GEORGIA TECH

ENGINEERS

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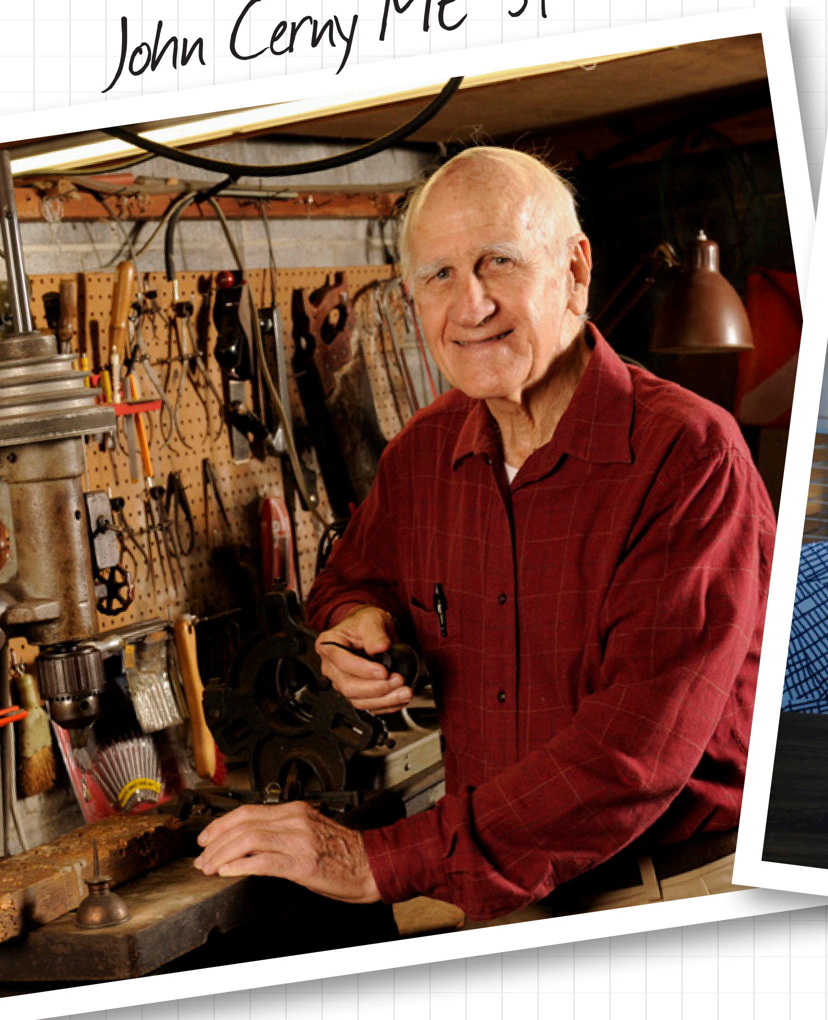
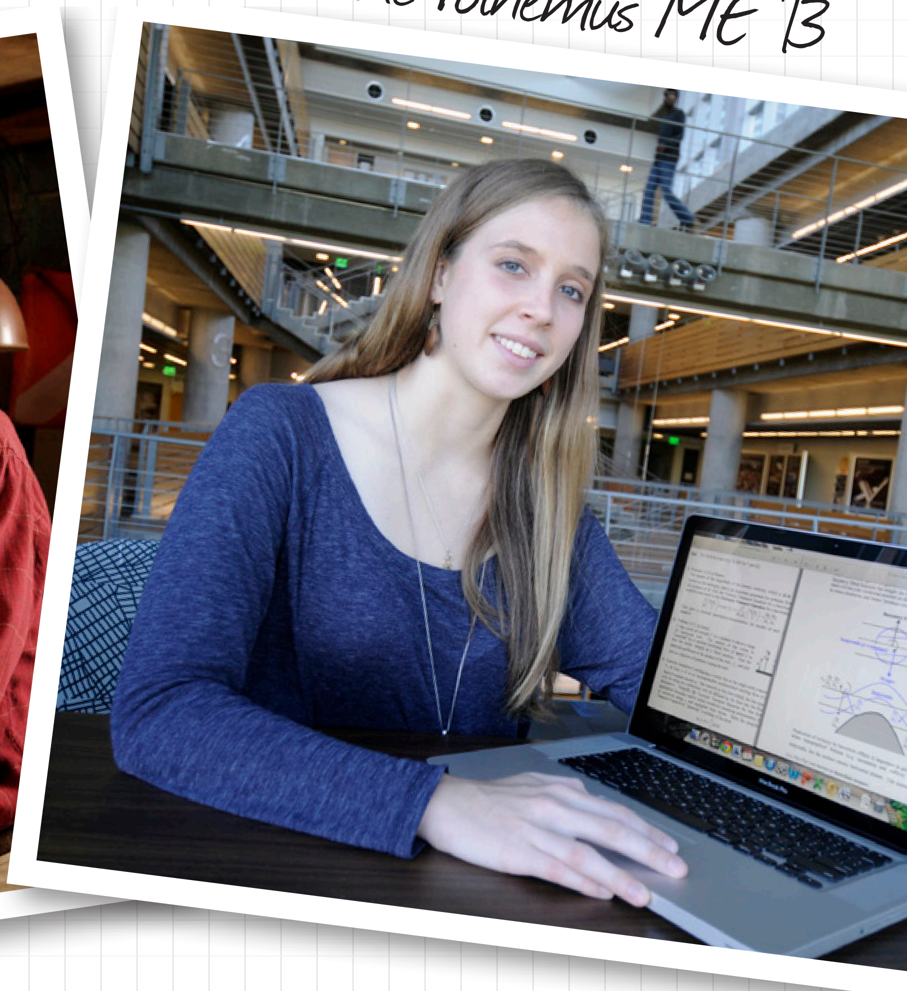
Spring 2014

John Cerny ME '51



Katherine Polhemus ME '13



Two alumni on what's wonderful about mechanical engineering

(no matter when you graduated)

Mission Statement

Georgia Tech Engineers strengthens the bonds between CoE's students, faculty, staff, alumni and friends by sharing the stories that link them. CoE is Georgia Tech's largest college, and Georgia Tech Engineers promotes a sense of community among its diverse members. While the magazine showcases research and study, it also focuses on the people behind those endeavors, reminding everyone in the College what makes it exemplary.

NICK BURCHELL

Dear Friends of the College of Engineering,

Another Fall has passed on campus. The excitement and bustle of the new academic year quickly gave way to exams, design projects, and job hunts. At the time this magazine was published, students and faculty alike had settled into a pace that belied what was truly taking place behind the brick walls.

There is no steady beat or cadence in the classrooms and labs. Frenetic may be a better word, and while we try to capture that spirit in this magazine, some things must be heard to be fully experienced.

You hear the hiss of the Invention Studio waterjet cutter and the steady hum of the 3-D printer; the high-pitched sounds of pneumatic drills from the GT Racing shed and the steady squeak of markers on whiteboards in the common areas where students gather to study. Add to that the steady clack of keyboards in computer labs and an occasional outburst as a concept hits home. It's funny that when we take a moment to go silent, we hear better.

And what I hear coming out of these old brick walls is the future. As I chat with faculty about their research or hear students talking about a lab, I am constantly reminded that they are "amping" it up, to use a sound metaphor. They relish new ideas, solutions, and products. You may not always be able to see it, but you can hear it.

Thanks for picking up this issue of Georgia Tech Engineers. You'll read about our latest accomplishments here, but if you have a chance to return to campus soon, try pausing for a moment of silence so you can hear them, too.

Gary

Gary S. May
Dean

You're holding the second issue of Georgia Tech Engineers, and that in itself is a slight miracle to me. There were moments I worried we wouldn't make it beyond the first issue.

Assembling a magazine is tough. I'm grateful to all the writers, designers, photographers, artists, students, professors, and alumni who helped bring this edition to life (because if I had to do it myself, these pages would resemble a kindergartner's art project). You'll find all kinds of stories and photos here, but the common element is polish – I want to make the hard work look easy.

That's something Georgia Tech does well, and it's reflected in some of this issue's features. This year marks the 125th anniversary of mechanical engineering at Tech, and we're celebrating with interviews of two ME graduates. The alumni were born decades apart, and while they have more in common than you might think, their stories remind us how much engineering education has evolved. These shifts can be difficult in academia, but the College of Engineering has adapted well to sea change.

The theme is also echoed in our discussions with women from Goldrush, Georgia Tech's dance team. Eight of the team's 13 members are engineering majors, and they seem to jump easily between performances, internships, volunteering, and classwork. It's tougher than it appears, but I'm in awe, and I think you'll feel the same when you read stories from them as well as the other Georgia Tech engineers who populate this issue. We hope it looks effortless.

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GEORGIA TECH
ENGINEERS

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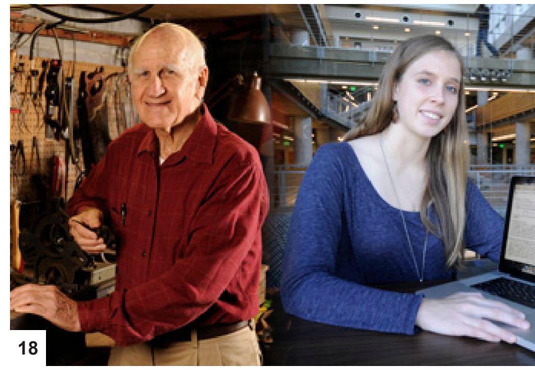
FEATURES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Here's a look at some of the sections you'll see in this issue of Georgia Tech Engineers and others:

SMARTER THAN
Test yourself with exam questions faced by today's CoE students.

OUTLIERS
Engineers are more than just their work, and some of them have interests or hobbies you might never expect.

GOING GLOBAL
Our engineers work around the world, and we chronicle their successes abroad.

FIRST PERSON
A member of the CoE community speaks in his or her own words.

MAKING IT HAPPEN
We look at how CoE alumni turn their lofty ambitions into reality.

POP QUIZ
A brief interview that won't count against your final grade.

AgriSense Project Could Streamline Cattle-Disease Testing

Bovine Respiratory Disease is the most costly beef cattle disease in North America, resulting in an annual loss to the U.S. agri-food industry of over $2 billion. It's also Ireland's No. 1 cause of calf death. To combat these losses, Professor Eric Vogel recently launched a research project called AgriSense that will focus on new sensor technology to diagnose the illness.

Vogel, of the School of Materials Science and Engineering, is conducting research under a $1.2 million U.S.-Ireland partnership between Georgia Tech, the Tyndall National Institute in Ireland, and Queen's University Belfast in Northern Ireland. The team is working to develop a sensor-based diagnostic kit to enable simultaneous testing for the four primary viral agents responsible for the disease.

The sensors will be fabricated on disposable plastic testers to keep costs down and reduce diagnosis time by up to four weeks. It is hoped that early detection and diagnosis will enable infected cattle to be isolated and allow for more tailored treatment programs.

The U.S.-Ireland program is a tri-jurisdictional program in which the National Science Foundation, Science Foundation Ireland, and Invest Northern Ireland jointly fund collaborative research.

– Alyssa Barnes

DARAGH MCSWEENEY

Corrections: *In "A Deeper Connection" from Vol. 1 Issue 1, Nancy Kim's section incorrectly implied that she visited Singapore and Beijing. Kim helped coordinate events in Singapore and Beijing; she did not travel there herself.*

ROB FELT

Award Honors Former ChBE Chair Rousseau

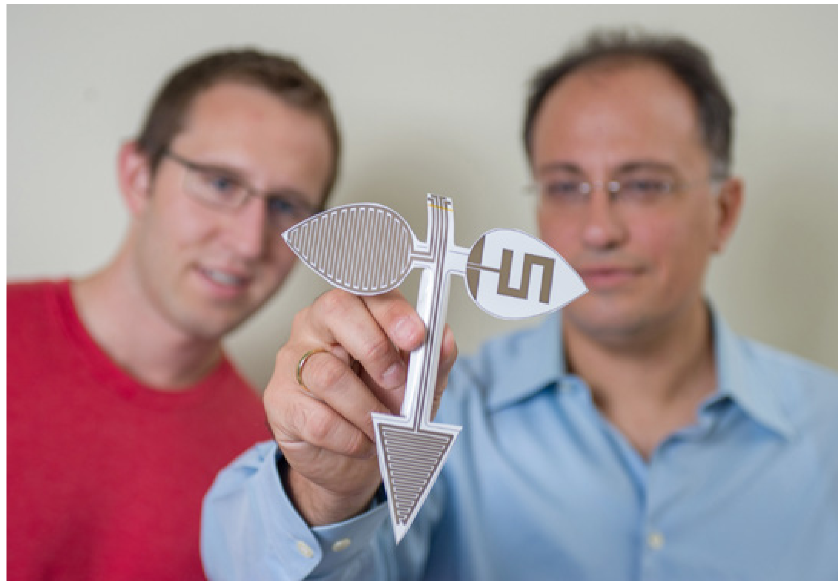
The School of Chemical & Biomolecular Engineering's former chair recently received a major award from the American Institute of Chemical Engineers.

Ronald W. Rousseau, Cecil J. "Pete" Silas Chair, is the recipient of the 2013 Founders Award for Outstanding Contributions to the Field of Chemical Engineering. The award is given on behalf of the American Institute of Chemical Engineers' (AIChE) Board of Directors, and it recognizes AIChE members who have made a significant impact on the field and have had a long, distinguished record of service to the profession.

After serving as school chair for 27 years, Rousseau stepped down from the position in June 2013. His research has explored numerous areas related to separation processes, with particular emphasis on phenomena influencing the characteristics of products from crystallization operations. This has resulted in more than 190 journal articles, book chapters, and monographs, and more than 260 presentations at technical meetings and seminars for industry and universities.

– Katie Brown

Researchers Receive Grant to Develop Origami-Shaped Antennas


ROB FELT

A Georgia Tech-led research team has been awarded a $2 million grant from the National Science Foundation to develop a unique approach to making compact and efficient antennas and electronics. The technology will use principles from origami to create complex structures that can reconfigure themselves by unfolding, moving and even twisting in response to incoming electromagnetic signals.

One of the four-year project's leaders is Manos Tentzeris, a professor in the School of Electrical and Computer Engineering, who will work with a team of students. Other leaders are John Etnyre, a professor in the School of Mathematics, and Stavros Georgakopoulos of Florida International University.

The structures they're developing could be fabricated from a wide variety of materials. Inkjet printing techniques would deposit conductive materials such as copper or silver onto the antenna elements to provide signal receiving and other capabilities.

Potential activation mechanisms would allow the antennas to rapidly unfold in response to incoming signals, including the harvesting of ambient electromagnetic energy, as well as the use of chemicals that produce movement in ways that mimic nature.

"Traditionally, antennas have been sizeable, and any reconfiguration required complex electronics technology," Tentzeris says. "We expect these tiny new antennas to morph using self-activation mechanisms that in many cases would not require electronics or electrical power."

The result would be powerful, ultra-broadband capabilities in an antenna measuring only a couple of centimeters when folded.

– Rick Robinson


ROB FELT

Magazine Recognizes CEE's Kari Edison Watkins for Transit Work

Mass Transit Magazine has named Assistant Professor Kari Edison Watkins to its 2013 40 Under 40 List, an annual "who's who" of professionals who have made significant contributions to the public transit industry.

Honorees were nominated by their peers and judged on criteria that included job commitment and achievement, industry involvement and contribution, and innovation in the field.

Watkins is a professor at the School of Civil and Environmental Engineering (and a 1997 graduate of that school herself). She earned her doctorate in civil engineering at the University of Washington, where she co-developed OneBusAway, a mobile app that gives transit riders real-time information on bus arrival times.

In addition to modifying that app for use in Atlanta, Watkins has initiated development of another app, CycleAtlanta, which provides cyclists with information on optimal routes in the city.

– Kathleen Moore

ROB FELT

CEE's Russell Earns Prestigious Regents' Title

The University System of Georgia's Board of Regents voted to approve the nomination of Professor Armistead (Ted) Russell for the honor of Regents' Professor.

This designation is reserved for tenured full professors whose scholarship, research, and other contributions to their fields have been recognized as exemplary by their peers. Russell is a professor in the School of Civil and Environmental Engineering (CEE), which last hosted a Regents' Professor with the tenure of the late George F. Sowers.

When announcement of the Board of Regents vote was made public, many of his CEE colleagues joined in praising Russell, who has been a CEE faculty member since 1996.

"I can't think of anyone more deserving of this honor than Ted," said Professor Reginald DesRoches, Karen and John Huff School Chair.

Internationally renowned for his prolific scholarship and research, Russell has published nearly 400 journal and conference papers, several books, and many book chapters – all of which have earned him more than 6,000 citations.

– Kathleen Moore

Eckert Graduates 100th Ph.D. Student

Professor Charles A. Eckert graduated his 100th Ph.D. student, Jackson Switzer, in June 2013.

Eckert is the J. Erskine Love Jr. Institute Chair in Engineering in the School of Chemical & Biomolecular Engineering. Before coming to Tech in 1989, he taught at the University of Illinois at Urbana-Champaign, and his first Ph.D. student graduated in 1969.

Since he began working at Georgia Tech, 57 Ph.D. students have graduated under Eckert's direction, and he anticipates having seven more candidates receive degrees by 2016. While he is no longer taking on new students, he plans to finish working with his current ones and will continue research with postdoctoral fellows.

His research focuses on the interface between chemistry and chemical engineering, but Eckert said his main focus always stays on his students.

"I do not see myself as a chemical engineer nearly as much as I see myself as a teacher," he says. "Seeing the growth and success of students is most fulfilling."

– Katie Brown

KATIE BROWN

National Institutes of Health Awards $2M for Engineering Approach to Understanding Lymphedema

The National Institutes of Health recently awarded Georgia Tech a $2 million research grant to unravel the mechanical forces at play in lymphedema, a poorly understood disease with no cure and little hope for sufferers.

Lymphedema develops when the body fails to circulate lymphatic fluid, a mixture of immune cells, proteins, and lipids. This fluid builds up in the arms, legs and genitals – sometimes causing extreme swelling and permanent remodeling of the tissue. The mechanisms involved in the progression of the disease are unclear, so mechanical engineering Professor J. Brandon Dixon's lab will use an engineering approach to studying the disease. This innovative methodology could lead to new technologies to test and treat lymphatic disease.

Solving this biological problem with engineering is an ideal strategy, Dixon says, because the lymphatic system is an engineered system — essentially a very complicated network of pumps.

By teasing apart the workings of the lymphatic system, Dixon's research could lead to diagnostic technologies that measure how well the lymphatic system is functioning, and also to therapies that manipulate the system and stop the painful swelling that occurs during lymphedema.

– Brett Israel

ROB FELT

MSE Professors Receive Grant for Novel Optical Metamaterials Research

Professors Vladimir Tsukruk (left) and Zhiqun Lin were recently awarded a $7.5 million grant for research on novel optical metamaterials.

The School of Materials Science and Engineering professors, in cooperation with the University of Central Florida, received the grant for a new Department of Defense Multidisciplinary University Research Initiative. Their work focuses on novel organized hybrid optical materials with a unique combination of light emission and adsorption properties, leading to controlled light propagation and enhancement characteristics unattainable by traditional homogeneous materials.

The team of theoretical and optic physicists, materials researchers and chemists is exploring opportunities provided by so-called parity-time reflection symmetry for creating a new generation of functional photonic materials with carefully matched refractive index spatial distribution.

– Alyssa Barnes

Diesel or Electric? Study Offers Advice for Owners of Urban Delivery Trucks

ROB FELT

For owners of delivery truck fleets who may be trying to decide between electric or diesel vehicles, researchers at Georgia Tech are offering some guidance: comparisons of the energy consumption, greenhouse gas emissions and total cost of ownership for the medium-duty vehicles.

The research team includes Valerie Thomas, a professor in the Stewart School of Industrial & Systems Engineering, Dong-Yeon Lee, a Ph.D. student in the School of Civil and Environmental Engineering, and Marilyn Brown, a professor at the School of Public Policy.

The advantages of electric versus diesel depend largely on how the trucks will be used and the source of electricity for charging batteries. In city driving with frequent stops, the electric trucks clearly outperform diesel vehicles. In urban delivery routes with lots of stop-and-start driving, electric trucks are roughly 50 percent more efficient to operate than diesel trucks overall. That makes them at least 20 percent less expensive than diesel-fueled trucks, and reduces greenhouse gas emissions by roughly 50 percent. However, electric delivery trucks lose their advantage in suburban routes that involve fewer stops and higher average speed.

The researchers found benefits of the electric vehicles depend on vehicle efficiency associated with drive cycle, diesel fuel price, travel demand, electric drive battery replacement and price, electricity generation and transmission efficiency, electric truck recharging infrastructure and purchase price. The study findings were reported in the journal Environmental Science and Technology.

The researchers were surprised to find that the electric truck had cost advantages over the diesel vehicle under some conditions, particularly in urban settings and in locations with relatively low greenhouse gas emissions from electricity.

– John Toon

Embracing the Unexpected in Engineering and Life

(with a little help from the rats)

by Ron Stuff, CE '82

As love affairs go, mine with Georgia Tech started badly: the arrival of the rejection letter. A politely worded note informed me that Tech was no longer accepting out-of-state applicants that year.

JOHN LAU

It was one of many opportunities that would come my way over the next three decades, often disguised as setbacks.

A week after the rejection letter, the Georgia Tech admissions office called with another bombshell: They wanted to offer me a National Merit Scholarship.

"That would be great," I said, "except you've already told me 'no.'"

The startled caller said he'd call me right back. Within the hour I was informed that Tech had found one more spot in its freshman class for a kid from the plains of Montana with pretty good math and science grades. I was ecstatic.

Up until that point, the chance to attend a school with Tech's reputation was something I had barely allowed myself to imagine. Even applying to Tech had been something of a lark. Now that application I almost didn't complete introduced me to a world beyond my so very limited horizon.

I suspect other alumni share my experience at Tech (and the College of Engineering): They challenged me to pursue more ambitious goals and work harder than I ever thought possible. Whatever our major, Tech demanded that we doggedly pursue problems that at first seemed unsolvable. In turn, we learned the wonderful fulfillment that comes from achieving something we thought well beyond our grasp.

A few years later, this mindset helped me to transform "the worst job I ever had" into "the best thing that ever happened to me." My junior year financial aid package included the work-study job of taking care of the lab rats in the biology department. My duties included feeding and watering them and, of course, cleaning their cages.

I really wasn't seeing the upside of this particular "opportunity" until I ran into a striking blond-haired lab assistant in the hall one day. There I was in my apron and rubber gloves, with a cart stacked six-deep with filthy rat cages. She was conducting the very research that I was cleaning up after. Somehow, she was able to see beyond the rat cages and give me a chance.

It was an amazing thing. Elizabeth Schlag (B.S. biology '82, M.S. applied biology '84, B.S. chemical engineering '86) went on to become my wife. Go figure.

My senior year at Tech looked like clear sailing. I had a solid GPA, good LSAT scores and a strong hunch that I'd be accepted into Emory University's law school. But once again, the unexpected threw a wrench into the works.

One of my recommendation letters needed for my law school application wasn't received. On top of that, Emory's letter telling me of this shortcoming got lost in the mail. When I finally learned that my application had been sidelined, the admissions process was closed.

Given that Liz and I were planning on marrying that fall, I needed a job. Quick.

The spring and summer of 1982 were not great times for sudden career moves. Across the country civil engineers were getting laid off in droves. Still, an engineering degree from Georgia Tech gives you an edge; I was able to secure a job offer from a firm in Alabama soon after the Emory fiasco. I felt like I'd dodged the bullet.

I should have known to expect the unexpected.

Two weeks before graduation (and a scant 12 weeks before our wedding!), my job offer was rescinded – another victim of a sagging economy. I wasted no time in reaching for the Yellow Pages – the job directory of choice in the days before the Internet. Beginning with A's, I started calling every civil engineering firm in Atlanta. I landed a job with Wiedeman & Singleton two weeks before the wedding. The first paycheck arrived the day before I said "I do."

I've been a lawyer for nearly 25 years now, but I wouldn't trade those four years in civil engineering for anything. Though I eventually attended another law school (Harvard '89), I now work for a worldwide engineering and construction company that has a passion for building the future. For a civil-engineer-turned-lawyer, this is as good as it gets.

Appearances to the contrary, getting here wasn't just dumb luck.

Like every good engineer, I believe deeply in thoughtful analysis, meticulous planning, painstaking preparation and then diligent execution to plan. What life (and Tech) have taught me, however, is that we should also be open to the opportunities presented by the unexpected and the unplanned.

Grit and perseverance are essential to success. When the plans go awry (and they often will), look for the opportunity among the rubble. That's what great engineers do. And Tech taught each of us to be one helluva engineer. ▪

“The reason I’m an engineer is because of ‘Star Trek’ and comics.”

13,000 Comic Books *& Counting*

CoE Dean Gary May has been collecting superhero comics since childhood

by Van Jensen

Dean Gary May's Tech Tower office betrays no sign of his lifelong hobby, at least until you peek behind his door. There, hanging beside an extra suit and a pressed shirt, is a bright red Superman cape — a handmade recreation given to May as a gift from staff members at the College of Engineering.

May collects comic books — superhero comics specifically. He started reading them when he was 4 or 5, growing up in St. Louis, and he has continued ever since, from his days as an undergraduate at Georgia Tech to his postgraduate studies in California to his return to Tech as a faculty member and administrator. At last estimate he had about 13,000 issues, which he reads and re-reads in a quiet room in his Atlanta home.

"It started when my dad would take me to Bob's Barbershop," May says. "Bob had comics and magazines for people to read when they came in. I just started looking at the pictures and putting the story together. Then I started to read the words. It really supplemented what I was learning in school."

Soon, May started to buy his own, often taking advantage of the six-for-a-dollar deal offered at the local Zayre discount store. "I'd go and get 12 or 18 and read them all day," he says.

He particularly liked books featuring teams of superheroes, like "Justice League" and "Avengers," in which the characters would have to combine their strengths to defeat villains.

"We'd go out and play 'Super Friends,'" May says. "I was always Superman. I felt like I needed to be the leader, even then. I asked my mom for more siblings so we could fill out the whole team."

Comic books offered more than just entertainment; they also guided May into his future career. The first comic he ever owned was an issue of "Avengers" shortly after the introduction of Vision, an android hero. When May went into engineering, he ultimately chose to do research related to artificial intelligence.

"The roots of that traces back to seeing robots in comics," May says. "The reason I'm an engineer is because of 'Star Trek' and comics. Sometimes they inspire me. As a researcher, you have to be creative. You have to imagine things that people don't think are possible. Comics are a very unconstrained medium."

Once May became a teenager, he says his father kept predicting that he'd lose interest in comics. May insisted that he wouldn't — and so far, he's held true.

Once he moved to Atlanta and enrolled at Georgia Tech, May discovered Oxford Comics, a well-stocked shop that became his new place to stop on Wednesdays, when new issues are released. He didn't find much of a comics-reading community at Tech, but most of his fellow students were caught up with course work. And because his dorm room was so small, May would take all of his comics back to St. Louis on breaks from school. Only fairly recently did he combine his collection, picking up the old issues from his parents' home and bringing them to Atlanta.

"I have this room, and the comics stay in that room," May says. His wife, LeShelle, a fellow Tech alum, "thinks it's goofy in a kind of loveable way." She'll call him Sheldon, after the character from the TV show "The Big Bang Theory," who has a penchant for superhero T-shirts.

At the couple's home, May's comics collection resides on a handful of bookcases. The issues are vertically aligned, stacked so thickly on shelves that they hold in place. Whereas most comics collectors slip each issue into protective sleeves and hide them away in boxes, May wants his comics accessible.

"I like to read them and re-read them," he says. "I'm probably hurting myself financially. But I've never tried to pick what I think will be valuable."

It's the stories that draw him in, stories of heroes battling villains, of good versus evil. And that, ultimately, is the lesson of superhero comic books — that there can be justice, and that it is worth fighting for.

"It's why I work on issues like inequities and underrepresentation," May says. "The best way to fight crime, after all, is through education." ▪

Van Jensen is the editor of the Georgia Tech Alumni Magazine and leads a secret double life writing comic books such as "Green Lantern Corps" for DC Comics and the creator-owned graphic novel series "Pinocchio, Vampire Slayer."

Facing page: The dean reads (and re-reads) his comics in a quiet room in his house. JOSH MEISTER

Protecting Aging Buildings from **Powerful Earthquakes**

CEE Chair Reginald DesRoches researches retrofits in a National Science Foundation project

by Kathleen Moore

When an October 2013 report in the Los Angeles Times revealed as many as 1,000 buildings in that earthquake-prone city were unprepared to withstand an earthquake, the College of Engineering's Professor Reginald DesRoches was concerned, but not entirely surprised.

"Many of those buildings were constructed before the 1970s, when California adopted seismic building codes for new construction," says DesRoches, a noted earthquake engineering expert and chair of the School of Civil and Environmental Engineering.

"Outside of California, those codes were not incorporated into new construction until the '90s. So what we have is a very large building inventory that is at risk of serious damage or collapse during a medium to moderate seismic event. They need some type of retrofitting that will prevent collapse in a large event and limit damage in a moderate event."

Developing those retrofits is the ultimate goal of the National Science Foundation's George E. Brown Jr. National Earthquake Engineering Simulation Research (NEESR) project, a three-year, $1.2 million project that DesRoches is leading. He is joined by his CEE colleague Assistant Professor Yang Wang, several graduate researchers, and a team of scientists from Virginia Tech, Rice and Howard.

"The goal is to develop building retrofits that are easily installed, relatively low-cost, and effective at resisting major earthquake forces," DesRoches says. "But before we can do that, we need to see how different retrofits actually perform. We have great mathematical models, but we need field-tested data."

That's exactly what the NEESR team will get in January 2014 when it subjects a specially built, 3,000-square-foot building to a series of simulated earthquakes. The building — a two-story structure located in an empty lot outside the CEE Structural Engineering and Materials Research Lab — lacks any earthquake-worthy reinforcements. It was built to satisfy building codes that were common in the 1970s. The seismic jolts it receives will be produced by a mobile shake table, on loan from researchers at UCLA.

With no exterior walls, the building may appear to be unfinished, but, according to CEE doctoral student Tim Wright, it is perfectly engineered to deliver maximum results. During seismic events, he says, exterior walls don't offer much stability anyway. The key to this building is that it's divided into four sections, which will allow researchers to test four different retrofits.

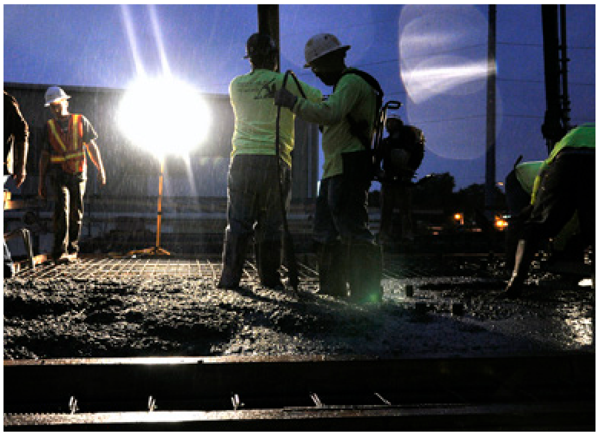
The results of those tests will be collected by a series of nearly 200 smart wireless sensors that have been embedded throughout the building.

"This will give us unprecedented opportunity to collect huge amounts of highly dependable data — data we can use to refine our models, and develop better retrofits," says Yang, who is heading up the research group that designed the sensors.

"The sensors can communicate with each other, and automatically execute damage detection algorithms. After an earthquake, data from the densely instrumented wireless sensors can be used for re-evaluating structural condition and determining remaining structural capacity," he says.

"This will give us unprecedented opportunity to collect huge amounts of highly dependable data — data we can use to refine our models, and develop better retrofits."

- CEE Assistant Professor Yang Wang



While the preliminary findings are months away, the NEESR project has already snagged the attention of professionals outside academia. Engineers, architects, policymakers, and builders are all eager for the project's goal: well-researched, easily adaptable, cost-effective retrofits for seismically vulnerable buildings.

Researchers will apply different shape memory alloys (SMAs) to three sections of the building, and compare the results to a fourth section that will have no reinforcements. A fair amount of research backs the use of SMAs, like nitinol, over steel supports. Detailed analytical studies of multi-story buildings have shown that, when subjected to ground-motion, the SMA bracing systems reduce the peak interstory drifts by an average of 75 percent.

JESSICA HUNT

From June through September, workers from Turner Construction and Winter Construction worked with more than 20 subcontractors to build the 3,000-square-foot NEESR structure that will be used to test earthquake retrofits.

Bottom right photo: Doctoral student Tim Wright (right) and project superintendent J.T. Mote review plans for the NEESR building.

JESSICA HUNT

Built to satisfy 1970s building codes, the completed structure will be subjected to a series of simulated earthquakes this year. The seismic jolts it receives will be produced by a mobile shake table, on loan from researchers at UCLA.

One of the SMA retrofits to be tested by the NEESR team is a tension/compression damper. Fabricated using a solid nitinol 1-inch bar, it has been shown to have excellent re-centering capability and relatively moderate damping values.

"Ultimately, we'll be able to decide which retrofits work best by doing detailed fragility analyses and creating vulnerability models of buildings with and without retrofits," says DesRoches.

"We'll also need to conduct cost-benefit and life-cycle cost analyses to determine which retrofits are appropriate for a particular structure. This project puts us in the forefront of reaching that goal." ▪

Think seismic events are just a California thing? **Think again.**

According to a study conducted by the Mid-America Earthquake Center, catastrophic consequences await the eight states in the New Madrid Seismic Zone if more is not done to prepare for a major seismic event. Located in America's heartland, this seismically vulnerable region experienced devastating earthquakes in 1811-12 and would suffer greatly if a similar-magnitude event were to occur today. The region could suffer damage to as many as 715,000 buildings, 3,500 bridges and nearly 425,000 local and interstate pipelines. About 2.6 million households could be left without power and 86,000 injuries and fatalities could result from damage to infrastructure.

Learn more about the NEESR team's work at **neesrcr.gatech.edu**

The School of Civil and Environmental Engineering at the Georgia Institute of Technology is proud to announce the establishment of

THE FREDERICK LAW OLMSTED CHAIR

Supported by a donation from Jenny and Mike (CE ’76) Messner, this endowed chair has been created to inspire future generations of civil and environmental engineers with the concepts pioneered and developed by legendary landscape architect Frederick Law Olmsted.

Generally regarded as the Father of American Landscape Architecture, Frederick Law Olmsted combined concepts of civil and environmental engineering, architecture, and urban ecology to create enduring environmental treasures in 24 states and the District of Columbia, including Central Park in New York City, the Emerald Necklace in Boston, and Druid Hills and Piedmont Park in Atlanta.

Candidates for this chair will be leaders in the field of sustainable urban infrastructure systems. Preference shall be given to individuals whose past and future contributions will be at the intersection of civil and environmental engineering systems, urban ecology, architecture, and policy.

For more information about this chair, contact Dr. Reginald DesRoches, Karen and John Huff School Chair at reginald.desroches@ce.gatech.edu

Georgia Tech School of Civil and Environmental Engineering
College of Engineering

The Logistics of Rebuilding Homes

The Health & Humanitarian Logistics Center collaborates with Habitat for Humanity International to improve disaster response

by Meghan Smithgall

Forest fires in California, flooding in Colorado, and tornados in Oklahoma – not to mention hurricanes in Mexico, earthquakes in Pakistan, and volcano eruptions in Indonesia. 2013 has seen natural disasters around the world.

Non-governmental organizations (NGOs) often respond to urgent needs created by such disasters by fielding donations and distributing supplies. But to reach the most people and save the most lives, they must plan responses far in advance.

Enter: the engineers.

Industrial and systems engineers are known for designing optimization tools and models to ensure the effectiveness and efficiency of organizations' work. For a humanitarian group facing the wake of a natural disaster, mitigation and decision aid tools become even more vital given the high degree of uncertainty and limited infrastructure and resources. Now, a College of Engineering alumna's work in this field is being adopted by Habitat for Humanity International (HFHI).

Industrial and systems engineering (ISyE) alumna Shelly Ballard, who earned a master's degree in 2012, teamed up with Professor Julie Swann of the Health & Humanitarian Logistics Center (HHL) for her thesis. Swann and Professors Özlem Ergun and Pinar Keskinocak cofounded and now direct the Center, which helps organizations improve logistics in emergencies and long-term development.

"We find that students can get really excited about using engineering skills in nontraditional environments like humanitarian systems," Swann says.

Left: Rose Flore Charles and her children received a Habitat for Humanity transitional shelter. Before moving into this shelter, they spent six months living in a makeshift shack that Rose cobbled together out of scraps. HABITAT FOR HUMANITY INTERNATIONAL/EZRA MILLSTEIN

Below: After the 2010 earthquake, this church in Leogane, Haiti, was destroyed. ISyE alumna Shelly Ballard teamed up with Professor Julie Swann to help Habitat for Humanity International more effectively respond to disasters like the earthquake. STEFFAN HACKER

Following a major disaster, one of the most urgent needs is adequate shelter. Ballard collaborated with Swann to design a product-mix optimization tool for Habitat for Humanity International to address a classic problem: How can an organization allocate limited resources to impact the most people for the least time and money?

Habitat, headquartered in Americus, Ga., maintains a large presence in Atlanta and throughout the world. It provides shelter assistance for people affected by disasters through its Disaster Risk Reduction and Response program, which offers "products" like damage assessment, transitional housing, home repair, latrine/ sanitation builds, and disaster and hygiene training and kits.

Habitat's senior director of global disaster response, Kip Scheidler, summarizes: "We have a variety of 'products' in our toolkit that we can bring to bear after a disaster to help a community recover. Deciding the most effective mix of those is not always easy, and yet it is essential if we are going to maximize our limited resources."

ROB FELT

Above: Professors Julie Swann, Özlem Ergun, and Pinar Keskinocak of the ISyE Health & Humanitarian Logistics Center. Below: Shelly Ballard.

CARIBBEAN HAZARD ASSESSMENT MITIGATION AND PREPAREDNESS

To help Habitat meet those goals, Ballard worked with the organization to decide which products and services would offer the most beneficial impact.

Using Open-Solver, free optimization software, Ballard and Habitat assessed the products and services Habitat offers after a disaster, the available resources and costs, and the measurable effectiveness of each type of product. For the tool's "input," Ballard looked at resources needed, constraints (such as time and budget), and available resources (including funding, materials, and volunteers) to create an effectiveness score. That score, along with input from Habitat, was then used to identify an optimum product mix.

In her analysis, Ballard used Hurricane Felix as an example. The Category 5 storm hit the coast of Nicaragua in 2007, destroying more than 10,900 homes and leaving 45 percent of the population without sanitation facilities. Using her tool, Ballard calculated an optimal product mix that showed a several-fold improvement in overall effectiveness compared to the mix of products actually used following the disaster.

Her methods offered the possibility of a much greater impact on the community for the same cost.

This type of industrial engineering, optimizing "value for money," is important for organizations like Habitat for Humanity, because it shows donors that their money is being used in the most efficient and effective ways possible.

Swann points to the important role that universities like Georgia Tech play not only in developing new science but in translating scientific approaches into practice, which can aid companies, NGOs, or government in decision-making under intense pressure.

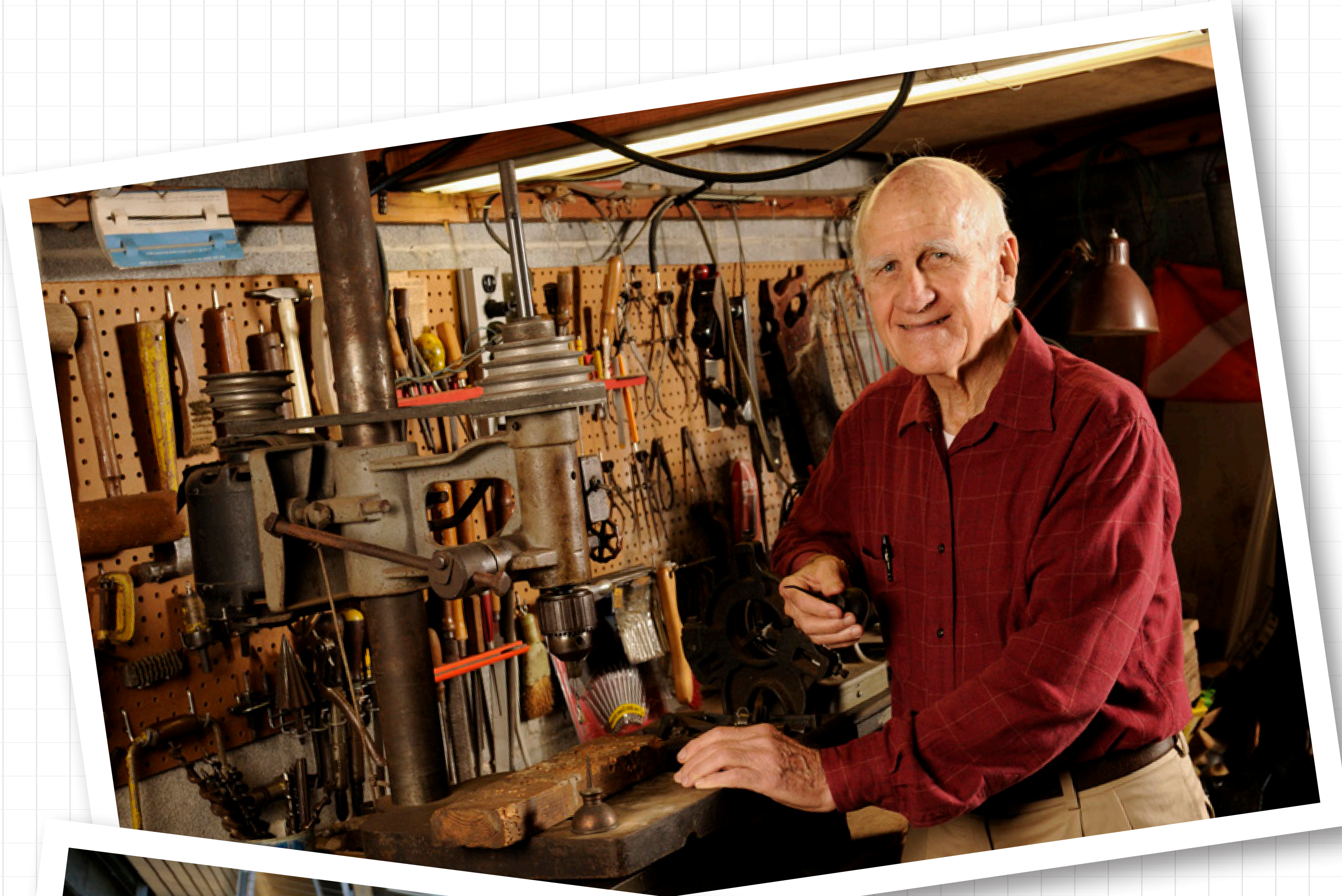
"I had actually participated in building Habitat houses when I was a freshman at Georgia Tech," she recalls, "so it is exciting to work with students to 'build' in a new capacity for Habitat."

In addition to her work on the product optimization tool in Atlanta, Ballard also traveled to the Caribbean on a research trip with HHL as part of Georgia Tech's Caribbean Hazard Assessment Mitigation and Preparedness interdisciplinary project. These countries at high-risk for hurricanes – such as Haiti, where Habitat has served more than 2,000 families in the last 30 years – are examples of areas where the tool could be effective.

"It's been such an honor to see the tool I built for Habitat being improved upon, and something Habitat is excited to share," says Ballard. "Perhaps the most exciting part is seeing organizations catch on to the vast potential of these tools! If the major players start building and using these tools, just imagine how many more people and families could be reached."

Ballard has moved on from Georgia Tech, but HHL and Habitat continue to expand on her work. Current ISyE student Le Jiang is volunteering with Habitat's Atlanta team to further improve what's now called the "Shelly tool."

"For a nonprofit, having an optimization tool puts HFHI at the forefront of their sector," Jiang says. "In combination with successfully quantifying effectiveness, this could potentially thrust HFHI into leadership in the nonprofit community." ▪



'There's no more interesting way to make a living'

As Georgia Tech's mechanical engineering program turns 125, two graduates of different eras share their perspectives of a changing field.

Interviews & Text *by* Michael Baxter
Photographs *by* Gary Meek

They are mechanical engineers, but they could not be more different.

John Cerny (B.S. ME '51) is 83, retired. Katherine Polhemus (B.S. ME '13) is 60 years younger and a Georgia Tech graduate student set to embark on a promising career. John hails from a tiny town on Florida's Gulf Coast; Katherine was raised in the bedroom community of Roswell, Ga. He finished Tech before women were admitted. Her everyday tool, a laptop computer, is one that never graced his office.

Her work in simulations and computer modeling concentrates on what could happen. His work focused on what did happen — he co-owned a firm that investigated engineering mishaps and malfunctions.

But John and Katherine do share one thing in common: Both decided to become mechanical engineers because the discipline's vast variety appealed to their intellectual curiosity.

As Georgia Tech's Woodruff School of Mechanical Engineering marks its quasquicentennial year — that's a century and a quarter for those keeping count — the insights of these two mechanical engineers from different eras cast a bright light on the wonder of the discipline, and how it's changed over the years.

Parental influence

JOHN | My dad owned a garage and machine shop in Florida. He borrowed $500 from his father to start the business. As a teenager, I worked there during the summers — first, just sweeping the floors, but later I worked the lathe and drill press and did some welding. At the time, I didn't realize how valuable it was to get a hands-on education like that.

My father manufactured lawn mowers, the direct-drive kind, and there was nothing fancy about them. We mounted the engines, made the handlebars, even the housings. Most of the mowers had these big bicycle wheels on the back – the grass sometimes grows pretty high in Florida.

KATHERINE | I've never been one of the MEs who are super hands-on. I wasn't the first person trying to nail every single nail when our team was building a robot in undergrad. But I did work with tools when I was young. I sometimes helped my dad with projects, and he taught me how to change a tire on the car. And he would always ask me questions about the world and how it worked, especially on long backpacking hikes.

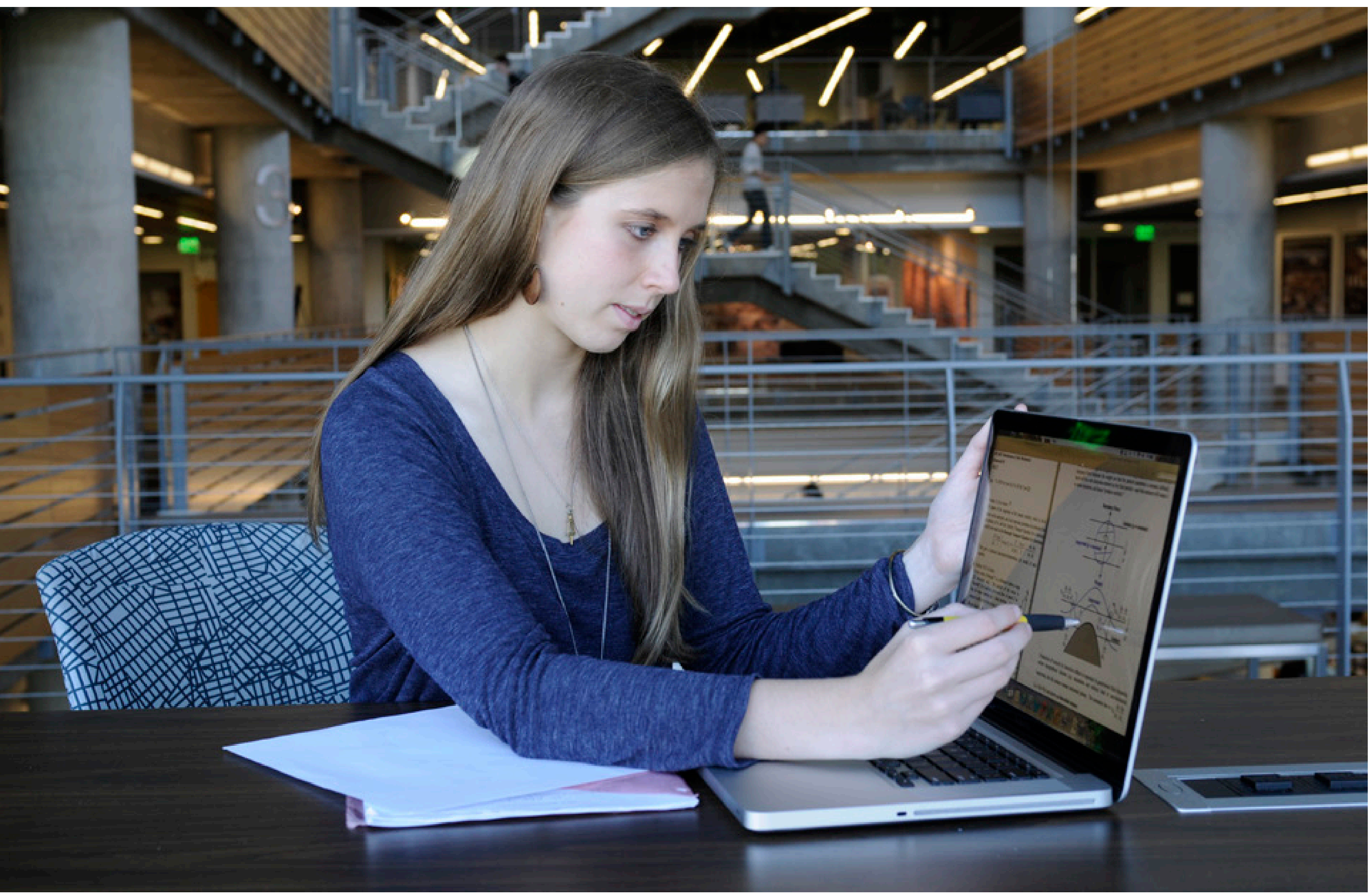
Both of my parents are engineers at Lockheed Martin. They've seen a lot of change — early on, they got to go through the whole process of punch cards, for example. Both kept up with their engineering over the years. And they could always help me with my math and science homework growing up.

Days of study

KATHERINE | My lab research project as an undergrad involved simulating the mechanical properties of particles. I created models of synthetic vesicles using software and changing code. Essentially, I developed the specifications needed for a synthetic particle to expand to the point where it ruptured and allowed smaller particles inside, then close back up. I read research papers to understand the physical properties so that my simulations reflected what was real.

So, envision a small vesicle, a hollow sphere. The point of my project was to see the different mechanics of the sphere – to see what I had to do to the inner matrix inside to make sure it ruptures, lets small particles inside, and then closes back and re-forms properly. Knowing how to do this can lead to new ways to deliver drugs inside the body. My project won a President's Undergraduate Research Award.

JOHN | I especially enjoyed working in the ME machine shop on campus. One part was the pattern-making lab, where we'd make patterns out of wood



to create castings. We used the rough castings, which we learned about from books and the professors. I wore the slide rule on my belt like everybody else.

In 1950, I made a drill press in that shop. They furnished us with rough casting parts, and I did some machine work on them, and drilled and tapped holes. I still have that drill press – it's in the basement of the house. We used it in my dad's shop for many years, and I sometimes use it here. So it's done some work. I also made a grinder, and I still use it, too.

ME outside the classroom

JOHN | After graduation in June 1951, I was called to active duty. Korean War. First I was with anti-aircraft artillery unit in Bavaria, and later I was stationed at Kaiserslautern, near the French border. I returned to Georgia Tech in 1954 to work in the Engineering Experiment Station with other engineers. We mostly did prototype work, building prototype radar systems for the military.

One project involved creating these geodesic lenses that were part of the radar system. Picture two aluminum bowls, each about 4 feet in diameter, and each made out of a flat sheet of aluminum, spun against a large wooden mandrel. They had to be carefully machined, then nested together. I ended up going to Boston and spending five weeks there to supervise their manufacturing. That was an experience.

I was in awe of some of the guys who worked at the Experiment Station. Just really smart, really capable people. We worked as a true team.

KATHERINE | I had a summer internship working for Schlumberger in Houston. They serve companies in the oil and natural gas industry around the world. When a company is drilling for oil, they sometimes need to have sections of the pipe blocked off with this device – I can't talk much about what it is, but the device takes one form to be put into a pipe, then changes form to serve as a plug. All of this happens in outdoor conditions, so they wanted to make sure that mud and liquid didn't create problems for the device when it changed form.

So my job was to use ANSYS Workbench software to simulate flow patterns over the device. For example, I created simulations of how mud would flow over this piece of technology — I would apply a wide range of data about conditions to simulate the mud flow. The resulting information would be used to help them decide whether to activate the device in certain conditions.

> *When I arrived at Georgia Tech, it was awesome to be in a large city for the first time. It was right after World War II, in the fall of 1947. Georgia Tech was covered up with vets.*

John Cerny

ME at work in the world

JOHN | One of my colleagues at the Experiment Station, Allen Ivey, had moved on to doing some investigative work in engineering for the insurance industry, and he came back and said, "Let's put together a business in this field." Insurance companies need outside help to investigate claims. So we formed Cerny & Ivey Engineering to do just that.

We would investigate cases of failed machinery, explosions, fires, accident reconstruction, structural defects in buildings — our job was to provide an independent analysis. We were called in for many different kinds of cases. What caused this crane to overturn? Why did this amusement park ride fail? Could this accident in the paper mill have been prevented?

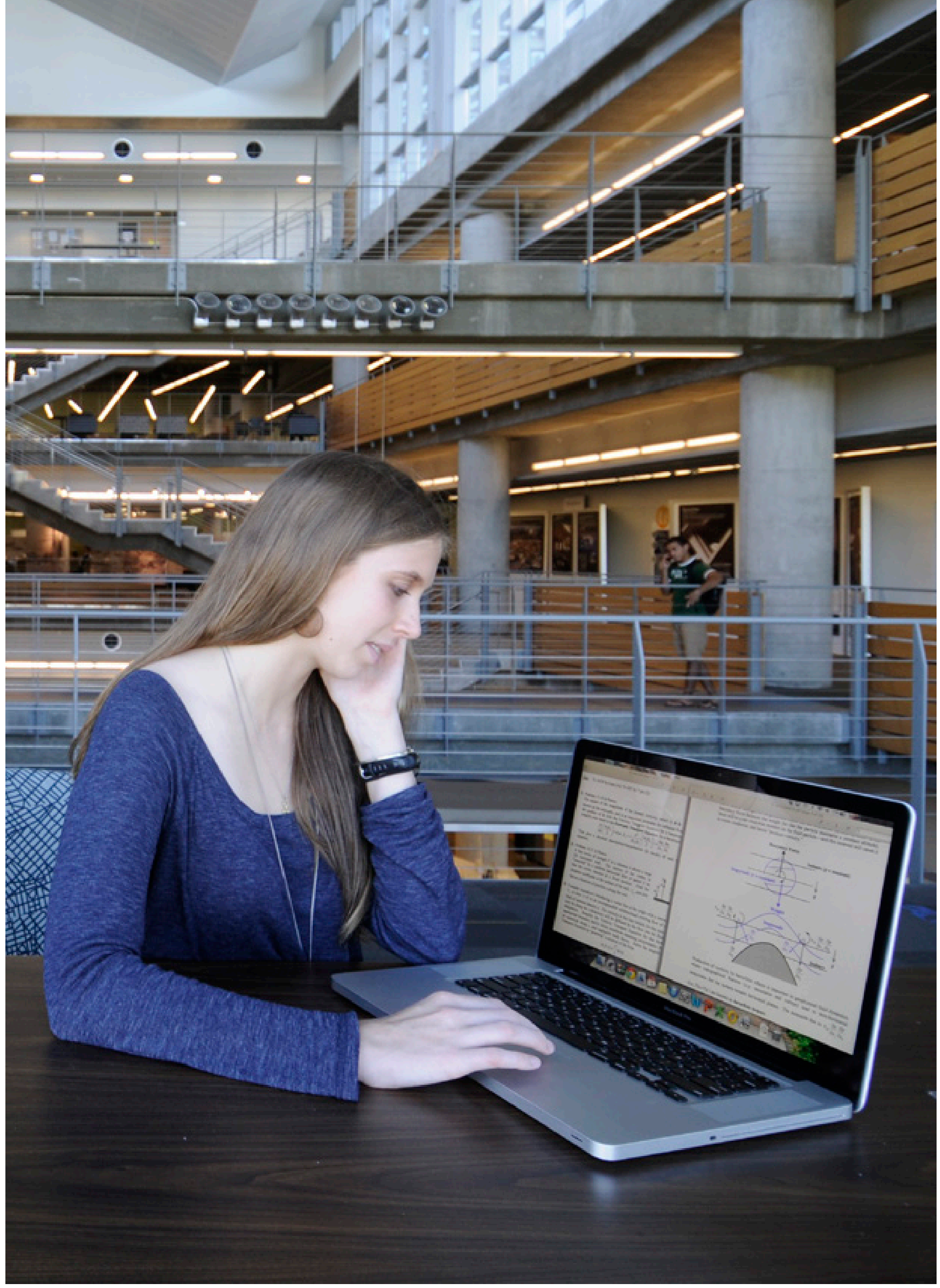
We also had a testing lab. Companies would provide us with a product, and we'd test it. For example, the mobile home industry would provide roof sections and wall sections for testing of their load bearing. Our firm ultimately grew to about 12 employees, and we had a number of chemical, mechanical and electrical engineers working as consultants.

KATHERINE | Since I'm a graduate student, my professional work experience is limited. I am taking a Special Problems course, however, which requires us to solve a real-world problem. Basically, I'm continuing what I started in my undergraduate lab project. Before, I was expanding a sphere to create a hole where smaller particles could enter. The method I'm working on now is different – it involves getting the larger particle to capture the smaller particles on top, then having the larger particle self-fold to keep the smaller particles inside.

Imagine polymer sheets made up of two layers, which have mechanical and chemical properties. I input different data points for pressure, motion,

> *The best part about going to Georgia Tech has to be the diversity. Tech has so many different classes to take; there's so much to choose. There's also diversity through the different faculty. We have professors from all over the world come to teach here.*

Katherine Polhemus



temperature change or other stimuli in order to simulate movement in these sheets — to make them fold or bend, and repeat the process, or reverse it. This might be a different way of getting drugs into a larger particle. It's still simulation work — I picked the research area after looking at bios and papers of research professors.

View of the alma mater

KATHERINE | The best part about going to Georgia Tech has to be the diversity. Tech has so many different classes to take; there's so much to choose. There's also diversity through the different faculty. We have professors from all over the world come to teach here. That's given me a real variety of specializations and perspectives.

I'm also passionate about teaching and tutoring. I have a TA position and help students in lab who have questions. I would like to teach someday, but first work in industry.

JOHN | When I arrived at Georgia Tech, it was awesome to be in a large city for the first time. It was right after World War II, in the fall of 1947. Georgia Tech was covered up with vets. It was tough on us teenagers to compete with them – quite a few of the vets were married with children. They were older, and they were smart.

I've kept in touch with Georgia Tech over the years. Many a time, I called upon professors and employees who worked at the Experiment Station to help us in the business. I hired experts in metallurgy, electronics, chemical engineering and other fields.

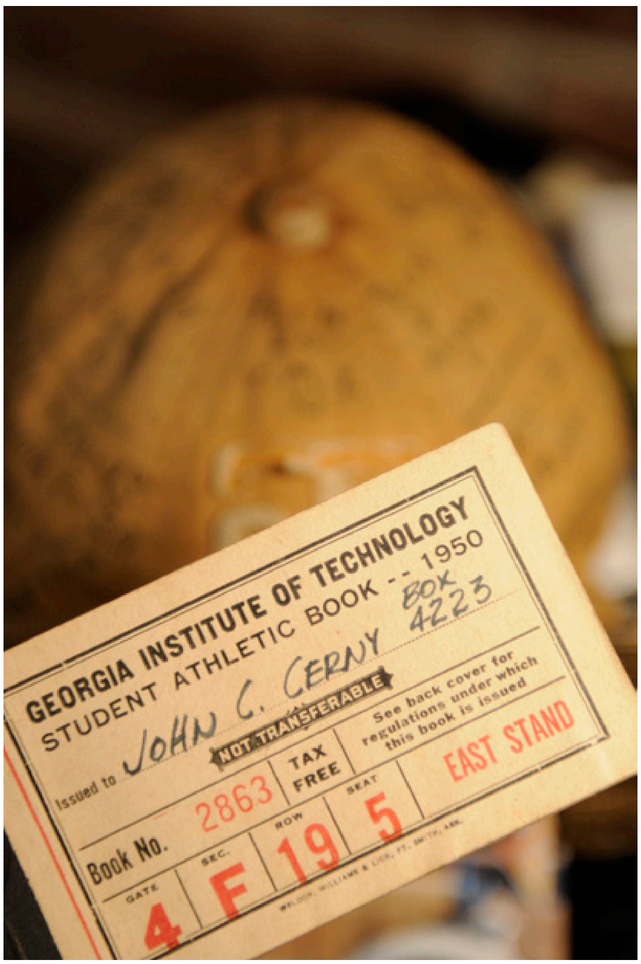
Today, I see the publications that Georgia Tech puts out, as well as some of the engineering societies, and what's happening in mechanical engineering is really, really amazing.

Why mechanical engineering?

KATHERINE | There are more job opportunities in ME, and at so many levels. And I like trying new things. I don't want to be doing the same thing over and over.

When you're doing research in essence, a lot of times it hasn't been done before. Last year, when I was doing coding, it may have been just coding in a section of the field. But when I went to the Web and browsed through research papers, I learned that this particular area hadn't been explored before. That was exciting. People had done variations, but they had never done this particular thing. So every time you try to solve a problem, you might come at it from a different approach. You use all sorts of skill sets from all classes of mechanical engineering.

JOHN | After working in my dad's shop, I knew that if I was going to go into engineering, it was going to be mechanical. I've always found the field interesting. When I had the firm, I became a member of several engineering societies, I attended conferences and seminars, I read the literature. There's no more interesting way to make a living. ▪



In 2013-2014,
the Woodruff School celebrates

125 YEARS OF ENGINEERING THE FUTURE

ME125

As Georgia Tech honors 125 years of its history, the Woodruff School is celebrating with events throughout the year.

March 26 | Gegenheimer Lecture

The Lecture Series on Innovation was established in 1995 through an endowment from Harold W. Gegenheimer (class of 1933) to support student programs that encourage creativity, innovation, and design.

April 24 | Woodruff Lecture

The George W. Woodruff School of Mechanical Engineering Annual Distinguished Lecture was established in 1990 to honor an engineer who has made a significant contribution to society.

April 24 | Capstone Design Expo

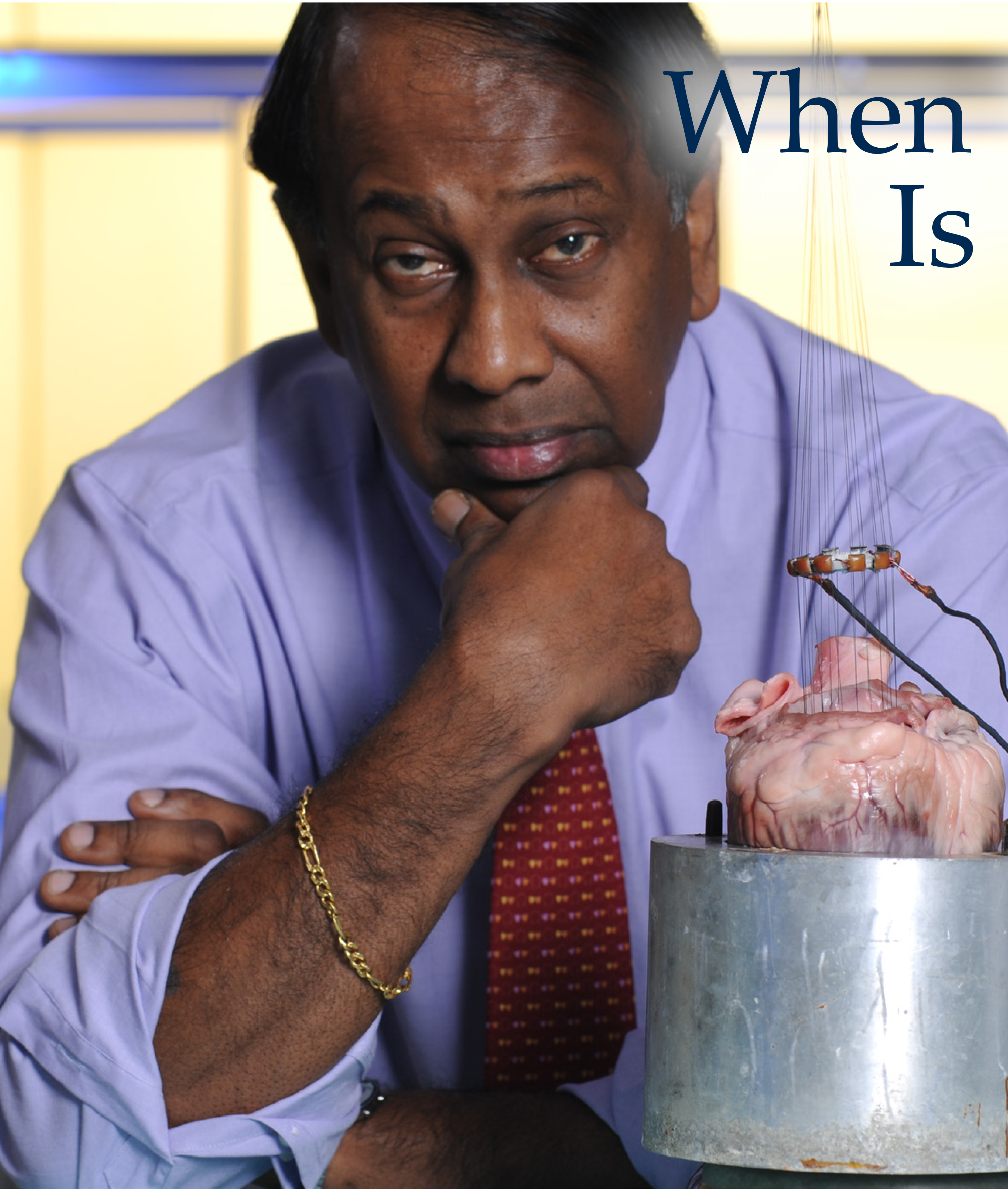
The Capstone Design Expo has become one of the largest student design expos in the United States. Students from multiple disciplines at Georgia Tech work in teams to solve industry-sponsored challenges, develop innovative tools to assist researchers, or work on their own dream projects.

May 1 | ME125 Anniversary Celebration

Woodruff School alumni from Atlanta are invited to attend a local gathering with a presentation by School Chair Bill Wepfer.

For more information on these and other events, visit **http://me125.gatech.edu/events**

–Jordan Shields



When Is

ENGINEERING the Best Medicine

Professor Ajit Yoganathan's pioneering work makes people's hearts work better every day

Story *by* Dori Kleber
Photographs *by* Gary Meek

Dr. Kirk Kanter used to correct heart defects in the youngest children the way every other pediatric heart surgeon did. He'd enter the operating room, open the infant's chest, look at the shape of the heart, and then — based on what he was seeing for the first time — make an on-the-spot judgment about the best surgical option.

Not anymore. While most surgeons still have to make last-minute decisions about rebuilding a heart that didn't fully develop, Kanter knows what he's going to do before he walks through the operating room door.

Kanter figures it out ahead of time by using software conceptualized by Ajit Yoganathan, Regents' Professor in the Wallace H. Coulter Department of Biomedical Engineering. Yoganathan is a leading researcher in cardiovascular fluid mechanics, the study of how blood flows through the heart, and it's his expertise that clues Kanter in to the best surgical choice.

Where some researchers are satisfied with making contributions to the body of scientific knowledge, Yoganathan is focused on translational research — or as he puts it, "getting things out of the lab from our research to impact healthcare and patients." He is the department's associate chair for translational research (a term scientists use for moving findings from the lab into clinical settings), and his dedication to developing real-world applications has made him a hero in the cardiovascular field.

Improving patient care and patients' lives is what drives Yoganathan. In delivering a 2012 lecture to the Biomedical Engineering Society, which honored him with its Pritzker Award, he said, "I think the main goal should be not the commercialization to make money as a faculty member, but to have the satisfaction of being able to see your research translated in the clinic towards helping human health."

Examining the tiniest hearts

The pediatric cardiac surgical planning tool that Kanter uses is one such practical application of Yoganathan's work in fluid mechanics. Kanter uses the tool to help patients whose hearts have only one ventricle. Although such cases are rare – two children per thousand births – the prospects for babies with single ventricle malformations are grim: Their hearts can't circulate blood through the lungs to be loaded with oxygen and on to the body. The lack of oxygen leads to rapid organ failure and even brain damage. Today, the outlook for single ventricle patients is better. Prenatal care often reveals the defect before birth, so surgeons are prepared to take immediate action. Doctors reroute the body's main veins directly into the lungs, bypassing the heart. The blood picks up needed oxygen, then flows from the lungs into the heart's single ventricle, which pumps it out to the body. To achieve success, surgeons must perform two or three surgeries in the patient's first three years of life, including the final operation that connects the veins to the lungs.

It's in preparation for this last operation, known as Fontan surgery, that Kanter uses Yoganathan's surgical planning tool. On his laptop, Kanter views a three-dimensional image of the patient's heart. The image has been created using MRI tomography, a series of magnetic scans compiled to show the heart's exact shape. Interactive features of the surgical planning tool, developed by Professor Jarek Rossignac in Georgia Tech's College of Computing, allow Kanter to turn the image and examine the heart from different angles. Then, based on his surgical experience, the doctor inputs several possible surgical corrections.

The virtual surgery software has an undeniable coolness factor, but the computation and analysis done in Yoganathan's lab makes the real difference. It's there that researchers evaluate each option, using complex formulas to figure out how the blood would flow to each lung after the correction.

Yoganathan never advises the surgeon on which option to choose. Instead, he sends images for each surgical scenario,

Assisted by Ph.D. students Eric Pierce and Andrew Seifert, Ajit Yoganathan reviews the performance of an implanted heart repair device. In its decades of work, Yoganathan's Cardiovascular Fluid Mechanics Laboratory has tested devices from every manufacturer that makes replacement heart valves for the American and world markets, leading to improved design and better function.

showing his prediction of blood flow through the lungs and heart. Then the surgeon makes the decision based on priorities for the specific patient.

Kanter says he typically has Yoganathan evaluate four to six options. Once he's seen the analysis, he can go into the surgery with high certainty he's choosing the best one. "Sometimes it's what we think would have worked," he says, "but I'm surprised at how often the best option is not the one I expected."

So far, the surgical planning tool, called SURGEM, is used at only a few premier children's hospitals in the United States, including the Children's Hospital of Philadelphia and Children's Hospital of Atlanta at Egleston, where Kanter works as one of the leading pediatric cardiac surgeons in the nation.

"We have people from all over the country contacting us and trying to do simulations for them so we can get the best operations," says Kanter, who was one of the first surgeons to use the tool. "This is hot stuff."

From bench to bassinet

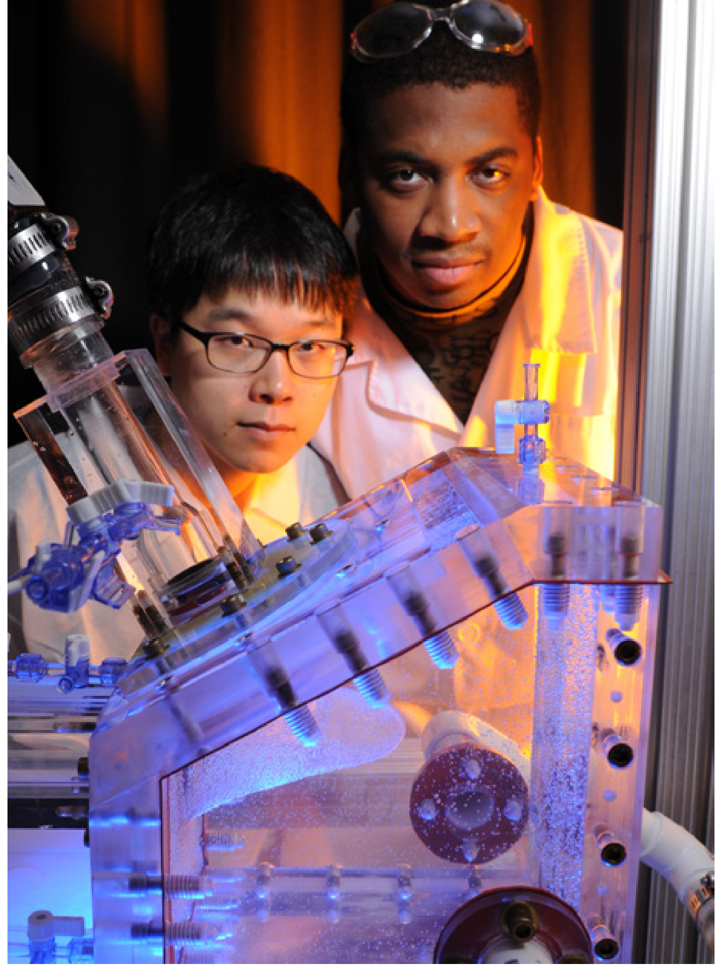
Since Yoganathan arrived at Georgia Tech more than 30 years ago, he's made it his mission to use science as a means to the ultimate end for biomedicine: improving human health. He brought the translational mindset from the California Institute of Technology, where he completed his doctoral work under Professor William Cochran. "He always said that engineering had a lot to offer towards medicine," Yoganathan recalls of his mentor. It was Cochran who first exposed Yoganathan to the field of cardiovascular fluid mechanics. Yoganathan, whose parents were a professor of pathology and a general practitioner, was hooked.

Yoganathan uses the common phrase "bench to bedside" when talking about his work, occasionally giving it a twist. "Bench to bassinet," he says, noting his lab's impact on treating the heart conditions of infants.

He insists that he doesn't set out to create new devices or change surgical methods. His goal is to understand the biomechanics of blood flow in the heart. But while he's doing the research, he sometimes gets a flash of insight about how to improve treatments — an inspiration that can turn into a major advance.

That's what led to the development of a surgical technique called a Y graft, which Kanter has used in two dozen Fontan surgeries. Yoganathan dreamed up the technique while he was studying single ventricle cases, analyzing post-surgical blood flows. He saw that when blood from the upper body and lower body entered the lungs, it was colliding and mixing. That effect slowed its movement, making it harder for the blood to be pumped through the lungs.

He wondered if grafting the veins in a Y-shape, instead of a straight graft, would help. Computer models gave credence to his idea. They showed the Y graft would make circulation more balanced and efficient. That would reduce the stress on the heart, which ideally would allow patients to live longer with less risk of heart failure — a common outcome that forces many single ventricle patients to undergo a heart transplant in their teens or early 20s, when their surgically repaired hearts give out.



This simulator mimics the function and the fluid mechanics of the left side of the heart. Ph.D. students Brian Jun and Ikay Okafor use the machine to evaluate the effects of heart failure and how repair devices can help improve patients' lives. Lab research allows absolute control of all the variables — an impossibility in clinical practice, where individual patients' overall health can affect how well a device performs.

Finding the answers

Yoganathan has seen his work translated to health care settings many times over. During decades of research on heart valves, he's worked with every manufacturer that has a replacement valve on the American market. He's also assisted the Food and Drug Administration in its regulation of cardiac devices.

This exploration of valves is both vast and painstaking. Much of his lab's work is done with porcine or ovine heart valves, which closely match human physiology. Researchers modify the valves to mimic different types and stages of valve failure. Then, they use engineering tools and techniques to monitor the resulting changes in blood flow and mechanical stress. Finally, they make a surgical correction and see what effect it has.

Yoganathan explains that his research aims to see how the valve's performance changes when its shape is changed by disease in the surrounding tissues or breakdowns of the valve itself. Then, investigators want to know how well various surgical corrections work to restore the valve's function. Finally, they try to figure out why some surgical repairs have a limited lifespan.

"It's really trying to understand why some of the surgical repairs eventually fail," he says.

The research done in the lab is invaluable, because only in the lab can a scientist control all the variables. In clinical practice, the differences among patients' overall health makes it nearly impossible to isolate the problems with a particular surgery or device. In Yoganathan's lab, though, the conditions are consistent, so scientists can isolate the sources of breakdowns – as they did when they studied bileaflet valves, the most common type of mechanical prosthetic heart valve.

In as many as 5 percent of patients, prosthetic valves lead to life-threatening blood clots. To reduce this risk, patients are prescribed anticoagulant drugs for the remainder of their lives; however, these medications can have serious long-term side effects. Yoganathan wanted to figure out what caused the clots in the first place.

His research showed how some of the blood traveling through the artificial valve tended to stagnate around the valve hinges. Stagnant blood leads to clots. If the valve could be redesigned to get that blood flowing, it could minimize or alleviate the clots.

Device manufacturers and surgeons pay careful attention to Yoganathan's work and adjust their practices accordingly. Likewise, Yoganathan listens to manufacturers and doctors and allows their practical needs to guide his research.

Professor Don Giddens, the former dean of the College of Engineering who helped recruit Yoganathan, says Yoganathan has always taken a collaborative approach to working with clinicians, even when such approaches were rare. He believes Yoganathan always knew that working hand-in-hand with practicing doctors would lead to the greatest impact on health.

"His focus on translational research – that is, getting things to patients, and direct interaction with the clinical environment – was path-breaking," Giddens says.

Yoganathan's influence has also shaped teaching at Georgia Tech, Giddens notes. Yoganathan spurred the creation of the master's and Ph.D. degrees in bioengineering, and he was a leader in the effort to establish the Coulter Department of Biomedical Engineering.

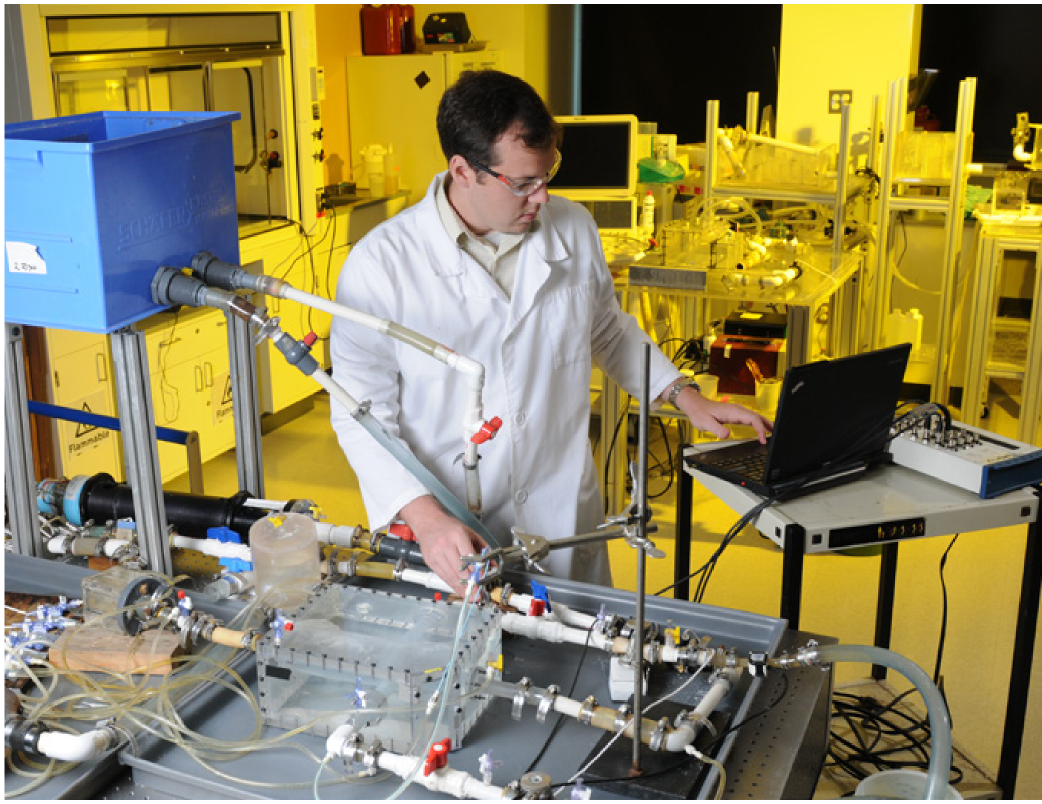
Beyond that is Yoganathan's impact on the future of biomechanical engineering by mentoring the engineers of the future. Over the years, more than 100 graduate students and post-doctoral fellows have trained and worked in Yoganathan's lab. One former student, research engineer Dr. Jorge Jimenez, says Yoganathan passes on to them his passion for improving lives through biomedical engineering.

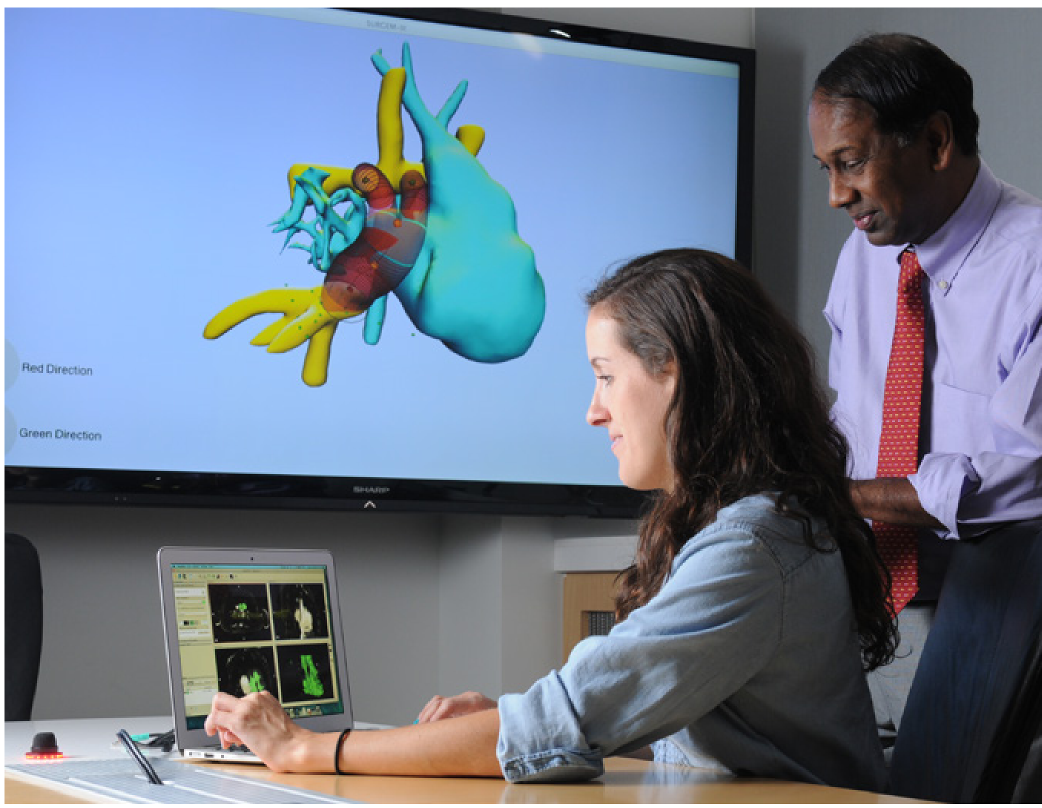
"The scientist is a very serious person, really driven," Jimenez says in describing Yoganathan, "but if you talk to him personally, you see that he also cares a lot" about the patients he's helping.

Jimenez became a full-time member of Yoganathan's research faculty in 2007 and now divides his time between working in the lab and leading Apica Cardiovascular, a commercial venture launched in 2009 based on research done in the lab. Apica is testing a device that would change heart valve replacement from an open-heart surgery to a minimally invasive procedure. The device can be inserted into the left ventricle of the heart without opening the whole chest. It can implant a replacement heart valve, then close the incision in the heart with minimal blood loss, alleviating the need to use a heart bypass machine.

That kind of radical shift in cardiovascular repair would only add to Yoganathan's already stellar reputation. Yet as much as he has accomplished during his career, and as proud as he is of how his research has set new standards for cardiovascular care, Yoganathan's pride in his own work is tempered by his reverence for the inherent design of the heart.

"No matter what, the human body and the heart are very well designed — from an engineering point of view," he says. "It has built-in safety factors. Even when there are small problems, the [heart] valve works fine. It takes a lot before that valve begins to fail and create significant medical problems... It's a marvel." ▪





Top: A maze of pipes and valves allows Ph.D. student Mike Tree to test how changes in blood flow affect a child's heart.

Bottom: Ph.D. student Maria Restrepo works with a computer simulation program that enables pediatric heart surgeons to run virtual tests of surgical options for repairing severe heart defects. Yoganathan's lab evaluates how each potential procedure will affect blood flow through the heart, guiding the surgeon to select the best remedy for a patient's needs.

ENGINEERS of Goldrush

INTERVIEWS *by* BEN WRIGHT
TEAM PHOTOGRAPHS *by* ART MORRISON

They're at every home football and basketball game, and countless other events, decked out in gold and white as they spread Georgia Tech pride. But the most common question they're asked is if they actually go to Georgia Tech.

To set the record straight, yes, all 13 women on the Goldrush dance team are current Georgia Tech students, and they're just as talented academically as they are athletically. Of the 13, eight are engineering majors, representing five schools and a range of intellectual interests – from Shelby, the aerospace major who has interned at NASA, to Heather, the team captain and President's Undergraduate Research Award recipient.

We asked each of the engineering majors on the team about dancing with Goldrush, balancing hectic schedules, dealing with stereotypes, and passion for engineering. Here are some of their responses.

Amy | ISyE, sophomore | Statesboro, Ga.

What is your favorite part of Goldrush?

The team is a great group of girls who are very close. It's good to have that support group and I know I can rely on them. Having this family away from home has been really great. Then there's the school spirit component – in high school I don't think I even went to a football game, and then when I came here, being on the dance team forced me to go to all the football and basketball games. I'm really into it and I love it.

What do you like the most about your major?

I feel like I work with people who care about the major a lot. Being an IE I have met a lot of friends, and we study together, work together, and hang out together. I really like the major because not only is it very prestigious and the highest ranked program in the country, but it's exciting to be among people who are so passionate about it. The professors really know what they are talking about and also care about what they are talking about.

Heather, *Goldrush Captain* | ChBE, senior | Alpharetta, Ga.

Why did you choose Tech?

It's such a great school and I really only applied to here and UGA, and I got accepted to both. And as much fun as I'm sure UGA would have been, Georgia Tech is such an incredible school, I couldn't pass up the opportunity to go here.

What type of research have you been involved in?

I am working with Dr. Sven Behrens' research group. I did that this whole past summer full-time with them and received the President's Undergraduate Research Award for this semester, so I am working about 10 hours a week for them again. We are doing a project for BASF, basically tailoring double emulsions to encapsulate an active herbicide.

What is the biggest challenge of being on the dance team?

Time management. We practice between six and nine hours a week. On game days we have to be there anywhere between three and a half and four hours before the football game to do Yellow Jacket Alley, Campanile performance, stairs performance, and pregame, and then we're there for the entire game. We perform at every men's and women's home basketball game too. It's a huge time commitment and then you are expected to always be on top of your game and know your material.

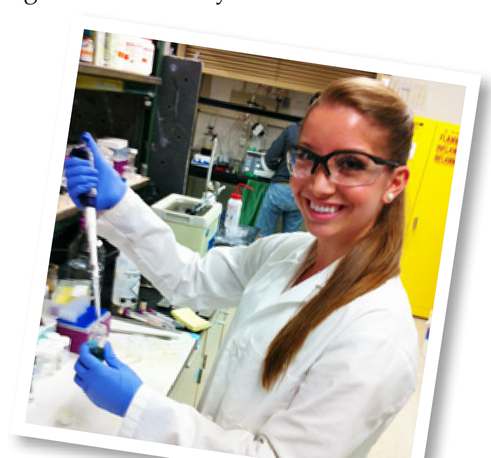


PHOTO COURTESY OF HEATHER

Kay | MSE, sophomore | Pittsburgh, Pa.

How has dancing influenced your approach to engineering?

I feel like dance has really given me a unique perspective on engineering because I have thought creatively my whole life through choreography. I also think being a dancer has helped me with memorization, which comes in handy in engineering. I've had to memorize routines since I was a little girl learning routines, so it just comes naturally to me now.

What do you like the most about being at Georgia Tech?

There are so many opportunities to get involved and meet new people, and the people are so down to earth, but motivated at the same time. It's inspirational to see what everyone is doing — if you have an interest there is something for you to do at Tech. I help MSE with recruiting. It's a really cool way to get people involved in your major and meet potential new students, and it's also a good way to get to know the administration.

Kristine | MSE, junior | Kansas City, Kan.

I ended up being valedictorian, and it was nice to be able to show him that dancers can be great students too. Maybe I helped change his mind about some of the stereotypes.

Why did you choose MSE as your major?

I'm really interested in bio materials and the way they can be used in medicine to improve quality of life. It gives me the chance to work in the medical field and help people without having to go through med school and become a doctor. We can build the tools and materials that doctors use.

Has anyone ever stereotyped you because you're a dancer?

When I was in high school I signed up for AP biology. The teacher, who knew I was on the dance team, came up to me and said, "Are you sure that you want to take this class? This is for college credit."

I just looked at him, and I was like, "I can do it." I was doing well in school and I knew I could handle one more AP class. I ended up being valedictorian, and it was nice to be able to show him that dancers can be great students too. Maybe I helped change his mind about some of the stereotypes.

Shelby | AE, junior | Overland Park, Kan.

PHOTO COURTESY OF SHELBY

How did you get into dancing?

When I was little I danced around the house all the time. I ran into furniture and stuff and my parents said, "We need to put her in to dance class, so she'll stop hitting furniture." I have been doing it for as long as I can remember and I love it. I feel like I wouldn't be as happy if I wasn't dancing in some way.

Have you been involved in any research?

This past summer I researched at NASA Ames Research Center in California. I worked on this project called the ADEPT, which is basically a mechanically deployable heat shield to be used on spacecraft. They're going to use that technology to go to Venus in hopefully 2023 if it keeps getting funded. It would be incredible to be able to say something I worked on went to another planet.

What types of stereotypes have you faced as a dancer?

Proving you can dance is a little bit easier than proving that you are intelligent. Education is important to me, so it's frustrating to me when people assume that I came to Tech just to dance and that I'm not smart enough for engineering. But it's not like that at all. I came here to study aerospace. That's my dream.

Kortney | ISyE, junior | Suwanee, Ga.

Why did you choose to study engineering?

I have always been more of a math and science person and I figured if I was coming to Georgia Tech that I'd study engineering. That's what Tech is known for. I chose ISyE because of the emphasis on math, which suits me.

What's your biggest challenge as a member of Goldrush?

Time management is a big challenge for all of us on the team. In addition to Goldrush and engineering I have a psychology minor and I'm director of Relay for Life. I'm also in a sorority and I work at the CRC. So it is safe to say I literally have no time. When we get to the point where football and basketball seasons overlap I run back and forth to everything. But I still manage; I still have my HOPE GPA. So it's working out so far.

I chose ISyE because of the emphasis on math, which suits me.

Rachel | ChBE, freshman | Houston, Texas

What is your favorite part of being a Tech student?

I love being surrounded by ambitious people and listening to them share their goals. It's intimidating sometimes, but it also pushes you. We really can do anything, and seeing that potential is really cool.

How do you balance dancing and engineering?

Growing up a dancer was like living in two different worlds because both of my parents have Ph.D.s. There was a balancing act, but I did find out early on that you can have that analytical side and the dancer side. Both parts have been a part of my life for a long time.

Chandler | CEE, junior | Houston, Texas

Tech pushes you past what you think your limits are... I'm going to be so proud of myself for meeting the challenges and doing things I never thought I'd be able to do.

Why did you choose civil engineering?

Civil engineering has different tracks you can take, and I wanted to do something with design or construction that had an environmental basis to it. Civil engineering is absorbing the building construction program, so it was a perfect fit. After meeting some people in the industry, it really makes me feel like I made the right decision when it comes to my education and my career after graduation.

How would you describe your Tech experience so far?

Being here has been the most difficult challenge of my life. I'm not sure how I'm going to make it sometimes, but I know that Tech accepted me because they believe I can do it. Tech pushes you past what you think your limits are. I know that when I graduate I'll look back and wonder how I did it all, but I'm going to be so proud of myself for meeting the challenges and doing things I never thought I'd be able to do.

How has being on Goldrush impacted you?

I'm such a nerd, and I have such an engineering mindset, but I really think dancing has allowed me to come out of my shell and be a more open person. I'm still very introverted, but when I'm in my Goldrush uniform it brings out a different side of me. I become all about school spirit and I become super outgoing. Then I go back to studying my dynamics homework and playing video games. It's fun to have both sides. ▪

PHOTO COURTESY OF CHANDLER

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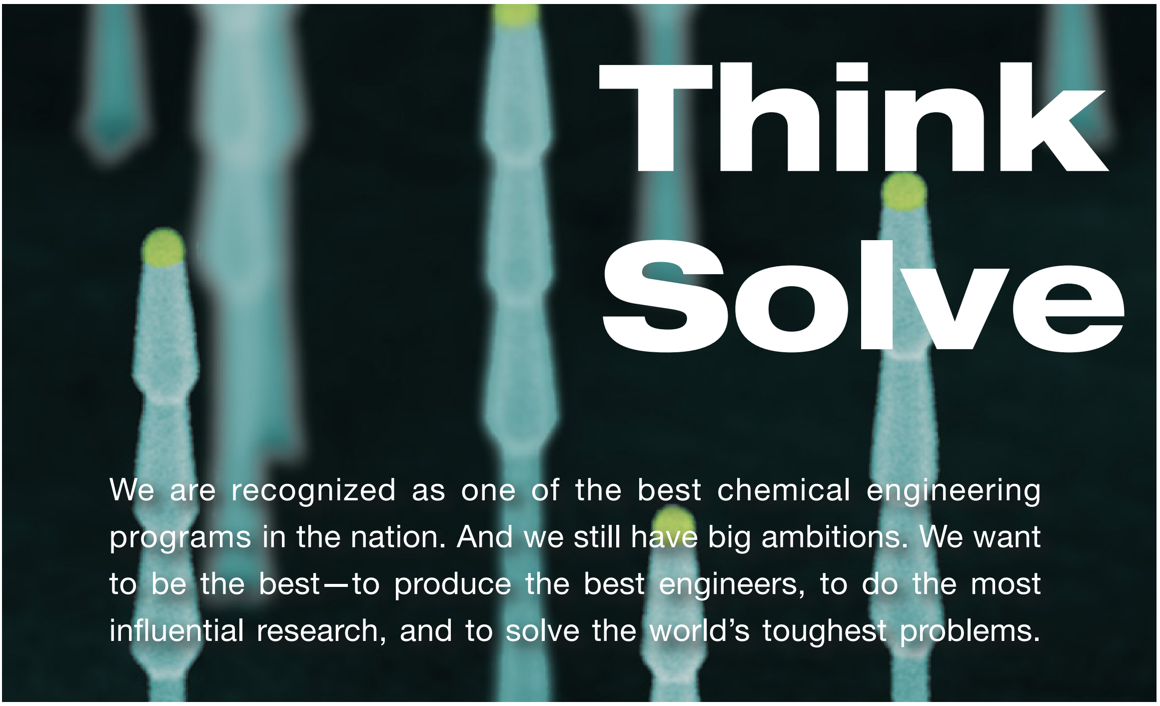

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Are You Smarter Than an...
Industrial Engineering Student?

Maybe it's been a while since you've taken an engineering test or quiz. But hey, it's like riding a bike. There are some things you never forget – like the Wankel engine. Can you still work the problems that CoE's industrial engineering students face? Time to get out the proverbial thinking cap and try your hand at some current quiz questions. (Remember, no slide rule or abacus allowed.) – Kay Kinard

PROBLEM 1

Evaluate the following integral.

$$y = \int_2^5 (3x^2 + x - 5)\,dx$$

a. y = x3 + 0.5x2

b. y = 125

c. y = -122.5

d. y = 112.5

PROBLEM 2

Determine the maximum of the function $y = 3x^2 - 4x + 9$.

a. + Q

b. 2/3

c. function has no maximum

d. 7.666

PROBLEM 3

A bowl contains 312 marbles: six red, seven green, eight blue, and the rest yellow. Three draws are taken with replacement. What is the probability of getting a red marble on the first draw, a blue marble on the second draw, and a blue marble on the last draw?

a. 0.00001

b. 0.00962

c. 0.07051

d. 0.99038

PROBLEM 4

Which of the following tools has the highest resolution?

a. A steel ruler

b. Ground flat stock

c. A caliper

d. A micrometer

PROBLEM 5

In a complex electronic system containing 1,000 devices in series, an increase in component reliability from 99.90% to 99.99% would improve the system reliability by a factor of approximately

a. 2.5

b. 3.7

c. 5.0

d. 7.5

PROBLEM 6

Which of the following standards provides guidelines for maintaining a calibration system?

a. ISO 9004

b. ISO 17025

c. ISO 14000

d. ISO 19011

PROBLEM 7

Assuming that everyone is independent and has an equal probability of having any of the 365 birthdays, how many people do you need in a room to have at least a 50-50 chance that two people will have the same birthday?

a. 183

b. 61

c. 40

d. 23

e. 10

ROB FELT

PROBLEM 8

A truck can hold up to 52 pallets of product. If y_i is a binary variable indicating whether the truck makes a delivery to the warehouse on day i, and x_i is a variable indicating the amount of product delivered on day i, then which of the following correctly models the constraint "If a delivery is made on days 1 or 2, then no more than 40 pallets may be delivered on day 3"?

a. $y_1 + y_2 \leq 40\, x_3$

b. $40\, y_1 + 40\, y_2 \geq x_3$

c. $40\, y_1 \geq x_3,\ 40\, y_2 \geq x_3$

d. $52 - 12\, y_1 - 12\, y_2 \geq x_3$

e. $52 - 12\, y_1 \geq x_3,\ 52 - 12\, y_2 \geq x_3$

PROBLEM 9

There are 5 basic types of spices. Any other spice is made by blending these 5 types of spices. The market sells 20 different blends. Unfortunately, none of these spice blends is my favorite blend. However, after buying specific quantities of each of these 20 spices and mixing them, I was able to produce my favorite blend. What is the smallest subset that you can buy to produce my favorite blend?

a. 5

b. 6

c. 10

d. 20

PROBLEM 10

Approximately how many years will it take to double an investment at a 6% effective interest rate?

a. 10 years

b. 12 years

c. 15 years

d. 17 years

e. 9 years

Answers: 1D, 2C, 3A, 4D, 5A, 6B, 7D, 8E, 9A, 10B

BEN WRIGHT

POP Quiz with Paul Fincannon

Officially, Paul Fincannon is BME's academic advising manager, but he's also its poet laureate. For the past several years, he's been emailing original haikus to the students he works with to get them through Dead Week. We quiz him about his work, which often draws on pop culture, and reprint our favorite Fincannon haikus.

- Lyndsey Lewis

Why did you become an academic adviser?
I went to grad school for guidance counseling development in New York state, and in the county I went to school in, there was very high unemployment. So I couldn't get a job as a guidance counselor. We moved to Michigan, where I was certified to be a guidance counselor, and I got a job at the University of Michigan in the office of admissions. I stayed there for almost 10 years, but I always kind of wanted to go into the advising capacity in some way if I couldn't be an adviser for high school students. I got a job at Emory for a year in the law school admissions office, but that just wasn't me, and then I saw this new exciting department open up with an adviser and I applied.

When did you begin writing haikus for students?
I don't how it started or why. One day I sent one out and then a year later I did one every day of Dead Week, just because it seemed like people needed a pick-me-up.

Who gets one?
All the biomed undergrads. That's the only people I send it to.

Do you ever receive responses?
Yes, I always get haikus back. A lot of them are much better than the ones I wrote.

How many have you written?
I just do it for Spring and Fall Dead Weeks. I only do five for each day of Dead Week, and that's about all I can muster up, honestly. I always have to go back and look to see what I have written about to give me ideas.

Do you begin writing them in advance or on the fly? Are you inspired by events that take place during Dead Week?
Lots of time I am inspired by popular culture. Sometimes Lindsay Lohan seems to be a popular topic of mine for some reason. Most of the time it's just about trying to identify with these students who are suffering through Dead Week.

What's the best part of your job?
I would say, like any adviser, just working with the students. They always pick you up – or, you pick them up and that in turn picks you up. These guys are terrific; they are going to go to do terrific things. ▪

Some of our favorite Fincannon haikus:

Dead Week is horror
Psycho, The Shining, Ringu
Nightmare on Ferst Drive

Hendrix kissed the sky
Katy Perry kissed no guy
You kiss good grades bye

Your Dead Week diet
Chips, Coke, candy, & coffee
B-MED hunger games

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GARY MEEK

AE Associate Professor Mitchell Walker stands with the space simulation facility in his lab, which is used to investigate electric rocket engines. These engines exhaust ions to generate the thrust for spacecraft maneuvers.