Atlanta Business Chronicle selected him as one of “Atlanta’s Most Admired CEOs in 2014.” Marshall is also a board member of the Georgia Tech Information Security Center Industry Advisory Board.

Jim McClelland recently retired as president and chief executive officer of Goodwill Industries in Central Indiana. McClelland has been active in the international development efforts of Goodwill Industries International and was heavily involved in starting new Goodwills in South Korea. He serves on the Dean’s Council of the Indiana University Kelley School of Business – Indianapolis, the Georgia Tech Grand Challenges Advisory Board, the Board of Governors of the Economic Club of Indiana, the Executive Committee of the Central Indiana Education Alliance, and the Urban Areas Commission of the Indiana University Public Policy Institute. McClelland earned his MBA from the Kelley School of Business at Indiana University.

Major General (Ret.) Kelly McKeague is transitioning from the military to the civilian sector. He most recently served as deputy director of the Defense POW/MIA Accounting Agency, which has worldwide responsibility for the analysis and investigation, search and recovery, and forensic laboratory operations to account for Americans missing from World War II to the first Persian Gulf War. After receiving his commission from Georgia Tech’s Air Force ROTC program, he began his 34-year career as an industrial engineer and served in a variety of engineering and legislative assignments. He and his wife, Nancy, reside in Alexandria, VA. ▀

Opposite page: New Advisory Board members
 Back row: Jim McClelland, Reed Baker, John Marshall
 Seated: Michele Etheredge, Major General (Ret.) Kelly McKeague



“ISyE is the best school of its kind anywhere, and I am incredibly impressed with the caliber of today’s students and how many of them are interested not only in preparing for a successful career, but also helping make the world a better place.”

— **Jim McClelland**



“What impresses me the most about ISyE today is the breadth and depth of its reach. There is not an industry or service, whether private sector or government, which doesn’t benefit from the improvements offered by an ISyE solution. In an era of increasing complexities and interdependencies, ISyE becomes all the more crucial.”

— **Major General (Ret.) Kelly McKeague**



“The overall quality of the facilities, faculty, and resources at ISyE is quite impressive. However the thing that most impresses me at ISyE today is the quality of the young men and women who are graduating from Georgia Tech. I might be a little prejudiced in my opinion, but when I hear from other employers who are not graduates of Georgia Tech talk about the quality of the people they hire from Georgia Tech, it reaffirms my opinion.”

— **Reed Baker**



Physical Internet Center Aims to Transform Supply Chain and Logistics Worldwide

by GARY GOETTLING

When it comes to supply chains and logistics, not only is Benoit Montreuil thinking outside the box, he's rethinking the box itself.

The Coca-Cola Material Handling and Distribution Chair in the Stewart School of Industrial & Systems Engineering (ISyE) at Georgia Tech, Montreuil is catalyzing a forward-looking new approach to the business of transporting, handling, and storing tangible goods. He calls this system the "Physical Internet."



CREDIT: GARY MEEK

We are trying to transform the logistics and supply chain system to a new era of hyperconnectivity that is more sustainable and much more efficient than what we have now," said Montreuil, who graduated from Université du Québec à Trois-Rivières in 1978 and received a master's and a Ph.D. in industrial engineering from Tech in 1980 and 1982 respectively.

"We're using the Internet as a metaphor," he explained, "but instead of moving data, we're talking about moving physical goods. The Physical Internet takes some of the basic characteristics of the information Internet — open access, standardization, interconnectedness, digitization, speed — and applies them to the operation of supply chains and logistics."

At Georgia Tech, this ambitious effort is based at the ISyE's new Physical Internet Center founded by Montreuil, who serves as its director.

The center's mission is threefold. One is to provide worldwide scientific leadership in the development and implementation of the Physical Internet, and to position the center as the primary resource for education and innovation. The second is to pursue technological breakthroughs through the center's research lab.

"In order for the Physical Internet to happen, we're going to need technological innovation," he said. "We want to steer that process and work with industry, technologists, and scientists to develop breakthrough technologies."

Among the areas of research interest are supply chain analytics, digital platforms, optimization, stochastics and simulation, and system informatics and control.

The third aspect of the Physical Internet Center's mission is to engage its corporate partners as "living laboratories to enable change in the field" for testing and applying new technological advances in real-world, practical situations.

To support its mission, the center plans to secure grants, pursue partnerships in academia and business, and participate in consortiums, Montreuil noted. It will also offer technical services in a range of areas related to the phase-in of the Physical Internet, which is expected to span decades, given the scope and complexity of the task.

"It's not something you can do overnight," he emphasized. "The Physical Internet is a progressively deployable, long-term solution to achieving a more sustainable global supply chain."

As Montreuil describes it, the Physical Internet is an open market where the transportation, storage, realization, supply and usage of goods conform to common physical and operational standards worldwide. In other words, supply chains and logistics operate, in effect, as a single integrated, coordinated system worldwide. The system is highly computerized, allowing for continuous real-time tracking and monitoring, and features asset sharing across industries over interconnected networks and transportation modes.

At present, "everybody has their own supply chain," he noted. "They have their own logistics, and they have their own manufacturing facilities and distribution centers, or they deal with their own service providers." Even companies that conduct international business typically pool only their own assets to meet their needs, he added. "In the Physical Internet, we're rather talking open asset sharing on a massive scale."



As an example of a potential Physical Internet innovation, Montreuil points to plans for new kinds of modular containers designed for efficient transportation, handling, and storage. Built to standard dimensions, they lock together somewhat like Lego blocks. They'd be durable, light, reusable, and fabricated from recyclable materials. Different structural grades would be available, notably transportation, handling, and packaging containers. These "smart" containers would be communication-enabled, giving each one a unique signature to facilitate tracking and provide relevant data about the container's contents, and ultimately take autonomous action as needed along their journey through the Physical Internet.

Each link in the producer-to-customer chain — from conveyor belts to trucks to warehouse layouts — would be adapted or built to accommodate the containers' dimensions with little or no wasted space.

The benefits inherent in an integrated, standardized supply chain and logistics network

and even if the transportation segment of that fraction was limited to trucks, the industry could realize \$100 billion in annual savings while achieving a 32 percent reduction in greenhouse gas emissions.

The Physical Internet Center draws upon the research capabilities of resources from multiple disciplines, including ISyE centers such as the Supply Chain & Logistics Institute, the Center for Health & Humanitarian Systems, the Center for Analytics Research and Engineering, the Center for Predictive Analytics and Real-time Optimization, and centers across campus, such as the Center for the Development of Applications of the Internet-of-Things.

"We're going to work with the top minds on the academic side," he said. "At the same time, we want to be closely aligned with industry. We're going to be very collaborative in Atlanta, and across the U.S. and the world. Many of the large companies based in Atlanta want to move forward. They understand that the status quo is not going to work for the medium term, and they want to put themselves ahead of the game. We've got several companies lined up through next year to work together with us on projects."

A number of Physical Internet investigation and implementation efforts are taking place around the world, Montreuil observed, several with his assistance. Substantial investments already have been made in Europe, where the Physical Internet is the "official grand vision for all logistics and supply chains in the 2030-to-2050 time frame." China has already established a Physical Internet research laboratory.

In addition, the continuing globalization of the economy has fostered a number of free-trade agreements that make a case for deployment of the Physical Internet because it would help "make these agreements feasible and work at the ground level."

In North America, "achieving critical mass for the Physical Internet requires exploiting existing infrastructures and means, then gaining momentum through large-scale adoption and innovation," said Montreuil. "We want to make sure we're following a road map that makes sense in enabling this vast space of investigation, innovation, testing, and implementation.

"At the Physical Internet Center, we're the nexus of this activity." ■



Benoit Montreuil, Coca-Cola Material Handling & Distribution Chair, and Yaarit Cohen, ISyE Ph.D. student, discuss hyperconnected logistics backbone networks for the Physical Internet, using the U.S. Southeast as an illustrative case. (credit: Gary Meek)

include time- and energy-saving efficiencies that yield lower costs while boosting productivity, according to Montreuil.

He cites a study by the National Science Foundation indicating that if only one-fourth of U.S. manufacturers adopted the Physical Internet,

Georgia Tech ISyE Alumni Receive a **10% Discount** on SCL Short Courses

The Georgia Tech Supply Chain & Logistics Institute (SCL) now offers seven supply chain certificate programs and course sections on the Atlanta, Savannah, and Panama campuses.

Certificate Programs:

Supply Chain Management
Distribution Operations Analysis and Design
Strategic Sourcing and Supply Management
Supply and Demand Planning
Lean Supply Chain Professional
Supply Chain Project Management
Health and Humanitarian Supply Chain Management

SCL launches new ONLINE Supply Chain Fundamentals courses.

For more information, visit scl.gatech.edu/fundamentals.

Upcoming Course Offerings:

Supply Chain Project Management Fundamentals

December 1-3, 2015

Lean Inbound Logistics (Savannah, GA)

February 17-18, 2016

Leveraging Supply Management Tools and Techniques to Improve Performance

February 23-25, 2016

Supply Chain Project Management: Vendor Selection and Management

February 23-25, 2016

Material Handling 101: Fundamentals, Analysis and Selection

March 23-24, 2016

Engineering the Warehouse

March 29-30, 2016

Visit SCL Booth at MODEX

April 4-7, 2016

Optimizing Packaging's Impact in the Supply Chain

April 13-14, 2016

Visit SCL Booth at Georgia Logistics Summit

April 19-20, 2016

Supply Chain Project Management: Effectively Managing Transformation Projects

May 3-5, 2016

Pre-planning Strategy for Health and Humanitarian Organizations

May 9-10, 2016

Tactical Decision Making in Public Health and Humanitarian Response

May 11-12, 2016

Systems Operation in Health and Humanitarian Response

May 13-14, 2016

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Senior Design Teams Find Innovative Solutions for Clients

Out of 30 teams of undergraduate students participating in Senior Design this year, the Home Depot team took home first place at the Spring 2015 Senior Design Competition. The other four finalists were teams that worked with the Center for Disease Control and Prevention (CDC), Energy Dispatch, Phillips 66, and United Parcel Services (UPS). Each of these teams found innovative and sustainable solutions for their clients.



The Home Depot team included advisor Dean's Professor and Stewart Faculty Fellow Shabbir Ahmed, Kelly Kujawa, Haley Hahmann, Mala Morjaria, Audrey Shlapak, Sean Moore, Alexander Hovancik, Wood Alter, and Casey Ferguson.

Home Depot Team

The Home Depot Senior Design team developed an optimization tool that will allow Home Depot to reduce seasonal product import transportation costs by 18 percent. The tool provides a standardized method for planning the containerization of products such that each container is maximally utilized and shipped on the most cost-effective date.

"The team implemented a sustainable tool that will save Home Depot in international transportation spent, as well as save my team time in terms of associate production," said Matt Blacky, International Logistics Manager for Home Depot. "The students were a pleasure to work with and very smart, with a lot of prior supply chain knowledge. They asked me really good questions about Home Depot's supply chain and were very involved with me from day one of the project. We are fortunate to have hired one of the students from the team with two others coming back as interns. I'd absolutely do this again."



The CDC team included Brian Gurbaxani (CDC), students Ivan Renaldi, Charmaine Chan, Jonathon Sutomo, Javeria Javeria, Caleb Mbuvi, Kimberly Adelaar, Matthew Daniels, Chu Qian, and were advised by Harold R. and Mary Anne Nash Professor Julie Swann.

CDC Team

In light of the recent Ebola outbreak, the CDC Senior Design team focused on how treatment facilities were critical to stopping the epidemic. However, beds were largely unavailable in some areas and went unused in others. Thus, they built a simulation to project the spread of cases within Guinea, overlaid with heuristics to trigger when and where to place treatment facilities. Their results showed that an additional 2,000 lives and \$25 million could have been saved if Ebola treatment units were set up quickly or if health centers had been built in advance in densely populated areas.

Energy Dispatch Team

The Energy Dispatch Senior Design team focused their project on truck scheduling and fuel inventory management, with an emphasis on reducing excessive travel by assigning drivers to handle certain deliveries. The team provided an optimization model to better schedule deliveries and assign trucks to gas stations, as well as a combination of a demand forecasting model and an inventory policy to manage store fuel inventory. By providing a user interface that integrates these models, annual transportation costs and inventory holding costs are drastically reduced to provide savings upwards of \$5.8 million per year.



The Energy Dispatch team included advisor Dima Nazzal, Executive Director of Student Experience, and students Nathaniel Jones, Zubbia Saeed, William Seo, Hailey Bae, Rohan Aggarwal, and Jacob Evans.

Phillips 66 Team

The Phillips 66 Senior Design team focused on making a Los Angeles refinery's distribution network more efficient. The team chose a location for a new distribution center that will be closer to their refinery's customer base, as well as calculated optimal inventory levels for the new distribution center. Their solution reduces expected inventory costs by 70 percent, transportation costs by 35 percent, and increases fill rate by 16 percent.



The Phillips 66 team included advisor Dima Nazzal, Executive Director of Student Experience, and students Jonathan Fairey, Kyle Kenney, Jennifer Taylor, Victoria Jones, Connor Zendt, and Alexander Edson.

UPS Team

The UPS Senior Design team developed new approaches for measuring and incentivizing quality in call centers, with specific focus on a center in Clark, Philippines. The center, comprised of 750 employees with 30,000 calls handled daily, experienced reduced quality and high costs resulting from the flawed incentives offered to its customer service representatives. Their project redesigned the entire Clark incentive program to drive improvements in employee behavior, call quality, and cost savings. UPS should see improved call quality and increased retention of top performers while streamlining costs by over \$100,000.



The UPS team included advisor Fouts Family Associate Professor Joel Sokol, and students Angad Chawla, Maria Samuel, Jeffery Allen, Katherine Marchand, Conrad Rybka, Bianca Palacio, and Samay Jhunjhunwalla.



In Conversation with
Edwin Romeijn
on Running a Top Ranked School

CREDIT: GARY MEEK

H. Edwin Romeijn took the helm as ISyE's H. Milton and Carolyn J. Stewart School Chair in January 2015, making him the eighth school chair in ISyE's history.

“Edwin has a unique blend of research expertise, teaching excellence, and national leadership that makes him well suited to expand ISyE's tradition of excellence and leadership in research and education and to keep the program at the forefront internationally,” said College of Engineering Dean Gary May.

Prior to joining ISyE, Romeijn was the program director for Service Enterprise Systems, Manufacturing Enterprise Systems, and Operations Research at the National Science Foundation in Arlington, Virginia, and Richard C. Wilson Faculty Scholar in the Department of Industrial and Operations Engineering at the University of Michigan. He received his M.S. in econometrics and his Ph.D. in operations research from Erasmus University Rotterdam in the Netherlands in 1988 and 1992, respectively.

Recently, I sat with Dr. Romeijn to chat with him about his vision, leadership, and what it is like to oversee a school consistently ranked the No. 1 industrial engineering program in both graduate and undergraduate education.

– BARBARA CHRISTOPHER

What piqued your interest in becoming ISyE's school chair?

Honestly, I did not have a career-long goal of going the administrative route. I used to view myself as a career researcher. Over time, I became more interested in looking at a bigger, more strategic view of our field. This came up for me, partly, due to my time as a program director at the National Science Foundation. At that time, I thought if the right opportunity came along I would be interested in taking on a larger administrative role. And by right opportunity, I meant finding something that had a combination of a strong program — a unique potential due to its history, environment, faculty, and student population — someplace close to my heart, and a place where I could contribute something.

When ISyE approached me, it qualified in all areas. ISyE has a long-standing reputation as the No. 1 program in both undergraduate and graduate studies, as well as having top-notch research programs. I was impressed with the size of the program, but mostly its diversity in both theory and application in optimization, statistics, manufacturing, supply chain, health care, energy, you name it. I was excited that my research has touched on a lot of the existing research groups in ISyE. That really spoke to me.

And being a part of Georgia Tech, one of the best technical institutes in the country — if not the world — creates unique opportunities for interdisciplinary research, which is important for all disciplines but especially for industrial and systems engineering.

I've been with ISyE for just under a year now, and I can say it is a great place to work.

What are you responsible for as ISyE's school chair?

Generally speaking, I am responsible for creating and maintaining a healthy environment in which students, faculty, and staff can thrive and be the best that they can be.

As part of your job as chair, you also meet and work with a lot of our alumni. How has that been so far?

Meeting with our alumni is one of my favorite parts of my job. They have been and continue to be instrumental in maintaining the success of ISyE through their involvement on the advisory board, student mentoring and other volunteering activities, as well as through their generous philanthropy.

I had the honor to meet the H. Milton Stewart family before I officially started this position and was impressed with their hospitality and dedication to ISyE. Since then I have gotten to meet many of our alumni, and I look forward to meeting



CREDIT: GARY MEEK

many more. I continue to learn the history and culture of this remarkable school through their eyes.

What are some of the traits of a good leader that you strive to embody?

There are two different yet intertwined traits that I work toward — to be a good listener and to communicate clearly. It's important to make sure that everyone feels heard, that their opinion matters, and their input is, at the very least, being considered. However, not everyone can get their way each time. While my goal is to build consensus as much as possible, sometimes it will be necessary to make decisions when there is no consensus. At the end of the day, I will always make a decision that I believe is for the good of the School as a whole and will work to communicate why a particular decision has been made.

How do you take a school that has had a long successful run as No. 1 and expand its tradition of excellence to have greater influence?

At the core is the faculty. To a large extent they dictate any new directions or changes within the School. The chair cannot single-handedly decide the direction of the School. A chair suggests, points, and helps coordinate groups of faculty so that synergies are explored and exploited, but at the end of the day it should be the faculty who provides the new ideas. They are the true experts in the different fields of specialization. It is the faculty who will make sure we remain leaders in the field and the No. 1 program.

What is hot in ISyE at the moment?

Analytics is a hot topic, of course. While ISyE can contribute to all three branches of analytics — descriptive, predictive, and prescriptive — it can play a particularly unique role when it comes to prescriptive analytics, i.e., in decision-making. In a way, ISyE has been dealing with problems related to this area for a long time. Yet with the explosion of different types of data available in recent years, there is a need for more and new modeling, statistical, and operations research methodologies. It is exciting that the field is facing problems that we could not conceive of five to 10 years ago, before this kind of data was available. The area of supply chains and logistics is seeing a reinvigoration, with new focus areas such as the Physical Internet and hyperconnected optimization. Areas such as health and humanitarian logistics, energy, and sustainability have been active areas in ISyE for some time but can only be expected to grow in importance in coming years. And with the advent of smart manufacturing, ISyE is poised to expand its role in the area of manufacturing as well.

What do you think are the keys to success?

Having passion and enthusiasm for what you do.

Students often ask me: What should I write my Ph.D. thesis about? What topics should I study to maximize my chances of a good position in five years?

I tell them to pick a topic that really excites them. If they are excited about the topic, most likely

they will work hard and be successful at what they do. More often than not, having passion and enthusiasm for the work you do will take you a long way.

What are some current opportunities for ISyE?

There are several opportunities open to us. ISyE has been No. 1 for a long time and has an excellent reputation in a lot of areas. Part of this is because we have great researchers. Part of it is because we have a large program. As a group we are doing fantastic work, but I'd like to see us further increase our leadership to the field as a whole. After all, it is the responsibility of the No. 1 school to do this.

Also, I'd like to see more bridges built and synergies exploited between the various research groups. This is an ideal time to come together and think harder about ways to work across platforms to drive our impact to greater heights. ISyE has a great group of researchers with so many great opportunities to be a front runner in some important upcoming areas.

Currently, we have a large number of undergraduate students. Our challenge there is to make sure we maintain the quality of the undergraduate program despite its growing size. But this is a challenge we are happy to face.

We have high-quality incoming students, and our outgoing students are in very high demand. Employers are scooping them up as soon as they graduate. So both the input and output is quite healthy, and we are dedicated to preserving and improving the quality of the program.

Tell me a little about your research.

My research has been on analytics and optimization theory and applications, in particular in the area of supply chain optimization and optimization in healthcare. I started off more in the area of theoretical optimization, development, and analysis of algorithms. Then I moved to add the area of applied or application-driven research to my work.

On the supply chain optimization side, the problems I work on are more theoretical and motivated by problems that can or may occur in practice but not necessarily following from collaborations with industry.

On the health care side, my work is much more practical. I work closely with radiation oncologists and medical physicists in developing new models and algorithms for finding optimal treatment plans for cancer patients.

How do you balance your research with the administration side of ISyE?

Now that has been a bit of a challenge over the last nine months. As time goes on and I get more fully acclimated, I hope to get more active on the research side again.

You have taught classes in operations research, stochastics processes, applied probability and statistics, supply chain management, and decision support systems. Can you tell me a little about how you teach?

When I teach a class, I always try to set it up in such a way that I encourage the students to actively think along. I want a dialogue with the students, not just a one-way street. I am not interested in the students learning by heart; I'm interested in them learning how things work. This way, they learn intuition behind things and how to approach problems in practice. That is the ideal situation for me.

What brought you to the U.S.?

I started my Ph.D. in 1988 in The Netherlands. At that time, quite a few Ph.D. students in The Netherlands spent part of their research time at top schools in the United States. I was fortunate to have the opportunity to spend a significant amount of my Ph.D. student years at the University of Michigan. After graduation, I received a grant from the Netherlands Organisation for Scientific Research [the Dutch counterpart of NSF] to spend a year as a postdoctoral fellow at Columbia University. I enjoyed the academic environment in the U.S.; it not only allows for a great deal of independence, but the tenure-track system is unique in that it rewards merit, motivation, and hard work.

And on the more personal side, what is your idea of a perfect day outside of work?

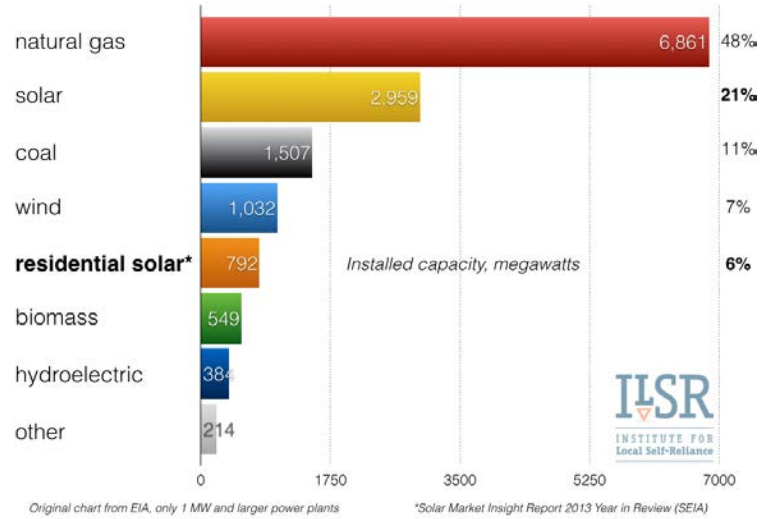
It's relatively simple, really. My wife, Sylvia, and I like to go outside, whether it is for a walk in the park, a bike ride, or to eat lunch or dinner. We also enjoy home remodeling activities, which has been our hobby for the last few years. Between Michigan and Florida, we remodeled several houses together. I like to do the demolition. Sylvia enjoys painting. And we both can install kitchens, flooring, etc. Neither of us can do the real construction work so we called in contractors for those. ■

Research Briefs

Energy: Decision-making Under Uncertainty

The massive deployment of natural gas power plants in the United States, continued integration of renewable energy, and debates over new environmental regulations make it crucial for today's utility companies to ask how to make long-term decisions for expanding generation capacities in the next 20-30 years given significant price, supply, and policy uncertainty. Under an NSF-funded project, Shabbir Ahmed, ISyE Dean's Professor and Stewart Faculty Fellow, and Andy Sun, assistant professor, along with Ph.D. student Jikai Zou are developing new methodologies for modeling and solving multistage stochastic generation expansion problems that provide systematic and quantitative solutions to utilities' long-term planning problem. The developed methodology significantly outperforms existing approaches.

For New Power Plants, Solar Is Rising (2013 Capacity Added)



Advanced Manufacturing: Composite Joining and Repair Technologies

Most aircraft are made of metal, but it is becoming more common for lightweight composites to be included in the construction. Lightweight materials allow the aerospace industry to realize better fuel efficiency, improve passenger comfort, and lower life-cycle ownership costs. The automotive industry is also increasing its use of composites for fuel economy and passenger protection. While using composites is invaluable, repairing them presents challenges. The Consortium for Accelerated Innovation and Insertion of Advanced Composites (CAIAC), funded by the National Institute of Standards and Technology, is taking on the challenge by developing a roadmap for composite joining and repair technologies. ISyE's Ben Wang, Gwaltney Chair in Manufacturing, and Chuck Zhang, professor, in partnership with over 40 companies, are leading the effort.



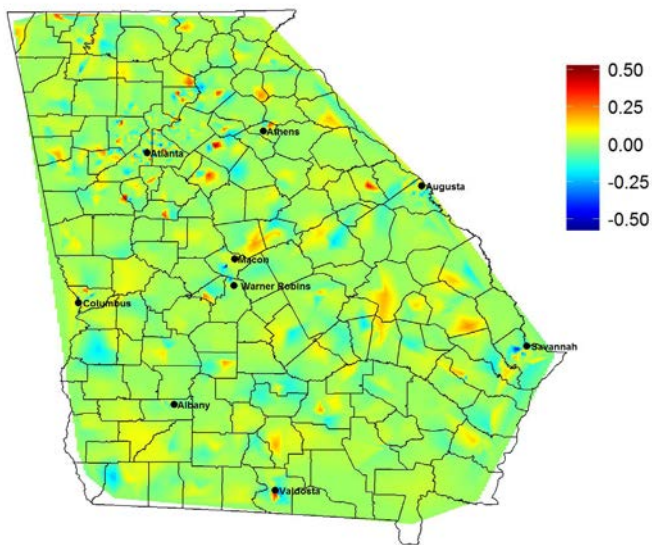
An aircraft radome damaged by hail storm. (credit: Ricardo Cirrielli)

Supply Chain: Transportation Practices in the California Cut Flower Industry

For the past several years ISyE Assistant Professor Alejandro Toriello has been involved in a project studying consolidation and cooperation in agricultural supply chains. This work began when Toriello and his colleagues obtained funding from the California Cut Flower Commission (CCFC), the state entity that represents flower farms, to study the transportation of flowers from California to customers around the country. The motivation was California's ongoing loss of market share to South American countries, driven by a variety of factors that include high transportation costs. Whereas 50 years ago California was the predominant source of cut flowers in the U.S., today it only controls around a quarter of the market, with the difference coming mostly from South America, especially Colombia. Toriello and his co-authors found that California farmers could save 35 percent of transportation costs — \$20 million annually — if they consolidated shipments to customers. They presented these results to various stakeholders, including farmers, the CCFC, and U.S. Congresswoman Lois Capps, whose district includes many of the farms. The CCFC also presented the study's results to the U.S. Congress and used them when applying for Department of Transportation funding for a consolidation center in Oxnard, just south of Santa Barbara. Toriello subsequently leveraged these findings to expand the study to general agricultural supply chains, and obtained project funding from the National Science Foundation to develop optimization and game theory techniques in such chains.



Toriello and team's study on transportation challenges of getting California's cut flowers to market has been expanded to study general agricultural supply chains.



The difference in projected availability of primary care providers in 2025 for the adult population when comparing availability under Medicaid expansion and non-expansion.

Health: Availability of Primary Care for Adults in Georgia by 2025 under the Affordable Care Act

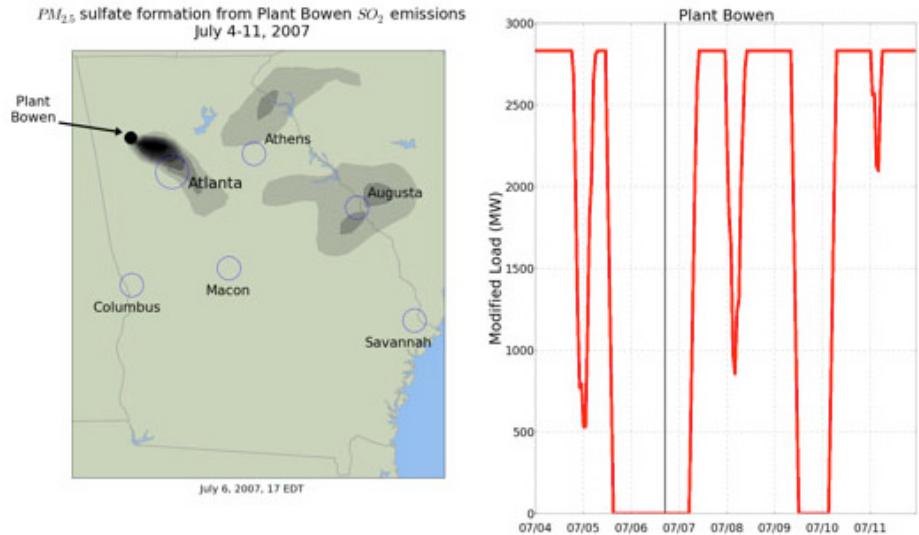
Many studies forecast that the increased demand for health care generated by the Affordable Care Act may not be adequately supported by the supply of health care services, potentially impacting the availability of providers. Furthermore, it has been suggested that the availability of adult primary care providers could worsen with the expansion of Medicaid eligibility.

Looking at Georgia's expected population by 2025, ISyE students Pravara Harati and Monica Gentili, and Nicoleta Serban, Coca-Cola Associate Professor, researched the projected impact of the Medicaid eligibility extension on availability of adult primary care services. Their research finds that while there are a few communities where the reduction in availability is significant, for most of the communities, availability changes little. This suggests that the increased demand due to a larger Medicaid population under Medicaid expansion will not be a significant burden on the privately insured population of Georgia.

Research Briefs

Sustainability: New Emissions Model Could Improve Air Quality, Health Effects

ISyE's Valerie Thomas, Anderson Interface Professor of Natural Systems, Joel Sokol, Fouts Family Associate Professor, and Ph.D. student Paul Kerl have worked with researchers from the Schools of Earth and Atmospheric Sciences, Civil and Environmental Engineering, and Chemical and Biomolecular Engineering to create a new capability to minimize the human health effects of air pollution from electric power generating facilities. The Air Pollutant Optimization Model (APOM) examines ozone emissions and fine particulate production. The APOM works differently from other emission models, which can take days to calculate the effects of various energy production plant combinations (such as biomass, natural gas, and coal). Instead, the APOM allows utility companies to analyze how numerous combinations of different power generator types could vary the air quality, all within less than a second.



The map on the left uses the traditional model and shows concentrations of pollution over more heavily populated areas without taking health effects into account. The chart on the right, which reflects the APOM, recommends curtailing the power plant's (Plant Bowen) operations at specific times.

"We looked at what would be the least expensive way of running these power plants if you take into account both the generating costs and the health impact costs," said Thomas. "You would still be operating plants that emit pollutants, of course, but at specific hours of high impact, you would reduce operations at the ones having the greatest impact and increase the use of facilities that have less impact or are in other areas."

Power is produced at varying costs, according to the type of plant generating it. When more expensive facilities are used in place of less expensive power-generating facilities, overall production costs increase. However, APOM finds solutions in which higher electricity production costs are more than compensated by the health savings — as much as \$92 million in a case study for Georgia — by reducing pollution's negative cardiovascular and respiratory impacts.

Stochastics: Understanding Complex Networks to Model Society's Most Important Problems

ISyE Assistant Professor David Goldberg's research is motivated by the need to understand the complex stochastic networks used to model many of society's most important problems. Such models, which arise in applications in supply chain management and inventory control, resource allocation in service systems, and designs of communication networks and financial markets, are often characterized by three features: large scale; complicated dependency structure; and intractability. Goldberg develops accurate, tractable, robust approximations for fundamental models commonly used in the study of such networks. A specific thrust of his work has been to use ideas from probability to develop new and provably effective algorithms for massive optimization problems. Such problems arise, for example, in the control of complex supply chains, and when making operational decisions about complex service systems. This is often referred to as "the curse of dimensionality," and for decades this problem led researchers to believe that optimizing such systems was intractable. Goldberg has combined novel ideas from probability and convex optimization to develop new and provably accurate algorithms and methods of analysis for these problems. His work shows us that as these problems become high-dimensional, even simple policies and approximations begin to perform very effectively.



Economic Decision Analysis: Researchers Develop Framework for Value-based Pricing of Cancer Drugs

At a time when cancer drug prices are rising rapidly, an innovative new study recently published in *JAMA Oncology* provides the framework for establishing value-based pricing for all new oncology drugs entering the marketplace. Using a highly sophisticated economic model, ISyE Assistant Professor Turgay Ayer and Ph.D. student Qiushi Chen, along with researchers at Winship Cancer Institute of Emory University, used an example of a new lung cancer drug.

Georgia Tech and Emory University researchers have focused their investigation on a drug called necitumumab, an experimental lung cancer drug made by Eli Lilly and Company. The drug is awaiting approval from the U.S. Food and Drug Administration, and Eli Lilly has not set a price yet. The researchers used their economic model to factor medication and administration costs with life expectancy, frequency and management of adverse effects, and quality of life. The results demonstrated that the value-base price for necitumumab ranges between \$563 and \$1,309 per three-week cycle, which is a significantly lower cost than most cancer drugs that have entered the marketplace recently.

According to the study authors, "The current system of paying for cancer drugs in the U. S. provides little incentive for manufacturers and physicians to consider value when pricing and using drugs." Although the study determined pricing for one specific drug, the analysis conducted establishes a model by which other cancer drugs can similarly be assessed in the future to develop value-based prices. The study concludes: "There is currently a crucial step in the drug development and approval process that is missing – an evaluation of cost and value."

At Georgia Tech, the Objective of Analytics Is to Support Decision-making

by GARY GOETTLING

Analytics is attracting a great deal of attention in the business world these days, and no one knows that better than Joel Sokol, the Fouts Family Associate Professor at the H. Milton Stewart School of Industrial & Systems Engineering (ISyE) at Georgia Tech.

Sokol also serves as director of Georgia Tech's new interdisciplinary Master of Science degree in Analytics, which graduated its first class this past August.

"We couldn't advertise the degree until it was formally approved by the Board of Regents, and that happened in late May last year," says Sokol. "So we missed the entire application season, which usually happens in the fall and spring. We were hoping we could scrape up 20 people to put this class together, but we got about 80 applications in just a few weeks. We accepted 44 outstanding applicants. All but three students enrolled, with a couple students deferring their admission, so we started with 39."

Word got out. The current class, which started in August 2015, drew more than 400 applicants, from which a class of 47 was selected.

These numbers reveal a growing interest in analytics among businesses and organizations as a way to analyze and interpret the data they acquire. At ISyE, where analytics has been central to its educational mission for many years, this interest is reflected not only in the number of applications to the new master's program, but also in analytics research into contemporary problems and a rigorous interdisciplinary curriculum that includes Senior Design projects for undergraduate seniors.

What is analytics?

The basic definition of analytics is the extraction of meaningful information from data. At ISyE, this definition goes a key step further.

"For us, analytics is not only the techniques to process data and extract information from data or even the knowledge obtained from data," says Martin Savelsbergh, James C. Edenfield chair and professor. "It is also how you can use that information or knowledge to improve business processes or make better decisions.

"Analyzing data per se is not what people are after," he adds. "In the end, you want to use what you learn from data to be better at something, and being better at something usually means that you make better decisions."

Savelsbergh points out that the ability to collect, store, and manipulate data has grown exponentially over the years, along with sophisticated techniques and algorithms for analyzing it. But more data in and of itself isn't necessarily the right objective.

There can be data overload, he says, citing an actual example of a trucking company that outfitted its vehicles with GPS and two-way communication so as to better keep track of its fleet.

"Every five minutes the company gets updated information from each truck regarding the time it is estimated to arrive at the distribution center. At one point, a signal is received that says a particular truck is expected in one and a half hours. Five minutes later the signal says the truck is expected in one hour and 40 minutes. Five minutes after that the signal says the truck will

arrive in an hour and 45 minutes — and so on.

"Is this really very useful information?" Savelsbergh asks. "What are you going to do with that information? Certainly the people at the trucking company don't know what to do with it."

While conceding that more information is generally better than less information, one must be careful to avoid collecting data simply for its own sake.

"You want to process, analyze, and understand the data — maybe understand trends — but whatever it is you're looking for in the data, you want to be sure it helps you make better decisions about something."

M.S. in Analytics follows an interdisciplinary approach

The practical, decision-enabling orientation of analytics at ISyE is evident in the new master's program as well, which includes an applied analytics practicum at the end of the one-year program.

Graduate analytics degree programs are relatively uncommon in the U.S., and the majority of those that do exist are part of a particular college or school.

"Ours is one of the handful that's interdisciplinary," says Sokol. "It's a joint program among the College of Engineering, the College of Computing, and the Scheller College of Business.

"Students get an interdisciplinary core that covers a full range of analytics topics, and then they pick a track to get a deeper specialization. Each of the

tracks is aligned with one of the three units. We have an analytical tools track that includes additional statistics, and ML and OR predictive and decision modeling material. Students who opt for the business analytics track get a deeper understanding of the practice of developing and executing analytics projects within businesses. In the computational data analytics track, students get additional depth in acquiring, managing, analyzing, and visualizing data."

Another unusual feature is that half or more of the 10 courses that students take are electives, which allows them to tailor their degree to fit their personal career interest.

"They may take courses in specific areas so they can perform the right kind of analysis for whatever industry they want to go into," Sokol elaborates. "For example, if they want to do analytics in the hospitality industry, they might take electives on pricing and revenue management, Web search and text mining, and optimization so they could capture and analyze data such as from TripAdvisor and, then use the results to suggest improved pricing policies."

The broad applicability of analytics is reflected in the diverse backgrounds of the program's applicants.

"The majority of them come in with degrees in business, engineering, math, statistics, or computer science, but we also get people with degrees in psychology, anthropology, astrophysics, linguistics, religion — a whole range of backgrounds," Sokol notes.

A variety of job experience is represented as well, with about 60 percent of applicants having had some previous employment.

Their resumes run the gamut from just a few years of post-bachelor's degree work experience to positions as lead product engineers and corporate vice presidents. One applicant had spent the past few years in the U.S. Navy aboard a nuclear submarine, according to Sokol.

Analytics helps undergraduates solve problems

When an Atlanta-area hospital wanted to cut wait time and provide more accurate wait-time estimates for its emergency room patients, it sought help from a group of Georgia Tech industrial engineering undergraduate students who took on the assignment as their Senior Design project.

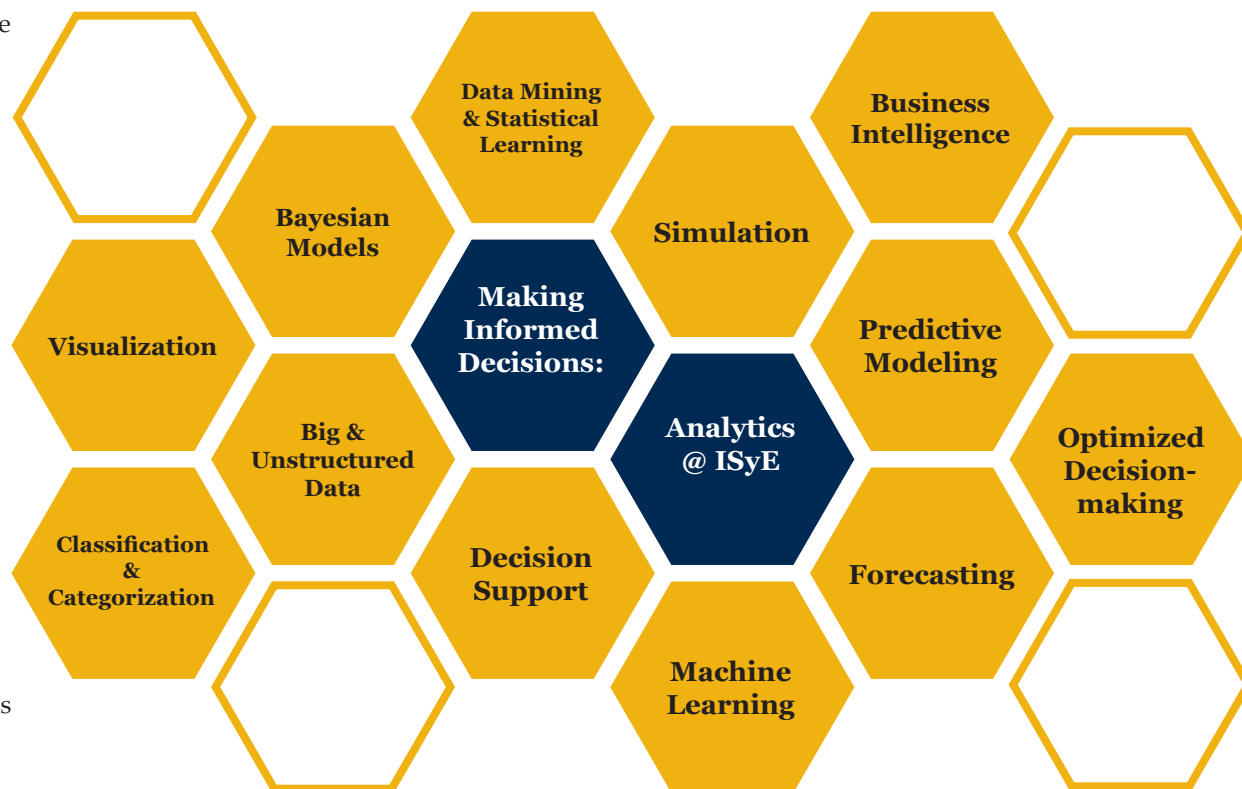
Senior projects are an integral part of the undergraduate curriculum, says Sokol, who supervises the program each fall. "At the end of their time at Georgia Tech, students form groups and carry out real industrial engineering projects for companies and organizations that need their help. A lot of what they do involves analytics, but at the undergraduate level."

Back at the hospital, the team of six students observed emergency room

operations over several months. They collected and analyzed data on patient arrivals and conditions as well as the amount of time taken to be seen by nurses, doctors, and other hospital staff. The students then used statistical techniques to model the emergency room system in a simulated environment, and devised process-improvement recommendations that would reduce wait time without changing the quality or quantity of care. They also developed a real-time simulation tool that helps the hospital give entering patients a more-accurate estimate of their wait time.

Other examples of senior capstone projects reveal the wide applicability of analytics and include delivery routing and logistics for supply chain design, pricing for hotels and parking, race strategy for a motor sports team, and the timing of trains and railcar sequencing.

In addition, student teams have worked with the Centers for Disease Control and Prevention on various aspects of their response to the Ebola outbreak, and improvements to the organ transplant system.



Analytics can improve medical decision-making

Data analytics research conducted at ISyE explores innovative new methodologies and techniques for analyzing data across a spectrum of applications, from energy and finance to supply chains and sports.

But no other area affects the quality of daily life for more people than their health.

Arriving at the best medical and health care decisions relies heavily on data, says Nicoleta Serban, Coca-Cola Associate Professor of ISyE. “We are interested in finding ways to capture and analyze data to optimize the decision-making process in health care.”

Her work extends into the arena of public health as well, where policymakers need data-driven conclusions to help them make effective problem-solving decisions.

Serban is co-founder and co-leader, along with Harold R. and Mary Anne Nash Professor Julie Swann, of the Health Analytics Group. Its mission is to provide a foundation for better medical decisions by applying mathematical and computational modeling techniques to health services research data and health economics data.

One of the challenges of health care analytics is that it may deal with so-called Big Data — huge data sets measured in terabytes and exabytes — but not always.

“The quality of data is a more important consideration than the volume of data,” Serban says. “The key term is ‘decision-making’ — that data is captured and analyzed for the purpose of making better decisions. Sometimes this involves Big Data, and sometimes it involves very little data.”

The Health Analytics Group’s wide-ranging research interests address both traditional and emerging health analytics models, including:

- Designs for telemedicine interventions that improve health care access or balance cost and equity.
- Logistics efficiencies that address patient flow at clinics or hospitals, the scheduling of medical residents and staffing of nurse call centers, and disaster-response planning.
- Decision support tools to help health care providers schedule catch-up vaccinations for children and adults or to optimize radiation treatment for tumors.
- Statistical techniques to help clinicians identify patients with the greatest risk for nonconvulsive epileptic seizures.
- Evaluations and recommendations to inform public policy such as the effects of school closures during an influenza pandemic, identifying areas with the highest levels of childhood obesity, quantifying the status quo of health care service utilization and pathways, interventions to treat or prevent disease, and the analysis of health-related expenditures.

One example of a specific research initiative is the group’s ongoing study of pediatric asthma.

Asthma — the second most common reason for pediatric emergency room visits in Georgia — impairs quality of life and contributes significantly to health care costs, particularly for emergency room visits and hospitalizations, many of which are preventable. These costs are especially burdensome to children from low-income households.

“Our immediate objective is to describe underlying asthma care pathways for children in the Medicaid program,” Serban explains. “For each pathway, we evaluate utilization and costs to suggest potential policy and network interventions.”

Designing interventions with the greatest impact on patients with limited resources begins with the creation of an asthma care baseline.

“We want to quantify a set of measures around pediatric asthma for the Medicaid population,” she notes. “Our initial baseline includes things related to outcomes and costs, and for geographical areas and subpopulations within the state of Georgia.”

Baseline data would include many of the complicating factors in treating pediatric asthma such as age, severity of the condition, and environment.

In addition, there are different levels of asthma care to consider, from doing nothing to obtaining care from a primary care physician or asthma specialist, or visiting the emergency room.

“Using retrospective Medicaid claims data, our research spans multiple directions,” she says. “In addition to the set of baseline measures for asthma care, we’re interested in linking access to outcomes, and identifying trends in care utilization and cost.

“Ultimately, our goal is to design policy and network interventions to improve health outcomes and access for people with limited resources.”

Spreading the word

Industrial engineers are problem solvers, which is why analytics is considered an engineering discipline.

“We’re not concerned with building or designing physical objects,” says Savelsbergh. “We’re interested in processes and in finding ways to improve the performance of businesses and organizations.” Thus, analytics is a natural fit.

“There are still a lot of people who are trying to understand what is meant by analytics,” he continues, “and this gives us an opportunity to interact with organizations either in government or private industry to not only talk about what we do in analytics, but to emphasize our belief that its goal is to improve decision-making.

“We have been doing analytics for a long time — and we’re very good at it.” ■

Expanding Our Global Footprint

Georgia Tech, Dutch Institute of Advanced Logistics, and the Flemish Institute for Logistics to Collaborate to Enhance Research, Innovation, and Knowledge Dissemination

Leadership at Georgia Tech's Stewart School of Industrial & Systems Engineering (ISyE), its Supply Chain & Logistics Institute (SCL) and the Physical Internet Center, along with DINALOG (the Dutch Institute for Advanced Logistics), and the Flemish Institute for Logistics (VIL) gathered together on October 6, 2015 to formalize a collaborative working relationship by signing a memorandum of understanding (MOU).

This joint collaboration will leverage common goals and interests in logistics to further enhance academic research, technological innovation, and knowledge dissemination in hyper-connected logistics.

With this new collaboration, ISyE and SCL continue to expand their global outreach in the field of supply chain and logistics. They are already working with affiliated international centers and programs in Costa Rica, Mexico, Panama, and Singapore.

"If we are to assist in making supply chains more efficient and reliable, it is important to understand logistics from an international perspective," said Edwin Romeijn, ISyE School Chair. "And by working with DINALOG and VIL, we continue to expand our network to improve logistics performance worldwide."

ISyE's Physical Internet Center catalyzes and leads projects in collaboration with scientific, industrial, and governmental partners from around the world, enabled by its new leading-edge Physical Internet lab.

DINALOG is the national institute responsible for the execution of the innovation program of the Dutch focus sector logistics. Within DINALOG, around approximately 300 organizations (logistics service providers, port authorities, shippers, and knowledge institutions) work together in open innovation to advance logistics and supply chain management. Currently, many Dutch professors perform joint research projects with professors at Georgia Tech, particularly associated with SCL and the Physical Internet Center.



Standing: Minister President Bourgeois (Flanders), Mayor Kasim Reed (Atlanta), Prime Minister Rutte (The Netherlands). Signing MOU seated: Francis Rome (Director of VIL – Flanders), Martin Savelsbergh (ISyE), Liesbeth Staps (Deputy Director of Dinalog – The Netherlands), Benoit Montreuil (ISyE), Iris Vis (University of Groningen – The Netherlands), and Edwin Romeijn (ISyE).

The third signer of this MOU is VIL, an open innovation platform for the logistics industry. Approximately 500 companies (shippers, carriers, logistics services providers, and port authorities) are members of VIL. With public funding by the government of Flanders in Belgium, VIL along with Flemish member companies perform logistics innovation projects to increase their member companies' competitiveness.

As part of this mutual cooperation, the signees have agreed to:

1. A grant scheme for Ph.D. candidates and post-doctoral researchers that will enable research visits to knowledge institutes in The Netherlands, Belgium, and at Georgia Tech.
2. A jointly organized seminar for researchers and practitioners in all three countries on the subject of "Towards virtual ports in a physical internet."
3. A jointly organized International Physical Internet Conference in 2017 or 2018 hosted by the University of Groningen.
4. And to foster other jointly developed projects and associated grant proposals. ■

On Guard: Defending a Thesis

Just as research grants and contracts shed light on the nature of research conducted by a program, so too does the completion of dissertations produced by our program's Ph.D. students. While not a comprehensive list, we are providing a few highlights of recent dissertations and where these students found their first position out of ISyE.

Kelly Kihm Bartlett, Ph.D. IE 2014
"Congestion-aware Dynamic Routing in Automated Material Handling Systems"

Advisors: **Shabbir Ahmed, George Nemhauser,** and **Joel Sokol**

First position: Research Scientist, Georgia Tech

Bahar Cavdar, Ph.D. IE 2014
"A Computation Implementation Parallelization Approach to Time-sensitive Applications"

Advisor: **Joel Sokol**

First position: Assistant Professor, Middle East Technical University

Alejandro Francisco Mac Cawley, Ph.D. IE 2014

"The International Wine Supply Chain: Challenges from Bottling to the Glass"

Advisor: **John Bartholdi**

First position: Professor, Pontificia Universidad de Chile

Melih Celik, Ph.D. IE 2014
"Resource Allocation Problems under Uncertainty in Humanitarian Supply Chains"

Advisors: **Ozlem Ergun** and **Pinar Keskinocak**

First position: Assistant Professor, Middle East Technical University

Vinod Cheriyan, Ph.D. OR 2014
"Models of Human Behavior with Applications to Finance and Pricing"

Advisor: **Anton Kleywegt**

First position: Senior Associate, Enova Financial

Cristobal Guzman, Ph.D. ACO 2015
"Information, Complexity, and Structure in Convex Optimization"

Advisors: **Arkadi Nemirovski** and **Sebastian Pokutta**

First position: Postdoctoral Research Assistant, Centrum Wiskunde & Informatica

Li Hao, Ph.D. IE 2015
"Residual Life Prediction and Degradation-based Control of Multi-Component Systems"

Advisors: **Nagi Gebraeel** and **Jianjun Shi**

First position: Data Scientist, Equifax

Liujia Hu, Ph.D. OR 2015
"Convergent Algorithms in Simulation Optimization"

Advisor: **Sigrun Andradottir**

First position: Senior Advisory Consultant, Ernst & Young

Tugce Isik, Ph.D. OR 2015
"Optimal Control of Queuing Systems with Non-collaborating Servers"

Advisors: **Sigrun Andradottir** and **Hayriye Ayhan**

First position: Assistant Research Professor, Clemson University

Pisit Jarumaneeroj, Ph.D. IE 2014
"An Economics Study of Container Ports in the Global Network of Container-shiping"

Advisor: **John Bartholdi**

First position: Assistant Professor, Chulalongkorn University

Aly Samy Megahed, Ph.D. IE 2014
"Supply Chain Planning Models with General Backorder Penalties, Supply and Demand Uncertainty, and Quantity Discounts"

Advisor: **Marc Goetschalckx**

First position: Research Staff Member, IBM Research - Almaden Research Center

Pratik Mital, Ph.D. IE 2015
"A Modeling Framework for Analyzing the Education System as a Complex System"

Advisors: **Donna Llewellyn** and **David Goldsman**

First position: Operations Research Consultant, Revenue Analytics

Rodrigue Tzoumpe Ngueyep, Ph.D. IE 2015
"Model Selection and Estimation in High Dimensional Settings"

Advisor: **Nicoleta Serban**

First position: Postdoctoral Research Assistant, IBM T.J. Watson Research Center

Matthew Plumlee, Ph.D. IE 2015
"Fast Methods for Identifying High Dimensional Systems Using Observations"

Advisors: **Roshan Joseph Vengazhiyil** and **Jianjun Shi**

First position: Assistant Professor, University of Michigan

Diego Alejandro Moran Ramirez, Ph.D. OR 2014
"Fundamental Properties of Context Mixed-integer Programs"

Advisor: **Santanu Dey**

First position: Assistant Professor, Virginia Tech

Sue Reynolds, Ph.D. IE 2014
"Statistical Estimation and Change-point Detection Methods in Public Health Surveillance"

Advisors: **David Goldsman** and **Kwok-Leung Tsui**, City University of Hong Kong

First position: Centers for Disease Control and Prevention



Left: Tonya Woods, M.S. Statistics 2012, Ph.D. IE 2015, successfully defended her thesis "Extracting Meaningful Statistics for Characterization and Classification of Biological, Medical, and Financial Data," in May 2015. Woods began working at Equifax after graduating.

Top Right: Woods with her advisor, Brani Vidakovic, discusses her presentation. Above: Woods and Vidakovic with her examination committee: Yajun Mei, Kamran Paynabar, Scott Nickleach, Mirjana Miloseric-Brockett.

Soheil Shayegh, Ph.D. IE 2014

"Learning in Integrated Opt Models of Climate Change and Economy"

Advisor: **Valerie Thomas**

First position: Postdoctoral Research Scientist, Carnegie Institute for Science, Stanford University

Min Kyu Sim, Ph.D. IE 2014

"Empirical Findings in Asset Price Dynamics Revealed by Quantitative Modelling"

Advisor: **Shijie Deng**

First position: Quantitative Research Analyst, Samsung Asset Management

Mallory Jo Soldner, Ph.D. IE 2014

"Optimization and Measurement in Humanitarian Networks: Addressing Practical Needs"

Advisors: **Ozlem Ergun** and **Julie Swann**

First position: Advanced Analytics Manager, UPS Atlanta

Heng Su, Ph.D. IE 2015

"Some New Ideas on Fractional Factorial Design and Computer Experiment"

Advisor: **Jeff Wu**

First position: Quantitative Associate, Wells Fargo

George Thiers, Ph.D. OR 2014

"A Model Based Systems Engineering Methodology to Make Engineering Analysis of Discrete-event Logistics Systems More Cost Accessible"

Advisors: **Leon McGinnis** and **Steven Hackman**

First position: Postdoctoral Research Assistant, Georgia Tech

Monica Villarreal, Ph.D. IE 2015

"Capacity Planning and Scheduling with Applications in Health Care"

Advisor: **Pinar Keskinocak**

Position: Senior Planning and Analysis, Denver Public Schools

Theoretical Research at ISyE

by SANTANU S. DEY and R. GARY PARKER

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The academic concentrations supported by the H. Milton Stewart School of Industrial & Systems Engineering (ISyE) are myriad. Its graduates at all levels reflect this variety by making substantive contributions in a broad span of important practical settings, such as supply chain logistics, manufacturing, health care, finance, natural systems, energy, and others.

It is also the case that ISyE places great value in maintaining a strong theoretical research presence in our fields, and, in parallel, strives to educate the next generation of scholars so that they are well-positioned to thrive as contributors to that effort. The concrete value of our emphasis on theoretical work and, by extension, the profession we serve, deserves a closer look.

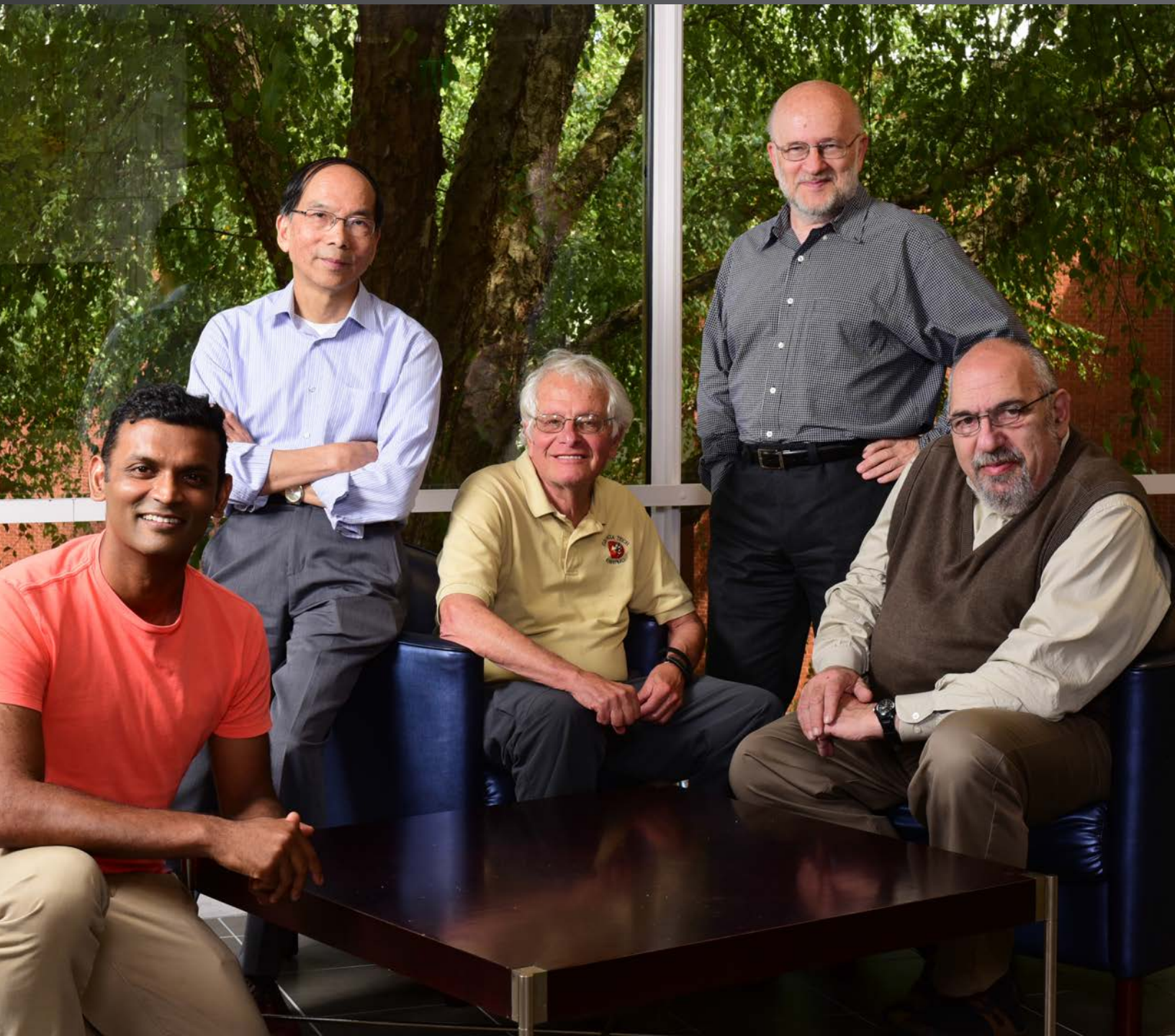
Sliding into pedantry is easy when it comes to defining theoretical research. The term by its very nature describes a relative concept. What could be considered “theoretical” by a software engineer might easily be declared “very applied” by a number theorist. Here we have used the “you-know-it-when-you-see-it” rule-of-thumb. Accordingly, a significant amount of theoretical research in our school takes place within the fundamental methodologies that are core to our discipline: mathematical optimization, stochastics and simulation, and statistics.

Theoretical research is often motivated by applications

Engineering, by definition, is an applied field; its practitioners solve important and real-world problems, often in incredibly creative and ingenious ways. Engineers draw their most effective technical skills from the hard sciences, most prominent among which are physics and chemistry. In the final analysis, engineers are users, doers. This certainly includes industrial engineers, with the exception that their core science base tends to be mathematics and statistics.

As is the case in most fields, the easy systems-level industrial engineering problems get solved routinely, and the genuinely hard ones ultimately prove resistant to existing methodological tools. Those hard problems don’t go away, leaving shakier options for their treatment, including the design of ad hoc fixes or approximations that may be clever and work in some cases but that may also fail miserably in others. But seeking ways to solve — or at least handle effectively — the hard problems is where the need for advances in existing theory most clearly reveals itself. Necessity, it’s true, is the mother of invention.

A commonly cited example — one that contributed directly to the development of what became the field known as Operations Research (OR) — relates to efforts by the



ISyE's Titans of Theory (left to right): Santosh Vempala, ISyE Courtesy Appointment and Distinguished Professor of the College of Computing, Jeff Wu, Coca-Cola Chair in Engineering Statistics and professor, George Nemhauser, A. Russell Chandler III Chair and professor, Alex Shapiro, professor, and Arkadi Nemirovski, John Hunter Chair and professor.

With this deep emphasis on theoretical research, traced largely from the early to mid-1980s, the Stewart School is among the elites in terms of its theoretical research activity and its corresponding impact on our fields.

British, in the years just prior to the outbreak of World War II. A multidisciplinary team of scientists, including many Nobel laureates, was assembled to conduct experiments on how fighter aircraft could be better deployed, based on radar-generated information. The need for success was obvious, and the groundbreaking work ultimately produced proved to be an important factor in winning the Battle of Britain. Similar teams helped to break enemy codes, optimize troop deployments, and even understand nuclear chain reactions.

Our methodological fields — the theory-oriented ones identified in the introduction, and that are prominently identified with ISyE — are also rife with similar stories where this scenario has played out. Typical are settings that benefit, sometimes in very practical ways, from results focused on seemingly abstract research pursuits such as understanding deeply how known methodologies work, generalizing and extending what is known, and, possibly, establishing formal limits regarding what can be known.

Some examples of famous outcomes of theoretical research include the well-known work of George Dantzig, conducted shortly after WWII, including his invention of the simplex algorithm for solving linear programs; John von Neumann's anticipation of duality theory, actually motivated by discussions with Dantzig during this same period; Stan Ulam's development in the late 1940s, following work related to the Manhattan Project, of the process that became Monte Carlo simulation; Ralph Gomory's circa 1960 work that set the basis for a theory of cutting planes that played a pioneering role in initiating the field of integer programming; Jack Edmonds who in the mid-1960s coined the phrase "good algorithm," and demonstrated the relevance of its formalization by presenting an ingenious solution for the so-called matching problem — which in turn ushered in the field that would become combinatorial optimization; and Richard Karp who, in the early 1970s, showed how apparently different problems were fundamentally equivalent in that either they all were solvable by a good algorithm or none were.

Common to all of these iconic contributions and developments that derived from theoretical research efforts is that they were authored by people educated and trained in mathematics. That this level of formal mathematical expertise

was applied in producing these fundamental results is, of course, not a requirement, but neither should it be a surprise; such is the nature of the mathematical machinery and rigor needed to make substantive progress. And, no one should find it peculiar that some of the most productive theoretical research success stories affiliated with ISyE have been authored by faculty trained at a certain level of applied and even pure mathematics.

The short historical list of work we've identified above accurately reflects the complexion of what constitutes fundamental research efforts as they would be viewed and practiced by many who conduct their scholarly work in methodological areas directly supported by ISyE. With this deep emphasis on theoretical research, traced largely from the early to mid-1980s, the School is among the elites in terms of its theoretical research activity and its corresponding impact on our fields. We are in the company of such institutions as MIT, Stanford, Berkeley, Columbia, and Cornell.

By any measure, at least a third of ISyE's full-time academic faculty are active in theory-based research as their primary focus — a remarkable number for industrial and systems engineering programs. In some facets of our methodological disciplines, our respective faculty have few (if any) peers. The ISyE faculty boasts some very famous scholars. In particular, the contributions to discrete optimization by George Nemhauser, convex optimization by Arkadi Nemirovski, stochastic optimization by Alex Shapiro, graph theory by Robin Thomas, design and analysis of algorithms by Santosh Vempala, and industrial statistics by Jeff Wu are unparalleled in the world.

Theoretical research breeds new application areas

Why even bother with something as obscure as theoretical research? The answer is that not much gets done without it. In fact, one of the outcomes of basic theoretical research is that it very often produces valuable and important practical results as spin-offs, especially as the work progresses. New questions often arise that open new avenues for fundamental research; much of this occurs along the way, even if the original problem being pursued remains elusive or resistant. It's not at all uncommon for these so-called spin-off results to sometimes rival, if

not overshadow — in both elegance and utility — the anticipated outcome when the research was initiated

Sometimes knowing that a tool has been invented for solving a problem in one context facilitates the search for related ones, where the newly discovered methodology can be applied. For instance, similar to the research group working on behalf of the British military, groups of interdisciplinary scientists in the U.S. army were formed to protect convoys, improve anti-submarine warfare, and increase success with bombers during the war. Then, by the 1950s, the methodological tools developed explicitly to solve military problems began to be useful in addressing many other postwar applications.

The typical paradigm is as follows: A scientist trained in various theoretical methodologies is introduced to a new and complex (and perhaps pressing) practical problem. The setting in which the problem arises need not be familiar to the scientist. Usually, the first step is to state this problem in a familiar mathematical form. Once this possibly difficult feat is accomplished, known algorithms, mathematical techniques, and theoretical results can take over to solve the problem. Indeed, the theoretical research accomplishments mentioned in the previous section, along with significant contributions by faculty at ISyE, are used daily to solve new problems for industry, business — and humanity in general.

The above described process often involves heavy lifting; there are no easy problems anymore, and seldom does the resolution of these problems follow as a routine or obvious application of what is known, even if the latter is a newly discovered outcome of an arduous theoretical effort. And, even knowing that a problem is solvable in theory does not mean that the solution will be instantaneously useful in business and industry. Often a gap needs to be bridged in moving from theory to practice, which can require some effort and time. Still, knowing that a problem is solvable, even in a theoretical sense, is a major hurdle to overcome if any hope for practical impact is to ultimately be realized.

Naturally, when the progression from theory to algorithm-creation to practical application plays out, limits inevitably will be reached. Sometimes, known theoretical methodologies

will be stymied. But then the investigative cycle repeats, and ultimately progress is made. This understanding is what motivates the research efforts of many of the aforementioned faculty in ISyE. That the School has attained its elite status as a center of serious theoretical research validates their efforts.

Final remarks

The intent here has not been to claim, or even suggest, that all theoretical research in our methodological fields can be painted with the same colors. The quality of theoretical work, no matter the field or discipline, can sometimes only be judged by experts, and certainly, its true worth is often gauged over time. Above all, since theoretical research is basic research, its value — or the justification of its worthiness for pursuit — cannot be exclusively influenced by utilitarian requirements or prospects of immediate payoff. For the payoff to become obvious and substantial can take time.

Theoretical research of the sort that we've been addressing here requires a great deal of support for its development. It's true that much of this support involves material resources such as time and money, but equally important is the need for support in terms of a strong institutional commitment in the endeavor—a genuine belief that a serious engagement in theoretical research is valuable and important. While ISyE has been a proud producer of strong, applications-focused research, it has also been enormously successful in building a strong and visible presence in the extremely competitive field of theoretical research. It is crucial that the School continues to solidify its place among those few, highly regarded academic programs with which it has earned the right to be considered a peer. The strongest evidence serving to corroborate this intention to stay at the theoretical forefront, in terms of quality and level of activity, can be gleaned from ISyE continuing to add young and exceptionally talented faculty to its roster. Many of these young stars were attracted by the heritage of excellence in fundamental research that has evolved in ISyE over the last 30 years, and it will be up to them to continue it. ■

Nemhauser Honored with Class of 1934 Distinguished Professor Award

by VICTOR ROGERS

George Nemhauser is widely considered to be one of the world's top optimization researchers, and he has received the official recognition to match: He is the A. Russell Chandler III Chair and Institute Professor in the H. Milton Stewart School of Industrial & Systems Engineering (ISyE), recipient of the inaugural Khachiyani Prize for lifetime contributions to the field, and the only person to twice receive the Lanchester Prize for best publication in operations research. He is also the first sitting professor at Georgia Tech to be elected to the National Academy of Engineering. Now, he has received the Class of 1934 Distinguished Professor Award.

"Almost all the awards I have received have been from my profession," Nemhauser said. "This is the Georgia Tech award. This means a lot to me because it connects directly to Georgia Tech."

The Class of 1934 Distinguished Professor Award recognizes outstanding achievement in teaching, research, and service. It is the highest award given to a faculty member. The award, instituted in 1984 by the Class of 1934 in observance of its 50th reunion, is presented to an active professor who has made significant, long-term contributions — contributions that have brought widespread recognition to the professor, to his or her school, and to the Institute.

Letters of support for Nemhauser's nomination came from colleagues and former students around the world.

"My stimulation and the fact that I can still be working and having lots of fun — as old as I am — is because of what these people give to me," said the 77-year-old. "I'm not this great humanitarian, [or an] unselfish guy by any means. It's completely a two-way deal. When I get a chance to work with these young people, to me, that's the greatest pleasure in life. That's always been the best thing for me: to work one-on-one or with a small number of undergraduate and graduate students and young faculty. Those are the people who keep me on my toes."

From center field to operations research

Growing up in New York, Nemhauser dreamed of playing center field for the Yankees. He estimated that by the time he was ready for the position, Joe DiMaggio would be retiring. That didn't happen. He was a teen when DiMaggio retired, and Mickey Mantle took the position.

"I played all sports — with lots of effort and very limited ability. I did not have talent," Nemhauser laughed. "But I

love math. I was the kid who could compute the other kids' batting average. I wasn't the best player, but if they wanted to know their batting average — see George."

When it was time to head to college, Nemhauser was leaning toward majoring in math, but his mother encouraged him to study engineering. It was during a summer internship that he first learned about optimization and game theory, and he was fascinated. He started graduate school in chemical engineering but switched to operations research as the field was just starting academically.

"Man, was I lucky," he said. "Any success like this — honestly, so much of it is luck: being in the right place at the right time. I believe that 100 percent."

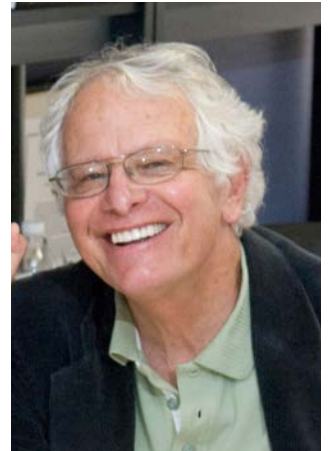
What is optimization?

"Optimization is about decision-making. Whether it's a problem in business or a problem related to health or medicine, the notion is: 'How can we use optimization to make better decisions?'"

"Most of these optimization problems have a huge number of variables and constraints. The contribution from our optimization group here at Georgia Tech — which, by the way is the best optimization group in the world, independent of me — is that we build the algorithms that allow [for] efficient computations for problems with thousands of variables."

Nemhauser's company, the Sports Scheduling Group, schedules games for the ACC, the SEC, the Big 10, and Major League Baseball.

"Scheduling Major League Baseball is a big optimization problem. You have all of these games to schedule, and a lot of it is driven by television contracts, which is where the revenue comes from. If you don't get the right games at the right time — that Saturday or Sunday afternoon game between the Yankees and the Red Sox — the contracts won't be what they would be otherwise."



Having fun

Having started teaching in 1961, Nemhauser has advised 65 doctoral students. Many of them are now on the faculty at MIT, Chicago, Northwestern, Carnegie Mellon, Berkeley, and other top universities around the world. One of the biggest changes he's noticed over the 54 years he's had dealings with graduate students is the interaction with them.

"I've always tried to eliminate formality. I hate formality. I'm a very, very casual person," he said. "When I started, there was more formality. To get a graduate student to call me 'George' was hard. But I needed to do that from the get-go, so I spent time trying to break down the formality that existed between faculty and students. Now, I think that problem has gone away. Things are much more casual."

In keeping with his casual approach, Nemhauser says he doesn't have a specific plan for the future.

"I don't know what's next," he said. "If I can keep my health and I'm having fun ..."

"I've never made long-term plans. I don't believe in them,"



Professor Nemhauser carried the ceremonial mace for one of the graduation ceremonies in May 2015. The mace is an ornamental staff carried as a symbol of authority and dates back to medieval England. The primary ornamentation of the mace is its three brass rods that symbolize the three primary components of Georgia Tech's mission: education, research, and service.

he said. "I've never had a five-year-plan in my whole life," he said. "A one-year-plan? That's good."

"My basic philosophy is: No. 1 — have fun in what you're doing. That, to me, beats it all." •

Professional Certificate Program Health & Humanitarian Supply Chain Management

Georgia Tech Health & Humanitarian Systems
Stewart School of Industrial & Systems Engineering

Did you know that science and engineering can help improve global health and humanitarian operations around the world to save and improve lives?

Georgia Tech's Center for Health & Humanitarian Systems (HHS) at ISyE is training practitioners from across the globe using advanced science and technology to improve disaster response and manage supply chains to deliver much needed aid and vaccines. By improving operational efficiency and cost-effectiveness for health and humanitarian organizations and governments, the HHS Center is helping donor dollars extend further to make a greater impact around the world.

Course participants have traveled to Georgia Tech from 18 different countries and have lived and worked in 76 countries across 5 continents.

"I plan to use the learnings and tools to help me better forecast demand for donated drugs in over 28 developing countries, improve collaboration with other NGOs and partners, and design and implement supply chain performance measures & scorecard."

**— Carla Johnson, IE '99
Supply Chain Systems Analyst for International Trachoma Initiative
at the Task Force for Global Health**

**May 9 - 14, 2016
Georgia Tech Global Learning Center**

To sponsor scholarships for health and humanitarian professionals at NGOs and in developing countries to attend the program, or for questions about registration, email hhs@isye.gatech.edu or visit hhscenter.gatech.edu/professional-education.



ISyE Alumna Rebecca Lally's Love of Math + Sports Analytics = Dream Career

Rebecca Lally, IE 2015, has combined her love of math and sports to create a career where her passions intersect. That intersection began when she landed a coveted internship with ESPN's Stats & Analysis department the summer before her senior year of college.

Lally's computer science knowledge, analytical mindset, and her attention to detail at both ISyE and ESPN are some of the keys to her success. Before graduating, she was offered and accepted a position with the St. Louis Rams in Football Information Systems. And she is already thinking about what she wants to be doing five years from now.

"In five years I would like to be innovating new ways to approach data in order to impact multiple departments within the front office. I have entered the sports world in the beginning stages of the Big Data movement, so in the next years I want to help change the way the game of football is analyzed and contribute to the foundation of how players are recruited."

This is a career best viewed from the 50-yard line.

You completed a dream internship and are now working for the NFL. How does that feel?

I worked really hard throughout my high school and college years to achieve my dream of working in sports. The internship with ESPN Stats & Analysis was an incredible experience that helped focus my career goals even further. Although I loved my time at ESPN, I knew the front office of a team was more aligned with where I wanted my career to go. That was my ultimate goal, but I never thought I would be so fortunate to begin my professional career with the St. Louis Rams. The trust and responsibilities the Rams have already given me confirmed that I am in the right place. They are excited to have me, and I am even more excited to be here. I actually spent my third week of work in Seattle at a sports science conference. I am embracing the opportunities I have to travel and continue learning new things. It has been everything I hoped it would be and more. I couldn't imagine being anywhere else.



What will a typical day look like for you?

My primary role is analyzing data on the football players. A typical day consists of fitting regression models to data, looking for trends, determining how to predict future performance and using software to visually analyze the data. All of this work is done as a collaborative effort with colleagues in different departments, such as scouting and strength conditioning, in order to assess their data analysis needs, improve the organization as a whole, and gain a competitive advantage.

How did ISyE prepare you for this new chapter in your life?

ISyE's curriculum of statistical programs like R and Minitab, as well as cross-disciplinary computer science classes with Python programming and SQL for databases are directly applicable in data analysis in the real world. In addition, analytical thinking, the ability to solve problems, and recognition of patterns in data are all keys to success. Lastly, I am thankful for Senior Design and the industry experience I gained from it. I improved my ability to work well on a team, problem solve, and meet deadlines. The impact that we were able to make was evident and motivating as I have begun my career.

How will you apply your IE skills to your work in sports?

R and SQL will be used in my daily work. My job will require creativity daily in order to find new avenues to analyze. I also will have to look at data through an unbiased lens, and use my IE statistical knowledge to validate any findings by finding relevance and significance of models and trends. In addition, my job will require the attention to detail that was required for success as an IE student.



How do you define success?

To me, individual success is defined by happiness. That happiness comes from my well-being, but also other sources such as my ability to make a direct impact and add value to the organization. For the team, success is observing how our analysis manifests itself in the way we play but also in winning games. The end goal is to win championships and get that ring.

What is one thing about you, that you are willing to share, that does not show up on your resume?

I hope that my experiences will inspire others to follow their dreams. One day I would like to be able to speak with young women in high schools or colleges in order to encourage them to find their gift and pursue a career where they can use that gift to make a difference. ▪

Honor your favorite Yellow Jacket by
creating a
**GEORGIA TECH
LEGACY**
in their name

Consider establishing an endowed legacy gift to honor someone special in the Georgia Tech community. Perhaps you would like to honor:

- **Your graduating daughter, son, or grandchild.**
- **Your favorite ISyE faculty member from your time as a student.**
- **A deceased loved one through a permanent memorial fund.**

A gift of \$25,000, payable over five years, will establish a permanent endowment fund in the name of your honoree and will provide resources for future generations of ISyE students, faculty, and programs for years and years to come. You and your honoree will receive annual reports on the impact of the fund. You, other family members, and friends can easily add to the fund throughout the years.

To learn more contact:
Nancy Sandlin at 404.385.7458 or
nsandlin@isye.gatech.edu



New Georgia Tech and NUS Center for Next Generation Logistics Launched

Georgia Tech, in collaboration with the National University of Singapore, officially launched the Center for Next Generation Logistics on July 24, 2015 in Singapore. The inauguration ceremonies were attended by 150 industry and government representatives and included presentations by the provosts of both universities. The center will serve as an open logistics innovation platform to:

- Identify and pursue pre-competitive and industry-focused research inspired by significant promise for economic and social impact and contributions to the body of knowledge.
- Accelerate and de-risk the path from knowledge discovery to innovation and commercialization.
- Nurture and develop the next generation supply chain and logistics workforce.
- Provide up-to-date business intelligence to better understand today's competitive landscape.

During the inaugural ceremonies, Georgia Tech Provost Rafael Bras noted, "Logistics is a major player of the U.S. economy, comprising over eight percent of the U.S. GDP, and Georgia, in particular, is a U.S. logistics hub. In parallel, Singapore and its container port thrive on expert logistics know-how. The new generation of logistics must integrate supply chains, movement of goods, manufacturing innovation, data analysis for predictive logistics, and growth of urban regions and megacities. It represents the future, and we are thrilled to define that future together with our Singaporean partners."

Chelsea C. White III, Schneider National Chair in Transportation and Logistics and Professor in the Stewart School of Industrial & Systems Engineering, has spearheaded Georgia Tech's participation in this initiative and is co-leader of the center along with NUS principal investigators Professors Lee Loo Hay and Chew Ek Peng.

"We are delighted to be collaborating with NUS in an area of research and innovation that has such potential societal and economic impact for both our countries. Next generation technology, data availability, customers, manufacturing innovations, and demographic trends will shape next generation logistics and supply chain systems, and it is critical that both nations are leaders in these areas to insure sustainable economic growth and prosperity," said White, who presented the center vision during the inaugural ceremonies.

Georgia Tech has collaborated with NUS for more than 15 years as the co-founders of the Logistic Institute – Asia Pacific, and the new center will further expand this collaboration.

The center has received seed funding from Georgia Tech and NUS over a two-year period to develop the center concept. It expects a five-year initial funding commitment of \$3 million annually from collaborating government agencies and industry partners to support approximately 25 faculty and graduate researchers. ■

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GENERAL INQUIRIES

Barbara Christopher

Communications Manager
404.385.3102
barbara.christopher@isy.e.gatech.edu

ACADEMIC ENGAGEMENT

Dima Nazzal

Executive Director of Academic
Administration and Student Experience
404.385.0727
dima.nazzal@isy.e.gatech.edu

INDUSTRY COLLABORATION AND RESEARCH OPPORTUNITIES

Alan Erera

Associate Chair for Graduate Studies
and Coca-Cola Professor
404.385.0358
alan.erera@isy.e.gatech.edu

UNDERGRADUATE CURRICULUM AND RECRUITMENT

Chen Zhou

Associate Chair for Undergraduate Studies
and Associate Professor
404.894.2326
chen.zhou@isy.e.gatech.edu

PROFESSIONAL EDUCATION

Meka Wimberly

Customer Service Manager
404.385.8663
meka@gatech.edu

PHILANTHROPY AND SPONSORSHIPS

Nancy Sandlin

ISyE Director of Development
404.385.7458
nancy.sandlin@isy.e.gatech.edu

H. Milton Stewart School of Industrial & Systems Engineering
755 Ferst Drive
Atlanta, GA 30332-0205



Georgia Tech ISyE graduate Caleb Mbuvi celebrates as he receives his degree during the Bachelor's morning ceremony at the spring 2015 commencement at the McCamish Pavilion on Saturday, May 2, 2015. (credit: HYOSUB SHIN / HSHIN@AJC.COM)