The cover features three individuals standing on a colorful, patterned path in a lush forest. On the left is an older man with glasses, smiling, wearing a dark suit and a patterned tie. In the center is a younger man with dark hair, wearing a dark suit and a gold tie. On the right is a woman with short blonde hair and glasses, wearing a dark jacket over a patterned scarf. The background is a dense forest with tall trees and green ferns.

Engineering **ENTERPRISE**

THE ALUMNI MAGAZINE FOR ISyE AND THE GEORGIA INSTITUTE OF TECHNOLOGY

SPRING 2008

Green Pages

Energy, Environment, and
Natural Systems in the
Stewart School of ISyE

**Georgia
Tech**



**College of
Engineering**

H. Milton Stewart School of
Industrial & Systems Engineering

Toward a More Environmentally Friendly World



Chelsea C. White III

It's spring and once again time for another issue of *Engineering Enterprise*. Our goal for this issue is to cover a strategic direction of the H. Milton Stewart School of Industrial and Systems Engineering that aligns with current topics of societal relevance to demonstrate how industrial engineering and operations research can be applied to improve the quality of life. Since discussions on energy, the environment, and natural systems are ever present in the media, politics, and around the family table, it is the perfect time to highlight how the Stewart School is addressing these pressing societal issues.

Further, this is a topic that was of considerable interest to recently deceased Professor Thiruvenkatasamy "Govind" Govindaraj, who was involved in sustainability efforts before it became a popular topic. For this reason, we are dedicating this issue to his memory. This issue also contains a memorial to Govind as well as an article by him describing his thoughts on the problems, challenges, and opportunities of sustainability in globalized societies, which he completed just prior to his death.

More specifically, in this issue we turn the alumni spotlight on alumnus Ray Anderson, founder and chairman of Interface Inc., and his passion that propelled him to become a world leader on issues of sustainability and the environment. In keeping with the environmental theme, our student spotlight features several of our students with environmental interests and contributions. Following, we then have several articles by our faculty describing how their research is helping to make the world a better place environmentally.

These articles address recent research in reverse logistics, recovery systems for recycling, the analysis of sustainable packaging, energy pricing strategies, the transportation of wind tower components, and honeybee- and ant-inspired environmental innovations.

In addition to learning about our work in sustainability and the environment, you'll also hear the latest news in the Stewart School community. It is a pleasure to announce that Jianjun "Jan" Shi, an internationally well known expert on the variation modeling, analysis, and control of complex manufacturing systems, has joined our faculty as the first recipient of the Carolyn J. Stewart Chair of Industrial and Systems Engineering. Also, Carolyn Stewart, the wife of alumnus Milt Stewart and for whom the new endowed chair was named, was just recently awarded honorary alumna status at Georgia Tech. Don't forget to read the ISyE Bulletin section to find out more about other faculty, student, and alumni news.

Inside this issue, we've also included a survey to gain feedback on what you like, dislike, would like to see added, etc., in our *Engineering Enterprise* publication. I would like to encourage you to fill out the survey and send it back to us as soon as is convenient for you. We value your opinions and are eager to hear back from you.

I look forward to seeing as many of you as possible back on campus soon.

A handwritten signature in black ink that reads "Chelsea C. White III".

H. Milton Stewart and Carolyn J. Stewart School Chair,
Schneider National Chair of Transportation and Logistics,
H. Milton Stewart School of Industrial and
Systems Engineering

Cover Photo

Ray Anderson,
John Jewell, and
Valerie Thomas



5-21 The Green Pages

The world is in the midst of a green movement and the H. Milton Stewart School of Industrial and Systems Engineering is at the research forefront. In the special section of this issue, "The Green Pages," you will read articles covering a range of topics on the environment that strategize how we can move toward a more sustainable society.

Featured in this issue:

Valerie Thomas is investigating how radio frequency identification (RFID) tags could be used to promote more efficient recycling and reuse. Alumni **Ray Anderson** and **John Jewell** of Interface Inc. are transforming the carpet manufacturing industry, eliminating waste while increasing renewable materials and energy.

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To promote supply chain research and education, business and government organizations partner with the Georgia Tech Supply Chain & Logistics Institute's faculty and students.

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Stewart School of ISyE Welcomes New 2007-2011 Advisory Board Members



Mike Anderson

Mike Anderson, IE 1979, Walter G. Ehmer, IE 1989, Ed M. Rogers, IE 1982, MS IL 2002, Steve J. Rogers, IE 1981, and Julio Villafane, IE 1985, joined the H. Milton Stewart

School of Industrial and Systems Engineering Advisory Board in 2007. The Board, comprised of distinguished professionals and community leaders, serves as a sounding board for the School Chair in an advisory capacity and assists with the Stewart School of ISyE's development goals. Each member brings extensive industry knowledge and unique expertise to this role and will serve a five-year term.

"We are delighted to welcome our newest members to the ISyE Advisory Board. Their commitment and dedication to the Stewart School is extremely valuable to ISyE's continued success," said School Chair Chelsea C. White III.

Mike Anderson is corporate services vice president for the Georgia Power Company and president and CEO of Georgia Power Childcare LLC. Anderson joined Georgia Power in 1979 and has held leadership positions in capital budgeting, system planning, customer operations, information technology, marketing, and external affairs. He was recruited from Texas Instruments Government Products Division, where he authored design criteria of nuclear warhead guidance systems technology for the U.S. military.



Walter Ehmer

Walter Ehmer is president and chief operating officer of Waffle House and chairman of Ozark Waffles, an operation of thirty-eight Waffle House restaurants

in the state of Arkansas. He has worked at Waffle House since 1992 in various leadership roles. Ehmer is an active member of his community and at Georgia Tech through Alpha Tau Omega fraternity, the 54th Roll Call Leadership Circle, as well as the Board of Trustees and Executive Committee of the Georgia Tech Alumni Association.



Ed Rogers

Ed Rogers is a senior staff manager with UPS's corporate strategy group. He has twenty-five years of experience in industrial engineering, program management,

management consulting, business process redesign, operations improvement, and strategy development. Rogers began his career as a U.S. Air Force officer and worked as a consultant before joining UPS in 1994.



Steve Rogers

Steve Rogers is vice president of IBM Integrated Supply Chain. He has worked with IBM in various leadership roles for more than twenty-five years.

In his current role, he is responsible for the end-to-end supply chain execution for two separate multibillion dollar brands.



Julio Villafane

Julio Villafane is the executive director for the Service Provider Strategic Accounts in Emerging Markets for Cisco Systems. These markets include Latin Amer-

ica, East and Central Europe, Africa, Middle East, and Russia. He is responsible for creating and contributing to the implementation of innovative and replicable profitable business models and for building effective partnerships and governance coverage with Cisco's client executives in these regions.



Dr. William Pulleyblank
Vice President

Center for Business Optimization
IBM Business Consulting Services

Distinguished Lecture

The H. Milton Stewart School of Industrial and Systems Engineering

On Thursday, April 17, 2008, guest lecturer Dr. William Pulleyblank will speak on "Computing, Business, and Operations Research: The Next Challenges."

for more information, visit: www.isye.gatech.edu/news-events/dls

ISyE Alumni

Ray Anderson and John Jewell at InterfaceFLOR's showroom in Atlanta, Georgia. The showroom was part of the U.S. Green Building Council's LEED-CI Pilot Program and achieved Platinum certification, the first in the world.



Ray Anderson

Ray Anderson, IE 1956, is the founder and chairman of Interface Inc., the world's largest producer of commercial floor coverings and interior finishes. Ray Anderson is, in the truest sense of the word, a man who can dream big and put that dream into action. After reading Paul Hawken's *The Ecology of Commerce*, Anderson had a revelation that led him to transform his company from a polluter to a world leader on matters of sustainability and the environment. He abandoned the comforts of the status quo and began producing some unimaginable results. Today, Interface Inc. is approximately 45 percent toward their vision of "Mission Zero," the once unimaginable journey for Interface or the petroleum-intensive industry of carpet manufacturing that has been forever changed by Anderson's extraordinary vision. "Mission Zero" is the company's promise to eliminate any negative impact it may have on the environment by the year 2020 through the redesign of processes and products, the pioneering of new technologies, and efforts to reduce or eliminate waste and harmful emissions while increasing the use of renewable materials and sources of energy.

"This reduced footprint is reflected in every product that Interface Inc. makes anywhere on Earth, not just one here and one there. This company further believes it will become restorative, putting back on balance more than it takes from Earth and doing good for Earth, not just no harm, through the power of its influence and in its role as Sherpa, leading others along the path it is blazing as it climbs 'Mount Sustainability' — that very high mountain but, very importantly, one that is proving to be scalable," said Anderson.



John Jewell

John Jewell, IE 2004, is an environmental research analyst at Interface Inc., where he guides environmental decision-making through Life Cycle Assessment. He also helps measure Interface's progress toward their "Mission Zero" goals by collecting and analyzing data on the manufacturing processes for each step of a carpet's life cycle from cradle to grave. He has presented at Georgia Tech and Emory on Interface and sustainability. Jewell recently became a LEED-accredited professional through the U.S. Green Building Council.

Jewell first became interested in the sustainability movement while earning an industrial engineering degree at Georgia Tech. His passion for this issue also grew from reading, but for him it was the works of Ray Anderson, Daniel Quinn, Bill McDonough, and Paul Hawken, among others. ISyE Professor Craig Tovey, who specializes in optimization and systems approach to sustainability, was also an inspiration. While at Tech, Jewell began conducting environmental research under Tovey, specifically around quantifying the financial burden of social and environmental problems. Ben Hill, a professor teaching Business Ethics, taught him the important role of the private sector in shaping the next environmental movement. Jewell later helped create an Introduction to Sustainability class by creating a syllabus, writing lesson plans, and delivering lectures. A meeting with Interface's VP of Engineering, Dave Gustashaw, led to Jewell's current job, where he says that he "is inspired daily by the innovative, passionate, and intelligent people who surround him."

For more information on sustainability in action at Interface Inc., visit www.interfaceinc.com/goals/sustainability_overview.html.

ISyE Students



Left to right: PhD students Dexin Luo, Nathaniel Tindall, Joy Huan Wang, Seth Borin, and Adaora Okwo in Georgia Tech's recycling yard.



Seth Borin

Seth Borin is a first-year PhD student from Little Rock, Arkansas, who completed his bachelor's degree in industrial engineering at the University of Arkansas. Borin is currently working on a research project titled "The Logistics Implications of Biomass Energy," under the direction of his advisors Don Ratliff and Harvey Donaldson. His project deals with the effect that the transportation sector will have on the use of biomass energy.

"To create a system that is truly sustainable, I think it is important to be able to view the overall system as well as understand the components of the system. In general, if we all could think beyond personal costs and benefits and look at the overall consequences of our actions, we could immediately begin to make a difference in the direction of becoming more sustainable."



Dexin Luo

Dexin Luo is a second-year PhD student from China. She completed her undergraduate degree at Qingdao University, majoring in environmental engineering. She then went on to Tsinghua University for one year before coming to Georgia Tech in August 2006. Luo is currently working on several research projects that focus on the use of energy. Working alongside her advisor Valerie Thomas, Luo is examining energy efficiency measures in the pulp and paper industry, biomass resource assessment for bioenergy production, and landfill gas as a renewable source of energy. An upcoming research project will focus on optimization applications in the biomass energy industry.

"To me, sustainability means a way of thinking: to do business as usual while always keeping the future in mind. Part of my inspiration to focus on sustainability comes from reading about James Ephraim Lovelock. He proposed the Gaia hypothesis, in which he postulates that the Earth functions as a kind of super-organism."



Adaora Okwo

Adaora Okwo is a third-year PhD student who was born in England but grew up in Redondo Beach, California. She received her bachelor's in operations research and financial engineering from Princeton University in 2005. Okwo, with advisor Valerie Thomas, is currently working on a research project that investigates whether renewable energy can meet Africa's developing needs. Socioeconomic development and mitigating climate change are two significant, yet conflicting, challenges facing Sub-Saharan Africa. Though energy is essential to sustainable development, the growing use of conventional sources is contributing to climate change. Okwo's research seeks an economically and technically feasible renewable energy path capable of meeting and sustaining Africa's development goals.

"When I think of sustainability, I think of systems that are able to perform near-optimally for an indefinite period of time. Sustainability is about finding long-term solutions. So it is important to use the skills and tools we learn in industrial engineering to find the 'best' long-term solutions."



Nathaniel Tindall

Nathaniel Tindall is a first-year PhD student from St. Petersburg, Florida. He graduated from Morehouse College and the University of Michigan-Ann Arbor with degrees in applied physics and materials science and engineering from the respective universities. Tindall, with advisor Don Ratliff, is currently working on a research project to determine the impact of supply chain and logistics on carbon emissions. His goal is to determine a score or index that reflects the level of carbon emissions involved in moving a product from its point of origin to its point of sale or consumption.

"Industrial sustainability and our planet's sustainability go hand-in-hand. It is important to develop systems and processes that help companies yield gains as well as help in making our planetary environment sustainable for the future."



Joy Huan Wang

Joy Huan Wang is a first-year PhD student from Tulsa, Oklahoma. She graduated from Michigan State University with both a bachelor's and master's degree in biosystems engineering. Wang, alongside advisor Valerie Thomas, is working on a research project to examine Georgia's resources and estimate its renewable energy potential for several technologies such as co-firing biomass with coal, solar energy, and wind energy. She is working on a document that estimates Georgia's potential for renewable energy and will serve as a tool for future research or legislation.

"Sustainability is a state where humans can maintain a comfortable standard of living while minimizing or eliminating their negative environmental impacts. It is our responsibility to preserve it for future generations to enjoy and cherish. Many technologies that may contribute to environmental sustainability may already exist. Their success may depend on a combination of production and supply optimization, economic analysis, and policy development. Industrial engineering can be influential in all these areas. Our work toward sustainability today will affect the world we leave future generations. Will it be one similar to the world as we know it or one with greater resource pressures and less ecological diversity?"





CHANGING THE SYSTEM:

Energy, Environment, and Natural Systems in ISyE

by Valerie Thomas

Everyone who follows the news knows about environmental problems. Climate change is the overarching issue, with greenhouse gases spouting from virtually everything we do — driving cars, heating and cooling our homes — and from the manufacturing of every kind of product. There is also water pollution from fertilizers and pesticides as well as air pollution from cars, power plants, and industry. There is deforestation, strip mining, lead paint on toys, electronics and batteries that aren't being recycled, and the list goes on. Petroleum supplies are of so much concern that prices are reported daily, and the stock market responds accordingly. The potential for geopolitical stress and conflict over access to petroleum and natural gas is a strong undercurrent in the politics not only of the Middle East but also of Europe, Latin America, Asia, Africa, and, of course, North America.

In both the press and politics, most of the environmental discussion centers on the problems. The long and heavy debates about the consequences of greenhouse gas emissions are parallel debates, past and present, about the impacts of air pollution, of lead exposure, of water pollution, and so on. These debates are essential when major changes in products, industries, or human activities are implied. And although the protracted U.S. debate about the science of climate change is derided as a symptom of anti-science stupidity and big money lobbying, these grueling debates have made the United States the world leader in environmental science.

The vociferous environmental debates sometimes overshadow the flip side of environmental problems — the solutions. Sometimes there are straightforward drop-in solutions, such as paint without lead, refrigerants without chlorofluorocarbons (CFCs), fluorescent light bulbs instead of incandescents, detergents that work in cold water, tap water rather than bottled water. Often, though, the confluence of environmental problems and human desires points toward complex changes in the way people, companies, and products behave. Internet sites like Freecycle that have people trading used items rather than throwing them away; companies like Interface that aim to make carpet with zero environmental impact; products and smart trash cans that can recycle on their own. These are just a few examples of the kinds of uncharted industrial and social changes that are arising as creative responses to environmental challenges.

The H. Milton Stewart School of Industrial and Systems Engineering's work in energy, the environment, and natural systems spans a large number of topics, but is integrated by the theme of new approaches that involve the interplay of people, nature, and technology. This, of course, draws on the strengths of the Stewart School of ISyE. Historically, industrial engineering has developed efficient and cost-effective approaches for manufacturing, transport, and commerce as well as for moving materials and products through supply chains, from the extraction of raw materials to manufacturing to retailing. The School's program on



Interface Inc. pipes in methane gas from a nearby landfill in LaGrange, Georgia, to power one of its plant processes. Here VP of Engineering, David Gustashaw, monitors the gas analyzer. As methane is drawn off to fuel the factory, the entire landfill volume is drawn down, increasing its capacity and postponing the city's next landfill opening for an estimated fifteen years.

energy, the environment, and natural systems is applying the full intellectual resources of the nation's leading industrial and systems engineering program to the challenges of energy, the environment, and economic development. But we do this not just because we are well trained and because the problems are important. We are very active in this area because it is also both intellectually stimulating and a lot of fun. We test and discuss a lot of "What ifs?" and "Could it be done?" On a typical day, conversations can range from the potential to make jet fuel from renewable energy, to the inspiration of honeybees in the design of Internet servers, to a system to recycle carpet throughout the United States.

We are doing research on energy efficiency in both freight transport and passenger transport. We are also doing research on renewable energy, at a local, regional, national, and global scale, as described below. We are working on ways to reduce the environmental impacts of products, through reuse, recycling, and redesign. We are also doing research on biologically-inspired design, notably the work of Professors Craig Tovey and Sunil Nakrani, who have used honeybee foraging techniques to design new protocols for Internet servers (see the article on Honeybees, p. 15), and the work of Professor John Bartholdi on ant-inspired bucket brigade assembly lines (see the article on Bucket Brigades, p. 18).

The Logistics of Sunshine

The sun shines all the time. We use and channel this energy in many ways, distributing it through supply chains and converting it into a wide range of products. We transform it into

carbohydrates in our agricultural systems. We draw on the stored solar energy in fossil fuel hydrocarbons. We use these carbohydrates and hydrocarbons to fuel our industrial systems, which create food, clothing, and shelter, and also to support a myriad of activities from steel mills to ballet, from space exploration to music videos.

How might we manage the flow of solar energy in the future? We can convert it directly to electricity with solar photovoltaics, or to heat with solar collectors, or first to carbohydrates in genetically modified plants and then to fuels such as bioethanol, biobutanol, or biokerosene. We can use wind turbines to make electricity from the sun-driven winds or use hydroelectric dams to draw on the sun-driven rains. Also, we could turn to other energy sources—nuclear fission, fusion power, or geothermal power.

The array of emerging energy decisions is a key focus of the Stewart School of ISyE's energy research. The growing use of plant matter for fuels includes not only corn-derived ethanol from the U.S. Midwest but also sugar-derived ethanol from Brazil. With the prospects of vastly increased use of cellulosic crops for energy such as grasses and trees, our group is addressing the multiple opportunities and constraints involved in the development of a major new fuel source based on plants. Questions include: How much petroleum could be replaced by biomass fuels? What are the most promising ways to use biomass? Can biofuels be environmentally benign? Can we produce enough food and fuel for everyone and still spare land for nature?

This research is global in scope but also has direct implications for Georgia and the entire



Valerie Thomas is investigating how RFID tags could be used to promote more efficient recycling and reuse.

Southeast region. With its vast forests and farmlands, Georgia and the rest of the Southeast may be well-suited to use wood, agricultural waste, forestry residues, and new crops like switchgrass to make electricity and transportation fuels. The magnitude of the demand for energy, however, suggests that a major fraction of Georgia's forests and agricultural lands could at some point be used to produce energy. While this could be a significant benefit from a climate and energy security perspective, the potential for environmental damage (through over-logging, removal of nutrients from the soils, loss of biodiversity) and the effects on other agricultural and forest products industries need to be evaluated in depth. As with other alternative energy sources, biomass energy has drawbacks and constraints, and we need a better understanding of where and what those limits might be. Our team is evaluating the amount of energy that could be generated from biomass both locally and globally; the relative merits of a range of fuel products versus electricity production; and

the environmental impacts of biomass energy (both the pros and cons), in terms of changes in land use, fertilizer use, and biodiversity. Although Georgia is not yet known as a major producer of renewable energy, the forest products industry has a great deal of experience in the production and use of energy from trees. With careful planning, Georgia could become a renewable energy leader.

Another key research area focuses on freight transport, and transportation in general. At the Georgia Tech Supply Chain & Logistics Institute (SCL), SCL Executive Director Donald Ratliff, other faculty, and myself are working together with students on ways to reduce petroleum use in transport systems. Along with ISyE Professor Ellis Johnson, and John-Paul Clarke, associate professor of aerospace engineering, I am analyzing ways to reduce petroleum use in air transport. This is an especially challenging problem because there are few near-term alternatives to jet fuel, and aircraft designs change slowly. However, there are a range of options that could

significantly improve fuel efficiency in air transport, including improved air traffic management and more energy-efficient, continuous descent of aircraft. And although kerosene is likely to continue to be the fuel for jets, kerosene can be produced from biomass through Fischer-Tropsch or other processes, with low net emissions of greenhouse gases, and simultaneous production of diesel fuel and electricity. Within a few decades, the carbon footprint of air transport could be lower than it is today, even if air transport continues to grow.

Computational Finance for the Earth

Financial markets will be key to the efficient reduction of greenhouse gas emissions. When pollutant emissions are regulated, companies can save money by buying or selling emission permits. Those that can make reductions cheaply can sell their permits; those that can't find cheap ways to reduce can buy extra permits. Already proven as a low-cost way to reduce sulfur emissions from power plants, markets for greenhouse gas emission permits are now being used in Europe in their mandatory greenhouse gas reduction system. Similar markets are growing in the United States for companies that are voluntarily reducing their greenhouse gas emissions, including Delta, Interface, and Herman Miller, to name a few.

Carbon markets will grow substantially if the United States implements controls on greenhouse gas emissions and allows trading of carbon emission permits. Professor Shijie Deng, director of the Quantitative and Computational Finance program, and I are working to develop a research program on carbon market finance. The research questions center on how companies can use carbon markets, financial approaches to reduce risk and uncertainty in these new markets, and measures to ensure that the market identifies and supports efficient approaches to greenhouse gas reduction (see the article on Energy Pricing, p.19).

Think Locally, Act Globally

The Earth's systems are inherently recycling. Most atoms remain on Earth indefinitely and are neither created nor destroyed. Sometimes the recycling is quick, within a few decades for the atoms in most plants and animals. Sometimes the recycling is slow, taking thousands of years for the carbon in the atmosphere to equilibrate with the carbon in the ocean and to be deposited as limestone.

Industrial supply chains, in contrast, are largely one-way, with very little recycling. This has worked fine so long as nature could be counted upon to handle the recycling for us, through biodegradation, dispersion, or deposition in sediments. But as human systems grow, nature's recycling is not enough: mines can be mined out, oil wells can be pumped dry, pollutants can spread, and garbage can pile up.

We don't need to put every atom back where we found it. But for many products and processes, there are atoms, molecules, and substances ending up in places where they cause a problem, and resources are too valuable to dump.

In theory, reverse logistics is no different from forward logistics. But the slow progress of recycling shows that the full power of industrial engineering is needed to crack some of these problems. Jane Ammons, a professor in ISyE and associate dean of Engineering, and Matthew Realff, an associate professor in chemical and biomolecular engineering, are pioneering the logistics of reverse supply chains, to bring products back from the consumer into industrial recycling systems (see article on Reverse Logistics, p. 13). Professors Ozlem Ergun and Beril Toktay are developing models for recovery and recycling of computers and other electronics products (see article on Computer Recycling, p. 12).

Smart Trash

Today's recycling systems rely on consumers to make an effort. Since only a very small number of products currently can be recycled — bulk products such as newspapers, cans, bottles, cardboard, and a few special products such as cars, some electronics and some batteries — recycling really isn't much of a burden for consumers. But if recycling is extended to many more kinds of products, if recycling rates are to go up, and if product varieties continue to increase while product lifetimes continue to decrease, then at some

point it will be too hard for consumers to figure out what to do with everything they own. Products need to be able to manage themselves — either to biodegrade benignly or to more or less automatically get themselves to the recycler.

Today's consumer products are cheap and abundant, largely due to industrial engineering applications, such as efficient industrial and commercial operations, efficient logistics,



"Smart" recycling bins could read RFID tags on any product being recycled, like this computer, for better recycling and could provide automated rebates to the customer.

and coordinated supply chains. A key innovation has been the Universal Product Code (UPC), the standard bar code now used worldwide on virtually every consumer product and credited with making possible the vast proliferation of products now available in grocery and retail stores.

What if the power of the UPC concept were applied to a restructured supply chain system,

designed to make the return, refurbishment, and recycling of all products easy? I am collaborating with several industry partners and with support from the U.S. Environmental Protection Agency to explore the potential to extend the UPC throughout the life cycle of products, with a combination of today's UPC bar codes and the recently introduced radio frequency identification (RFID) tags. With identifiers on the product and not just on the package, products could perhaps manage their own recycling, with smart trash cans and sensor-equipped recycling trucks managing the reverse logistics in the same way that today's warehouses and distribution centers manage the forward logistics.

Creating a more energy efficient, sustainable society is crucial in maintaining a sustained quality of life. We have not only a problem but also an opportunity. There are many ways that we could produce less waste and bring harmful emissions way down. The challenge is to innovate our way out of this problem, to find the best environmental solutions we can. For questions or to become involved in our efforts, contact Valerie Thomas at valerie.thomas@isye.gatech.edu. For development opportunities, contact Nancy Sandlin at 404.385.7458 or nancy.sandlin@isye.gatech.edu.

Valerie Thomas is the Anderson Interface Associate Professor of Natural Systems at the H. Milton Stewart School of Industrial and Systems Engineering. She has a joint appointment in the School of Public Policy, has an adjunct appointment in the School of Earth and Atmospheric Sciences, and is working with faculty and students throughout Georgia Tech through her teaching and as part of the Brook Byers Institute for Sustainable Systems.



Creating a more energy efficient, sustainable society is crucial in maintaining a sustained quality of life. We have not only a problem but also an opportunity.

RECOVERING, REUSING, RECYCLING:

Creating Stable Collaborative Recovery Systems

by Ozlem Ergun and Beril Toktay

Closed-loop materials lead to less mining of natural resources and contribute to sustainability. Closing the loop on material use means recovering, recycling, or reusing all components of post-use products. Ideally, closed-loop supply chains generate zero consumer waste and result in less mining of virgin materials. However, this innovative approach to material use depends on a high level of coordination and appropriate logistics structures.

The current U.S. recycling rate of used electronics is low — around 15 percent by some estimates (www.epa.gov/ecycling/index.htm). Environmental policymaking in Europe and Japan now requires producers to take on a much greater responsibility for increasing these rates. For example, the Waste Electrical and Electronic Equipment (WEEE), the European community's directive on waste electrical and electronic equipment, stipulates that producers finance collection, treatment,

recovery and disposal of all the electrical components in their products.

On May 2, 2007, the state of Minnesota passed the strongest U.S. producer responsibility bill to date, assigning fiscal responsibility to manufacturers of electronics equipment for the management of household e-waste and setting specific collection and recycling targets as in the European Union. Four other bills, all with different provisions, are already in existence in the states of California, Maine, Maryland, and Washington, while twenty-two states are currently considering similar legislation (www.computertakeback.com). However, the wide disparity in particular implementation plans shows a lack of unified policy guidelines that a wide range of organizations such as Hewlett-Packard, Dell, the Northeast Recycling Council, the Consumer Electronics Association, and the Computer TakeBack Campaign are trying to fill with competing



“model bills.” These recent and interesting developments immediately raise the following question: What is the right system for the United States?

Recognizing that any recovery system will involve significant investment, the costs and benefits of which will impact consumers, brokers, recyclers, transportation companies, manufacturers, and remanufacturers, we are developing and analyzing market-based mechanisms for creating stable collaborative recovery systems. We also have developed network design and reconfiguration algorithms that take into account the selfish behavior of the network's components, as well as market and allocation mechanisms that enable and encourage collaboration and coordination among these components.

Ozlem Ergun is an associate professor at the H. Milton Stewart School of Industrial and Systems Engineering and co-director of The Research Center for Humanitarian Logistics at the Georgia Tech Supply Chain & Logistics Institute.

Beril Toktay is the Nancy J. and Lawrence P. Huang Associate Professor of Operations Management at the College of Management.

The current U.S. recycling rate of used electronics is low — around 15 percent by some estimates.

REVERSE LOGISTICS:

Growing an Infrastructure for Recovery, Refurbishment, and Recycling

As populations increase, our utilization of resources has to change. It must become radically more efficient and less harmful to our environment. One strategy for achieving greater material and energy efficiency is the recycling of products back into refurbished units, recycled components, and useful raw materials. However, efficient recycling requires attention to the strategic design of reverse production systems. Unlike production systems whose goal is to make best use of available resources in order to bring a product to market, reverse production systems deal with ways to efficiently bring a product back from market after end-use for product recovery, refurbishment, spare parts recovery, and recycling.

Jane Ammons, associate dean of the College of Engineering and professor in the H. Milton School of Industrial and Systems Engineering, and Matthew Realff, associate professor in the School of Chemical and Biomolecular Engineering, have been working on reverse production systems for more than ten years. Two important areas of concentration are: (1) reducing electronic waste, or e-waste and (2) the recovery of carpet. Realff recently chaired a group who has

developed the new American National Standard's Institute (ANSI) standard for sustainable carpet design.

Each year, approximately 4.7 billion pounds of carpet are disposed of in this country. The annual landfill cost for the disposal is \$100 million, though the potential value of the disposed material is estimated at \$2.8 billion. Therefore, developing production systems that support the recovery, processing, and resale of carpet at the end of its useful life is an important part of the U.S. economy. Ammons, Realff, and their research team have developed a mathematical framework to facilitate the growth of economically viable used carpet collection networks that will provide sufficient raw material input for production processes that required significant capital investment.

Another important area of focus is e-waste. Due to legislative requirements, environmental considerations, and market image, the disposal of end-of-life electronic components, or e-waste, is attracting tremendous attention in many parts of the world. Improper disposal is creating serious long-term environmental problems, especially in developing nations. Major hazardous components in the e-waste stream are cathode ray tubes (CRTs), due to high lead content. However, effective management of returned used-product flows has tremendous impact on both the profitability and resulting financial viability of the reverse production systems. Designing efficient reverse production systems for e-waste is complicated by the high degree of uncertainty that surrounds several key factors. Ammons and Realff's work in this area involves the strategic design and operation of infrastructure to collect and process

e-waste such as used televisions, monitors, and computer central processing units (CPUs). The goal of their mathematical models is to achieve economic viability for the system of independent collectors and processors through good contract and material flow network design.

Their research team is extending its work to address new operational control and infrastructure design problems associated with the uncertainty and variability in closed loop supply chain flows on a global scale as products evolve through their life cycles. Working with companies and government organizations, their objective is to facilitate recycling and reuse and eliminate product disposal in landfills (some of which is hazardous waste, like CRTs).



Segregated monofills can store material, like carpet, so that if it becomes viable in the future, we can more easily "mine" these landfills.



Economic and Environmental Framework for Analyzing Sustainable Packaging

by Leon McGinnis and Chen Zhou

Product and component packaging can have a major influence on cost, energy, and the environment. In general, for any packaging system, there will be some trade off among these factors. For instance, lowest cost packaging solutions may not be the best solution in terms of environmental impact or energy consumption. In fact, there is so much interaction among the direct costs of packaging, the logistics impacts, and the end-of-life disposal that a fairly complex analysis is required to identify the best options available. While these issues are important to look at nationally, they are especially important for parts sourced from a different hemisphere, due to the added impacts on logistics costs and energy consumption.

In many companies today, environmental or sustainability objectives are not yet quantified to the same extent as operational cost objectives. As a result, operations managers face a challenge in trying to make decisions that simultaneously meet their cost, quality, and delivery requirements yet also demonstrably move the organization toward greater sustainability.

A recently completed project in the Sustainable Design and Manufacturing Program of the Manufacturing Research Center addressed this issue. Along with Tina Guldborg, research engineer in the Manufacturing Research Center, and ISyE graduate research assistants Jin La and Al Harjati, we developed a framework to integrate financial and environmental analyses of alternative packaging and logistics



Packaging can have a major influence on cost, energy, and the environment.

solutions to address these issues. In our research project titled “An Economic and Environmental Framework for Analyzing Globally Sourced Auto Parts Packaging System,” we show that careful engineering analysis of the system of packaging can address not only cost but also energy and environmental impacts, and it can provide decision makers with the information they need to move toward more sustainable packaging systems.

Our research team has developed an extended value stream model describing the material flow for packaging. Based on this model, an integrated part and packaging material flow analysis is proposed to provide aggregated data in order to support total cost analysis, life cycle environmental impact analysis, and energy consumption analysis.

The team applied this approach to new international supplier strategies in the automotive industry. We considered three options for parts sourced in Asia: traditional carton-on-pallet (the base case), a returnable direct-to-lineside container, and a plastic direct-to-lineside container designed to be recycled. The analysis showed the recycled package to be the preferred approach, with a 24 percent reduction in cost, a 6 percent reduction in energy, and more than 7 percent reduction in environmental impact. Although the models are quite intricate and developing them is a

painstaking process, once the models are in place, it is a relatively simple matter to repeat the analysis for other similar parts.

Global sourcing of manufactured parts raises important and complex questions about logistics costs and environmental sustainability. Packaging system design has a major impact on both, but the impact is not easy to assess because of the complex coupling between package design, logistics costs, and environmental impact. The novel approach taken by our research team allows these complex relationships to be analyzed in a way not possible with existing tools.

For more information on this approach, contact Leon McGinnis at leon.mcginis@isye.gatech.edu or Chen Zhou at chen.zhou@isye.gatech.edu.

Leon McGinnis holds the Eugene C. Gwaltney Chair in Manufacturing Systems and is a professor at the H. Milton Stewart School of Industrial and Systems Engineering and research director at the Georgia Tech Supply Chain & Logistics Institute.

Chen Zhou is the associate chair for Undergraduate Studies and is an associate professor at the H. Milton Stewart School of Industrial and Systems Engineering.

Honeybees Inspire New Server Strategy

by Megan McRainey

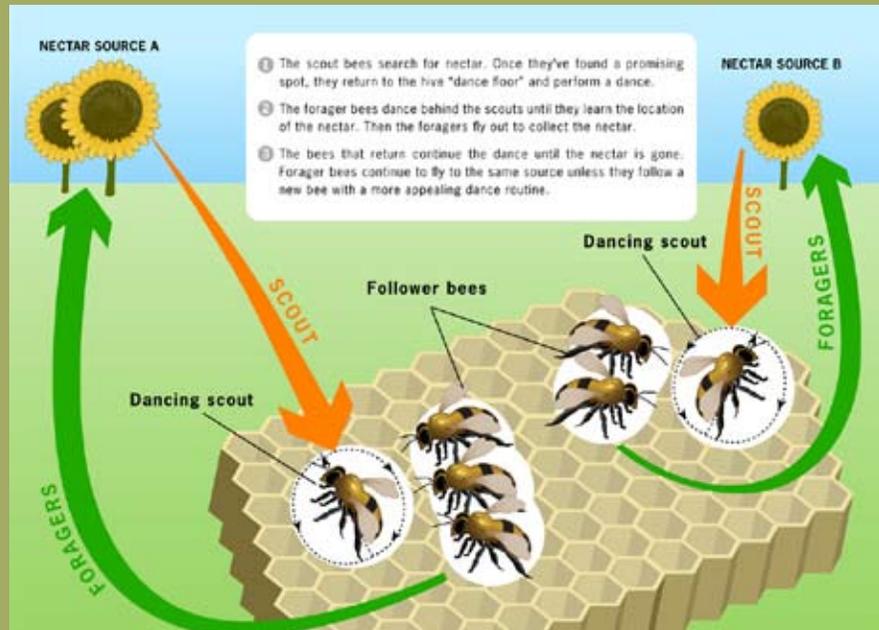
Honeybees somehow manage to efficiently collect a lot of nectar with limited resources and no central command — after all, the queen bee is too busy laying eggs to oversee something as mundane as where the best nectar can be found on any given morning. According to new research from Georgia Tech, the swarm intelligence of these amazingly organized insects can also be used to improve the efficiency of Internet servers faced with similar challenges.

A bee dance-inspired communications system developed by Georgia Tech helps Internet servers that would normally be devoted solely to one task move between tasks as needed, reducing the chances that a Web site could be overwhelmed with requests and lock out potential users and customers. Compared with the way server banks are commonly run, the honeybee method typically improves service by 4 percent to 25 percent in tests based on real Internet traffic. The research was published in the journal *Bioinspiration & Biomimetics*.

After studying the efficiency of honeybees, Craig Tovey, a professor in the H. Milton Stewart School of Industrial and Systems Engineering, realized through conversations with Sunil Nakrani, a computer science colleague visiting from the University of Oxford, that bees and servers had strikingly similar barriers to efficiency.

The more Tovey and Nakrani discussed bees and servers, the surer they became that somehow the bees' strategies for allocating limited resources in an unpredictable and constantly changing environment could be applied to Internet servers.

Honeybees have a limited number of workers at any given time to fly out to flowers, collect nectar, return to the hive, and repeat until the nectar source is depleted. Sometimes, there's an abundance of nectar to be collected; at other times nectar is scarce. The bees' environment is constantly



changing — some flower patches occasionally yield much better nectar than others, the seasons shift, and rainy days make nectar collection difficult. So how do the bees manage to keep a steady flow of nectar coming into the hive?

Internet servers, which provide the computing power necessary to run Web sites, typically have a set number of servers devoted to a certain Web site or client. When users access a Web site, the servers provide computing power until all the requests to access and use the site have been fulfilled. Sometimes there are a lot of requests to access a site and sometimes there are very few. Predicting demand for Web sites, including whether a user will access a video clip or initiate a purchase, is extremely difficult in a fickle Internet landscape.

Bees tackle their resource allocation problem (i.e., a limited number of bees and unpredictable demand on their time and desired location) with a seamless system driven by "dances." Here's how it works: The scout bees leave the hive in search of nectar. Once they've found a promising spot, they return to the hive "dance floor" and perform a dance. The direction of the dance tells the waiting forager bees which direction to fly; the number of waggle turns conveys the distance to the flower patch; and the length conveys the sweetness of the nectar.

The forager bees then dance behind the scouts until they learn the right steps (and the particulars about the nectar), forming a bobbing conga line of sorts. Then they fly out to collect the nectar detailed in the dance.

As long as there's still nectar to be found, the bees that return continue the dance.

While all that dancing may not sound like a model of efficiency, it's actually optimal for the unpredictable nectar world the bees inhabit, Tovey said. The system allows the bees to seamlessly shift from one nectar source to a more promising nectar source based on up-to-the-minute conditions. All this without a clear leader or central command to slow the decision making process.

Internet servers, on the other hand, are theoretically optimized for "normal" conditions, which are frequently challenged by fickle human nature. By assigning certain servers to a certain Web site, Internet hosts are establishing a system that works well under normal conditions and poorly under conditions that strain demand.

Tovey and Nakrani set to work translating the bee strategy for these idle Internet servers. When one server receives a user request for a certain Web site, an internal advertisement (standing in a little less colorfully for the dance) is placed on the "dance floor" to attract any available servers. The ad's duration depends on the demand on the site and how much revenue its users may generate. The longer an ad remains on the "dance floor," the more power available servers devote to serving the Web site requests advertised.

Megan McRainey is a media relations specialist in Georgia Tech's Communications & Marketing department.



SUSTAINABILITY IN GLOBALIZED SOCIETIES:

Problems, Challenges, and Opportunities

by Thiruvenkatasamy “Govind” Govindaraj

The Clothes on Our Backs: A Parable for Our Times?

Paul Seabright begins his book on the history of economic institutions with a description of his new shirt: “This morning I went out and bought a shirt . . . the shirt I bought, although a simple item by the standards of modern technology, represents a triumph of international cooperation. The cotton was grown in India, from seeds developed in the United States; the artificial fiber in the threads comes from Portugal and the material in the dyes from at least six other countries; the collar linings come from Brazil; and the machinery for weaving, cutting, and sewing from Germany; the shirt itself was made in Malaysia. The project of making a shirt and delivering it to me in Toulouse has been a long time in the planning, since well before the morning two winters ago when an Indian farmer first led a pair of ploughing bullocks across

his land on the red plains outside Coimbatore.”¹ Mr. Seabright is describing many of the core activities that we industrial engineers do.

For me it hits closer to home for another reason as well. I grew up in those very same red plains outside Coimbatore, where my grandfather grew cotton over a generation ago. Many in my extended family have continued to be involved in the cotton and apparel industries. Cotton is no longer a major crop in that region, ironically as a result of the wildly successful apparel industry that exports most of what it produces to the West and the Persian Gulf, which has made farm labor unaffordable. The aquifers and farms have become unproductive as a result of the pollution from untreated dyes dumped by the apparel industry, other environmental degradations brought on by a combination of government policies and rampant corruption, long-term effects of climate change, and population increase.

Growing cotton requires enormous quantities of water and pesticides, even though these considerations are normally absent and relegated to externalities in traditional accounts of the apparel industry. Many water bodies are highly polluted with pesticide runoffs from cotton fields, besides losing large quantities of water for growing cotton.² Such stories are all too common in the emerging giant, China, as well.³ Even though environmental and social costs are generally labeled as externalities, and promptly ignored, in traditional economics, they are real costs to the people who inhabit those places and to the people who

lose their jobs when their work is outsourced to places where environmental and labor standards are weak or nonexistent. The clothes we buy certainly don't reflect such costs. While the negative consequences are sometimes unintentional, and often without malice, with well-defined and generally accepted means for computing, the costs will go a long way to help minimize or eliminate these costs.

The Fuels that Stoke the Engines of Progress

Continued growth of the economy and our lifestyles based on high levels of consumption depends on a high-energy diet of fossil fuels, even though it is generally recognized that fossil fuels are being depleted rapidly. Then there is the inconvenient truth of global climate change. Nevertheless, consumption of fossil fuels continues unabated, even as the price of crude oil continues to increase. If oil becomes expensive, and/or supplies become undependable, coal and natural gas are likely to assume increasing importance, with nuclear and renewable sources of energy supplying some of the power needs.

Biofuels (primarily from ethanol manufactured from sugarcane and its byproducts and wastes) as well as biodiesel from soy, rapeseed, and palm oil have also been proposed as alternative sources of energy in the short term, with cellulosic ethanol as a possible energy source in the future. However, there are serious concerns, such as food and income security for the poor, destruction of rain forests, and possible extinction in the wild of orangutans.⁴ Citing a report from the Friends of the Earth, George Monbiot observes that



You might be surprised to learn the number of countries involved in making this shirt.

“Almost all the remaining forest [in Sumatra and Borneo] is at risk. Even the Tanjung Puting National Park in Kalimantan is being opened up by oil planters. The orangutan is likely to become extinct in the wild. Sumatran rhinos, tigers, gibbons, tapirs, proboscis monkeys and many other species could go the same way. Thousands of indigenous people have been evicted from their lands, and some 500 Indonesians have been tortured when they tried to resist. The entire region is being turned into a vegetable oil field.”⁵ Clearly, in a civilized society, the threat of extinctions and food insecurity as antidotes to the eventual depletion of fossil fuels can no longer be ignored as mere externalities.

Conceptual and Methodological Challenges

Engineers, entrepreneurs, and businesses that are interested in implementing sustainable, and equitable practices often face many challenges that seem unsurmountable. Political and practical problems are often compounded by conceptual and modeling difficulties and by a lack of appropriate information on alternatives that would result in more benign outcomes and long-term consequences to the environment. Quite often, the global consequences are either not known in advance or do not become apparent in a timely fashion. Convenient and reliable means for taking into account the “externalities” are lacking; the

intractability of many relevant and interacting factors complicates the problem. Nevertheless, confronting and solving the intractability problem now can pay rich dividends in the future. Ecologists and ecological/environmental economists have been studying some of these issues for the past decade or two, even though their models and methodologies are of limited scope in tackling engineering and business problems. The engineering and business communities seem to be relatively immune to such knowledge and expertise. For instance, even in well-researched articles on global manufacturing operations, the environmental consequences are not considered, perhaps because it is extremely difficult to do so or because it is so contrary to traditional thinking in economics that no one dares even to mention them.⁶

Directions for Research and Instruction

Understanding systems in their entirety is a natural strength and advantage in industrial engineering, and we are capitalizing on this knowledge and expertise. We are developing comprehensive analytical and/or computational models that account for long-term consequences. Sustainability of global scale systems along cultural, economic, environmental, and social dimensions is the driving force behind the modeling effort. We are investigating globalized manufacturing

problems such as those described in the context of apparel production discussed earlier. The goal is to develop mathematical and computational models useful for evaluating possible options and consequences of decisions, e.g., simulation models. Among others, such models will help compute numerical measures for different aspects of sustainability.

On the instructional side, I believe that young minds are more likely to invent innovative solutions to the complex problems of sustainable systems. Therefore, I have been teaching an Honors Program course on engineering sustainable systems. After an overview of sustainability, global climate change, and related issues, my students are designing a city of the future that will be self-sufficient to the fullest extent possible. We have chosen to design and build this city in northern Tennessee, with an eventual steady state population of 700,000 (roughly the size of Memphis) in twenty years. The location was chosen based on finding a place with moderate climate and undeveloped land.⁷ The detailed plans that my class is developing will form the basis for continuing investigations of sustainable cities and systems, both in courses and in research.

Footnotes

1. Paul Seabright, *The Company of Strangers: A Natural History of Economic Life*. Princeton: Princeton University Press, 2004.

2. Fred Pearce, *When the Rivers Run Dry: Water — The Defining Crisis of the Twenty-first Century*. Boston: Beacon Press, 2006.

3. Elizabeth Economy, *The River Runs Black: The Environmental Challenge to China's Future*. Ithaca: Cornell University Press, 2004.

4. Donald Kennedy, (2007). The biofuels conundrum. *Science*, 316(5824): 515.

5. Georgia Monbiot, *Heat: How to Stop the Planet from Burning*. Cambridge, Massachusetts: South End Press, 2007.

6. R. A. Smith, (2007). The eco-suicidal economics of Adam Smith. *Capitalism Nature Socialism*, 18(2): 22-43.

7. We have not spoken with anyone in Tennessee, but we believe that they will enthusiastically welcome such a city in their state!

An H. Milton Stewart School of Industrial and Systems Engineering faculty member, Thiruvenkatasamy “Govind” Govindaraj died December 7, 2007 at the age of fifty-eight. Professor Govindaraj was beloved by his family, colleagues, students, and friends, and he will be greatly missed.



Ant-inspired Bucket Brigade Assembly Lines Increase Pick Rates at Major Distribution Centers

by John J. Bartholdi III and Donald Eisenstein

Social insects, such as bees or ants, operate complex logistics systems that are efficient even though no agent is in charge. Instead of a centralized control, each agent follows a simple local rule and an efficient global organization emerges spontaneously.

We have successfully adapted this idea to coordinate order-pickers in a warehouse. Under a protocol termed “bucket brigades,” each worker follows a simple rule; and without conscious intention or even awareness of the workers, the flow of work is smoothed and bottlenecks are dissolved. Furthermore, this happens without a work-content model or the advice of engineers, consultants, or management.

The bucket brigade protocol has increased pick rates by 20-50 percent at some major distribution centers.

What are Bucket Brigades?

Bucket brigades are a way of organizing workers on an assembly line so that the line balances itself. Here is how it works. In an assembly line, products are progressively assembled as they move down the line, from worker to worker, toward completion. This is a familiar organization in manufacturing, but assembly lines are found in all types of industries, wherever work is passed from person to person in sequence.

A classic challenge in the management of assembly lines is to balance the assignment of work so that there are no bottlenecks in the flow. This is hard to do because it requires first knowing how much work is inherent in assembly, and then dividing that work



The bucket brigade protocol has increased pick rates by 20-50 percent at some major distribution centers.

appropriately among the workers. Balancing an assembly line is typically done by engineers and represents a significant project. But because bucket brigades are self-organizing, the need for such centralized engineering is reduced or even eliminated. Furthermore, bucket brigades are able to achieve better balance than any engineering team because bucket brigades redistribute the work, not based on estimates (time-motion studies), but on the time it actually took a particular worker to perform a particular task.

This idea may be found in the social insects like bees or ants, which are highly effective at organizing themselves even without a blueprint, plan, or management. Instead, global coordination emerges spontaneously through the multiple interactions of many participants, with each following simple rules. Similarly, when workers on an assembly line are organized into bucket brigades, they can function as a self-organizing system that spontaneously achieves its own optimum configuration, without special equipment, time-motion studies, work-content models, management, or software control systems.

The operation of bucket brigades is simple: Each worker carries a product towards completion; when the last worker finishes his product, he walks back upstream to take over

the work of his predecessor, who walks back and takes over the work of his predecessor and so on, until, after relinquishing his product, the first worker walks back to the start to begin a new product. If, in addition, workers are sequenced from slowest to fastest, then we call the system a bucket brigade and the workers will spontaneously gravitate to the optimal division of work so that throughput is maximized.

In this, the simplest version of bucket brigades, workers must maintain their sequence. No passing is allowed and so it can happen that one worker might be blocked by his successor. In such case, we require that the blocked worker simply wait until his successor has moved out of the way, so the blocked worker can resume work. (This waiting is not necessarily bad because it is the means by which the workers migrate to their optimum locations.)

Benefits

- There is a reduced need for planning and management because bucket brigades make the flow line self-balancing.



Energy Pricing Strategies in Competitive Markets

by Shijie Deng

- Production becomes more flexible and agile because bucket brigades “tune” themselves, without time-motion studies or the other cumbersome endeavors of assembly-line balancing.
- Throughput is increased because bucket brigades spontaneously generate the optimal division of work.
- Secondary labor is reduced and quality improved because bucket brigades operate with the absolute minimal work-in-process.
- Training and coordination are simplified because it is easy for workers to know what to do next.

Who is Using Bucket Brigades?

Currently, bucket brigades are used mostly in distribution warehouses to organize order pickers, in the apparel industry to organize garment sewers, and in simple assembly processes. We believe bucket brigades to be more widely applicable but feel that the greatest economic significance is in order picking, which is very labor-intensive. A typical high-volume distribution warehouse employs hundreds of workers to pick orders and the work must be rebalanced daily, and sometimes more often.

The following is a list of some current users of bucket brigades. (Note, however, that implementations of a bucket brigade sometimes differ in local ways depending on the context, so not all of these operate strictly “by-the-book” as we have described.)

- Anderson Merchandisers
- CVS Drug Stores Inc.
- Gap Inc.
- Mitsubishi Consumer Electronics America
- RadioShack
- *Reader's Digest*
- Walgreen's
- Wawa Convenience Stores Inc.

John J. Bartholdi III holds the Manhattan Associates Chair of Supply Chain Management at the H. Milton Stewart School of Industrial and Systems Engineering and is research director at the Georgia Tech Supply Chain & Logistics Institute.

Donald Eisenstein is a professor of operations management at the University of Chicago Graduate School of Business.

With the restructuring of the electricity supply industry spreading across the world, wholesale power markets have been established in the power generation sector for procuring and selling electricity. However, much of the distribution sector, or the demand-side, of the power industry remains regulated. While load-serving entities such as utility companies are obligated to serve customers who choose to stay with them at regulated retail energy prices, they are exposed to tremendous market price risk when they need to purchase electricity from open markets. This presents great challenges to, while at the same time creates significant new business opportunities for, the utility companies and other load aggregators to control and manage the load patterns of their wholesale and retail customers.

If there were no economic incentive offered for changing consumption patterns, a significant portion of electricity demands (or loads) would be almost inelastic to electricity wholesale price changes. When electric power prices spike, inelastic demands can cause utilities to incur huge costs due to purchasing power to fulfill demand during peak consumption periods.

As a way of hedging the financial risks resulting from wholesale price spikes as well as mitigating the reliability risks associated with power supply shortfalls and transmission network congestion, utility companies and power marketers have put forth various demand response programs, such as real-time pricing and electricity load management programs, for managing the price and volumetric risks in serving customer demands. These programs range from directly controlling the end uses of small customers to voluntary

load shedding in response to real-time market price signals by large industrial and commercial customers, so as to increase the price elasticity of the loads.

Pricing strategies commonly adopted by utility companies for inducing demand responses include a fixed-rate price discount and load reduction-based rebate. While the fixed-rate price discount strategy offers the user an upfront discount in the electricity rate in exchange for a firm commitment in load reduction at the time of needs and the load reduction-based rebate, the load reduction-based rebates provide the participants with more flexibility as the load reduction is voluntary and rebates are only paid to foregone energy consumption.

These pricing strategies have analogous counterparts in financial markets. For instance, the fixed-rate discount is equivalent to the premium paid to energy consumers for call options on energy usage sold to the utility companies by the consumers. When the energy demand and market price become abnormally high, the utilities exercise these options to “buy” energy consumptions from consumers, which allow the utilities not to purchase energy in the open market at high prices to serve loads, thus avoiding potential large losses. To properly value such options or structure the pricing strategies, utility companies need not only to take full advantage of the financial energy commodity contracts such as those traded on the New York Mercantile Exchange but also to incorporate operational characteristics of their generation capacity and customers into their analysis.

By applying financial engineering methodology, we have developed quantitative models for analyzing the optimal design of such pricing strategies for utility companies and the optimal operational strategies for the large industrial and commercial consumers of energy in response to the utility pricing strategies. For more information on this project, contact Shijie Deng at deng@gatech.edu.

Shijie Deng is the associate professor and director of Quantitative and Computational Finance program at the H. Milton Stewart School of Industrial and Systems Engineering.



EMIL Students Develop Prototype System for Transporting Wind Tower Components

by John Vande Vate



The H. Milton Stewart School of Industrial and Systems Engineering's Executive Masters in International Logistics (EMIL) Program provides a hands-on learning approach where participants complete real-world, current business assignments. Rather than pursuing a traditional master's thesis, EMIL participants work in teams to complete global supply chain projects that identify opportunities across complex supply chains to remove cost, reduce cycle time, and enhance revenue.

This real-world hands-on approach to education has provided Tim Michaels, wind logistics manager at GE Energy in Norcross, Georgia, and a member of the current EMIL class, with the unique opportunity to gain further insight into a complex global transportation issue that he faces at GE.

GE Energy, a leader in supplying wind capacity in the United States, produces wind turbines with rated capacities ranging from 1.5 to 3.6 megawatts at manufacturing and assembly facilities in Germany, Spain, China, Canada, and the United States. According to the American Wind Energy Association (AWEA),

GE Energy delivered 764 wind turbines in 2006, more than 50 percent of the towers installed in the United States that year. The AWEA estimated that GE will install nearly 1,400 towers in 2007 — a year-on-year increase of more than 80 percent.

In his position at GE, Michaels is responsible for coordinating the efforts of special project carriers, railroads, and shipping lines to ensure that all the wind tower components make their way from GE plants and component suppliers around the globe to project sites across the United States.

Michaels worked with a team of master's students in the Stewart School to develop a prototype system to help manage the growing and increasingly complex challenge of transporting all the wind tower components to project sites on time and at the lowest cost.

"The students were grouped into three distinct teams," said Michaels. "Each team was able to approach GE Energy's challenge of component allocation and planning project fulfillment from a unique perspective. The ideas the teams provided were thought provoking, system-based, and actionable. GE looks forward to implementing many of these concepts."

Over the years, wind towers have grown in generating capacity and size. In the 1980s a typical wind tower generated 25 kW and had a rotor diameter of 10 meters or about 33 feet. Towers

today generate over 1.5 MW with rotor diameters of 71 meters or 233 feet.

One challenge in meeting the growing demand for ever more powerful wind towers is their growing size. A typical wind tower consists of three 122 foot blades, each weighing about 7 tons and with a 60-ton rotor hub sitting atop a tower that is itself assembled from three sections measuring 70 to 100 feet long and weighing between 32 and 60 tons.

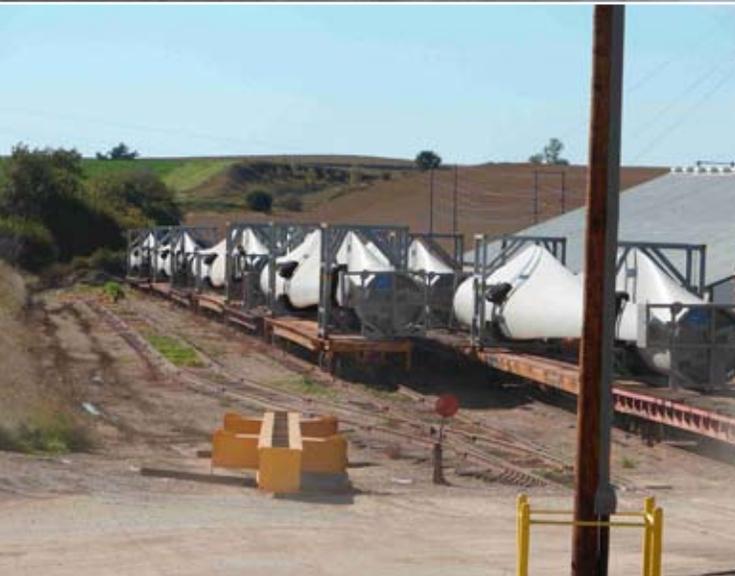
These components come from all around the globe and must converge on the project site in accordance with tight time schedules. New wind farms are usually in relatively remote parts of states like Texas, Minnesota, Colorado, Oregon, etc., but they occasionally pop up in more urban locations like the one in Atlantic City, New Jersey. In either case, urban or rural, the logistics challenges of moving these giant structures around the world and across the country are daunting.

For more information on this project, contact Greg Andrews, managing director, EMIL, at greg.andrews@isye.gatech.edu or visit EMIL's Web site at www.emil.gatech.edu.

John Vande Vate is a professor and the director of the H. Milton Stewart School of Industrial and Systems Engineering's Executive Masters in International Logistics Program.

“The ideas the teams provided are thought provoking, system-based, and actionable. GE looks forward to implementing many of these concepts.”

*~ Tim Michaels
Wind Logistics Manager,
GE Energy*



The Power of the Wind



In these days of concern about global warming, rising fuel prices, air quality, and limited water resources, wind energy is a winner. It is the least expensive, most developed renewable energy technology that can quickly reduce carbon emissions on a large scale. Wind farms do not burn coal, oil, or gas, nor do they require significant amounts of water. In addition, wind energy is safe. In twenty years of operation, the wind industry has recorded only one death — a German skydiver parachuted off course into an operating wind plant.

Other countries are already far along in exploiting wind's potential. In 2006 alone, the European Union installed more than 7,500 MW of wind capacity worth some \$13.3 billion, bringing the total operating capacity to 48,000 MW or approximately 3.3 percent of total EU electricity consumption. Denmark already satisfies nearly 20 percent of its electricity needs via wind energy.

Total installed capacity in the United States is less than 14,000 MW — enough to serve nearly four million homes, but less than 1 percent of our electricity needs. With a nearly 24 percent compound annual growth rate over the past ten years, U.S. wind power generation is growing quickly. Even so, it will take more than thirteen years for wind energy to satisfy 20 percent of the United States' electricity needs, as Battelle Pacific Northwest Laboratory, a federal research lab, estimates it can. According to the U.S. Department of Energy, wind could theoretically supply the equivalent of 5,800 quadrillion BTUs of energy each year — more than fifteen times current world energy demand.





Superior supply chain research and education has to have a solid footing in industry practice and has to focus on timely challenges.

LEADERS IN LOGISTICS:

Win-Win Industry-University Partnerships

by Martin Savelsbergh

Can you stay ahead of the competition in terms of supply chain performance without being aware of the latest trends and innovations? Can you have a successful research and education program in supply chain and logistics without knowing what keeps those in supply chain and logistics professions awake at night? Of course the answer to both questions is a resounding, “No.” Supply chain performance can be what distinguishes a company from its competitors and to maintain and sustain that advantage in the marketplace; it is essential to be aware not only of best practices but also to be part of and continuously pursuing supply chain innovations. Superior supply chain research and education has to have a solid footing in industry practice and has to focus on timely challenges. It does not take a genius to see where these observations and arguments are leading us: industry-university partnerships. This is precisely what the Leaders in Logistics program at the Georgia Tech Supply Chain & Logistics Institute (SCL) is all about. It is one of the longest running and most successful programs offered by SCL.

HIGHLIGHTS OF LEADERS IN LOGISTICS PROJECTS

Partner: Avio-Diepen Inc.
Research Faculty: Julie Swann
Project: Forecasting and inventory management technologies for the aviation after-market

Partner: BMW Manufacturing Corp. LLC
Research Faculty: John Vande Vate
Project: Managing international parts supply

Partner: CARE
Research Faculty: John Vande Vate
Project: Best practices in supply chain management

Partner: DayJet
Research Faculty: George Nemhauser, Martin Savelsbergh
Project: Optimization-based scheduling for per-seat on-demand air transportation

Partner: Delta
Research Faculty: George Nemhauser
Project: Fleet assignment and revenue management

Partner: Eastman Kodak
Research Faculty: Jane Ammons
Project: Supply chain design for new products

Partner: Genuine Parts
Research Faculty: John Bartholdi
Project: Design of a cross-docking freight network

So what is the Leaders in Logistics program? First and foremost, it is a unique opportunity for business and governmental organizations engaged in supply chain and logistics practice to partner and interact with SCL's faculty and graduate students. The core component of a Leaders in Logistics partnership is in-context research, generating new knowledge, new tools, and new insights related to a topic of interest and importance to the industry partner. In-context research is conducted by a team comprised of at least one faculty member and at least one PhD student. The in-context research is complemented by generic research and oriented towards creating new knowledge, and new tools of long-term interest to the logistics community as a whole.

So what's in it for the university? First, it provides an opportunity to acquire domain knowledge, and therefore an opportunity to conduct relevant and timely research, which, in turn, will strengthen its educational programs and offerings. At the same time, it gives PhD students a chance to actively engage in real-life applied research. An important consequence, not to be underestimated, of outstanding research and exceptional education is that it attracts top students from around the world. This inflow of talent enhances our ability to perform top-notch and innovative research and thus strengthens our Leaders in Logistics program. These partnerships also provide valuable financial support for faculty and PhD students.

The Leaders in Logistics program is structured in the form of a membership with an

annual contribution. As mentioned above, a member (or partner) works with the leadership of SCL to define an in-context research project of mutual interest and to identify an appropriate research team. Research projects are scoped for completion over a twelve-month period, but many of them, continue and expand over multiple years.

Furthermore, the member can choose to participate in the educational program offered by SCL or to emphasize and strengthen the research efforts. Finally, the member is invited to attend the Supply Chain Executive Forum, the premier logistics and supply chain management program held twice a year on Georgia Tech's campus.

More than thirty business and government organizations have participated in the Leaders in Logistics program over the past ten years; some of them for ten years in a row. During this period, many PhD students have devoted part or all of their dissertations to topics related to or motivated by the research conducted under the Leaders in Logistics umbrella. These are truly win-win industry-university partnerships.

For more information, visit www.scl.gatech.edu/industry/leaders or e-mail Martin Savelsbergh at mwps@isye.gatech.edu.

Martin Savelsbergh is the Schneider Professor at the H. Milton Stewart School of Industrial and Systems Engineering, and research director at the Georgia Tech Supply Chain & Logistics Institute.



The core component of a Leaders in Logistics partnership is in-context research, generating new knowledge, new tools, and new insights related to a topic of interest and importance to the industry partner.

Partner: Ford
Research Faculty: Donald Ratliff
Project: Optimizing the design and execution of the Ford Service Parts supply chain

Partner: Intel
Research Faculty: John Vande Vate
Project: Platform planning: Improving the forecasting and planning process

Partner: Manhattan Associates
Research Faculty: John Bartholdi
Project: Strategies for cycle counting

Partner: Praxair
Research Faculty: Martin Savelsbergh
Project: Inventory routing for an industrial gas producer

Partner: RubberNetwork LLC
Research Faculty: Martin Savelsbergh
Project: Continuous-move tours for shipper collaboration

Partner: Saia LLC
Research Faculty: Alan Erera, Martin Savelsbergh
Project: Dynamic load planning for a regional less-than-truckload carrier

Partner: SABRE Holdings
Research Faculty: Ellis Johnson
Project: Models and methods for integrated, robust airline planning, and scheduling

Partner: Tupperware
Research Faculty: Paul Griffin
Project: Zone skipping optimization

Partner: United Distributors
Research Faculty: Alan Erera, Martin Savelsbergh
Project: Construction and maintenance of fixed routes for spirits, wine, and beer distribution

Partner: YRW Corporation
Research Faculty: Alan Erera, Martin Savelsbergh
Project: Driver domiciling and driver scheduling for a national less-than-truckload carrier

Senior Design Group Works to Eliminate Malaria in Sudan

All seniors in the H. Milton Stewart School of Industrial and Systems Engineering culminate their undergraduate educational experience with a capstone course called Senior Design. It provides students with firsthand experience at solving real-world problems in a team environment. Student teams select a major design project from a company or nonprofit organization and exploit all available resources in order to develop a solution for the client.

During fall semester 2007, twenty student groups participated in Senior Design, three of which were selected as finalists to present their projects to faculty, students, and industry sponsors. The winning team worked on a project sponsored by the Centers for Disease Control and Prevention (CDC) to develop an effective production and distribution method to reduce the malaria-transmitting mosquito populations in Sudan, Africa. Student members of the CDC group included Allan Garcia, Jason Hoff, Mary Beth LaHatte, Alejandro Leyva, John Shea, and Ashley Thompson, with Professor Craig Tovey serving as faculty advisor.

Background

The International Atomic Energy Agency, the Sudan national government, and the CDC are collaborating to build a mosquito production facility in the northern part of Sudan. The facility will aid in testing the feasibility of using the Sterile Insect Technique (SIT) to eliminate the existing malaria-transmitting mosquito population located in the vicinity of Merowe, Sudan. Malaria is one of the most



Left to right: Mary Beth LaHatte, Alejandro Leyva, Ashley Thompson, Allan Garcia, John Shea, and Jason Hoff show the predicted mosquito population decrease using the Sterile Insect Technique.

severe public health problems worldwide. As a vector-borne infectious disease, it is a leading cause of death in many developing countries, with young children and pregnant women being the groups most affected.

Senior Design team members worked with entomologist Dr. Mark Benedict in designing a cost-effective production and distribution system for the mass rearing and releasing of sterile male mosquitoes at release sites in Merowe. Using the SIT, the goal is to eliminate the existing mosquito population within one year of implementation. Because female mosquitoes only mate once, the SIT works by releasing sterile males into the population. When females mate with the sterile males, they do not produce offspring. If enough sterile males are released, the entire mosquito population is eliminated.

Project Objective

The purpose of this project was to establish and provide a set of guidelines and recommendations that will aid in the implementation of the SIT for mosquitoes in Sudan. Student team members completed several tasks to achieve their project goal. First, they developed a model to estimate population densities of adult mosquitoes at the designated release sites in Merowe. Next, they determined how many sterile male mosquitoes must be produced in order to eradicate the entire population when released. Third, team members determined the most cost effective process to produce the required number of sterile males. Finally, the students determined the best locations to release the

sterile male mosquitoes as well as the most cost effective means to deliver the mosquitoes to these locations.

Findings

One of the important benefits of the SIT is that it does not negatively impact the environment. CDC group member Ashley Thompson explained, "The Sterile Insect Technique, or SIT, attacks malaria at the source of transmission: female mosquitoes. This process eliminates the need for preventative measures, such as insecticide treatments, which can have detrimental effects on the environment."

Further, the CDC student team determined the most effective way to implement the SIT program largely depends on conditions in Merowe, including the time of year and river level. As a result of this finding, the students developed a software tool that finds the best strategy based on a set of factors input by a user. Part of the benefit of the flexibility designed into the software tool is that it can be used to determine the best SIT strategy in other parts of the world where malaria is also a problem.

If your company is interested in submitting a project for consideration, visit www.isye.gatech.edu/seniordesign for more details.

Findings for this article were created within the framework of a student design project and its contents are neither sanctioned by the Georgia Institute of Technology nor the Centers for Disease Control and Prevention.



Left to right: John McKenney, MG Conrad W. Ponder Jr., Krista Schuler Tillman, Chelsea C. White III, Allison Beard Luzier, Ralph D. Malone, and Joseph Mello (2006 Winner) at the 2007 College of Engineering's awards ceremony.

CoE Alumni Awards Ceremony Honors Stewart School of ISyE Graduates

Georgia Tech's College of Engineering held its annual Alumni Awards Induction Ceremony on November 2, 2007. Among the many notable Georgia Tech alumni and friends in attendance, five H. Milton Stewart School of Industrial and Systems Engineering graduates were recognized for their professional and personal accomplishments. Honorees included:

Council of Outstanding Young Engineering Alumni

Allison Beard Luzier, IE 1996, senior vice president and relationship underwriting team leader, north Florida region of the Commercial Real Estate Bank, Bank of America.

Academy of Distinguished Engineering Alumni

Ralph D. Malone, IE 1988, president and chief executive officer of electrical, manufacturing, and assembly operation for

Triana Industries Inc.; **John McKenney**, IE 1990, president and chief operating officer of McKenney's Inc.; **MG Conrad W. Ponder Jr.**, IE 1969, (retired) chief integration officer for the U.S. Army, and senior associate with Booz Allen Hamilton; and **Krista Schuler Tillman**, MS IE 1980, strategic consultant in the telecom industry.

Gold & White Honors

Four graduates of the H. Milton Stewart School of Industrial and Systems Engineering were recognized during the Gold & White Honors Ceremony on February 7, 2008. Honorees included:

The Joseph Mayo Petit Alumni Distinguished Service Award

The Alumni Association's highest honor, was awarded to **E. Roe Stamps IV**, IE 1967, MS IE 1972, founding managing partner of Summit Partners in Miami, Florida; and **Michael E. Tennenbaum**, IE 1958, senior managing partner of Tennenbaum Capital Partners in Santa Monica, California.

The Dean Griffin Community Service Award

Named for the late Dean of Students George C. Griffin, this award was presented to **Ray Anderson**, IE 1956, chairman of Interface Inc. in Atlanta, Georgia.

The 2008 Outstanding Young Alumnus Award

This award was presented to **Troy Rice**, IE 2001, supervisor, Florida Power & Light Co. in North Palm Beach, Florida.

Honorary alumna status was awarded to **Carolyn J. Stewart**.

Alumni Association President **Joseph P. Irwin** stated, "Georgia Tech and the Alumni Association have been the beneficiaries of the remarkable work and passion of its alumni and friends over the years. The Gold & White Honors is but a small recognition for the contributions that these recipients have made to advance the Institute and society."

The Stewart School of ISyE congratulates this year's honorees on their exemplary contributions.



ISyE-NEWS

Receiving the H. Milton Stewart School of ISyE's new quarterly e-newsletter is a great way to **keep in touch** with the progress of our faculty, staff, students, and alumni as they **advance** the knowledge and practices for the improvement in industrial and systems engineering.

To subscribe, visit: www.isye.gatech.edu/news-events/enews



Jianjun “Jan” Shi, the Carolyn J. Stewart Chair in Industrial and Systems Engineering, congratulates Carolyn Stewart on her recent honorary alumna status.

INFORMS Awards

Faculty and students of the H. Milton Stewart School of Industrial and Systems Engineering were honored at the November 2007 Institute for Operations Research and the Management Sciences (INFORMS) annual meeting in Seattle. Honorees included:

William J. Cook, Chandler Family Chair and Professor, was awarded the Frederick W. Lanchester Prize, with coauthors **David Applegate**, **Bob Bixby**, and **Vasek Chvatal** for their book entitled *The Traveling Salesman Problem: A Computational Study*. The book presents the latest findings on the most intensely investigated subjects in computational mathematics. The Lanchester Prize is awarded for the best contribution to operations research and the management sciences published in English.

Former PhD students **Bill Cooper** and **Tito Homem-de-Mello** and Associate Professor **Anton Kleywegt** were awarded the INFORMS Revenue Management and Pricing Section Prize for their entry entitled “The Spiral-Down Effect in Revenue Management.” This honor is awarded for the best contribution to the science of pricing and revenue management. As a PhD student, Cooper was advised by **Dick Serfozo**. He currently is at the University of Minnesota. Homem-de-Mello was

advised by Associate Professor **Alan Erera** and is currently on the faculty at Northwestern University.

Professor **Jiangang “Jim” Dai** was named INFORMS Fellow. Dai is a leading researcher in the applied probability community, focusing on stochastic processing networks used for the design, analysis, and control of complex systems including communication networks, manufacturing systems, and large service systems. The INFORMS Fellow Award recognizes members who have made significant contributions to the advancement of operations research and the management sciences.

Former PhD student **Juan C. Morales** was awarded the TSL Best Dissertation Prize by the Transportation Science and Logistics Society (TSL) of INFORMS for his thesis entitled “Planning Robust Freight Transportation Operations.” The TSL Best Dissertation Prize is the oldest and most prestigious honor for doctoral dissertations in the transportation science and logistics area. Morales was co-advised by Associate Professor **Alan Erera** and Schneider Professor **Martin Savelsbergh**.

PhD student **Juan Pablo Vielma** won the INFORMS Optimization Society Student Paper Prize. The winning paper, entitled “A Lifted Linear Programming Branch-and-Bound Algorithm for Mixed Integer Conic Quadratic Programs,” was written with his co-advisors **George L.**

Nemhauser and **Shabbir Ahmed**. This is the first year that INFORMS Optimization Society has presented a student prize.

PhD student **Richa Agarwal** and Assistant Professor **Ozlem Ergun** were selected as one of six finalists in the INFORMS Junior Faculty Interest Group Paper Competition for their work entitled “Network Design and Allocation Mechanisms for Carrier Alliances in Liner Shipping.”

PhD student **Richa Agarwal** and Assistant Professor **Ozlem Ergun** were selected as Runner-Up in the INFORMS Computing Society Student Paper Competition for their work entitled “Ship Scheduling and Network Design for Cargo Routing in Liner Shipping.”

PhD students **Alaa Elwany** and **Ying Hung** were selected as finalists for their individual entries in the Quality Statistics and Reliability Best Student Paper competition. Elwany’s advisor was **Nagi Gebraeel**, and Hung was co-advised by **Jeff Wu** and **Roshan Vengachilyil**.

Former PhD student **Andreea Popescu** was selected as a finalist and received Honorable Mention for the George B. Dantzig Award that is given for the best dissertation in any area of ORMS that is innovative and relevant to practice. Popescu was co-advised by Professor **Ellis Johnson** and Associate Professor **Pinar Keskinocak**.

Faculty News

Greg O. Andrews joined the H. Milton Stewart School of Industrial and Systems Engineering as managing director of the Executive Masters in International Logistics (EMIL) program in August. With twenty-seven years in the logistics and transportation industry and as a graduate of the EMIL program, he brings an ideal mix of industry and academic expertise to the position.

William J. Cook, the Chandler Family Chair and Professor, and **Arkadi Nemirovski**, the John Hunter Chair, were appointed adjunct professors in the School of Mathematics in September 2007 by School Chair William T. Trotter. Adjunct professor status is the highest honor one School can bestow on a faculty member in another School.



Faculty and staff of the H. Milton Stewart School of Industrial and Systems Engineering celebrated alumna Anne Marie Eaton's 100th birthday at the School's annual holiday celebration. School Chair Chelsea C. White III presented Anne Marie with a certificate of appreciation, recognizing her and her husband Paul's devoted and faithful service, steadfast dedication, and generous support to Georgia Tech and the Stewart School of ISyE. Anne Marie is Georgia Tech's oldest living alumna.

In July 2007 **Ozlem Ergun**, **Joel Sokol**, and PhD student **Lori Houghtalen** were awarded the Management Science Strategic Innovation Prize from the Association of European Operational Research Societies for their work on air cargo alliances.

Jiangang "Jim" Dai has been awarded the Edenfield Professorship for a three-year term. **James C. Edenfield** (IE 1957), CEO and president of American Software Inc., established the Edenfield Professorship to assist the H. Milton Stewart School of Industrial and Systems Engineering in leading the field in research and education.

Stephen Downs was appointed Edenfield Executive-in-Residence in September 2007. In this role, Downs is working to establish a research and educational program for healthcare and humanitarian logistics within the Georgia Tech Supply Chain & Logistics Institute.

Nagi Gebraeel joined the H. Milton Stewart School of Industrial and Systems Engineering as an assistant professor in July 2007. Gebraeel specializes in research

that plays a vital role in the ability to accurately predict unexpected failures in complex engineering systems.

Pinar Keskinocak was elected vice president for Membership and Professional Recognition of the 2008 Institute for Operations Research and the Management Sciences Board of Directors.

Anton J. Kleywegt was elected secretary of the 2008 Institute for Operations Research and the Management Sciences Board of Directors.

Meilong "Charles" Le joined H. Milton Stewart School of Industrial and Systems Engineering's faculty as Global Logistics Scholar for the next two years. Le comes to the Stewart School of ISyE from Shanghai Jiao Tong University (SJTU) and will be working with **Ellis Johnson** to launch the MSIE dual degree program with SJTU as well as contributing to the Georgia Tech Supply Chain & Logistics China Logistics Research Center and other School activities.

Jye-Chyi "J.C." Lu was inducted as a Fellow of the American Statistical Association, a scientific and educational society promoting excellence in the application of statistical science across the wealth of human endeavors. Lu joins the H. Milton Stewart School of Industrial and Systems Engineering colleagues **Paul Kvam** (inducted in 2006), **Kwok-Leung Tsui** (inducted 2003), and **Jeff Wu** (inducted 1985) with this distinguished honor.

George L. Nemhauser, A. Russell Chandler III Chair, was honored at the *Optimization Research Symposium: Recognizing Professor George Nemhauser's Contributions to the Field of Operations Research* at the Georgia Tech Hotel and Conference Center in July. The two-day event included tributes to Nemhauser, with fellow researchers who roasted and toasted him, as well as presentations highlighting the depth and breadth of the contributions he has made to the field of operations research.



William B. Rouse completed his latest book entitled *People and Organizations: Explorations of Human-Centered Design* (John Wiley & Sons, 2007). Exploring human-centered design, Rouse identifies and discusses the people who operate, maintain, design, research, and manage complex systems.

Martin Savelsbergh was awarded the Schneider Professorship for a three-year term to support research and development in logistics and supply chain engineering in ISyE.

Jianjun “Jan” Shi joined the H. Milton Stewart School of Industrial and Systems Engineering in January 2008 as the Carolyn J. Stewart Chair of Industrial and Systems Engineering.

Pete Viehweg will serve as Executive-in-Residence for the Georgia Tech Supply Chain & Logistics Institute’s Center for Warehousing and Distribution during the 2007-08 academic year. In this role, Viehweg will help direct projects and will be a viable industry resource to researchers.

Ming Yuan was selected as a 2008 Georgia Cancer Coalition Distinguished Cancer Scholar for his research to stratify breast cancer into biologically distinct types and correlate them with outcome and therapy response. The Coalition selects scientists engaged in the most promising areas of cancer research.

Chen Zhou was appointed Associate Chair for undergraduate studies in ISyE beginning January 1, 2008.

Alumni News

Kristen Anclien, IE 1996, a real estate broker, is the owner of RE/MAX Around Atlanta in Sandy Springs, Georgia.

Sherri (née Tedder) Babb, IE 1985, recently joined the corporate team at First Choice Community bank in Newnan, Georgia.

Matt Browner, IE 1996, has been promoted to account director with Avenue A Razorfish. He is responsible for designing digital marketing solutions for clients such as BellSouth and Cingular Wireless.

Jim Butterworth, IE 1984, received a social justice award from Dartmouth College in January. He is a founder and principal of Incite Productions, a Colorado-based company that produces documentaries promoting positive social change around the world.

Roberto Castro, IE 2007, received the NCAA’s Top VIII Award, one of the highest honors in college sports, on Sunday, January 13, 2007 at the NCAA convention. Castro is one of eight winners chosen for their combination of athletic, academic, and public service achievements. He shared the Byron Nelson Award as the nation’s top senior golfer, was a three-time All-American, and a two-time Academic All-American.

George Cates, IE 1959, of Memphis, Tennessee, has been named to the University of Tennessee Board of Trustees by Governor Phil Bredesen. Cates retired as founder, chairman, and CEO of the Cates Co. and has also served with Memphis Light, Gas, and Water, as president of the Memphis Rotary Club and Memphis Botanical Gardens, and as vice chairman of the Memphis and Shelby County Airport Authority.

Stephen Choy, IE 1992, received a doctor of pharmacy degree from the University of Florida’s College of Pharmacy in May. In June 2006, he began a pharmacy practice residency with Kaiser Foundation Hospital in Fontana, California.

David Cohen Solis, MS IL 2006, was named president of the Asociación de Usuarios de la Zona Libre de Colon, which is the Business Association of the Colon Free Zone. Founded in 1979, the Colon Free Zone is now the world’s second largest free trade zone and a tremendous entity at the Atlantic gateway to the Panama Canal.

Andrew Cornelious, IE 1998, was recently promoted to Assistant Business Unit Manager at GM’s Stamping Plant in Indianapolis. Prior to his promotion, Cornelious served as launch manager for GM’s H3 Hummer Program. He earned a master’s in engineering science from Rensselaer Polytechnic Institute in 2001.

Steve DeWeese, IE 1984, passed the project management professional exam and was awarded certification. He currently works for Northrop Grumman Defense

group as an acquisition, logistics, and technology program manager in the Office of the Assistant Secretary of the Army.

Walt Ehmer, IE 1989, president and CEO of Waffle House spoke at the Georgia Tech Alumni Career Conference held in Atlanta in March 2007. Ehmer stressed the importance of long-term career objectives and personal contact in the workplace.

Bill George, IE 1964, has authored a new book entitled *True North: Discover Your Authentic Leadership* with Peter Simms. The book examines how to be an authentic leader by developing yourself and being true to your beliefs and your life story in the face of challenges and seductions. George is professor of management practice at Harvard Business School and the former CEO of Medtronic Inc.

Douglas A. Gray, MS OR 1987, has joined Quepasa Corporation as chief technology officer, overseeing all of the company’s software and system development operations.

Dan Gretsich, IE 1991, MS IE 1995, and **Jeanette Gretsich**, CHEM 1990, are the founders of SOLARHOT, a solar thermal manufacturing company located in Carey, North Carolina. SOLARHOT received the highest rating for an OG-300 freeze-protected system on the market from the Solar Rating and Certification Corp. in June 2006.

Three graduates from the H. Milton Stewart School of Industrial and Systems Engineering have been nominated to the Alumni Association Board of Trustees: **Richard Guthman Jr.**, IE 1956, retired senior vice president of government and public institutions banking for First American Bank of Georgia; **A. Wayne Luke**, IE 1972; corporate development officer for TalentQuest; **Jess Newbern III**, IE 1966, retired founder, owner, and CEO of Newbern Building Services Inc., now called Virginia Trane.

Eileen Hitcho, IE 2001, MS HS 2002, graduated from the Medical College of Georgia in May 2007 and in June began a residency in emergency medicine at the Carolinas Medical Center in Charlotte, North Carolina.

Holly A. Hoenes, IE 2000, earned a doctor of medicine degree in May 2006 from



The H. Milton Stewart School of Industrial and Systems Engineering hosted the 2007 Oyster Roast at the historic Inman Park Trolley Barn. More than 180 alumni, faculty, staff, and friends had the opportunity to reunite with colleagues and meet current faculty of the School. Thanks to Betty and Frank Peeples, IE 1949, the Oyster Roast has become a wonderful Homecoming tradition.

Mercer University School of Medicine in Macon, Georgia, and was awarded the Leonard Tow Humanism in Medicine Award. This honor is awarded by the faculty to a student who has demonstrated the highest standard of compassion and sensitivity in interactions with patients. Hoenes is continuing her training in pediatrics and child neurology at the Cincinnati Children's Hospital Medical Center.

Timothy Hudson, IE 1999, has been promoted to manager of components service solutions and channels at Rockwell Automation. Hudson is responsible for managing \$120 million over Pennsylvania, Delaware, Washington, D.C., Fairfax, Virginia, and south New Jersey.

Thomas H. Johnson, IE 1971, has been elected to serve on the board of directors of Coca-Cola Enterprises, Inc. through April 2009. He will serve on the board's audit, finance, and government committees. The former chairman and CEO of Chesapeake Corp., Johnson also serves on the board of directors of Mirant Corp., Superior Essex, Universal Corp., and CMGI. He is a former trustee of the Georgia Tech Alumni Association.

NASA has assigned **Army Lt. Col. Robert S. Kimbrough**, MS OR 1998, as a member of the crew for Endeavour's STS-126 mission, targeted for launch in September 2008. The Space Station Assembly mission will deliver equipment to the International Space Station, enabling larger crews to reside aboard the complex. Kimbrough was selected as an astronaut in 2004.

Bill Linder, IE 1992, has joined Visiprise Inc. as Western regional sales manager and is currently located in Durango, Colorado. Visiprise is a leader in integrated manufacturing operations solutions, and has been one of Atlanta's fastest-growing private companies by the *Atlanta Business Chronicle*.

Robert D. Martin, IE 1969, recently joined The Interlochen Group, an Atlanta-based consulting firm providing interim chief financial officers and controllers to middle-market businesses throughout the United States.

David A. McClain, IE 2001, earned the Certified Family Business Specialist designation with MassMutual Financial Group in May 2007.

Travis Moody, IE 1990, has published a book, *Financial Breakthrough: God's Plan for Getting Out of Debt*, which is available at Barnes & Noble, travismood.com, and Amazon.com. Moody is a senior group leader with Target Distribution and lives in Maumelle, Arkansas.

Matt Moore, IE 2005, has been named deputy political director and communications director of the Republican Governors Association in Washington, D.C.

Fay Cobb Payton, IE 1989, associate professor of information systems at North Carolina State University's College of Management was named the first SAS Faculty Fellow. Payton uses SAS software in her classes and is developing a set of teaching materials specifically for SAS instructors.

David A. Perdue, IE 1972, MS OR 1976, chief executive officer of Dollar General was the recipient of the Captains of Industry award presented by the Institute of Industrial Engineers (IIE) at the annual IIE conference in Nashville, Tennessee. As one of IIE's most prestigious honors, this award recognizes leaders in business, industry, and government who have achieved significant success at a national or international level.



Maj. Gen. Conrad W. Ponder Jr., IE 1969, retired from the Army Reserves in April after thirty-seven years of service. For the last four years, he served on active duty as the chief integration officer in the Office of the Chief Information Officer/G6 at the Pentagon. Ponder was awarded the Distinguished Service Medal and the Silver Order of Mercury at a retirement ceremony held at the Pentagon.

Dusty Riddle, IE 2003, has been named a William E. Simon Leadership Fellow at the Simon School of Business at the University of Rochester.

Heather Smith Rocker, IE 1998, was selected as the executive director for Women in Technology (WIT). WIT promotes the advancement of women in the field of technology and is a founding society of the Technology Association of Georgia.

R. Stephen Rosenholm, MS IE 1980, has joined Hiscock & Barclay LLC as counsel. Rosenholm's practice includes preparation and prosecution of patent, trademark, and copyright applications.

Craig Sands, IE 1983, retired from the Air Force in April with the rank of lieutenant colonel. Sands was stationed at Fort Eglin Air Force Base in Florida.

Stephen W. Slawsky, IE 2001, has been promoted to director of production for Fodor's Travel Publications, a division of Random House in New York City.

Karen Steadman, PhD IE 1993, founded Leadership Futures, a consulting firm in Atlanta in 2006. Leadership Futures advises senior leaders and their organizations on sound investments in leadership talent. Services include executive assessments, accelerated leadership development programs, and performance optimization.

James Tidwell, IE 1996, has been promoted to business development manager in the power quality division of Eaton Corporation.

Deaths

Theodore Charles Beachman, IM 1958, IE 1961, of Fairhope, Alabama. He retired from General Motors Corp. as a production superintendent after thirty-two years with the company. At Georgia Tech, he was a member of Sigma Phi Epsilon.

James Robert Cary, IE 1955, of Marietta, Georgia. He retired as president of E-Con Inc., a manufacturer's representative company he started in 1978. He served in the Navy Reserve as lieutenant junior grade and completed active duty in 1957. At Georgia Tech, he was a member of Alpha Tau Omega.

Former Assistant Professor **Lloyd W. Clarke** of Hagerstown, Maryland. Lloyd received his PhD in systems engineering from the University of Pennsylvania in 1992. He worked in the H. Milton Stewart School of Industrial and Systems Engineering as a postdoctoral fellow from 1992 to 1993 and then as an assistant professor from 1993 to 1999. Upon leaving Georgia Tech, Lloyd worked in logistics operations at Schneider National, later joining ILOG to pursue optimization software development.

James L. "Larry" Dallam, IE 1955, of Baton Rouge, Louisiana.

Joseph C. Griffith, CE 1962, MS IE 1966, of Columbia, South Carolina. Griffith retired as a consultant for the State of South Carolina.

Sig Guthman, IE 1951, of Sandy Springs, Georgia. Guthman worked thirty-seven years with Atlantic Envelope Co., which his family had founded. He also served passionately as a volunteer at the Atlanta Botanical Garden, where he edited its volunteer newsletter, titled "Digging In," for sixteen years, earning the Garden's Lifetime Volunteer Award in 2003. He was active in numerous hobbies, including art collecting, electronics, landscape photography, sculpting, singing, travel, woodworking, and welding.

William Jackson "Jack" Lester, IE 1948, of Martinsville, Virginia. A textile executive, he retired from Tultex in 1992. He was executive vice president of Lacy Manufacturing Co. for thirty-two years and became president of the company in 1975. He was chairman of the History committee that published a book that chronicled the 150th anniversary of the First Presbyterian Church in Martinsville and was past chairman of the United Fund. Lester was a veteran of the Navy.

William J. Penn Jr., IE 1950, of Macon, Georgia.

Kenneth R. Pickren, IE 1958, of St. Simons Island, Georgia. Pickren worked for DuPont de Nemours & Co.

Thomas R. Porter, IE 1972, MS IE 1976, of Marshall, Virginia. An Air Force veteran and lawyer, Porter was director of litigation services for Grant Thornton. He received a juris doctor degree from George Washington University in 1982.

Distinguished Professor **Rick Rosenthal, PhD IE** 1975, of Monterey, California. Rosenthal graduated from John Hopkins University in mathematics in 1972 and from Georgia Tech in operations research (OR) in 1975. After graduation, Rosenthal served as an assistant and associate professor of management science at the University of Tennessee. In 1984, he joined the OR Department at the Naval Postgraduate School, serving as National Academy of Sciences senior research fellow, associate professor, full professor, distinguished professor, and chairman of the OR Department.

Reuben Rose, IE 1950, of Livingston, New Jersey. He was chairman of the board of Kern Investment Corp.



In Memory: Thiruvenkatasamy “Govind” Govindaraj

Associate Professor **Thiruvenkatasamy “Govind” Govindaraj** died on December 7, 2007. Govind’s primary research interests were in understanding and characterizing the role of humans in technologically complex environments, with a scope ranging from well-defined engineered systems to globally distributed systems in which cultural, environmental, political, and social factors were significant. In addition to studying computer-based systems to assist human operators in complex, real-life, engineered environments, he was investigating the design of systems and environments that were both easy and pleasant to use by human operators while contributing to sustainable development over the long run.

“Govind was a true humanist — he had a strong interest in and concern for human welfare, values, and dignity; more importantly, he walked the talk; he practiced what he believed — whether it was caring for the environment or the underprivileged in any part of the world, a remote village in India or the oppressed in Myanmar (Burma),” said Sundaresan Jayaraman, professor of textile engineering at Georgia Tech and a close friend and colleague of Govind’s. “He was always ahead of his time. He was into ‘Green’ and ‘Sustainability’ long before CSR, or Corporate Social Responsibility, became a label that everyone today wants to wear whether they believe in it or not. He was a man of integrity and simplicity who was uncompromising when it

came to principles of fairness and doing the right thing. Above all, he was a dedicated and loving husband and a caring and doting dad. Indeed, he was unique — he was Govind.”

On the instructional side, Govind believed that “young minds are more likely to invent innovative solutions to the complex problems of sustainable systems.” “Professor Govind was my mentor, a great person, a fabulous professor, and foremost my friend,” said Luis Herrera. “He was my PhD thesis advisor. He guided me throughout my research and gave me his unconditional support. Thanks to him, I was able to complete my research. He was going to hood me during commencement. I am terribly shocked and saddened by his loss.”

Govind taught an Honors Program course on Engineering Sustainable Systems. Students were designing a sustainable city as an example for other cities around the world. Stephanie Lu, one of the students in this class, included comments on Govind’s class in the December issue of the Honors Program newsletter. “Dr. Govindaraj taught us more than we ever expected about sustainability — what it is, different ways of looking at it, what issues it presents, how to solve those issues in more ways than the obvious ones, how to solve issues in our own fields of study, how to look more holistically at issues, and at how solutions are intertwined and can overlap,” said Lu.

Govind was a dedicated professor, a loving husband, father, and friend. He is survived by his wife, Renuka, and their daughter, Thendral, his mother, two sisters, and two brothers.

Stay in Touch • Drop Us a Line

The Alumni News section highlights promotions, awards, scholarships, fellowships, and publication of books. Let us hear from you! It’s a good way to stay in touch with your classmates.

Who: _____

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