

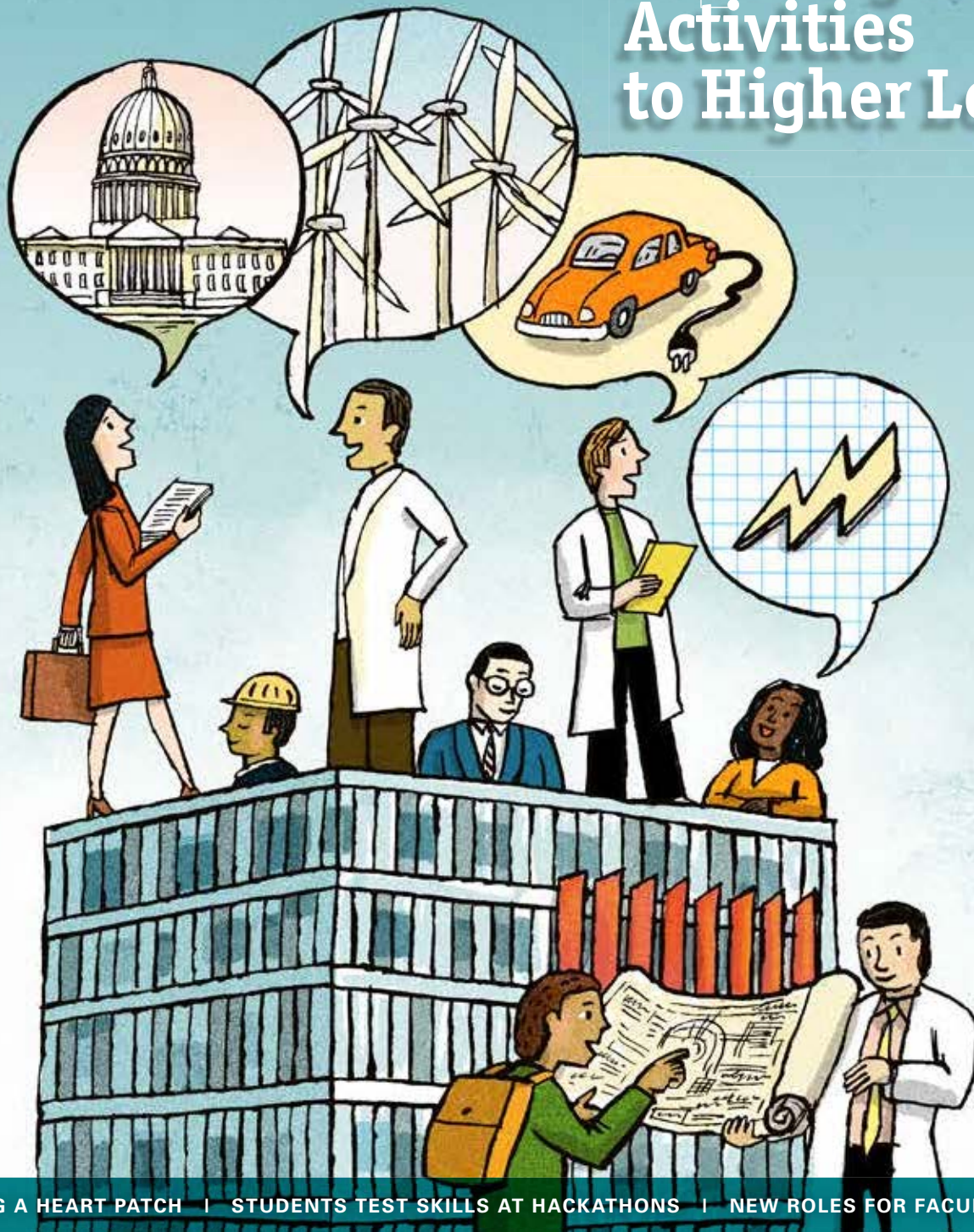
Carnegie Mellon University

ENGINEERING

Carnegie Institute of Technology • Fall 2013

Power Up

Elevating Energy
Activities
to Higher Levels





THE FIRST YEAR

It's Not All Fun and Games

The first year at CIT is exciting, but for students fresh out of high school there are challenges. To help them transition to college life, CIT offers, through the Deepak and Sunita Gupta First Year Experience, programs and activities that allow young students to find their place in the CIT community.

During Orientation Week 2013, the Class of 2017 loaded onto buses and went to FunFest, a local entertainment center, where they could hang out in a casual setting. (Based on the photos and student feedback, it appears that the trip was a success.) These students will soon learn that in addition to attending classes, they are expected to attend Success Series workshops that promote academic, personal and professional growth. Then there are networking events, such as the Meet, Mix and Mingle and First-Year Networking Night that allow first-years to socialize with professors, upperclass students and alumni so they can learn about CIT's majors and begin building their network as young engineers. CIT maintains that by purposefully engaging students throughout their first year, they develop confidence and become better equipped to make choices throughout their academic career.



Carnegie Mellon University

ENGINEERING

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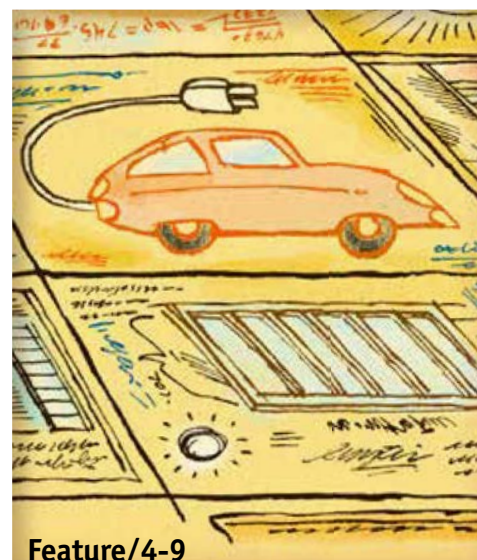
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Power Up. Elevating Energy Activities to Higher Levels

The world must make fundamental transformations in how energy is used and produced. This will require science, technology and public policy innovations. This is where the Scott Institute for Energy Innovation steps in.

Cover and feature illustrations by
ROBERT NEUBECKER



We are in this together.

CIT comes alive when the fall term starts. Over the summer, the Carnegie Mellon campus is a bit quiet because so many faculty and graduate students are busy conducting research or presenting at conferences around the world. However, when students return in August, the increase in the energy

level is palpable. The staff grows busy helping students solve all sorts of challenges associated with the new semester. The faculty returns to their classrooms, eager to engage the students in their courses. The students are excited, too; well, most of them. I know this because more than 30 years ago, I was a student at Carnegie Mellon. The beginning of a new school year always stirs happy memories about my student days, but now, as dean of the College of Engineering, my thoughts focus on the challenges of leading this extremely energetic and highly accomplished collection of faculty, staff and students into the future.

As many of you know, I became dean in January 2013 succeeding Pradeep Khosla, who became the chancellor of the University of California San Diego. I would like to acknowledge and thank Pradeep for his excellent leadership of the college from 2004-2012. He brought new and exciting resources to the college, including Sherman and Joyce Bowie Scott Hall, which is just starting to be constructed. I also wish to acknowledge the exemplary service of Vijayakumar Bhagavatula, who was appointed interim dean after Pradeep's departure and guided

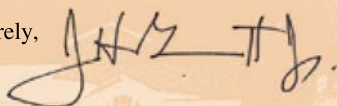
the college with great effectiveness during the semester when the dean search was conducted.

I am deeply committed to the university and the college as it has been my home for three decades, and I truly look forward, with your help, to taking CIT and CMU to our next and greater level of success. Since my appointment, I have been working with department heads, faculty and staff throughout CIT to more deeply understand the departments, institutes and centers within the college, their immediate and long-term needs, how they interrelate, how they build from each other's strengths and what is needed to make them and the college even better. This fall, we are conducting a major and broad-based strategic planning process whereby we will give the CIT community, including alumni (through the CIT Dean's Advisory Council) a chance to identify transformative opportunities in education, research and operations for the college. I greatly look forward to seeing the strategic plan for the college take shape, and I will use it as a guide for making decisions regarding the future of the college.

Over the past six months, I have had the chance to meet with many interesting and successful alumni at events held in Pittsburgh and in other cities. After every one of those meetings, I came away exhilarated by what our alumni have accomplished in their careers. They are leaders in academia and industry, they have started extremely successful companies, they have invented products and services used worldwide, and they have made a difference. These interactions have reaffirmed what I have always believed to be true; you, our alumni, are vital for our success. CIT alumni have graciously mentored students through internships and networking opportunities, have helped facilitate faculty/industry interaction and support, and have freely given their time in support of the college in a variety of important and impactful ways.

CIT has been and continues to be a place that is bustling with creative, driven and dedicated people. The school may be small, but we have earned our reputation for excellence and innovation. I am extremely proud of the current state of CIT, but I know we are able to ascend further, and I hope you will continue to support us as we strive to continuously improve all that we do.

Sincerely,



James H. Garrett Jr.
Dean, College of Engineering



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We want to hear from you.

Send email to
stokes@cmu.edu
Please include your name and, if applicable, major and date of graduation. Letters will be edited for clarity and space.

FYI

2013 Alumni Award Honorees

The CMU Alumni Association is proud to announce that the following members of the CIT community were chosen as 2013 Alumni Award Honorees. Their accomplishments and contributions were celebrated at the annual Alumni Awards Ceremony on September 27, 2013 as part of Cèilidh Weekend.

Alumni Distinguished Achievement

Alan Washburn (E'62, '63, S'65) is a distinguished professor emeritus in the Operations Research Department at the Naval Postgraduate School and is an active member of the National Academy of Engineering.

Alumni Distinguished Service

Richard Creech (E'84) is president and principal of Creech Engineers, a 50-person civil engineering, surveying and mapping firm headquartered in Stuart, Fla. On behalf of CMU, he has served on the Board of Trustees, CIT Dean's Leadership Council, Alumni Association Board and Civil Engineering Advisory Board.

Alumni Service

Marullus A. Williams (E'95) is the president of Limbic Systems, Inc., an IT consulting firm. Since graduating from the Information Networking Institute (INI), he has recruited for the INI with a focus on minority and women students. He is a member of the INI Alumni Leadership Council, and in 2012, he was the commencement speaker for the INI Diploma Ceremony.

Student Service

Lenny An (E'11, '12) joined Accenture as a consultant, focusing on Systems Integration. At CMU, he complemented his studies by staying involved with student organizations. He belonged to Sigma Phi Epsilon, and was a co-lead for the Student Planning Committee for Cèilidh Weekend 2012, a Highland Ambassador and an orientation counselor. Today he is involved in the CMU NYC Alumni Board.

Sangita Sharma (E'13) now works for Accenture in Philadelphia, Pa., as a systems integrations analyst. At CMU, she was active in the Student Life Office, where she served as a resident assistant, a mentor and finally a head orientation counselor for a first-year residence hall. During her junior year she served as the vice president of the Student Body. Later, she served as the student representative for the Alumni Association Board.

Top Student Honored by U.S. Department of Transportation

Yeganeh Mashayekh, a dual Ph.D. candidate in civil and environmental engineering and engineering and public policy, received a Technologies for Safe and Efficient Transportation (T-SET) Outstanding Student of the Year Award from the U.S. Department of Transportation.

At the 22nd Annual Council of University Transportation Centers' banquet on January 12, 2013, Mashayekh was honored for her present and future contributions to transportation.

Mashayekh examines the economic and environmental cost effectiveness of transportation-related strategies. "While most transportation strategies attempt to improve traffic conditions, not all of them result in environmental and/or economic savings from society's perspective. My research holistically looks at costs and savings associated with various strategies in terms of health, environmental and economic impacts. The goal is to help public agencies invest in and implement strategies that result in net benefits across multidisciplinary boundaries," explains Mashayekh.

Mashayekh works with Chris Hendrikson, the Duquesne Light University Professor, and her research is sponsored by the T-SET University Transportation Center.



Gregory D. Winfree, Research and Innovative Technology Administration deputy administrator of the U.S. Department of Transportation, presented Yeganeh Mashayekh her award.





Power Up

Elevating Energy Activities to Higher Levels

BY SHERRY STOKES

Across Carnegie Mellon University, you will find people engaged in a spectrum of energy activities. The College of Engineering (CIT) has research centers that delve into shale gas issues, carbon sequestration, novel materials, efficiency — the list goes on. Energy-centric academic programs and courses have proliferated. The college's collaborative relationships with industry have helped us transfer innovations into the marketplace and encourage startups, including Aquion Energy and Plextronics. (On average, CMU professors and students create 15 to 20 new companies annually.) CIT faculty members engage policymakers at Capitol Hill briefings on topics ranging from electric vehicles to securing the grid. With such a deep, broad energy presence already established, the question arises: Why has Carnegie Mellon committed itself to establishing the Wilton E. Scott Institute for Energy Innovation?

The point of the Scott Institute is to corral all of the university's energy activities and move them to a higher level, explains M. Granger Morgan, the inaugural director of the Scott Institute and the University and Lord Chair Professor of Engineering. And there's more: a guiding precept of the institute is to promote and not impede the entrepreneurial activity that's underway in CMU research centers. (The institute will not have administrative control of the centers under its umbrella.) Andy Gellman, the co-director of the Scott Institute and Lord Professor of Chemical Engineering, says that the institute represents the collective efforts of more than 30 highly specialized centers. "The institute can encourage synergy between centers and encourage them to work together for funding opportunities for which they may not have considered applying alone," says Gellman. Additionally, a number of faculty conduct energy research independent of any particular center. "The Scott Institute serves to represent them to the outside

world. The institute also serves as a single point of contact at CMU for outsiders who are interested in learning about what we do in energy," says Gellman.

In September 2012, with a generous lead gift from Sherman and Joyce Bowie Scott, the institute was founded with the purpose of improving energy efficiency and security and developing new, clean and sustainable energy sources. In less than a year, the advantages of the Scott Institute revealed themselves in a big way. In April 2013, CMU received a \$30 million gift from the Richard King Mellon Foundation to expand energy research, education and innovation. The gift, the largest private foundation grant in the university's history, will enable the Scott Institute to advance its mission. A portion of the funds will be used for the construction of Scott Hall that's currently underway. Other monies will support new professorships and fellowships for graduate students, who are instrumental in expanding research. Finally, there will be discretionary

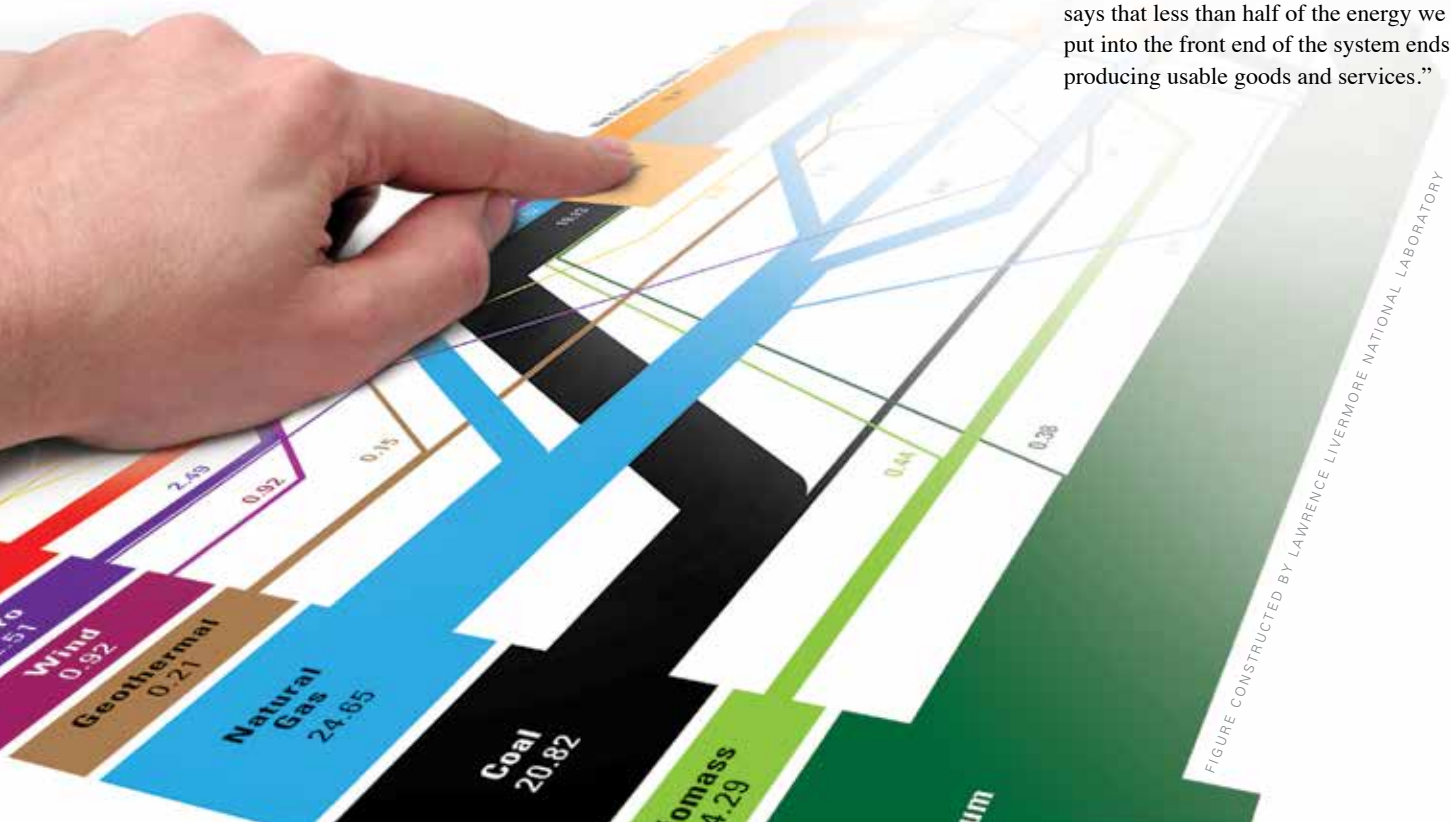


M. Granger Morgan

money to seed new initiatives (see more about this on page 9). This financial support will help the institute accomplish much, especially when it is coupled with the A to Z approach to problem solving that is prevalent throughout CIT.

Get The Picture

In his quiet office in Baker Hall, Morgan produces a diagram and begins, "This picture represents the U.S. energy system." On the diagram's left, he points to energy sources, such as hydro, coal and natural gas. His finger travels across the picture and he explains how energy is used for electricity and other purposes. On the light gray area his finger stops, "this area is wasted energy, and basically, this picture says that less than half of the energy we put into the front end of the system ends up producing usable goods and services."





Andy Gellman

The diagram illustrates the challenges the Scott Institute will address. “The first thing we will focus on is making greater use of the energy we’ve already got. How do you get more productive goods and services out of it?” asks Morgan. Another objective is to develop new, clean energy sources. Moving back to the picture, Morgan points to the middle, the part that shows energy moving from its sources to its final applications, “We want to make all of this here more efficient and secure. That includes making electric power systems more reliable.”

“We are not focused on any particular energy technology,” says Gellman, “We have faculty working across all areas that are relevant to energy. That means everything from energy capture [i.e., wind, coal, solar] to the conversion of energy into electricity. We have people working on distribution, transmission and at the end, consumption. We have people who model and optimize large complicated systems. On the technology side, we cover everything.” This system-wide approach is

one of the major distinguishing features of the Scott Institute.

Another trait that separates the institute from peer institutions is Carnegie Mellon’s might in public policy. “There are technical problems and there are regulatory problems that are characteristic

of many of the energy issues we are working on. The comparative advantage of CMU is that we can work smoothly across that entire continuum,” says Morgan, who explains that CIT and its Department of Engineering and Public Policy (EPP), CMU’s Tepper School of Business and the Heinz College reinforce the institute.

Two-Pronged Approach

Mirroring the institute’s technical and policy-oriented approach to energy research is the appointment of Gellman and Morgan as its directors. Gellman, who served as the head of Chemical Engineering for 10 years, has been instrumental in cultivating a relationship with the Department of Energy’s National Energy Technology Lab (NETL) that resulted in the NETL Regional University Alliance. Morgan heads CMU’s EPP Department and the NSF Center for Climate and Energy Decision Making at Carnegie Mellon. Together they direct activities by tapping into their corresponding areas of expertise.

“The institute can encourage synergy between centers and encourage them to work together for funding opportunities for which they may not have considered applying alone.”

ANDY GELLMAN

"Few universities, if any, have the technology, policy, economic and behavioral expertise that Carnegie Mellon does."

M. GRANGER MORGAN

Complex energy problems require multidisciplinary solutions. For example, most electricity in the U.S. is generated at large central plants. "You see the plants along the Ohio River and big plumes pour out from their cooling towers. That is waste heat. And it's not that engineers are doing a bad job. Basic thermodynamics requires that those plants reject a lot of low-grade heat. Because the plants are in the middle of nowhere, it is hard to use that heat for anything else," says Morgan. Yet if we applied distributed generation technologies and built smaller plants closer to demand sites, the exhaust heat from those plants could be used for heating and cooling. "You can almost double the efficiency from which the input energy gets converted into useful services. You can go from around 40% to 80%," adds Morgan.

There are technical and economic challenges associated with distributed generation but the regulatory obstacles reign supreme. "At the moment, the only people who are allowed to build microgrids are the utilities, and they don't have much incentive to do this," says Morgan. "What one would like to have are others who engage in Silicon Valley entrepreneurial-style innovation in microgrids that are located throughout our distribution system."

Lighting is another area where efficient technologies can significantly reduce energy waste says Gellman. Incandescent light bulbs convert only about 5% of the energy they use into light. The U.S. Department of Energy (DOE) states that switching to LED lighting over the next 20 years could save the country \$250 billion in energy costs during this period, cut electricity use for lighting by almost half, and nix 1,800 million metric tons of carbon emission from spewing into the air. CMU has done a lot of work in solid-state lighting. While the up-front costs are still higher than incandescents or compact fluorescents, the life-cycle costs are lower. "Technology is part of the issue, but the other issue is how do we smooth out costs to promote wider adoption? How do we address issues of behavior?" asks Morgan. CMU researchers are studying the full gambit of lighting: from how to improve solid-state technologies to how to smooth out their costs and encourage consumer demand.

With the same cradle-to-grave perspective, the Scott Institute is looking at energy generation. In western Pennsylvania, as in many U.S. states, shale gas is a topic of enormous discussion. CIT faculty and students are contributing to the dialogue by examining shale gas production, including its extraction through hydraulic fracturing (fracking) and horizontal drilling; how gas development affects the environment; and the economic impact of shale gas. In April 2013, the National Academy of Engineering held a symposium, "Shale Gas: Implications for America's Regional Manufacturing Economies" at Carnegie Mellon. The

Scott Institute's first policymaker's guide, written by the Scott Institute's Debbie Stine, was released in March. Akin to the institute's approach to the shale gas is its work in renewable energy, such as wind and solar. Jay Apt, professor of Technology in the Tepper School of Business and in EPP leads a major project to study how these intermittent and variable sources of power can best be used (www.RenewElec.org). Another large body of CMU's research deals with making power systems resilient to cyber attacks and natural disasters. The Scott Institute released a second policymaker's guide. (These policymaker's guides are available online at www.cmu.edu/energy/public-policy/index.html.)

Innovation Needed All Around

To reach a sustainable energy future, it's obvious that we need technology innovation, but we also need innovation in regulatory approaches and structuring incentives to encourage the adoption of new technologies. In addition, we need to examine the disincentives that discourage society from using energy in a cleaner, more efficient manner. Morgan explains that if an old power plant starts retrofitting, say they want to replace motors in the blowers with more efficient ones, the Environmental Protection Agency (EPA) can tell the owners that they have to bring the entire plant up to current emissions standards. However, if the plant continues to run using the old motors, then it doesn't have to change anything.

To help policymakers better understand the ramifications of the actions they take or don't take with regards to energy, several years ago CMU researchers undertook a project to develop a framework for disposing of carbon dioxide. "For years, Ed Rubin [the Alumni Chair Professor of Environmental Engineering and Science] has built models of carbon capture and sequestration, but we figured out that the technical side was only half the problem. The other half was regulatory obstacles," says Morgan.

The sequestration project took shape when a team from CMU's Engineering and Public Policy department collaborated with the Vermont Law School, a top-ranked environmental law school, and Van Ness Feldman Law Firm, a leading energy law firm in Washington, D.C. In addition, Robert Nordhaus, former general counsel of the DOE and a partner at Van Ness Feldman, provided legal input while the schools offered technical and regulatory contributions. Together they drafted a model bill, the "Carbon Capture and Sequestration Regulatory Act of 2012," which is designed to "establish a comprehensive system for the safe and effective transport and geologic sequestration of carbon dioxide."*

"For the first time ever, here is a whole bill that says if you want to implement these things, here's how to do it," says Morgan. "We distributed the bill on Capitol Hill. We have no illusions that anyone will pass the bill as it is written. Bills are scissored apart and then put together again," says Morgan. However, the point remains—sound and comprehensive information delving into the technical and regulatory aspects of CO₂ capture and sequestration is available for elected officials.

"The ability to do this is what sets us apart," says Morgan. Few universities, if any, have the technology, policy, economic and behavioral expertise that Carnegie Mellon does. By leveraging the intelligence and creativity of our faculty and students, the Scott Institute will help society transition into a future that includes safe, clean, secure and sustainable energy.

* The Carbon Capture and Sequestration Regulatory Act of 2012 may be found in the book, by M. Granger Morgan and Sean T. McCoy, published by RTF Press.

SEEDING INNOVATION

When the Scott Institute funded their first round of seed grants, they had explicit criteria. "If the research wasn't novel, it wouldn't fly," says Andy Gellman. "We looked for ideas that involved synergies between people of different skill sets or from different areas on campus. Projects needed to yield results in one year with a small amount of funding. We also wanted to position researchers so they can get funding from other sources in the future." The institute received 26 proposals, all of which clearly merited funding, however, it only had resources to support six.

The seed grants will explore:

Developing low-cost, high efficiency solar thermophotovoltaic (TPV) cells.

TPV represents a revolutionary approach to converting solar energy into electricity. This could be a game changer because TPV cells theoretically have a maximum efficiency of 85%. Realizing the potential of TPV technology will require exploration of materials design and transport processes. Principal investigators (PI) are Sheng Shen (MechE) and Gary Fedder (ECE).

Reducing the cost of silicon wafers for solar cells by using horizontal ribbon growth (HRG).

The cost of silicon wafers is around 45% of a solar panel's cost. By developing a novel HRG process, the cost of a wafer could decrease 40-60%. PIs are B. Erik Ydstie and Aditya Khair, both of ChemE.

Creating collaborative distributed optimization techniques for resource management in microgrids.

This project aims to develop a distributed resource optimization framework for microgrids to enable real-time plug-and-play architecture. The PIs on this project, Gabriela Hug (ECE) and Soumya Kar (ECE), contend that without sound modeling and decision-making abilities in these systems, the reliability of electricity can be at risk.

Collaborating with the Government of Rwanda to identify smart grid technologies that will help Rwanda develop a sustainable energy infrastructure.

ECE Professors Bruce Krogh, the director of CMU-Rwanda, Hedda Schmidtko (CMU-R, CMU Silicon Valley) and Marija Ilic (CMU Pittsburgh) will work with Rwandan students to identify the most effective sensing and control technologies to embed in the Rwandan power grid.

Understanding the causes and consequences of China's wind power manufacturing surge.

China is a major manufacturer and exporter of wind turbines and this raises technology, policy and economic questions in the U.S. EPP's Inês Azevedo, Lee Branstetter of the Heinz School and Long Lam, a Ph.D. student in EPP will work with faculty from Tsinghua University in China to address questions about how U.S. government and industry should respond to China's emergence.

While the institute could not support projects proposed by Jason Hong, Norman Sadeh, and William Cohen from the School of Computer Science, and from Nina Baird and students in the School of Architecture, it made a pair of small seed grants to encourage these two groups to begin to work together.

COUNTERING A NEW ENEMY WITHIN



Franz Franchetti

"It's possible to hijack a system without anybody noticing. You don't have to throw off the signals by much to make bad things happen."

As cars become more like computers, a question looms: What if they get hacked?

BY MIKE VARGO

defense forces in the wrong place on the French coast.

The tactic has now moved into cyberspace, where it takes a new form. The new agents of disinformation are software viruses that can get into automated sensing-and-control systems, skewing the data they read. This can trick the systems into doing what they should not. Franz Franchetti, a research professor in Electrical and Computer Engineering (ECE) at Carnegie Mellon, explains the scope of the threat — and why the Defense Advanced Research Projects Agency (DARPA) has given his research group a \$6 million grant to help develop countermeasures.

"Think about the Stuxnet virus," Franchetti begins, meaning the virus that reportedly caused much damage at a uranium enrichment plant in Iran. The plant had arrays of centrifuges for a key separation process. "The core idea was to mess with the sensing signals" in the control systems, he says, and "it made the centrifuges go crazy," spinning at the wrong speeds until many failed.

Next, Franchetti continues, think of that idea applied to mobile systems. The U.S. intelligence and military services use drone aircraft for a variety of purposes. "If someone can bias the positioning signal, maybe a drone thinks it's flying 100 meters above the ground, whereas it's crashing," he notes.

Now for the part that brings the threat close to home. More and more motor vehicles, from military convoys to family cars, have a powerful but potentially risky combination of IT systems. They have growing networks of onboard sensors and controls to operate the vehicle, plus onboard wireless to communicate with the outside world. The latter could let a malevolent party send in a bug. Then, as Franchetti says, the bug could start messing around.

How a Little Bit Can Do Big Damage

Systems vulnerable to Stuxnet-style intrusions — potentially, if not right now — would include anti-lock braking, adaptive cruise control, lane departure warning systems and many more. They play roles in sensing and regulating non-trivial functions such as when and how the vehicle stops, accelerates and changes course. As Franchetti points out, a simple bug in the lane departure system could entice you to drift into trouble, or prompt a correction that actually un-corrects your path. In heavy traffic at high speed, havoc could ensue.

And the insidious element in all such cases is that "It's possible to hijack a system without anybody noticing," Franchetti says. "You don't have to throw off the signals by much to make bad things happen. If a system wants the car to go straight, you find an unsecured

Disinformation has long been a dangerous weapon. Through history, much of it came from spies who were actually double agents: the D-Day operation in World War II was aided greatly when Nazi generals, misled by false intelligence, put a sizable part of their

sensor and bias the signal from it just a little bit, so it always says the car is going a little to the left of the actual direction." Small deviations from the normal often go unnoticed. A driver may not feel the drag and pull of a low tire until it goes flat, and, similarly, a hijacked car may seem fine until a time comes when little bits matter.

Moreover, concerns will increase with the advent of self-driving vehicles. They already are street legal for testing in many places, and are expected to be safer, eventually, than human-driven cars, but not if they're infected. For instance the car might "see" a stop sign ahead but be biased to stop a little farther ahead, with the front end in cross-traffic.

The problem has led to a quest for the kind of solution Franchetti and his group are working on: to make the vehicle itself know it's been tampered with.

Disin



Can We Give the Designer a Toolkit?

Franchetti's DARPA project is different from "the classic security project, where you try to harden the system" to keep intruders out, the ECE professor explains. "It's trying to put some intrinsic logic into the system, so it can figure out when things are wrong. And it's not just an abstract programming problem. You have to understand how all of these systems work, and try to make them check to notice when readings are not consistent." Franchetti gives an exaggerated example of how a consistency check would go: "You know that if you accelerate for five seconds, even at the maximum, you cannot be on the other side of Pittsburgh." That is, if GPS data shows a distance traveled that doesn't tally with other readings, something is fishy.

The trouble is that sneaky, small discrepancies will not stand out so glaringly. As Franchetti observes, sensors are not totally accurate to begin with, and the signals have noise in them, so "there's a lot of uncertainty." Achieving fine resolution without setting off false alarms is

one daunting task; another is accounting for the myriad ways an attacker could meddle with the multitudes of different signals in play.

Altogether the project is exceedingly complex. The ultimate goal is not a finished security system, Franchetti says. Rather it is "to give engineers who try to design these things a software toolkit. Ideally, they can spec out the problem [for the particular vehicle and onboard systems involved], and then press a button: the software does it for them."

Why the Team is a Big Deal

The expected time frame is four to five years. Laborious as it is, the project is deemed worthwhile due to the potential scale and ubiquity of the threat. DARPA has other teams working on security toolkits for aircraft; Franchetti's Carnegie Mellon-based group is one of four groups for ground vehicles. And, says Franchetti, the work now being done "really shows the interdisciplinary capabilities of Carnegie Mellon."

He wants to emphasize the point, since non-experts looking at the project team are likely to miss it: "They'll say, 'Yeah, yeah, it's all ECE and Computer Science people, what's the big deal?'" As Franchetti sums it up, "You have no idea how interdisciplinary it is to have a formal proof person talk to a robotics person, turning around to talk with a signal processing person, who talks to a compiler person. They're in different worlds. Normally they would never cross paths at a conference; they have no joint language. It takes effort to talk across these areas."

And that effort, too, is worthwhile, he concludes. "Because when people talk across areas, great things can happen."

Along with Franz Franchetti, the faculty research team members are Professors José Moura and Soumya Kar in ECE, and Manuela Veloso and André Platzer in CS, plus the computer scientists David Padua at the University of Illinois at Urbana Champaign and Jeremy Johnson at Drexel. The project is part of DARPA's High-Assurance Cyber Military System (HACMS) program.

formation'

DEVELOPING NEW TECHNOLOGIES IN RWANDA FOR RWANDA

AN INTERVIEW WITH HEDDA SCHMIDTKE

BY BRUCE KROGH
Director, Carnegie Mellon
University Rwanda



Hedda Schmidtke

In January 2012, Hedda Schmidtke became the first faculty member hired specifically for CMU-Rwanda, with a joint appointment with CMU-Silicon Valley. Before joining Carnegie Mellon, she was the research director of the TecO group at Karlsruhe Institute of Technology (KIT), a premier German university. Schmidtke is an expert in intelligent applications for lightweight mobile and distributed systems, including computing platforms such as RFID, mobile phones and Smart Spaces.

In this interview, Schmidtke shares her perspectives on what CIT is accomplishing in Kigali, Rwanda.

What attracted you to CMU-Rwanda?

When I heard about CMU-R, it immediately struck me as the most consequent, rational and bold thing to do to foster the enormous human potential in East Africa.

What is unique about CMU-Rwanda relative to programs initiated by other U.S. universities in Africa?

CMU-R is distinctive in two key aspects. Compared to other U.S. university programs, which are generally short-term, Carnegie Mellon is establishing a full-time faculty in Rwanda. With respect to local, African universities, CMU-R is able to attract internationally competitive faculty by offering a stimulating research environment and the organizational structures required for performing cutting-edge research.

In my opinion, short-term programs can be detrimental to development. Let's say I distribute mobile phones with educational apps to street kids to see whether literacy will increase. I'm quite sure the answer is yes. Great, paper published! When I go away and take my fancy phones with me, what will happen? Disappointment, another broken promise. No two-day or three-week course can have a sustainable learning result. Real development needs long-term commitment, both on the sides of the teacher and the student. This is what CMU-R provides. Moreover, by offering full-fledged CMU master's degrees, we will set new standards.

What are some of the opportunities you see in pursuing your research in Africa?

Reduction of poverty is crucial, but this has to be separated from technological or creative potential.

The Internet and social media are bringing people from diverse economic and cultural situations closer together. CMU-R is a spearhead for this massive technological endeavor. We are not only bringing technology here [Rwanda], we plan to make it here. This summer CMU-R students embarked on two research projects in the areas of eHealth and smart energy systems. They will develop novel technologies in Rwanda for Rwanda.

CMU-R received a grant from Ricoh Innovations to pursue research in eHealth and mHealth. What are eHealth and mHealth and what projects are in the works?

ICT (information and communication technologies) plays a large role in making health systems more economical and effective. This is important for the health sector in the U.S. and Europe, but even more so in resource-constrained settings. The notion of eHealth refers to the use of ICT for public health applications, and mHealth is a branch of eHealth that focuses on the development of mobile technologies.

It might be surprising from a U.S. or European perspective, but Rwanda is very advanced in the application of eHealth technologies. For example: Rwanda uses an Open Source Medical Record System; disease outbreaks and cases of malnutrition are detected using eHealth applications that enable fast intervention; maternal health in rural areas is promoted through an education and reminder system based on mobile phone text messages. These applications improve and save lives, while reducing the cost of the health system as a whole.

We are working on projects that align with that general strategy. The first project pertains to big data reasoning. We are developing a lightweight reasoning method that provides knowledge to patients, healthcare professionals and decision makers by combining techniques from big data analytics with a nonmonotonic reasoning method. [Nonmonotonic reasoning enables intelligent systems to operate sufficiently when receiving incomplete or changing information.]

Another project in mHealth provides direct patient support. We are investigating how to use social network technologies to increase health awareness.

What insights have you gained by working with the students?

Students here are outspoken and enthusiastic, and they are especially good at project-oriented work where they can show their creative talents. We often discuss how mobile technology can be applied in countries of the EAC [East African Community]. I have gained a new outlook on the potential of this technology to change Africa.

CMU-R

BUILDING PIECES TO MAKE A PATCH FOR THE HEART

Although Adam Feinberg looks fit, one would not suspect he might be one of the world's leading muscle builders.

BY MIKE VARGO

An assistant professor in Biomedical Engineering and Materials Science and Engineering at Carnegie Mellon, Adam Feinberg's goal is to help surgeons rebuild some of the body's most crucial muscles, those of the heart.

Feinberg has a five-year, \$2.25 million New Innovator Award from the National Institutes of Health (NIH) to support his research. It draws on initial work done a few years ago, when he was a postdoctoral fellow at Harvard. His research is so novel and intricate that his former team leader there, the bioengineer Kevin "Kit" Parker, has said Feinberg is perhaps "one of three or four people in the world" capable of pursuing it. Feinberg has studied materials science and engineering, along with bioscience, which has given him the interdisciplinary skills needed for this challenge.

The problem has to do with the cells of heart muscles. Located in the heart walls, these cells contract and relax to create the pumping action. Unlike other muscle cells, they will not divide to create new ones of their kind. As Feinberg says, "You are born with all the heart muscle cells you will ever have. They are formed only during [embryonic] development." When some are killed — as when a heart attack starves the muscles of oxygen — there is no self-healing or tissue regeneration, and though the heart may survive, it is weakened. How then to fix the damage?

"You are born with all the heart muscle cells you will ever have. They are formed only during [embryonic] development."

Biologists have made one big stride. The heart muscle cells can be grown in vitro, with the new iPS cells (induced pluripotent stem cells) that avoid the ethical issues of using human embryonic stem cells. The difficulty is getting these cells to take root and live in the heart. "If you just inject them, it doesn't work. Or it may work for a while but it doesn't last long," Feinberg says. And he believes he knows why: the extracellular matrix isn't right.

The extracellular matrix is densely interwoven strands of proteins and other molecules that hold cells in place and give shape and strength to the tissue. Feinberg says the extracellular matrix in an adult heart "is nothing like the extracellular matrix in an embryo," which provides "the right context" for the new cells to grow. Thus one part of his current research is seeing just how the embryonic extracellular matrix is formed. Another is developing the ability to bio-fabricate, in the lab, extracellular matrix scaffolds with that kind of structure, so that if iPS cells are put into them, they'll grow properly into living heart muscle cells. The end product would be an engineered "patch" that could be grafted into a damaged heart and would integrate there to restore function.

Every step requires great ingenuity. To study embryonic hearts, Feinberg started with the knowledge that most vertebrate embryos are very similar. That is why, in one corner of his lab at Carnegie Mellon, a visitor will find fertilized chicken eggs. The top of each egg is carefully removed to let a confocal microscope peer in while the chick embryo grows. The results are 3D microscale videos of hearts taking shape — which, Feinberg says, "will give us templates for scaffold design."

Meanwhile, scaffold-making is a mix of multiple arts. From the prior research, Feinberg and his Ph.D./postdoc team can uncoil protein molecules into fibrous strands by a "biomimetic" process that emulates how live organisms do it. Next, they are adapting photolithography methods, like those for making microchips, to "print" test scaffolds in varying patterns. If it all comes together, they'll have heart patches.

It will take years of trials and more advances to make this heart repair a medical reality. But other applications may be ready sooner, notably a patch for cornea repair in the eye.

"I guess it's my combination of training that has put me in a position to even think of doing things this way," he says. "Now we'll see if we can implement it. I think we have a shot."





James H. Garrett Jr., Dean of the College of Engineering, is Carnegie Mellon Through and Through

When Jim Garrett first arrived at Carnegie Mellon, he was fresh out of high school. Now some 30 years later, he is the dean of the school that laid the foundation for his life's work.

As a kid raised on the outskirts of Pittsburgh, Jim Garrett and his parents routinely walked past Carnegie Mellon University on their way to the museum. Strolling through Oakland, the boy wasn't thinking about his future, but his mom was. In high school, Garrett sensed he wanted to be a civil engineer, "I was interested in large structures and how they got built." When he started applying for college, his mother suggested that he consider Carnegie Mellon. Out of respect for his parents, he visited campus and met with Fran McMichaels, the head of Civil and Environmental Engineering in those days. After a rousing meeting, Garrett knew that he belonged at CMU. He also knew that it would be an expensive proposition, but his father replied, "You go and do it."

Garrett has been at CMU since he was 17, and he's gained a broad perspective on the CMU experience. Like many students, he discovered first-hand how challenging CIT can be. "My first semester, I tangled with a computer course that caused me to wonder if I was in the right place. I prevailed, and it's funny now how much of my research and professional activities are in computing in civil engineering."

"CMU demands a lot of the students, but if you are not tearing muscle and feeling some pain, you are not learning. CIT really knocks you out of your comfort zone and in that process you grow in ways you didn't think you could," explains Garrett.

"I know that CIT demands a lot from faculty, too," he says. Rising through the ranks, he is keenly aware of the challenges faculty face at various points in their careers. In 1990, Garrett

joined CIT as an assistant professor in Civil and Environmental Engineering (CEE). He was promoted to associate professor in 1993 and to full professor in 1996. Garrett, who is the Thomas Lord Professor of Civil and Environmental Engineering, served as head of the Department of Civil and Environmental Engineering from 2006-2012. In January 2013, he was appointed dean of the college.

"What makes being a dean challenging is that I have a hard-charging group of people who are looking at me to help bring the resources they need and to provide direction and coordination," says Garrett. He's undaunted by these challenges because "the people I interact with — the faculty, staff and students — pursue excellence. They all bring their strengths and perspectives to problems, and if I listen and work with them, together we will find better solutions to problems. This is what happens when you have a diversity of backgrounds and intellectual opinions. This is what makes Carnegie Mellon exciting," says Garrett.

Determined to tap the energy and ideas that originate on campus, Garrett has assembled the CIT Strategic Planning Committee to work with him and produce a five-year college strategic plan by Spring 2014. This plan will identify where CIT can transform engineering research and education. To help the committee make informed decisions, town hall meetings and other activities are scheduled for this fall.

"I want to interact with people and hear their ideas. The college is in great shape, but now is the right time for CIT to reevaluate its strategic direction," says Garrett. "I know we have something special here in CIT. It is important to me that we continue to strengthen CIT and move the college forward in ways that make sense for us."

Faculty Leaders in New Roles



DAVID DZOMBAK

Assumes Leadership of Civil and Environmental Engineering Department

David A. Dzombak, the Walter J. Blenko, Sr. University Professor, was named head of the Department of Civil and Environmental Engineering (CEE), effective August 1. He succeeds James H. Garrett Jr., who became CIT's dean.

Dzombak, who has been at CMU for 25 years, is an accomplished researcher and educator. He joined CEE as an assistant professor in 1989 and advanced through the ranks to full professor. In 2010, Dzombak was named a University Professor, the highest academic distinction bestowed on faculty members at CMU.

An internationally recognized expert in environmental engineering, Dzombak was elected into the National Academy of Engineering in 2008. He served as faculty director of the Steinbrenner Institute for Environmental Education and Research. Since November 2012, Dzombak had been serving as interim vice provost of Sponsored Programs at CMU.

Dzombak has vast consulting experience with both public and private organizations. He currently is a member of the EPA Science Advisory Board and chair of the board of directors of the Association of Environmental Engineering and Science Professors Foundation. He's been a member of various EPA Science Advisory Board committees since 2002, and a member or chair of several National Research Council committees since 2000. He is a fellow of the Water Environment Federation and the American Society of Civil Engineers.



ALLEN ROBINSON

The Raymond J. Lane Professor of Mechanical Engineering Appointed Department Head

Allen L. Robinson was named head of the Department of Mechanical Engineering on February 1, 2013, succeeding Nadine Aubry, who became dean of the College of Engineering at Northeastern University. Robinson has been a Carnegie Mellon faculty member for 14 years with appointments in Mechanical Engineering and Engineering and Public Policy. In addition, he briefly served as a professor in the departments of Atmospheric Science and Mechanical Engineering at Colorado State University.

At CMU, he co-founded the Center for Atmospheric Particle Studies, a research center focused on the study of air quality and atmospheric chemistry. He is leading a new major research thrust to quantify the climate and air quality impacts of unconventional gas development, and his work has led to improved policy assessments of air pollution and the climate.

In recognition of his outstanding research and leadership contributions, Robinson was also appointed as the Raymond J. Lane Distinguished Professor in Mechanical Engineering. Raymond J. and Stephanie H. Lane, established this eminent professorship in memory of Ray's father, a Carnegie Tech alumnus in Mechanical Engineering. "This professorship is awarded to individuals with entrepreneurial spark and leadership abilities so endemic to the problem-solving environment at CMU," said Ray Lane, a partner emeritus at Kleiner Perkins and chairman of Carnegie Mellon's Board of Trustees.

An award-winning researcher, Robinson serves on a number of professional boards, including the Environmental Protection Agency Clean Air Scientific Advisory Committee (CASAC), Air Monitoring and Methods Subcommittee and the Health Effects Institute Research Committee. He is also on the editorial board of the journal, *Progress in Energy and Combustion Science*. At CMU, Robinson received the CIT Outstanding Research Award, the Ahrens Career Development Chair and the George Tallman Ladd Outstanding Young Faculty Award.

In the next issue of *ENGINEERING*, we will report on the reception that was held on September 27 to celebrate Robinson's appointment as the Raymond J. Lane Distinguished Professor of Mechanical Engineering.

Faculty Leaders in New Roles



LORENZ T. BIEGLER Will Head Chemical Engineering

Lorenz (Larry) T. Biegler, a University Professor and the Bayer Professor of Chemical Engineering, will become the new head of the Chemical Engineering Department, effective November 1. He succeeds Andrew J. Gellman, who has headed ChemE since 2003. Biegler was also elected into the National Academy of Engineering this year for his pioneering contributions to large-scale nonlinear optimization theory and algorithms for application to process optimization, design and control.

Since joining CIT in 1981, Biegler's work in computer-aided process engineering and projects in design research and systems analysis have earned him international acclaim. He has been a visiting scholar at Northwestern University, a scientist-in-residence at Argonne National Lab, a distinguished faculty visitor at the University of Alberta, a Gambrinus Fellow at the University of Dortmund, a Fulbright Fellow at the University of Heidelberg, a Chang Jiang scholar at Zhejiang University and a Distinguished Jubilee Lecturer at IIT Bombay. He has taught courses on dynamic optimization in Argentina, China, Finland, Colombia, Germany and Mexico, and started new research activities with colleagues in all of these countries. Here in Pittsburgh, he served as director of CMU's Center for Advanced Process Decision-Making from 1999-2005.

Among his many achievements, Biegler is a recipient of the Warren K. Lewis Award for Chemical Engineering Education and the Computing in Chemical Engineering Award from the American Institute of Chemical Engineers. He is a fellow of the American Institute of Chemical Engineers.

2013 proved an eventful year for Larry Biegler, who was named the head of Chemical Engineering and elected into the NAE.



BOB IANNUCCI Leads Silicon Valley Campus

Bob Iannucci has been named associate dean and director of CMU's Silicon Valley campus, effective September 1. He succeeds Martin L. Griss, director of the Disaster Management Initiative and founder and former director of the CyLab Mobility Research Center.

"I am honored to be named head of CMU's innovative and entrepreneurial campus that sits in the middle of Silicon Valley, the worldwide hub of technology innovation," said Iannucci, a distinguished service professor at CMU-Silicon Valley and director of the CyLab Mobility Research Center with a courtesy appointment in the Department of Electrical and Computer Engineering.

Prior to joining CMU, Iannucci served as the chief technology officer of Nokia and head of Nokia Research Center (NRC). There, he spearheaded the effort to transform NRC into an open innovation center, creating "labs" at the Massachusetts Institute of Technology (MIT), Stanford University, Tsinghua University, the University of Cambridge and Ecole Polytechnique Federale de Lausanne. Under his leadership, the NRC's labs and labs delivered fundamental contributions to the worldwide Long Term Evolution for 3G (LTE) standard; created and commercialized Bluetooth Low Energy; created and promulgated what is now the MIPI UniPro interface for high-speed, in-phone networking; and generated many other communications technology innovations.

Iannucci has led engineering teams at two startups, including Exa Corporation, which went public in 2012. He also served as director of Digital Equipment Corporation's Cambridge Research Laboratory and was vice president of research at Compaq.



A New Era for CIT Research

NEW ROLE FOR FEDDER: Associate Dean for Research

Gary Fedder, the Howard M. Wilkoff Professor of Electrical and Computer Engineering, Professor of Robotics, has agreed to be the first CIT Associate Dean for Research, effective July 1, 2013.

Initiated by Dean James Garrett and garnering strong support from the faculty, this new position was created to identify and respond to major research opportunities within the college. In addition to expanding research, Fedder will steward and at times lead in the development of major proposals. He is also responsible for the development and oversight of distributing research-related grants for student fellowships, equipment, seed research funds, etc. A small team of seasoned professionals is being assembled to assist Fedder with critical tasks.

Fedder's research reputation, his interdisciplinary perspective and experience in leading major college-wide research proposals, make him ideally suited for his new position. He is the director of the Institute for Complex Engineered Systems (ICES). His research interests include microelectromechanical systems (MEMS) modeling and fabrication, integration of MEMS and CMOS, physical sensor design, nonlinear dynamics of MEMS, RF MEMS, gas chemical microsensors and implantable biomedical sensors.

From 2011 to 2012, Fedder served as a technical co-lead in the policy subcommittee of the U.S. Advanced Manufacturing Partnership set up by President Obama. He worked with industry and academia to generate recommendations that motivated the spring 2012 announcement of the National Network for Manufacturing Innovation (NNMI). He helped lead a team from the Pennsylvania, Ohio and West Virginia "Tech Belt" region to win the pilot institute for the NNMI called the National Additive Manufacturing Innovation Institute (NAMII), where he now serves as secretary on their Executive Committee.

Senior Executive Director for Research Initiatives Named

Matt Sanfilippo has been appointed as senior executive director for Research Initiatives in CIT. He will assist Gary Fedder, the associate dean for research, in an effort to enable strategic research opportunities across the college and steward the development of proposals for major research opportunities along strategic themes.

His duties entail providing collaboration, communication and networking support among CIT research center directors and other university personnel who are engaged in the pursuit of research opportunities with industry and government.

Sanfilippo has served as executive director of the Institute for Complex Engineered Systems (ICES) and the Center for Sensed Critical Infrastructure Research (CenSCIR). He has been the associate director of the Pennsylvania Infrastructure Technology Alliance since 2006. At ICES, he played a key role in the growth of infrastructure-related research that led to the creation of the Pennsylvania Smart Infrastructure Incubator. Last year, Sanfilippo led the effort to create a new PA-sponsored program called RAMP (Research for Advanced Manufacturing in Pennsylvania) that engages PA manufacturers with CIT faculty to perform translational research.

Accelerating Innovation and Entrepreneurship (I&E) in CIT

Cognizant of the important role U.S. universities play in driving innovation and entrepreneurial growth, the College of Engineering intends to seek new strategic opportunities in these areas and gain greater visibility for its efforts. Leading this charge is **Jonathan Cagan**, CIT's first director for Innovation and Entrepreneurship.

Cagan's new assignment positions him as CIT's liaison to the university's Center for Innovation and Entrepreneurship (CIE). He will work with the CIE to create programs that promote innovation and entrepreneurship and help develop a strategy that integrates these initiatives across Carnegie Mellon, including the Silicon Valley campus.

Cagan, the George Tallman and Florence Barrett Ladd Professor of Mechanical Engineering, is an expert in product development and design methods for early stage product development. His research focuses on design theory and methods, product development and strategy, cognition in engineering design and computational design tools. His design methods and research have been applied in a variety of industries.

In 2002, Cagan co-founded the CMU spinoff DesignAdvance Systems. A year later, he co-founded the Master of Product Development (MPD), which has been consistently ranked in the top three Best Graduate Programs in Industrial Design by *U.S. News & World Report*.

In April 2013, the MPD program celebrated its 10th anniversary (see below). This fall, the highly acclaimed program

changed its name to the **Master of Integrated Innovation for Products & Services** (MII-PS) to reflect the launch of the Integrated Innovation Institute. Jointly supported by CIT, the College of Fine Arts' School of Design and the Tepper School of Business, the new institute will provide professional master degree programs, executive education and applied research including industrial consortia. Built on the primary disciplines in product innovation including functional performance (engineering), human interface (design) and economic value (business), the institute will cross-train students to become elite innovators. The program's co-directors represent each school: **Jonathan Cagan**, CIT; **Eric Anderson**, Design; and **Peter Boatwright**, Tepper.

Symposium Examines Innovation in the Next Decade

To celebrate the 10th anniversary of the Master of Integrated Innovation for Products & Services (formerly known as the Master of Product Development), a panel of innovation leaders presented their insights at a symposium titled, "Innovation in the Next Decade."

On April 12, 2013, in Robert's Engineering Hall, the co-directors of the master's program and a guest panel explored how globalization, technology, economics and other factors will affect innovation in the future. The panel included: **Eric Close** (TRP'97), who builds and manages product and service-based technology companies and holds 12 patents in robotics, software and controls; **Dee Kapur** (TPR'76), retired vice chairman and chief product officer of Navistar International Corp., America's largest manufacturer of trucks, diesel engines and school buses; **Megan Stanton** (CFA'04, MPD'05), associate director of Business Design at BMW Designworks in Los Angeles; and **Donna Sturgess**, president and founding partner of Buyology Inc. and former global head of Innovation, GlaxoSmithKline. This year, Sturgess joined the MII-PS program as its first executive in residence.



Brumley Receives Career Development Chair

David Brumley, an assistant professor in Electrical and Computer Engineering, received the Gerard G. Elia Career Development Professorship in Engineering. Brumley is an expert in computer security with an emphasis on software security.

The Elia Professorship was established by Benjamin and Rose M. Elia to honor their son Gerard G. Elia (B.S., M.S. Science'72, '73; Ph.D. MechE'77) who passed away in 1995. The professorship rewards accomplished young scholars and promotes their future development.

Brumley graduated from CMU in 2008 with a Ph.D. in computer science. Prior to attending CMU, he earned a master's in computer science from Stanford, where he served as a computer security officer from 1998-2002 and handled thousands of computer security incidents.

In addition to his research and teaching at Carnegie Mellon, he is the faculty sponsor for the CMU computer hacking team, which was ranked #1 and #2 in the world in 2011 and 2012, respectively. He received an NSF CAREER award and the United States Presidential Early Career Award for Scientists and Engineers from President Obama in 2010, and in 2013, the Sloan Foundation Award. Brumley holds a courtesy appointment in the Computer Science Department.



Dedicated

Remembering Dr. George A. Roberts



On February 15, 2013, George A. Roberts, a dedicated alum and benefactor of the Carnegie Institute of Technology, passed away. Roberts, who earned his B.S., M.S., and Ph.D. in metallurgy from Carnegie Tech in '39, '41, '42, worked as a metallurgist for Vanadium Alloys Steel Corporation (Vasco) in Latrobe, Pennsylvania, and eventually became its president. In 1966, Vasco merged with Teledyne, Inc. where Roberts became president and chief executive until his retirement.

Roberts was a staunch supporter of Carnegie Mellon and served as a university trustee. His commitment to CIT culminated when he contributed the initial funding for Roberts Engineering Hall. Upon its completion in 1997, Roberts Hall became the first engineering building constructed on campus in 35 years.

Equipped with state-of-the-art labs and classrooms, the building has had a transformative effect on advancing the objectives of the Materials Science and Engineering Department, the Data Storage Systems Center, and Center for Nano-enabled Device and Energy Technologies. Roberts' generosity has enabled CIT faculty and students to push new boundaries in engineering and reinforce Carnegie Mellon's reputation as an international research and education leader.

Expert Duo Leads Pennsylvania Smarter Infrastructure Incubator

Burcu Akinci and Bruno Sinopoli have been appointed co-directors of the Pennsylvania Smarter Infrastructure Incubator (PSII). The PSII, an interdisciplinary research lab at Carnegie Mellon, works with Pennsylvanian companies and institutions to leverage emerging technologies that blend physical infrastructure (transportation systems, buildings, etc.) with cyber infrastructure (computers, networks and sensors). Ultimately, the PSII's efforts will enable governments, cities and industries to build smarter infrastructure.

Akinci and Sinopoli aptly represent the PSII's combined focus. Akinci, a professor of civil and environmental engineering, conducts research that draws on information models and sensors to streamline construction and infrastructure-management practices. Sinopoli, an associate professor of electrical and computer engineering, develops tools for securing and controlling cyber-physical systems.

The incubator is stimulating research and industry activity in western Pennsylvania. The PSII was founded in 2010 with funding from the State of Pennsylvania, Bombardier and IBM. Since then, the PSII's partnership program has grown to include other prominent companies. To learn more about the PSII and partnership opportunities, visit: www.cmu.edu/psii.



Burcu Akinci (left) and Bruno Sinopoli (above)

Moura Elected into NAE

José M.F. Moura, the Dowd University Professor in the Department of Electrical and Computer, was elected into the National Academy of Engineering (NAE), one of the highest professional honors an engineer can achieve.

Moura earned this distinction for his contributions to the theory and practice of statistical signal processing. His research spans statistical and algebraic signal, image and information processing with applications in radar and sonar, telecommunications, bioimaging, networked and distributed systems and recently, large datasets (Big Data) supported by networks.

At CMU, he co-founded and co-directed the Center for Sensed Critical Infrastructure Research (CenSCIR). He also founded and directs the Information and Communication Technologies Institute that manages the CMUIPortugal Program.



José Moura



New Professorship Supports Exceptional Young Professors



Bill Strecker attended CMU as a Hertz Foundation Fellow. Prior to receiving the award, he was interviewed by Edward Teller, the theoretical physicist who is considered the father of the hydrogen bomb. "It was a challenging interview because he started by asking me questions on advanced field theory and nuclear physics. I apparently answered his questions to his satisfaction and then managed to switch the conversation to computers. He got interested in that," recalls Strecker.

To support future generations of information technology professionals, Bill and Nancy Strecker have generously endowed the Dr. William D. and Nancy W. Strecker Early Career Professorship, and CIT is proud to announce that **Onur Mutlu** is its first recipient.

Bill Strecker, who earned three degrees in electrical engineering at Carnegie Mellon (B.S., M.S., Ph.D. EE, '66, '67, '71), was the principal designer of the VAX computer architecture and head of Engineering at Digital Equipment Corporation (DEC). During his career, he earned 15 patents in computer architecture and design, was honored as an ACM Fellow and National Academy of Engineering member, and awarded the IEEE's W. Wallace McDowell Award. His tenure at DEC proved fruitful both professionally and personally. It was there he met Nancy, who also spent her career at DEC in sales and marketing. Nancy says that her father thought they had the perfect arrangement, "Bill builds computers and I sell them." The Streckers found the environment at DEC stimulating. "We did every technology imaginable in computing. We started with sand and made semiconductors, and we did application software at the other extreme. There was always something new and interesting to do at Digital," says Bill.

Mutlu, like his benefactors, has an innovative spirit. An assistant professor in Electrical and Computer Engineering, Mutlu is rethinking how computer memory should be redesigned. He is developing microprocessors, computer memories and platforms that quickly and reliably store, manipulate and communicate massive amounts of data. Related to this work is his research that explores how systems and devices can be designed to speed up biological applications such as DNA sequence analysis by orders of a magnitude. He and his team are also creating microprocessors that are more predictable and robust, making them resilient to potential cybersecurity attacks.

Since joining CIT in 2009, Mutlu has earned a number of prestigious awards, including the 2012 Intel Early Career Faculty Honor Program Award and the 2010 National Science Foundation CAREER Award. Mutlu is an accomplished researcher, but he also enjoys teaching and mentoring undergraduate and graduate students. His passion for developing and sharing knowledge is exceedingly important to the Streckers.

"Both Nancy and I strongly believe in the fundamental and life altering contributions that education makes to our society. Sponsoring a professorship, most particularly at Carnegie Mellon, seemed like an excellent way to support our focus on education," says Bill. "After all, Carnegie Mellon made a big impact on my life and I wanted to make an impact on Carnegie Mellon."

"We wanted to impact Carnegie Mellon," adds Nancy. "The seed for Bill's career was planted here, and out of that grew a wonderful career. What goes around, comes around. Now we will enjoy watching Onur's career evolve and grow."

"Both Nancy and I strongly believe in the fundamental and life altering contributions that education makes to our society."

Left to right: Bill and Nancy Strecker, Onur Mutlu

Jacobo Bielak Awarded the Paul Christiano Professorship



In recognition of Dr. Paul Christiano's significant contributions to the Department of Civil and Environmental Engineering, the College of Engineering and Carnegie Mellon, a group of his friends and colleagues created a professorship in his memory. At a reception on May 21, 2013, University Professor Jacobo Bielak was honored as the inaugural recipient of the Paul Christiano Professorship of Civil and Environmental Engineering.

Christiano, who passed away in 2001, served Carnegie Mellon with tremendous dedication as the head of CEE (1986-1988), dean of CIT (1989-1991), and in 1991, former President Robert Mehrabian appointed him provost, the university's chief academic officer through July 2000. During his tenure, Christiano strengthened academic and research units and he led a movement at the university that fostered cross-disciplinary and interdisciplinary education and research, a hallmark trait of CMU.

At Carnegie Mellon, Christiano positively influenced many people and that provided the motivation to create the professorship. At the reception, Dean James H. Garrett Jr. described how a casual conversation between Larry Cartwright and himself sparked a plan to establish a lasting legacy for Christiano. What began as a grassroots effort to raise funds swelled into an amazing undertaking that raised \$2.5 million and created a chair.

"On behalf of Carnegie Mellon, I want to thank all of the donors, and especially President Robert Mehrabian and CMU Trustee Tom McConomy and his wife Eileen for their support. Also, on behalf of all of the donors, I would like to say how pleased we are that Jacobo Bielak, who was quite close to Paul, is the first recipient of this professorship," says Garrett.

Bielak is internationally recognized for his work in the area of large-scale ground motion modeling and its effects on structural response to earthquakes. His research using high-performance computing in the propagation of seismic waves has led to more realistic modeling of earthquake ground motion in large basins. In fact, this work constitutes the most advanced numerical technique available to study the complex mechanisms of seismic ground motion.

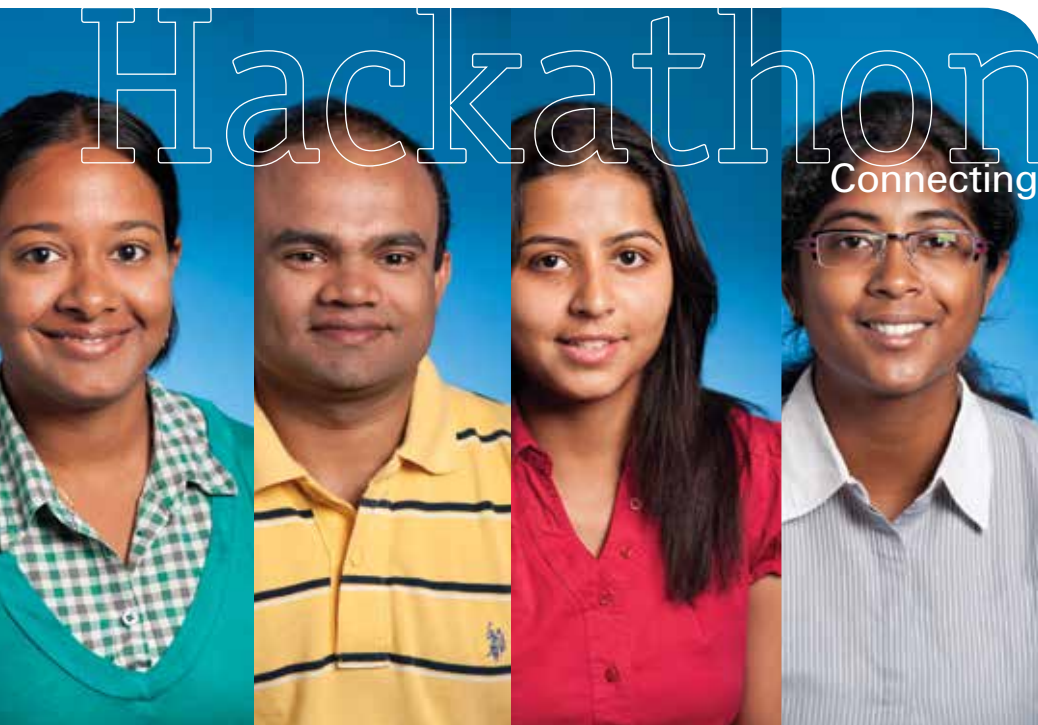
While Bielak is highly respected for his research, like Christiano, he is an outstanding teacher and advisor, too. During his 32-year career at CMU, Bielak has achieved significant professional honors. He was elected into the National Academy of Engineering in 2010 for advancing knowledge and methods in earthquake engineering and regional-scale seismic motion simulation. He is a member of the Mexican Academy of Engineering and the Mexican Academy of Sciences. In 2009, he was named a University Professor at CMU. He has also received the Gordon Bell Prize and the Outstanding Research Award from CIT.

The College of Engineering wishes to acknowledge and thank these donors for creating an everlasting remembrance of Paul Christiano and his legacy.

Dr. Robert Mehrabian
Thomas and Eileen McConomy
Dr. James H. and Ruth Ann Garrett
Professor Lawrence Cartwright
Dr. Behnam Motazed and Dory Halati
Dr. David Dzombak and Carolyn Menard
Jeffrey Bolton
Walter and Anna DeForest
Richard and Jill Creech
Seth and Pamela Pearlman
Dr. Alan Husak
Dr. Cliff and Megan Davidson
Dr. David Troxell
Dr. Thomas Siller
Dr. Chris and Kathleen Hendrickson
AEEESP Foundation
Patrick Keating
Dr. John Onstott
Thomas and Robbee Baker Kosak
Dr. Walid Keyrouz



Norene Christiano graciously addressed guests at the reception that honored her late husband's legacy and Jacobo Bielak's achievements.



Connecting Talent with Opportunities

BY ANN LYON RITCHIE

Coding against the clock, Pooja Gada, Ditaya Das and Divya Natesan had just created a new application for mobile devices within 24 hours for an AT&T-sponsored hackathon in Redwood City, Calif. The three master's students in information technology from the Information Networking Institute (INI) crowded around other exhausted software developers and listened for the winners to be announced. It was exhilarating.

The team's app iSight took second place in its category. A gaming app, iSight allows someone to use a mobile device to scan a room through its camera lens and automatically make a list of objects to be found. It's perfect for making up a scavenger hunt for kids on a rainy day. The students were inspired by a trend called augmented reality, which uses digital graphics to enhance or interact with real-world environments.

Hackathons in the Bay Area, Gada explained, offer the chance for her and other students at Carnegie Mellon's Silicon Valley campus to apply what they've learned from CMU courses such as Machine Learning and Android Mobile App Development. Plus, the students meet other developers at various stages of their careers and can watch them in action, including engineers from some of the industry's greatest giants such as Microsoft, Google and Facebook.

Shrikant Adhikarla, another INI master's student in information technology, relishes such events. He competed in and won prizes at hackathons sponsored by Sprint and PayPal last fall. At one event, he met an executive who showed genuine interest in finding a position for Adhikarla within his company.

Adhikarla felt the local high tech culture was so integral to his studies that he extended his program into a fourth semester at

the Silicon Valley campus. He sought out industry conferences and went to local meet-ups in San Francisco where developers assist each other in learning new trends.

Adhikarla, Gada, Das and Natesan are all considered "bicoastal" students, enrolled in the INI Pittsburgh-Silicon Valley Master of Information Technology programs. They spend the first half of their programs with traditional students in Pittsburgh and the last half at the campus in Mountain View. Under the leadership of Dr. Dena Haritos

Tsamitis, the INI began offering three MSIT programs in 2008.

"The INI bicoastal programs balance the strength of Pittsburgh's academic offerings with some incredible hands-on learning opportunities," said Tsamitis, director of the INI. "The students access real employers as they participate in course projects and co-curricular activities."

The faculty members weave industry experience with activities at the Silicon Valley campus. Much of the coursework is project-based and led by instructors who have launched new products and businesses. Special events offer exposure to business incubators, venture capitalists and other technology leaders and innovators. The staff provides career coaching, as well as resources for aspiring entrepreneurs. Over the past decade, the Silicon Valley campus has built up a solid reputation among businesses in the Bay Area.

"The moment you mention you're from Carnegie Mellon University, people start pulling out their business cards," said Gada about networking events. "They want to know when you're graduating and what your job plans are."

Gada and her teammates on iSight had competed together before, rising as the top developers in an all-women hackathon sponsored by ESPN at Stanford University. Among their winnings, they won a tour of ESPN studios in Bristol, Conn., along with the satisfaction of beating out Stanford teams on their home turf. But the students who study at the Silicon Valley campus know the real prize is gaining experience. In the Bay Area, the developers stretch their mind and flex their skills for the chance to be a part of the next new technology. Participation counts.

Pictured above from left to right: Divya Natesan, Shrikant Adhikarla, Ditaya Das and Pooja Gada



When Engineers Become

Imagineers

BY TARA MOORE

Can you imagine designing an amusement park ride while you were a senior in college?

That's exactly what three mechanical engineering students did. Laura Laham, Andre Sutanto and Anisha Vyas, along with Jane Liu of the Art Center College of Design in California, entered the Walt Disney Imagineering's ImagiNations Competition. The annual nationwide competition asked students to design a Disney experience somewhere in the world where the company does not currently have a presence.

"We looked all over the world and thought, 'Where can we get a Disney story inside the culture?'" said Vyas, the team captain, who had reached out to Laham and Sutanto last year when the three were juniors and eligible for the competition. They made it to the semifinals, and decided to compete again this year in the hopes of winning.

The students decided upon Indonesia and designed an entire package for Disney, from a market analysis of the country to the track design to scaling the models onto the actual location that they selected for their attraction.

"If you wanted to fabricate this, you could actually go and start the fabrication process," Laham said. Disney recognized their efforts and awarded them second place in the 2013 competition, with a \$1,000 prize.

The group's project, called *Legenda Emas: The Golden Tale*, is an interactive boat ride that centers around an Indonesian legend about a prince and a princess who fall in love. An evil, jealous witch turns the princess into a snail to keep the two apart.

During the ride, CGI animation is used to control the environment around the guests seated in the boat. Computer graphics create rocks, trees and even characters. Guests can help the prince find his

Pictured above from left to right are Jane Liu, Laura Laham, Anisha Vyas and Andre Sutanto with Mickey Mouse.

princess by waving their hands and moving virtual objects out of the way of the boat thanks to Kinect, a motion detection device. The prince can even call out to guests by name through RFID (radio-frequency identification) technology, which personalizes the experience by linking the guests' social media accounts with the ride.

At the end of the competition, the students experienced a very fulfilling moment when a man from the crowd told them that his Indonesian father used to tell him the *Legenda Emas* when he was a child. When asked if their project did the story justice, he said yes.

"It's amazing when someone comes up to you and tells you how much meaning your work has for them," said Sutanto.

The students' engineering background was invaluable to the project. Beyond using circuits, laser cutting and 3-D printing, the three emphasized how important it was that they had a firm grasp on the basics of not just engineering but also programming and marketing.

"Engineering really does teach you how to think about problems," said Vyas. "All of our different experiences with engineering led us to create a unique project that encompassed engineering in many different ways, from vehicle engineering, to interactive technology, to business analytics."

The competition allowed them to test their limits and discover that, while they are young engineers, they can still produce creative, innovative products.

"When we were there, we realized that not only is this fun work—and hard work—but it's achievable," said Laham. "As students, we can be Imagineers."

WHEN SOMETHING GOOD COMES ALONG

BY SHERRY STOKES



In 2004 Bill O'Donnell (B.S. ECE, 1989) was chief architect at Intuit in the Boston area, designing small business network services and e-business infrastructure. "It was a great place to work. It was gratifying to say, 'I work at Intuit,' and people would say, 'Oh, yeah, I use that software.'"

O'Donnell had no intentions of leaving Intuit, but that changed one dreary winter's day when his old boss Paul English called. English asked O'Donnell to meet him for lunch at Harvard Square. English's reason for the meeting, "We're going to start a travel site."

It was raining and O'Donnell didn't want to drive into Cambridge. Further, there already were travel websites, like Travelocity and Orbitz. He replied, "I like my job and the people I work with. They pay me well. I have two kids and my wife is pregnant with our third."

"You'll want to come," said English.

The temptation was too much. O'Donnell drove to Cambridge and met English, a former VP of technology at Intuit, and Steve Hafner, a co-founder of Orbitz. During lunch, the story of KAYAK, the tech company that provides easy-to-find online travel information, unfolded. O'Donnell says English "who was looking for something to do" had talked to General Catalyst, a venture capital firm in Boston. In the meantime, Hafner, after leaving Orbitz, talked to General Catalyst, too, about starting another travel website. General Catalyst introduced Hafner to English, and they decided to form a business. The next step was getting a top technical team together in two weeks, and that is where O'Donnell came in.

During lunch, O'Donnell learned what would distinguish KAYAK from other sites. "The three-word pitch was 'Google for travel.' We were not booking anything, but we would find you what you wanted." After seafood and a beer, "I was on board. I called my wife and told her I was quitting my job. I took a 45% pay cut and off I went."

Within days a small startup team consisting of business and technical people was in place. "One of the best things about a startup is that you can see the entire company in a room at a table," says O'Donnell, who was appointed the chief architect. While the title may mean different things at different companies, he loosely defines it as being "responsible for the technological direction and high level view of the way the pieces of software, website or whatever you are working on, fit together."

O'Donnell had worked with most members of the new team at different companies over a 10- to 15-year span, "We knew each other really well and it was very collaborative." They hashed out what language, hardware and operating system to use, among other issues. "That's some of the most fun stuff," he says. Being a part of the team from the beginning was important because as the chief architect O'Donnell had to work with the team to "establish rules and determine boundaries about where things would live and how they talked to each other. When you have a large software system that grows over time and new features are added, software has a natural urge to tangle together and become messy, horrible spaghetti. I learned this from hard experience at other places." He explains that when starting out, "You try to look down the road and think about what could possibly come along. You can't plan for everything. But if you establish boundaries up front, you are better off in the future."

The future certainly proved rosy for KAYAK. In May, Priceline.com Inc. completed its acquisition of KAYAK for \$1.8 billion. When asked if he thought KAYAK would become so successful, O'Donnell says, "It wasn't guaranteed, but I was counting on it!"

FINAL WORDS

How can research universities reinvigorate manufacturing in the U.S.?

John Helveston

Doctoral Student

Engineering and Public Policy



Before we reinvigorate U.S. manufacturing, we need to figure out what to make; research universities play a central role in answering this question. Research is being conducted to identify unexploited opportunities to leverage the global economy to transform technology development and guide manufacturing decisions. For example, if China adopts the electric car, global battery costs would likely fall, which could lower the price of all electric vehicles (EVs) around the world and potentially increase their adoption in the U.S. The question is, should the U.S. wait and let China lead, or should the U.S. take the charge in the EV market? Research seeking to understand such complex systems can guide U.S. manufacturers' decisions in what vehicles to manufacture and when. Research universities play a critical role in guiding such complex decisions for both private and public stakeholders.

Gary Fedder

Associate Dean for Research;

Director, ICES (Institute for Complex Engineered Systems);

Howard M. Wilkoff Professor of ECE;
Professor of Robotics



Universities can help reinvigorate manufacturing in the U.S. by placing greater attention on integrating manufacturing in their curricula for undergraduate and graduate students across disciplines in the sciences, engineering and humanities. The advent of low cost, high performance equipment for automated manufacturing and for additive manufacturing (aka 3D printing) is creating a rebirth of interest in manufacturing. In response, universities should create new safe, smart and sustainable infrastructure on their campuses to cater to students who will then adopt and embrace these emerging manufacturing technologies for use in course and research projects. New partnerships with industry and government should be forged to encourage and sustain manufacturing-based research and to gain greater access by researchers to manufacturing infrastructure. These initiatives can then be leveraged to build K-12 outreach programs that excite and engage our youth and to enhance workforce development within community colleges that train for the manufacturing jobs of the future. The cumulative result of these efforts will be a skilled workforce with hands-on advanced manufacturing experience and a sustainable output of manufacturing innovation.

Harry B. Shimp

President, Charon Industries

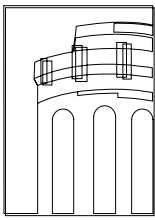
(GSIA, 1979; M.S., MechE, 1980)



A company can choose one of two core manufacturing strategies to gain competitive advantage. The first is to produce a better product than your competitor, a strategy that depends on product innovation. Alternatively, it may choose to produce the same product at a lower cost, which demands process innovation. Research universities can contribute in both cases.

Almost all companies pursue an evolutionary approach to product development. But explosive growth requires revolutionary change, the kind of change that almost always comes from the "blue sky" thinking that research universities foster. The keys to success are communication and understanding. Companies need to understand the technical potential of inventions, whereas universities need to understand the needs and limitations of the market.

Process innovation rarely gets the attention that new products do, but the success rate of this approach is much higher. The vagaries of achieving future market acceptance are replaced by more quantifiable gains in cost and quality. Research universities can act as "manufacturing information interchanges," evaluating different process approaches from various sources and helping to optimize them.



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