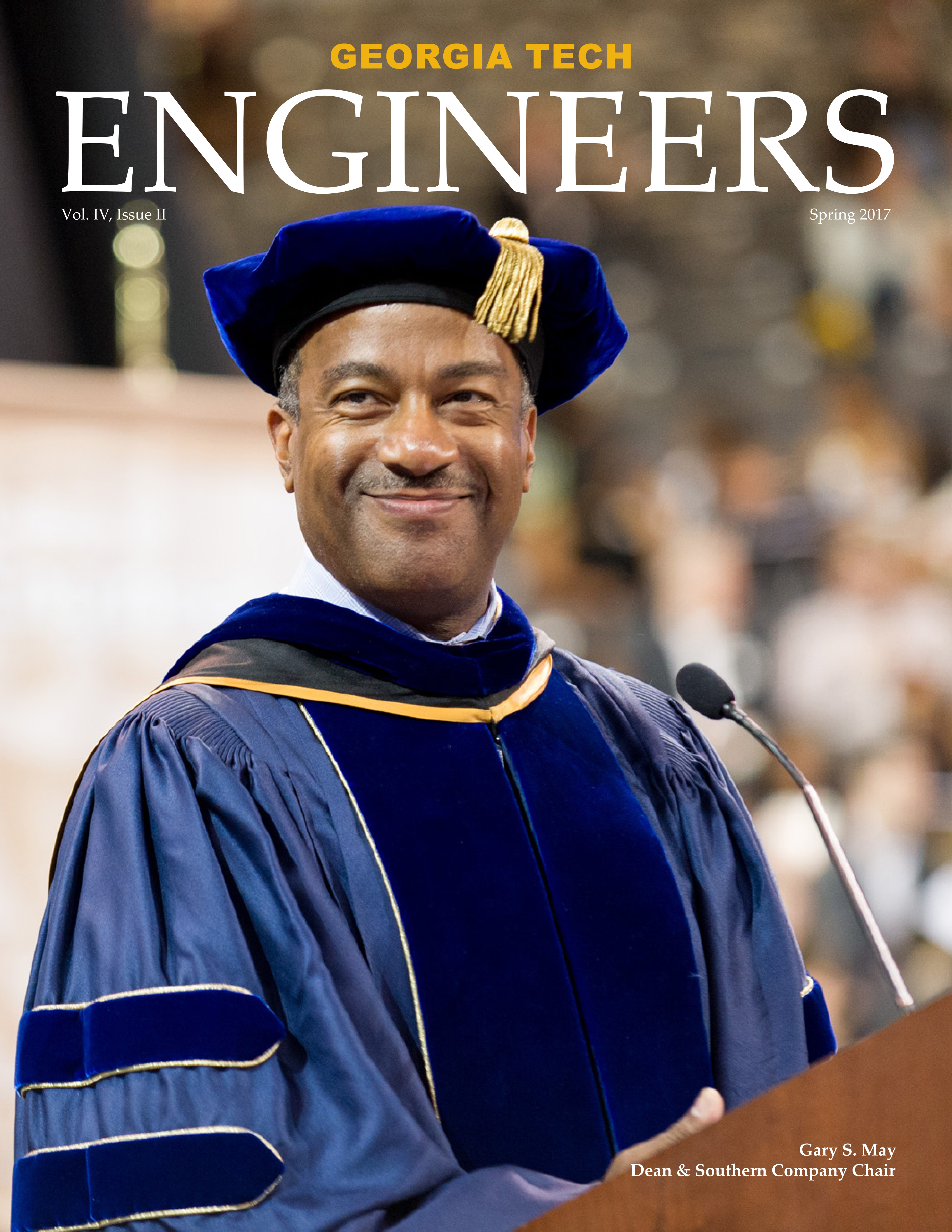
GEORGIA TECH

ENGINEERS

Vol. IV, Issue II

Spring 2017



Gary S. May
Dean & Southern Company Chair

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.

JASON MADERER

Dear friends of the College of Engineering,

One of my earliest goals as Dean was to better communicate with our alumni and friends. There are so many good stories at the College that never make the news but are worthy of our attention. Out of this, a magazine was born, and twice a year we try to give you a more personal glimpse into Georgia Tech engineers — some of our triumphs and at times a few tributes.

It has been an honor to be the dean of the College of Engineering. The people I work with — faculty, students, alumni, and staff — constantly amaze me. They are smart, curious, creative, and passionate about what they do. That is what makes leaving Georgia Tech so hard.

As many of you know, I am departing Tech to become the seventh chancellor of the University of California, Davis. I guess this is one way to make the cover of the magazine. As much as I love being dean, this represented an opportunity to impact a larger community by advocating for equal access to education, using discovery to address societal challenges, and spearheading efforts in nurturing a new generation of leaders.

Leading a campus will put my skills to the test, but not the ones I learned when I received my degrees in electrical engineering. Engineers have quite an array of professional skills — perseverance, creativity, communication, collaboration, problem solving, and listening — and I will lean on those heavily.

I will always be thankful for the preparation Georgia Tech gave me to take on new challenges, as well as the opportunities to grow and lead. So even though I depart the campus, I am, and always will be, a helluva engineer.

Gary

Gary S. May
Dean & Southern Company Chair

The College of Engineering has for years been known as a hub of innovation and forward thinking. With campus maker spaces like the Invention Studio, entrepreneur-centered programs like CREATE-X, and courses centered on hands-on learning, CoE is always at the forefront of what's next.

Now, a big initiative called NextEng is rolling CoE's innovation-centric programs under a single umbrella. NextEng aims to give every Georgia Tech student a hands-on learning experience before she or he graduates — a lofty goal, but one that seems increasingly attainable given the glut of relevant programs. This issue of the magazine will introduce you more to NextEng, a signature program initiated by departing Dean Gary May. He's on his way to lead the University of California, Davis, and while this issue is primarily dedicated to that, his programs will of course live on at CoE.

No matter your connection to the College, we think the students and faculty behind NextEng will inspire you. If you've got NextEng questions or ideas of your own, though, don't hesitate to reach out — my email address is below. We always count on friends and alumni to help us strengthen our offerings to educate the engineers of tomorrow.

Lyndsey Lewis
editor@coe.gatech.edu

CONNECT WITH US

VISIT
coe.gatech.edu

FOLLOW
twitter.com/gatechengineers

LIKE
facebook.com/gtengineering

WATCH
youtube.com/coegatech

SUBSCRIPTION PREFERENCES
If you wish to change your Georgia Tech Engineers subscription or add yourself to its mailing list, please send a request to editor@coe.gatech.edu.

GEORGIA TECH
ENGINEERS

Georgia Tech Engineers is published semiannually by the College of Engineering at the Georgia Institute of Technology.

Vol. IV, Issue II • Spring 2017

Dean
Gary S. May

Director of Communications
Kay Kinard

Editor
Lyndsey Lewis

Contributing Writers
Alyssa Barnes, Michael Baxter, Desirina Frew, Ashlee Gardner, Jason Maderer, Kathleen Moore, Jackie Nemeth, Joseph Novack, Camille Pendley, Maureen Rouhi, Joshua Stewart, Ben Wright, Shelley Wunder-Smith

Contributing Photographers
Tony Benner, Nick Burchell, Nicole Cappello, Ross DeLoach, Rob Felt, Ashlee Gardner, Fitrah Hamid, Jacob Iacino, Danny Karnik, Jason Maderer, Gary Meek, Josh Meister, Kathleen Moore, Pete Souza, Pete Winkel

Contributing Illustrator
Michele Melcher

Contributing Editor
Polly Ouellette

Graphic Designer
Sarah Collins

Associate Deans
Rob Butera
Associate Dean for Research and Innovation

Laurence Jacobs
Associate Dean for Academic Affairs

Kimberly Kurtis
Associate Dean for Faculty Development and Scholarship

Doug Williams
Associate Dean for Administration and Finance

Address
225 North Avenue
Atlanta, Georgia 30332-0360

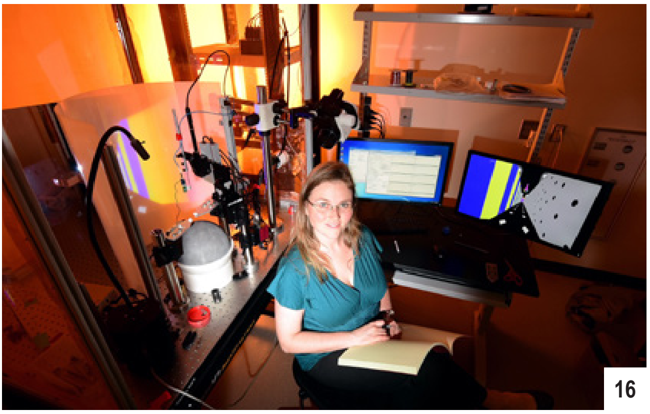
Phone
404.894.3350

Website
www.coe.gatech.edu


24


8

38


16

FEATURES

DEPARTMENTS

DEPARTMENT GUIDE

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

SYLLABUS
CoE is a giant college spanning a broad array of disciplines. In Syllabus, we spotlight one of the College’s programs.

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

BRIGHT IDEAS
Learn about the innovations that define engineering at Georgia Tech.

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

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

COVER PHOTO: ROB FELT

New Research Center Focuses on Lifestyle Innovations

Georgia Tech and Kolon Industries have signed a historic agreement establishing the Kolon Center for Lifestyle Innovation, an interdisciplinary research center bringing faculty and students from across Georgia Tech together to explore the role of advanced materials and manufacturing to create lifestyle innovations through research and development. Kolon will initially invest $3 million over a five-year period to establish the Center.

Sungmee Park, M.S. TE '95, was instrumental in the initiative, which began in 2010 with the establishment of the Kolon Term Professorship in the School of Materials Science and Engineering.

"I am delighted that the Kolon Center for Lifestyle Innovation brings together two world-class leaders in advancing materials and manufacturing research and education at Georgia Tech," she said, "while contributing to Kolon's growth engines and vision to be a global lifestyle innovator."

The Center will fund research projects each year, providing support for faculty and graduate students. Additional opportunities include graduate fellowships, undergraduate research scholarships, as well internships in the Kolon Group of Companies.

– Alyssa Barnes

TONY BENNER

$17 Million Contract Will Help Establish Science of Cyber Attribution

Georgia Tech has been awarded a $17.3 million cyber security research contract to help establish new science around the ability to quickly, objectively, and positively identify the virtual actors responsible for cyberattacks, a technique known as "attribution."

While the tools and techniques to be developed during the four-and-a-half year effort won't point directly to the individuals responsible, the initiative will provide proof of involvement by specific groups, identifiable by their methods of attack, consistent errors, and other unique characteristics. Such attribution could support potential sanctions and policy decisions — and discourage attacks by providing transparency for activities that are normally hidden.

The research, sponsored by the U.S. Department of Defense, is led by Georgia Tech researchers in collaboration with other academic institutions and companies. The project is expected to create an attribution framework dubbed Rhamnousia — in Greek mythology, the goddess of Rhamnous and the spirit of divine retribution.

"We should know who our friends are and who our enemies are in the cyber domain," said Manos Antonakakis, an assistant professor in the School of Electrical and Computer Engineering (ECE) and the project's principal investigator. "We owe it to the people of this country to objectively reason about the actors attacking systems, stealing intellectual property, and tampering with our data. We want to take away the potential deniability that these attack groups now have."

At Georgia Tech, researchers from the School of ECE, College of Computing, and GTRI will team with Antonakakis on this effort.

– Jackie Nemeth

Four BME Faculty Members Joining AIMBE College of Fellows

Four biomedical engineering faculty members have been elected to the American Institute for Medical and Biological Engineering (AIMBE) College of Fellows. Being selected for the organization is one of biomedical engineering's most prestigious distinctions.

The College of Engineering faculty members chosen for the 2017 class are Sathya Gourisankar, Jaydev P. Desai, Machelle Pardue, and Edward A. Botchwey. They were inducted into AIMBE's College of Fellows during the annual meeting, which took place in Washington in March.

Fellows are "considered the life-blood of AIMBE," according to the organization, "and work towards realizing AIMBE's vision to provide medical and biological engineering innovation for the benefit of humanity." The honorees are chosen from across academics, industry and government.

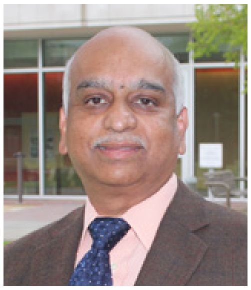
Gourisankar is a professor of the practice at the Coulter Department of Biomedical Engineering (BME), and he directs the Biomedical Innovation and Development program. He boasts more than 30 years of pre-clinical and clinical biomaterials research and product-development experience in medical device industries.

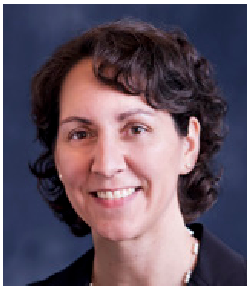
Desai, who came to BME last year, is a Distinguished Faculty Fellow at the school. His research interests center on image-guided surgical robotics, rehabilitation robotics, cancer diagnosis at the micro-scale, and grasping.

Machelle Pardue, a BME professor, was selected for AIMBE thanks to her contributions to understanding and treating blinding diseases.

Botchwey is an associate professor at BME. His lab aims to develop new techniques to repair, replace, preserve, or enhance tissue or organ function.

– Lyndsey Lewis






PHOTOS COURTESY BME

Clockwise from top left: Gourisankar, Desai, Botchwey, and Pardue.

AE Student Chosen for Astronaut Scholarship

Cameron McMillan, a fourth year aerospace engineering student, has been chosen by the Astronaut Scholarship Foundation to receive a $10,000 scholarship.

Announcement of the prestigious award came from none other than Georgia Tech alumna and three-mission astronaut Jan Davis, B.S. '75.

"The criteria for this award is that only the best and brightest students pursuing science, technology, engineering or math degrees are considered," said Davis.

McMillan, 22, was one of only 40 students nationally to receive the annual scholarship, and one of only a select few to receive the top amount of $10,000, said Davis.

Ultimately, McMillan hopes to enter the private sector as a researcher — after earning a master's degree in advanced vehicle design and optimization. Right now, however, he is immersed in three different research projects.

As a member of the NASA Model-Based Systems Engineering (MBSE) project in the ASDL, he is researching an engine certification protocol for a commercial carrier that is increasingly partnering with NASA.

– Kathleen Moore

KATHLEEN MOORE

3-D Printed Heart Valve Models Could Help Doctors Treat Aortic Stenosis

PHOTO COURTESY ISYE

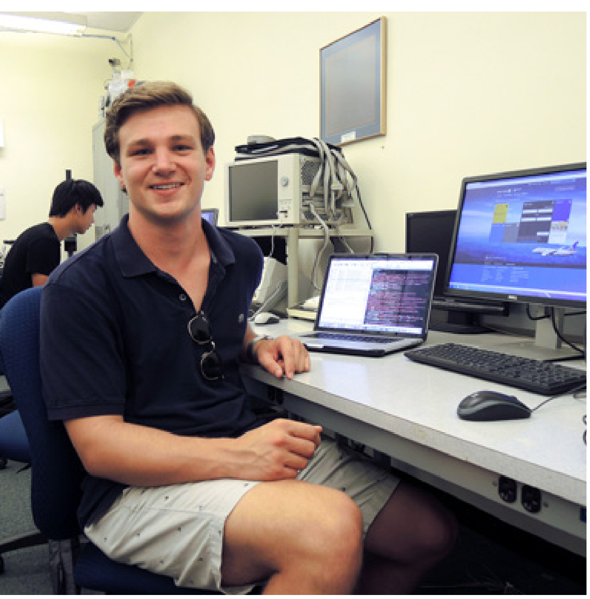
Tens of thousands of patients each year are diagnosed with heart valve disease, with many needing lifesaving surgery to treat the condition.

Professor Chuck Zhang, of the Stewart School of Industrial & Systems Engineering, and researchers at the Georgia Tech Manufacturing Institute are working on a tool that could help cardiologists care for patients with the disease. Drawing on highly detailed imaging from CT scans, they are using 3-D printers to make an exact model of an individual patient's heart valve. These one-of-a-kind models represent the size and proportion of the heart valve and can also mimic its physiological qualities, such as how it feels and responds to pressure.

The goal is to provide doctors with a new tool for planning procedures to treat aortic stenosis, a condition in which the valves in the left side of the heart narrow, restricting blood flow and potentially leading to heart failure. The condition is commonly associated with elderly patients, and its prevalence is thought to be on the rise as the population ages.

"There is big potential for these models," Zhang said. "We're thinking in the future, this may be a standard tool for pre-surgery planning and for training new surgeons."

– Shelley Wunder-Smith



ASHLEE GARDNER

Computer Engineering Student Donates 5 Million Air Miles to Student Organizations

Ryan Pickren, a recent graduate from the School of Electrical and Computer Engineering (ECE), is donating 5 million United Airlines miles to Georgia Tech student organizations that participate in charity work.

Pickren has been earning miles in United's Bug Bounty Program since October 2015. The program, started in May 2015, incentivizes researchers to identify and report potential security issues that could affect the company's websites, apps, or online portals. Mileage awards can range in value based upon a qualifying bug's potential impact to United or the airline's customers. Since the program's inception, Pickren has been the most successful participant, earning more than twice as many miles as any other participant.

He was inspired to try the program after taking an "Introduction to Cybersecurity" course with Professor Raheem Beyah. Initially compelled by the possibility of free air travel, Pickren soon found that working the program had other benefits.

"I took a look at the program and realized how fun it was," Pickren said. "My main motivation to keep at it was that I found it fascinating."

Upon realizing his success in the program, Pickren knew he wanted to give back to the place that taught him everything he knows about cybersecurity and computer bugs.

The gift is one of the largest in-kind donations made to the Institute by an undergraduate student.

– Ashlee Gardner

Georgia Tech Launches Ph.D. in Ocean Science and Engineering

Georgia Tech now offers an interdisciplinary Ph.D. program in ocean science and engineering.

The new program aims to train ocean scientists and engineers by combining basic and applied sciences with innovative ocean technologies.

A partnership of the College of Sciences and the College of Engineering, the program involves faculty from the Schools of Earth and Atmospheric Sciences, Biological Sciences, and Civil and Environmental Engineering.

"The greatest challenges in research result from the growing complexity, interconnectedness, and linkages of phenomena, which cannot be addressed within traditional disciplinary boundaries. This applies especially to the ocean — the largest environmental resource on Earth," said Annalisa Bracco, the program's co-director and a professor in EAS. "Chemical, biological, and physical processes in ocean cannot be viewed in isolation."

What's needed, she said, is an integrated approach to interpreting scientific data and developing effective solutions to immediate problems, such as loss of coral reefs, and their long-term consequences, such as loss of biodiversity.

School of Civil and Environmental Engineering Associate Professor Kevin Haas said the program brings together for the first time the large number of researchers focused on ocean studies but scattered across Georgia Tech academic units.

"We will be able to take a more holistic approach," he said, "through collaborations between scientists and engineers to address issues such as ecological impacts of global climate change and develop engineering solutions to adapt to or mitigate these impacts."

The inaugural class of OSE students will enroll in fall 2017.

– Maureen Rouhi

New Master's Degrees Focus on Interdisciplinary Topics

Challenges don't limit themselves to one particular field of study, so why should the people who tackle them? That is the thinking behind the College of Engineering's increased focus on interdisciplinary masters degrees, including an online M.S. in analytics (OMS Analytics), a three-track M.S. in cybersecurity, and an M.S. and MBA dual degree offered in conjunction with the Scheller College of Business. Led by ISyE's Joel Sokol, OMS Analytics is an expansion of the traditional on-campus master's in analytics, which has not been able to keep up with demand. The online version of the program will accommodate more students at a lower price, and open up access to working professionals who can complete the coursework outside of traditional school hours.

The cybersecurity program is an expansion of the master of science in information technology with new specializations in energy systems, policy, and information security. The energy systems track is housed in the College of Engineering and is led by ECE's Raheem Beyah. Meanwhile, the dual MBA degree program offered through the Scheller College of Business will allow students to prepare themselves for a career in the corporate world while simultaneously saving time and money as they earn an M.S. and MBA at the same time or one after the other.

– Ben Wright

GARY MEEK

Engineering the 21st Century Classroom

Faculty throughout CoE are breaking new ground in creative instruction.

by Desirina Frew

There's a lot riding on today's engineering students. The roster of challenges facing our nation and world seems as formidable as ever — updating civic infrastructure, vanquishing threats to health, creating technologies to promote the sustainability of food, energy, water and the environment.

New approaches are needed to conquer these and other challenges — and Georgia Tech is delivering. Faculty are teaching students not only how to solve problems, but also how to find and identify them; to think like designers and storytellers as well as mathematicians; to observe with curiosity and without preconceptions; to fail, get back up and try again.

The College of Engineering is a source and setting for much of this activity, and the four stories that follow illustrate how. Collectively, these stories reflect a guiding principle from the college: Meeting the world's demands for invention requires originality and ingenuity in education.

STEM from storytelling: A teaching model comes to life

Begin with a clear jar (a mason jar will work). Add corn syrup — that's plasma. Next, add red and white beads, the red and white blood cells. Smaller white beads are platelets. Then, shake it up.

At this stage, the fluid in the "blood jar" is sticky and viscous; or, as you might say to a group of 7-year-olds, it's "gloopy." So you add some water until the fluid flows naturally, providing an object lesson on why it's important to stay hydrated.

The "blood jar" is the most popular activity devised by Dr. Wilbur Lam's unique HealthReach class, in which biomedical engineering undergrads teach STEM concepts to hospitalized children using the kids' illnesses as a springboard.

Chronically ill children often struggle academically. They tend to miss school and combat high stress that comes with health problems. But with the hands-on experiments created by Georgia Tech students, children in Atlanta-area hospitals are enjoying their STEM lessons and often earning better grades.

One of Lam's key goals with HealthReach is to teach his students how to communicate science concepts effectively to all audiences. The first semester of HealthReach is spent exploring design concepts and practicing presentations in what Lam describes as a "boot camp" for learning how to teach sick kids. Students work in groups to create activities and demonstrations like the "blood jar" and then present them to their peers in class.

Often, after developing and sharing their experiments and gadgets, students will tweak their designs. "At the core, it's very much a design course in engineering," Lam says. "The class enables students to really become engineers in the sense that they get to design, develop and invent and go straight to the end user, a child with a chronic disease."

In their second semester, HealthReach students visit local Children's Healthcare of Atlanta hospitals a couple times a week and work directly with kids. So far, they've interacted with about 400 student-patients, many of whom are repeat customers.

Next, Lam wants to implement a study to assess the program's long-term impact on the academic performance of chronically ill kids. If Lam and his colleagues can produce concrete data on HealthReach's value, it could inspire similar projects elsewhere.

Developing an entrepreneurial mindset

A young man arrives at the intensive care unit of Massachusetts General Hospital, suffering from congestion, cough, fever and chills. He is diagnosed with bronchitis, prescribed steroids, and sent home.

But a day later, he's back in the emergency room, vomiting and struggling to breathe. The hospital admits him; doctors struggle to save him. Their efforts are unsuccessful. After two weeks he's removed from life support and passes away.

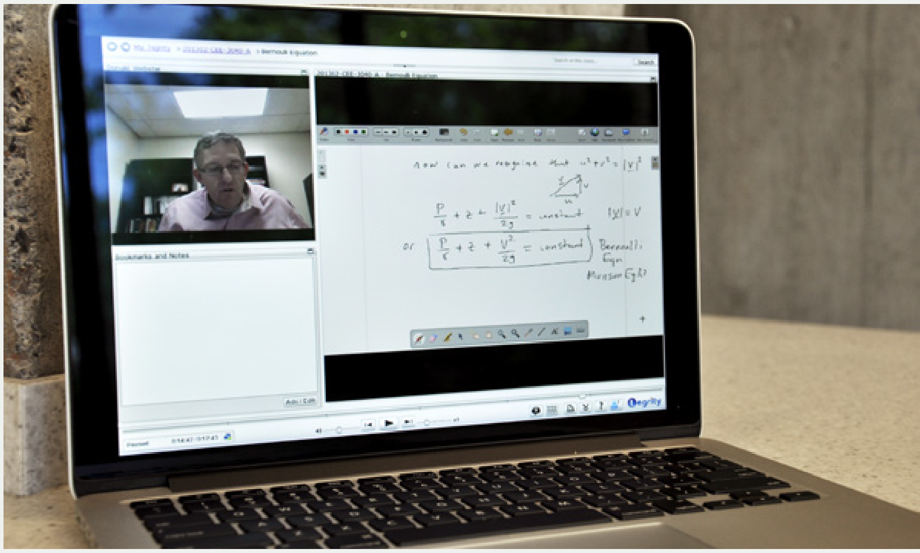
This case study, examined at length in the New England Journal of Medicine, forms the basis of the Engineering Physiology course taught by Dr. Kyla Ross and Dr. Phil Santangelo.

At the beginning of the course, Ross and Santangelo tell their students: "You've been hired by Mass General Hospital to evaluate this case. Your team is looking for missed opportunities in disease detection, progression and intervention. Your assignment is to make recommendations for a different standard of care."

For the entire semester, students work in groups to assess this case from every conceivable angle and develop models to explain what went wrong. In the process, students synthesize and apply knowledge and techniques from many past courses.

They also draw on the considerable expertise of their professors and teaching assistants. Ross's area is systems physiology; Santangelo's is cell biology. Graduate assistants cover mathematical modeling and algorithm coding.

According to the final conclusions of the case study, the young man died from influenza A virus, complicated by staphylococcal pneumonia and herpes simplex virus (HSV) type II. Those complications present a number of variables. It's up to the students to decide what problem they want to solve — and how to solve it.



In a flipped-classroom model, students view lectures online and participate in interactive, hands-on learning during class time. ECE professor Bonnie Ferri teaches a flipped version of Circuit Analysis (opposite page).

One group explores how influenza's suppression of the immune system could lead to reactivation of HSV II or accelerate staph infections; perhaps immunotherapy could have helped. Another group examines the drugs the patient received in the emergency room and modeling interactions; maybe there was an unintended immunosuppressant effect. And another group analyzes the window in which antivirals for flu would have been most effective.

GARY MEEK

Each group then analyzes their problem through mathematical models, refined through trial and error and the input of their professors and classmates. "We have them try it once, reflect on that, try it again," Santangelo says. "The philosophy of this class is fail fast, and fail often. But it's failure with a purpose, because the students gain the insight and competence to find and solve problems for the rest of their lives."

Student invention from keen observation

The first time Jorge Mena noticed a dirty ultrasound machine circulating in the emergency room, he didn't really think about it. Someone would clean it before the next patient, right? But then he noticed the same thing again. And again.

Mena was a biomedical engineering senior, enrolled in Dr. Jeremy Ackerman's clinical observation design course. In this class, students spend 6-8 hours a week in emergency rooms across Atlanta, and their job is to watch, listen, and learn.

Ackerman isn't just a biomedical engineering professor; he's also a practicing emergency physician who sees patients at some of those same Atlanta hospitals. With that interdisciplinary mindset, Ackerman challenges his students to think like designers and storytellers, and identify the hospital's flaws in architecture, process, and technology. "We know there are problems around here somewhere," he says. "You find them."

For Mena, that problem was dirty ultrasound wands. A typical emergency room has just a few ultrasound machines. When a patient arrives with abdominal trauma or internal bleeding, staff grab the nearest ultrasound machine. Then, it's on to the next patient. In the rush to save lives, there's often no time to assemble cleaning supplies to sterilize the machine.

Mena observed that the ultrasound wands in use were sometimes soiled with dried gel or smears of blood, potentially exposing patients to infections. So when he began his senior design capstone project, he told his teammates about it, and together they came up with a solution: a disposable polymer pad that attaches to the ultrasound wand. One side has a slick coating that replaces the ultrasound gel. The other is adhesive so it adheres easily to the surface of the wand. After the ultrasound is performed, the technician can throw away the dirty pad.

The young entrepreneurs took their idea and launched a start-up company, SonoFAST. Today, Mena is helping to get it off the ground while also attending medical school at the University of California, San Francisco.

FlexSpark, which developed a device to prevent deep vein thrombosis, is another startup to originate from the course. Syed Hasnain, the company's co-founder, credits Ackerman's class with the start-up's success. As of early 2017, the startup had raised $1.2 million in venture funding and landed a $65 million distribution contract.

"You realize, going into the corporate world, just how unprecedented this access to medical staff is," Hasnain says. "When we began the accelerator, we were the underdogs, a bunch of undergrads competing with Ph.D.'s and working doctors. But we'd been able to get the input of about 97 different medical professionals on our device."

This gave his team the edge, Hasnain says — and enabled them to design a device that would meet a genuine need for both patients and hospital staff.

"Most biomedical engineering courses focus on developing tools to solve problems," Hasnain says. "But Dr. Ackerman's course is unique in giving us the opportunity to unleash our curiosity in a practical environment and identify and solve actual problems in healthcare. It's really a transformative experience for students who take it."

Remaking labs for the real world

Here's one way to practice calculating the acceleration of an object: Get a long curved track, a pinewood derby car and a handheld accelerometer.

But the method has a few problems. For one, it's a hassle to transport and construct such a system, so it's very difficult to use as a classroom demo. And you can only handle one such track, which means just a few students take a hands-on role, while others have to watch.

So a Georgia Tech research group, aptly named Hands-On Learning, decided to create a replacement: a small, portable pendulum, the bottom of which holds a smart phone with a built-in accelerometer (commonplace in smart phones today).

When the pendulum starts swinging, the phone swings with it, allowing students to track and gather data about the rate of acceleration. Because the pendulum device is affordable and easy to make, every student in class gets an opportunity to work the experiment.

Hands-On Learning is one of Georgia Tech's unique Vertically Integrated Projects or VIPs. The projects bring together interdisciplinary teams of undergraduate and graduate students, post-doc researchers and professors to tackle ambitious research challenges.

Through the Hands-On Learning VIP, undergrads earn course credit as they design better ways to explore engineering principles in the classroom. In the process, they create valuable tools and approaches to improve the learning experience for their classmates and themselves.

The group is led by Drs. Bonnie and Al Ferri, both professors and associate chairs for undergraduate affairs in their respective schools. Professor Bonnie Ferri in ECE has spent 13 years exploring ways to incorporate hands-on experiments into her electrical engineering courses. Her husband, Dr. Aldo Ferri (ME), is implementing similar projects in his mechanical engineering courses.

Together, the Ferris have received three National Science Foundation grants to develop mobile hands-on experimental modules, and the experiments they've developed benefit about 2,500 Tech students each year.

This year, the Hands-On Learning VIP is tackling their most ambitious project yet: programming and modifying a remote control car that rides on a customized table-top treadmill. From the car's electronic circuitry to the mobile apps used to control it, every aspect of the project offers a way to help engineering students apply their lessons in the real world. ▪

Building a Better BME with Problem-Based Learning

One student says his problem-based class has been integral to his education.

by Joseph Novack

In the biomedical engineering (BME) department at Georgia Tech, a commitment to improving people's lives through technology is built into every course. BME students are quickly introduced to the idea of delivering solutions to real-world clinical problems, which taps into the reason many of us selected this major: We want to be part of a collaboration that solves serious health care problems in a multidisciplinary way.

As a first-year biomedical engineering student, I worried about how I was going to apply my engineering knowledge. Sure, I can tell you about stress-strain curves, write pages of code, analyze deformable bodies, or apply Bernoulli's equation, but my biggest concern was always learning to channel that knowledge into an idea that could make or break a research endeavor. My worry began to fade by my second semester, though, when I took my first problem-based learning design class.

Here, BME students were organized into teams of six. Each was given a major problem to consider, a set of deadlines and a goal to contribute a legitimate idea or solution to the problem. To solve it, teams could take on any approach, from building a mechanical device to developing a new type of sensor. There is no better way to grow confidence in handling the research and development process than to brainstorm, plan, manage, and implement an innovation you and your team created from scratch.

The problem-based learning rooms are a critical component of these design classes. Whiteboards are on every wall of the work room, and an experienced facilitator is always available to answer questions and help keep the teams on track. In addition, professors are encouraging and focused on asking questions that guide the team's advancement. In the beginning of the semester, most classroom time is spent discussing research and making lists on the walls with relevant information. By the end, the whiteboard space is used to find creative solutions to issues standing in the way. Questions like "Why did this fail?", "How strong would it need to be to prevent rupture?" or "How do we calculate rotational acceleration from shear force?" cannot be solved easily. The most motivating factor, however, is that those questions (once answered) can be incorporated into the design that team is building to solve the given problem.

Another defining factor in problem-based learning is the use of presentations and papers to illustrate work and progress. Since every team member is responsible for oral presentations, the group is only as strong as its weakest member. As a result, everyone is equally invested in making sure each group member has a solid understanding of the project. Students learn that working in cooperation with each other is paramount. Emotional intelligence, patience, and communication are just as important to research as innovation, technical expertise and creativity.

In my first semester taking a problem-based learning class as a second-year student at Georgia Tech, my team's topic was concussions, which we eventually narrowed down to detecting concussions in football players. With eight group members in one room, the white boards were soon covered with all sorts of potential ideas, from an on-field camera tracking system to a blood test based on biomarkers released on impact. Our first major deadline forced us to focus on just three of our solutions, and another team member and I presented our ideas to a panel of students.

Based on the panel's feedback, our group had to narrow down the three solutions to one, and from there develop a mathematical model that would solve a potential problem in the idea's development. My team hoped to develop a silicone helmet sensor that would detect force impacts at different angles and translate it to known

There is no better way to grow confidence in handling the research and development process than to brainstorm, plan, manage, and implement an innovation you and your team created from scratch.

JACOB IACINO

values for linear or rotational acceleration that cause concussion on the human brain. Our biggest challenge was using principles of deformable bodies to calculate the relationship between a force impact at some angle and the corresponding rotational acceleration. In our next big presentation, my team and I had to explain this relationship to another student panel, which included a graduate student working in the field of deformable bodies. With the new feedback from that presentation, we developed a physical mold of the silicone sensors at 10 times the actual size and performed tests on it, dropping all sorts of different weights from a known height to see if the sensor would work as it was predicted to.

Several professors in the biomedical engineering department went out of their way to help us, even allowing us to use a wet lab when it was needed. In the end my team and I created a mathematical model, tested a fabric and silicone prototype, and gave another oral presentation to demonstrate our solution. Learning what it took to solve a real-world problem from hypothesis to solution taught me more about scientific research, problem solving, conflict resolution, and diligence than any class I have ever taken.

Internships, co-ops, and careers all require an engineer to apply his or her knowledge in unconventional and innovative ways, and any biomedical engineer who has taken a problem-based learning class will be readily prepared to take on those challenges. By participating in classes that require well-communicated solutions based on technical skills, research, creativity, and teamwork, we learn how to translate theory into practice. Problem-based learning is an excellent introduction to real-world research and development, and it has been one of the most motivating classes in my college career. ▪

History in the Making of Devices

Russell Dupuis' discovery 40 years ago gave us today's definitive process for mass-produced electronics.

by Michael Baxter

We think of the engineers, scientists, and inventors who change the world as icons. Alexander Graham Bell. Thomas Edison. Albert Einstein — their largest contributions can be recited in just a few words.

But some of them live among us, unnoticed, even though they too made contributions that profoundly impacted everyday life. Russell Dupuis is one of them.

The smartphone you peer into, the LED bulb in your desk lamp, the Blu-Ray player that serves up your favorite film — all are here largely because of Dupuis, a professor in electrical and computer engineering at Georgia Tech.

That's because an essential component of their manufacturing traces back to a process that Dupuis developed in the late 1970s, a process that ushered in a new breed of mass-produced compound semiconductors. These electronic components — particularly those forged of elements from columns III and V in the periodic table — can operate at extremely high frequencies or emit light with extraordinary efficiency. Today, they're the working essence of everything from handheld laser pointers to stadium Jumbotrons.

The process is known as metalorganic chemical vapor deposition, or MOCVD, and until Dupuis, no one had figured out how to use it to grow high-quality semiconductors using those III-V elements. Essentially, MOCVD works by combining the atomic elements with molecules of organic gas and flowing the mixture over a hot semiconductor wafer. When repeated, the process grows layer after layer of crystals that can have any number of electrical properties, depending on the elements used.

Dupuis remembers well the autumn day in 1976 he first produced a working III-V semiconductor device using MOCVD. "It was a solar cell," he recalls. "I had built my own reactor mostly out of spare parts to study the MOCVD process to grow a semiconductor on a gallium arsenide substrate. I took the solar cell outside and connected it to a current meter, and it worked pretty good. Since MOCVD was viable for solar cell technology, I thought it should be good for lasers and LEDs."

PETE WINKEL

He was right. At the time, Dupuis was a member of the technical staff at Rockwell International, hired to create working devices based on the MOCVD process being explored by Rockwell chemist Hal Manasevit.

"They knew they needed devices to make systems," he says, "and I sold them on the idea that I could evaluate different materials using MOCVD to make those devices."

After his initial success, Dupuis built a second reactor and refined the process. He then published a paper on his discovery and presented it at the 1977 Device Research Conference, an annual gathering of industry professionals and academics. But before the presentation, he was approached by a familiar face: Nick Holonyak, a University of Illinois professor who was Dupuis' mentor.

"He came to my room and said, 'I see you've got an interesting paper — can you build thin layers with MOCVD?' Dupuis says, laughing. "I said, I can do as many as you need. Nick looked at me like I was crazy and said, 'I've been trying to do this for five years.'"

Holonyak is a history-making engineer in his own right. Mentored by John Bardeen, the inventor of the transistor, he became the first to create a visible light-emitting diode in 1962, a breakthrough that continues to transform electrical lighting. While a senior at Illinois in 1969, Dupuis joined Holonyak's lab.

Today, at the age of 88, Holonyak continues to operate a lab, and his praise for Dupuis is nothing short of ebullient.

"Russ Dupuis should be known as the person who invented the big process that's now used to manufacture all the lasers and LEDs," Holonyak says. "He has all the tricks to handle the complicated gases, the complicated chemistry, the stuff that explodes. I actually call the process 'Dupuis-MOCVD' — I hyphenate it."

Their meet-up at the conference led Holonyak and Dupuis to reunite in the name of electrical engineering. Together, they published a paper after Dupuis demonstrated that MOCVD was superior to another emerging process, molecular beam epitaxy (MBE), in growing high-purity layers for compound semiconductors. In other words, they showed that MOCVD would work even for compound semiconductor devices that required complex structures.

Meanwhile, MOCVD began to take off as an electronics manufacturing process. Today, it remains the most widely used technology for creating thin-film compound semiconductors for electrical devices.

Dupuis left Rockwell in 1979 to join AT&T Bell Labs and later transitioned to academia, joining the faculty at the University of Texas, where he worked for 14 years. In 2002, he inquired about a position in Georgia Tech's College of Engineering.

"It was a chance to work with really smart graduate students," he remembers. "Plus, Georgia Tech had a building that was perfect for a clean room setup. I announced I was leaving a year before I actually left Texas, and when I walked in the door at Georgia Tech, the new lab was finished. The support here has been exceptional."

These days, Dupuis is a Georgia Research Alliance Eminent Scholar and holds the Steve W. Chaddick Endowed Chair in Electro-optics. He continues to explore new combinations of atomic elements to make thin-film compound semiconductors.

"Russ Dupuis should be known as the person who invented the big process that's now used to manufacture all the lasers and LEDs."

— NICK HOLONYAK

And while he may go unrecognized in the local Starbucks, he has not escaped acclaim. In 2003, the White House welcomed him, Nick Holonyak, and a third engineer, George Craford, awarding all three the National Medal of Technology. Most recently, in 2015, he was one of five recipients of the National Academy of Engineering's esteemed Charles Stark Draper Prize — again, honored alongside his mentor, Holonyak.

While appreciative of the honors, Dupuis remains grounded as an engineer, more at ease with labor than with glamour.

"I remember our team in Holonyak's lab hand-building 36 furnaces in the machine shop to support a project," says the man whose reactor forged from spare parts ended up making history. "New ideas don't require the best equipment. So if you've got a new idea, get your act together, and with the tools on hand, try it and test it. Because someone somewhere else may get there before you do." ▪

A New Way to Approach Alzheimer's: From the Beginning

by Lyndsey Lewis


GARY MEEK

If you keep up with medical news, you've probably heard of beta amyloid. It plays the villain in plenty of stories about Alzheimer's disease: One of the signature markers of Alzheimer's patients is plaque buildup created by the protein.

Researchers know that much. The problem is, underlying causes of memory problems in Alzheimer's disease are still poorly understood.

Annabelle Singer, a new assistant professor at the College of Engineering, is trying to change that. Through studying brain activity in mice genetically programmed to get Alzheimer's, she hopes to help chart earlier signals of disease — and maybe even engineer ways to prevent or reverse it.

Singer began in the Coulter Department of Biomedical Engineering in mid-2016. Instead of jumping right to plaque, her Alzheimer's research focuses on brain activity before plaque forms.

"If we understand these patterns of neural activity that predict behavior and memory deficits," Singer said, "then we can use these as a marker for the disease."

That's a big ambition, but for now, its setting is relatively modest. Singer and members of her lab work in a space equipped with computers, neural-recording devices and a curved screen. They train mice to navigate a virtual-reality maze (which looks a little like a 1980s video game) projected on the screen, and then they record brain activity as the mice respond to challenges and rewards they find there.

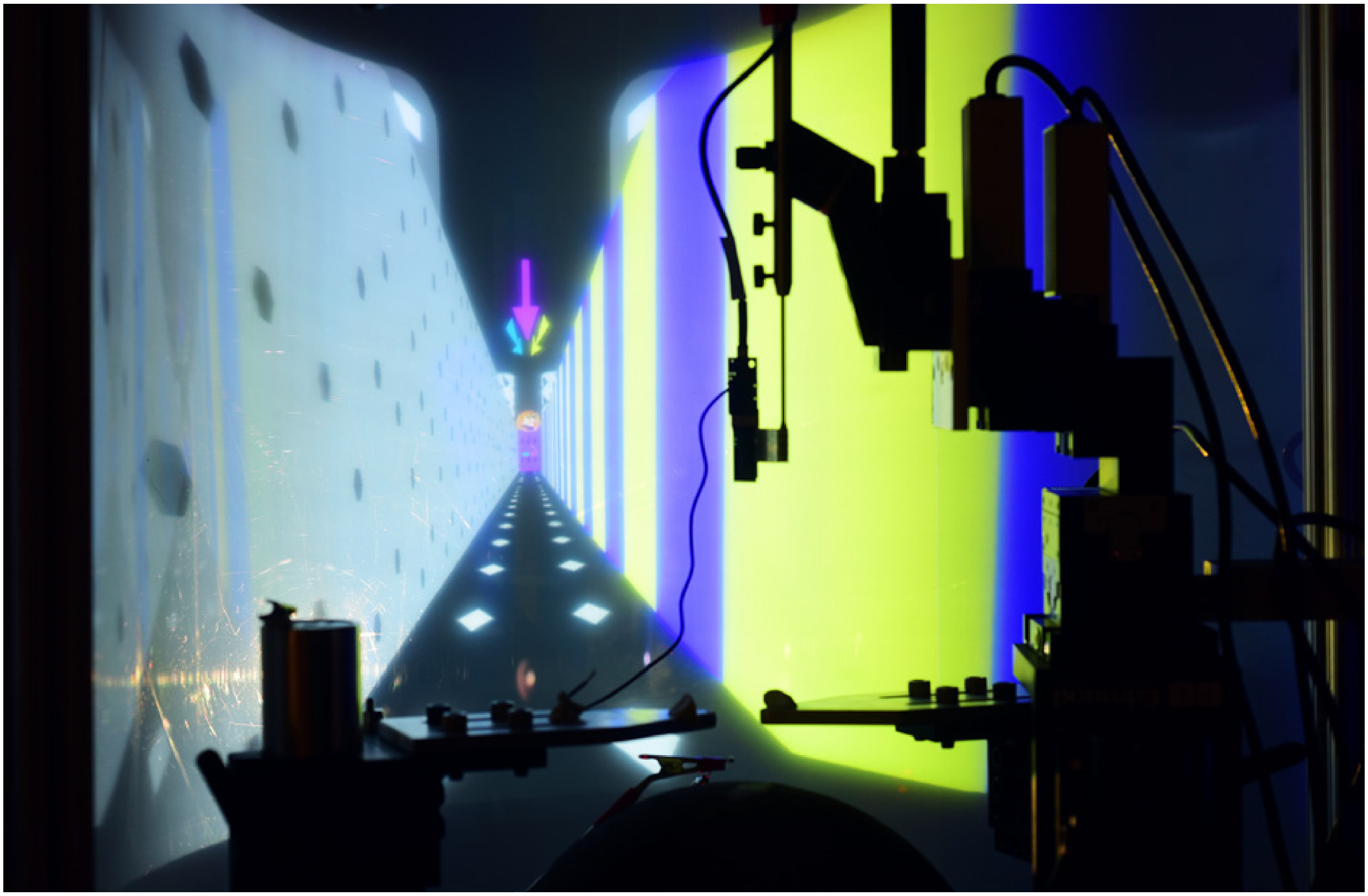
The idea is to track deficits in neural activity, because they can have sharp impacts on behavior. If doctors and scientists can change patterns in this activity early on, Singer reasons, there might be a chance to prevent Alzheimer's altogether.

She's already made significant strides in her research. Working with Hannah Iaccarino, a graduate student in Professor Li-Huei Tsai's lab at the Massachusetts Institute of Technology, she recently published an article in Nature. Its central study, which focused on mice with early signs of Alzheimer's, revealed huge potential for driving brain waves as an Alzheimer's disease treatment. Surprisingly, they could drive these therapeutic brain waves with a simple flickering light, like a strobe light but faster.

Under the right conditions, the lighting could do more than just impact brain waves; it could actually redirect them to help clear beta amyloid plaque. Eventually, Singer would like to see similar kinds of noninvasive treatments — light therapy that can change patterns in brain activity, for example — tested on people.

But for now, there's a lot more work to go with mice. Singer, who received her Ph.D. from the University of California, San Francisco, saw Georgia Tech could offer the kind of interdisciplinary atmosphere her research requires.

"I wanted to go to a place that did excellent neuroscience and excellent engineering," she said, "and I wanted to know that there would be students who were comfortable with both sides of it."



GARY MEEK

Singer and members of her lab train mice to navigate a virtual-reality maze projected on a curved screen. They record brain activity as the mice complete the task.

In her lab, she's taken on students with backgrounds in both areas, and Emory University's joint stake in the Coulter Department means Singer has access to its Alzheimer's Disease Research Center. She also appreciates the supportive atmosphere among Tech faculty members.

"I feel like people are rooting for me as a young faculty member, regardless of whether or not it helps them, and that's nice," she said.

Singer was always interested in psychology. In graduate school, she got involved with the UCSF Memory and Aging Center, where patients were tested for memory problems and thinking issues. What really interested her, though, was how to bridge that kind of work with what she was already doing. Her own research centered on neurons and the ways they work together to create new memories, and she wanted to link that research with the wider world of human brain function.

Later, during her postdoctoral years, she saw she could explore her interests in "understanding Alzheimer's disease at what we call the circuit or system level." That is to say, she wanted to learn more about how a brain's neurons might misfire long before an Alzheimer's diagnosis.

Singer knows the stakes are high. Though her current work is concentrated on mice in the lab, she's always conscious of its implications on human life.

"We think about our lives, ourselves, in terms of stories," she said. "I am who I am because of the things I've done and the experiences I've had. If you lose that, it's like you lose yourself."

Still, Singer thinks some of Alzheimer's most devastating realities might also signal hope for new treatments. She noted that patients don't experience "a steady decline in cognitive function, so it's not like every day you get a little worse. Instead, patients can shift between seeming pretty normal and seeming pretty lost and disoriented, even in the same day."

"That kind of spontaneous shift from highly functional to dysfunctional — that's not cell death," she explained. "Those are reversible things in the brain. If we can figure out what's going on there, that's a potential route to a therapy." ▪

From Point A to Problem Solved

Biomedical engineering students confront a more challenging way of learning.

by Michael Baxter

Peer through the narrow window into Room 1232 Whitaker, and you'll see what appears to be a typical college class: professor talking, students listening, whiteboards.

But if you were inside the room, you'd find that this class is anything but typical.

The students sit in pairs, facing each other, four to a table. The instructor, Maysam Nezafati, is not lecturing; he's demonstrating a problem. Teaching assistants walk the room, depositing desk blotter pads onto the tables. Notebooks and laptops aren't allowed — each student tandem must tackle Nezafati's problem on the giant pads.

Welcome to the spring semester session of BMED 2210, an early course in biomedical engineering where students apply material and energy equations to address real-life situations.

Solving problems is foundational to engineering courses, but the "Problem Solving Studio" approach taken in BMED 2210 is somewhat revolutionary. In a traditional lecture class, the professor talks and models equations, then sends the students off to try it on their own. Conversely, nearly all class time in the Problem Solving Studio (PSS) is spent team-tackling complex problems with little or no previous instruction on how to do so. By using the requisite desk blotter pads, the students must present not only their solution but also how they arrived at it.

"The power of this environment is that the students learn by doing, in public, and in cooperation with their peers," says Joe Le Doux, an associate professor of biomedical engineering who created the PSS method. "And because the work is done in the open, the instructor can make real-time changes to the difficulty of the problem to make sure each student is being challenged at the appropriate level."

> "The power of this environment is that the students learn by doing, in public, and in cooperation with their peers," says professor Joe Le Doux.

Today's session illustrates the concept perfectly. After Nezafati assigns two problems and a practice quiz, the class is quiet. Eyes dart up to the ceiling, down to the desktop, over and around the room. Some signal anxiety; most reflect deep thought.

Then the buzz of low conversation begins to emerge, the volume steadily growing louder as 24 pairs of undergraduates start to confer with each other. A hand is raised here, another over there, summoning Nezafati and teaching assistants Brandon Holt and Cassidy Wang, whose job is to roam the room and help students maneuver through their mental logjams.

"The first problem was fairly simple, and if they write down the 10-step solving method and do the analysis, they could find the answer," Nezafati says later. "But the second problem was harder. They needed to figure out a component that was missing and how to work that into the solution."

Therein lies a hallmark of the Problem Solving Studio: The problems are designed to be hard enough to inhibit solving them individually, but not so difficult that students find them impossible.

"Other problem-solving approaches begin with completely open questions, like 'how do you stop cholera in Haiti?'" says Le Doux. "Our studio is at the other end of the spectrum. We're working on a rigorous analysis of a particular question, only the complexity is not already filled in, like it is in a textbook problem. Many different variables have to be considered, and the students need to work together and apply different ways of thinking about the question."

Le Doux decided to pioneer the method back in 2009. "I was teaching a class lecture style, and it wasn't going well," he says, adding that the students didn't seem to be connecting to the material. He consulted with Wendy Newstetter, a learning scientist on staff at the Coulter Department of Biomedical Engineering, who encouraged him to try some different techniques. One was problem-based learning found in medical education. So they added an hour to the 3-hour credit course to create a problem-solving supplement to the lecture.

"But I quickly learned that not everyone would interact in the exercise," Le Doux says. "Some watched while others worked. That's when I tried the desk blotters — they had to take notes on the big blotter pad."

After more trial and error, the course became entirely dedicated to in-class problem solving, with no lecture. "It used to be you really needed the lecturer because you didn't have as much access to information as you do today," says Joe Le Doux. "A good lecturer helped determine which facts are most important. But that lecturer can only make the material appropriate for a fraction of the students. The Problem Solving Studio allows the instructor to personalize the experience for each student."

"It definitely pushes me to think beyond how I previously thought," says Mary Kathryn Clark, a freshman BME major. "I draw a picture of the system, because every problem requires a level of visualization. Then I ask, 'what can I manipulate to find out something else? And how do I set up a series of equations to find that?'" To prepare for quizzes, she explains the steps of her problem solving to her roommate, whom she acknowledges "sometimes zones out."

That level of explanation and demonstration is key to the PSS approach. Cassidy Wang, one of Nezafati's TAs who took the course in fall 2015, says it's what makes the approach most challenging. "I'd never been a fan of rigid rules, and this class has a lot of conventions in solving engineering problems," Wang says. "But if you can't explain something in a way that someone else can understand, then you really don't understand it enough yourself."

If there's a "secret sauce" to the Problem Solving Studio, it's a concoction of collaboration and communication — working with a partner out in the open, then detailing the step-by-step journey to a solution. So far, it's shown to be effective. Le Doux says the class garners more positive feedback from students compared to traditional classes as well as a higher level of mastery of course content, as evidenced by change scores on concept inventory tests.

PHOTOS COURTESY JOE LE DOUX

"Plus, we looked at about 300 students longitudinally to see how they did in the follow-on course," he says. "The PSS students, on average, do about a half-letter grade better than those who took the lecture-based version. And the biggest gains were made by students who have 'average' GPAs overall."

Nezafati is now one of four faculty members teaching BMED 2210 using the Problem Solving Studio approach, and the method is gaining traction within the College of Engineering and beyond. A generation from now, it may be far more commonplace in higher education.

"Unlike a lecture environment, you're constantly getting feedback about what the students know and where they are in the learning process," Le Doux says. "And you get to know the students better, too." ▪

Making the Leap from Professor to Dean

Former CoE faculty members who took dean roles elsewhere reflect on Georgia Tech.

by Lyndsey Lewis

Supportive colleagues. Interdisciplinary research. Valuable mentorship opportunities.

These are just a few of the reasons listed by former College of Engineering professors about what makes CoE a great place to work. Over the past few years, those former faculty members have all accepted dean roles at other universities, demonstrating that the College also offers an excellent foundation for leadership.

"I truly appreciate the commitment that Georgia Tech has to undergraduate learning and to innovation in engineering education," says Steve DeWeerth, now dean of the P.C. Rossin College of Engineering and Applied Science at Lehigh University. While at Georgia Tech, he held posts including associate chair for graduate studies in the Coulter Department of Biomedical Engineering and associate dean for research and innovation.

Tech's focus on interdisciplinary research and innovation shaped DeWeerth's vision for Lehigh. One of his first orders of business there was to initiate an "envisioning process" for his college. This faculty-led advancement of Lehigh engineering focuses on enhancing research impact and interdisciplinary endeavors.

DeWeerth says what when the Lehigh job opened, he knew it was the right time to move. But there are still things he misses about Georgia Tech.

"People are really committed to the university," he says. "Georgia Tech is such a wonderful place that way."

The Institute is committed to them in turn. Faculty members have plenty of chances to tackle new challenges, which Ravi Bellamkonda (now dean of engineering at Duke University) named as key to his career growth.

"Georgia Tech is a dynamic, can-do place and is very permissive to those who want to engage and lead," says Bellamkonda, who left Tech when he was chair of the Coulter Department. "As a result, I had many experiences at Georgia Tech that allowed me to discover and develop my ability to have impact beyond my department. GT/Emory BME and IBB faculty, staff, and students are very special."

Perhaps it might seem natural, then, that mentorship is also important at Georgia Tech. Bellamkonda can name plenty of fellow faculty members and administrators

From left: Former CoE professors Gilda Barabino, Ravi Bellamkonda, Barbara Boyan, Bobby Braun, Steve DeWeerth, and Joseph Hughes.

who influenced his career, including Bob Nerem of the Petit Institute for Bioengineering and Bioscience, Georgia Tech Executive Vice President for Research Steve Cross, and Bill Todd of the Scheller College of Business.

"It is also special and unusual to have Provost Rafael Bras and President Bud Peterson be so accessible and willing to give their time freely," Bellamkonda says.

As Gary May, the outgoing dean of the College of Engineering, prepares for a new role himself as chancellor of the University of California, Davis, several former CoE faculty members also cite the value of his leadership in inspiring their own paths to dean roles.

"I have been lucky to have been able to assemble an outstanding leadership team," says Barbara Boyan, who became dean of engineering at Virginia Commonwealth University in 2013. "Watching [former CoE Dean] Don Giddens and Gary May as role models, I learned to trust my team."

Boyan spent over a decade at CoE, and she ended her tenure there as associate dean for research and innovation. While at Georgia Tech, she helped spearhead the Institute's relationship with Children's Healthcare of Atlanta, and she directed the Translational Research Institute for Bioengineering and Science (which led to the creation of the master's program in biomedical innovation and development).

"The leadership team empowers faculty and staff at all levels to be the best that they can be," she says.

That fact might make it difficult to leave Georgia Tech at all, but new opportunities always beckon. Bobby Braun, who was a professor in the School of Aerospace Engineering until 2016 (and spent a year as NASA's chief technologist), saw a dean role at the University of Colorado Boulder as a chance to "integrate the leadership and management skills I developed at NASA with the academic and scholarship experiences I had matured at Tech."

Like other faculty members, Braun highlights the influence his colleagues had on his career. He names Ben Zinn, David S. Lewis Jr. Chair in Aerospace Engineering, and AE Chair Vigor Yang as two of his foremost mentors.

"I certainly learned the significance of interdisciplinary research at Georgia Tech," Braun says. "Just as significant, I learned the importance of true scholarship, collegiality, personal respect, and the need for open and consistent communication."

Sometimes, taking a position as dean can give a faculty member the chance to build on an emerging legacy. Gilda Barabino served as Georgia Tech's first vice provost for academic diversity (in addition to the Coulter Department's associate chair for graduate studies). Now that she is a dean, Barabino says, she continues her work opening doors to more diverse students.

"My position as dean of The Grove School of Engineering at The City College of New York affords me the opportunity to lead one of the most diverse engineering schools in the nation," she says. "CCNY's historic mission of access to excellence appealed to me and my desire to ensure that the talent pool for engineering is fully tapped and that a diverse cadre of engineers are trained to creatively solve societal problems."

Her interdisciplinary collaborations at Tech, as well as the administrative posts she held, help guide her as dean.

"Opportunities for leadership and professional development are critical to the advancement of faculty and to the advancement of the institution," she notes.

Joseph Hughes, who spent nine years at CoE, can speak with a unique authority about how the lessons of Georgia Tech translate to dean roles. He recently stepped down as Drexel University's dean of engineering.

"My job as dean at Drexel was a dream come true," he says. "Challenging. Rewarding. Frustrating. Exciting. New, every day."

While at Georgia Tech, he served as Karen and John Huff Chair of the School of Civil and Environmental Engineering (and briefly the Tellepsen Family Chair of Engineering). He appreciated the respect and freedom granted to Tech faculty members — as well as the sense of accountability.

Those qualities extended beyond faculty members, he notes. At Drexel, he thought back on two particular Georgia Tech mentors who embraced some of the Institute's best qualities.

"Whenever I questioned my compass as dean, I said to myself, 'What would Don Giddens do?' He was a remarkable dean and is a great human being," Hughes says. "Second, I would recall something that Wayne Clough instilled in me: I had just given a great talk to the Georgia Tech board (or so I thought), and Wayne pulled me aside and said to me, 'You never said the word student. Never do that again.' He was not happy with me. I have never forgotten the lesson." ▪

PHOTO COURTESY NASA

Georgia Tech Astronaut Returns to Earth

Shane Kimbrough spent nearly six months on the International Space Station.

by Jason Maderer

Georgia Tech graduate Shane Kimbrough is back here on Earth following a nearly six-month stay on the International Space Station (ISS). Kimbrough and two Russian cosmonauts undocked from the station 250 miles above the planet the morning of April 10. They landed in Kazakhstan 3.5 hours later to officially end a 173-day mission that began on October 19.

Kimbrough served as commander of the ISS for the majority of the stay, joining Tim Kopra as the second Georgia Tech alumnus to hold the position in 2016. Kimbrough received his master's degree in operations research from the H. Milton Stewart School of Industrial & Systems Engineering in 1998.

Kimbrough and his crewmates traveled 73.2 million miles while in space. That's 2,768 orbits of the Earth. Kimbrough conducted four spacewalks totaling more than 26 hours. His last one, on March 30, was the sixth of his career.

During the mission, he also captured cargo ships with a robotic arm, grew lettuce, and flew a flag from the Ramblin' Wreck.

This was Kimbrough's second trip to space — he flew aboard the space shuttle in 2008. Georgia Tech has 14 astronaut graduates, tied for second among public universities. ▪

InVenture Team Turns Idea Into Startup

One year later, TruePani is taking their water disinfection system to the next stage.

by Joshua Stewart

A year ago, School of Civil and Environmental Engineering seniors Samantha Becker and Shannon Evanchec were convinced they could change lives in rural villages around the globe.

They were about to sell InVenture Prize judges on their antimicrobial cup and lotus flower, which uses copper to kill germs in household water in places like India where contamination with *E. coli* and other microbes is a significant problem. The idea is to drop the lotus in the common household water storage tanks in these communities to keep it clean and replace household cups with the special antimicrobial ones so germs won't grow there either.

The product won them InVenture's People's Choice Award, $5,000, and eventually got them into Georgia Tech's CREATE-X startup program.

Now Becker and Evanchec have graduated, and they're working full-time to turn their creation into a business they call TruePani. So far they've secured their first round of angel investment and made a return trip to southern India.

"We had the lotus in 12 households in India, and we spent a month collecting data on that," Evanchec said. "We wanted to get design feedback from people that would actually be using it and also make sure it would work in the real world, because up until that point, everything that had been done was lab testing."

The pair is combing through all of that data and sending their designs out for third-party testing. They're also putting together a scientific advisory board and trying to figure out how to manufacture the cups and lotus flowers.

"You go into this thinking, 'OK, I'm strong in engineering and I'm strong in microbiology,' but we're just undergraduate students. We don't have the experience in manufacturing, we don't have the credibility of someone who has a Ph.D., and we don't have experience in business," Evanchec said. "It's kind of getting a crash course in all of those things as you're trying to grow this business."

GARY MEEK

TruePani's antimicrobial water disinfection system uses a thin layer of copper to keep water clean. Their cup's design mimics the shape of those typically found in households throughout rural India, and the lotus flower — a symbol of purity in Indian culture — is attached to a chain so it can be placed in the home's water storage container.

She said that's where CREATE-X helped, providing mentors and connections to help students with startup ideas navigate those tricky waters.

"Sam and I — and, I think, a lot of cofounders of startups — get kind of tangled up in this hairball of all of your work you have to do and all of the problems you have to solve," Evanchec said. "You have to have someone standing outside that and giving you perspective, saying 'You're too bogged down on this, here's the big picture. Here's what you need to be focusing your time on.' If you don't have that, I think it's really hard to be successful."

Right now, TruePani is just Becker and Evanchec along with a Georgia Tech international affairs student who's working with them as an intern. They're also getting help from a friend who studies biomedical engineering. But Evanchec hinted recently some exciting developments are on the horizon that could push their fledgling company to the next stage.

"We'll keep you posted about that," she said, smiling. ▪


TECH

“We were the lucky ones, Dr. May”

As Gary May prepares to become chancellor of UC Davis, Georgia Tech’s College of Engineering says goodbye.

by Lyndsey Lewis

The press release begins like any other: “University of California President Janet Napolitano has selected Georgia Tech Engineering Dean Gary May to be the next chancellor of the University of California, Davis...”

Nothing unusual; just another announcement about an administrator on the move. After six years at the College of Engineering’s helm, May will fly west for a bigger, fancier role at a new university.

But a peek at his Facebook page, which drew hundreds of comments in the days after Georgia Tech published that press release, reveals a more interesting story.

ILLUSTRATION: MICHELE MELCHER

Unlike many deans, Gary May has always been more than his title. He was first a product of the College of Engineering — a 1985 electrical engineering graduate — and later became a symbol of it.


ROB FELT

"So sad to see this legend leaving our campus," wrote one person.

"We were the lucky ones, Dr. May," said another. "Thank you and congratulations."

Then there was this: "I left industry to become a middle school science teacher to increase the pipeline of students that can pursue careers in engineering. You inspired me to do so."

Unlike many deans, Gary May has always been more than his title. He was first a product of the College of Engineering — a 1985 electrical engineering graduate — and later became a symbol of it. His legacy at CoE is evident not only through the College's rankings or programs, but in the friends and admirers he's won through his career here.

"I love the place," May says. "I'll always love the place, no matter where my career takes me."

The Innovation Boom

He's spent years working to make the place better. May became dean of the College in 2011, following a nationwide search, and he has overseen more than 400 faculty and 13,000 students each year. Before being named dean, he was the Steve W. Chaddick Chair of the School of Electrical and Computer Engineering. (His research centers on computer-aided manufacturing of integrated circuits.)

Chaddick himself knows May personally, and he credits him for encouraging more collaboration across majors and research fields at Tech. For example, Chaddick says, his leadership paved the way for the boom in interdisciplinary projects at the Capstone Design Expo — a shift that students themselves wanted.

"Gary is very good at sensing what is going on with students, not just faculty," Chaddick says.

One of May's most recent student-centric accomplishments is the creation of NextEng, a collective of Georgia Tech programs that encourage innovation in learning and research. Several of its offerings are programs that May spearheaded during his stint as dean, such as CREATE-X (which promotes entrepreneurship among undergraduates).

When the entrepreneurship theme picked up momentum among students, Chaddick says, May was eager to jump on board.

"Gary was very supportive," he says. "He was sensitive to what students cared about and found ways to help support these sort of ground-up programs."

May is particularly proud of CoE's advancements in innovation over the past few years. When he became dean, he notes, Georgia Tech was still considered a few steps behind many of its peers in the area. Now, the Institute is famous for focusing on societal challenges, pushing hands-on learning, and supporting student startups.

"That was the thing that was not as strong at Georgia Tech," he says, "and is getting stronger and has potential to be among the very top places in the country."

Promoting Diversity at CoE and Beyond

Some of the things May will be remembered for began well before he

PETE SOUZA

was ever named dean. He's a longtime advocate for diversifying engineering, and he understands the importance of getting kids interested early (and keeping them hooked later).

One of his signature initiatives speaks to this need. SURE, or the Summer Undergraduate Research in Engineering/ Science program, gives underrepresented minority and women students the chance to flex their skills in high-level engineering work. Designed to encourage students to pursue graduate education, SURE traces its roots to a program May founded called GT-SUPREEM, which was also the first thing he received a grant for at Georgia Tech.

"That program has a special place in my heart and in my career," he says.

Alexis Coates, now a student at Georgia Tech, first met the dean at the Summer Engineering Institute (SEI), in which high school students take on major engineering

GARY MEEK

Top: One perk of being dean — meeting major leaders in science, technology and politics. Above: May and his wife, LeShelle, with Buzz. Opposite page: The dean wears navy and gold regalia at commencement, reflecting the official colors of the University of California, Berkeley (where he earned his doctorate).

ROSS DELOACH

“Gary has been instrumental in promoting diversity in STEM fields at Georgia Tech and throughout the United States.”

– Reggie DesRoches

Top: Gary and LeShelle at the College of Engineering Alumni Awards Induction Ceremony. Opposite page: A Star Trek fan through and through, May will perhaps be the first UC Davis chancellor to have participated in a cosplay photo shoot.

projects. May visited SEI to discuss both Tech and higher education in general.

“Whether it be SEI, SURE, or his many talks and engagements around the country and world,” she says, “Dean May has opened the door to limitless possibilities for me and so many others.”

Reggie DesRoches, the Karen and John Huff Chair of the School of Civil and Environmental Engineering, points out that May’s advocacy has left a permanent imprint on both CoE and engineering at large.

“Gary has been instrumental in promoting diversity in STEM fields at Georgia Tech and throughout the United States,” he says. “There are thousands of underrepresented students that are working in STEM fields because of the various programs that Gary has developed and supported.”

DesRoches has known May for almost 30 years, and he admires his willingness to share the limelight and commend his coworkers.

“He is the first to say that he cannot take credit for the success of the CoE, and that the hard work is done by the chairs, associate chairs, faculty, and staff,” DesRoches says. “However, it is his vision and leadership that has inspired us towards that success.”

There are a few things left undone. When May took office as dean, he said he wanted to vault CoE to the rankings “medal stand,” as he calls it — one of the top three engineering schools as judged by U.S. News & World Report. That placement still eludes the College, but its other strides in U.S. News rankings (and elsewhere) would seem to make up for that.

May leaves CoE with both its graduate and undergraduate programs ranked among the top 10, while all eight schools under the College are also in the top 10 of their kinds.

He’s also mindful of some triumphs that rankings don’t quantify. CoE is, he points out, “simultaneously diverse, large and excellent.” That’s no small feat, and it’s something the College quietly achieves every day.

‘A Pretty Compelling Story’

In many ways, then, he has his work cut out for him at UC Davis, another institution that’s diverse, large, and excellent at once. Like Georgia Tech, Davis is ranked among U.S. News’ top 10 public universities, but May knows that it’s not yet a household name across the country.

“Davis is a place that is very strong in many areas,” he says. “I think what I’d like to be able to do there is raise the profile.”

May is not a stranger to the University of California system — he received his master’s and doctoral degrees from Berkeley (which is where he met DesRoches). But he knows how much CoE has shaped him as an engineer, professor and leader.

Deborah Kilpatrick, the chair of CoE’s external advisory board, is grateful for how much he’s shaped the College in turn.

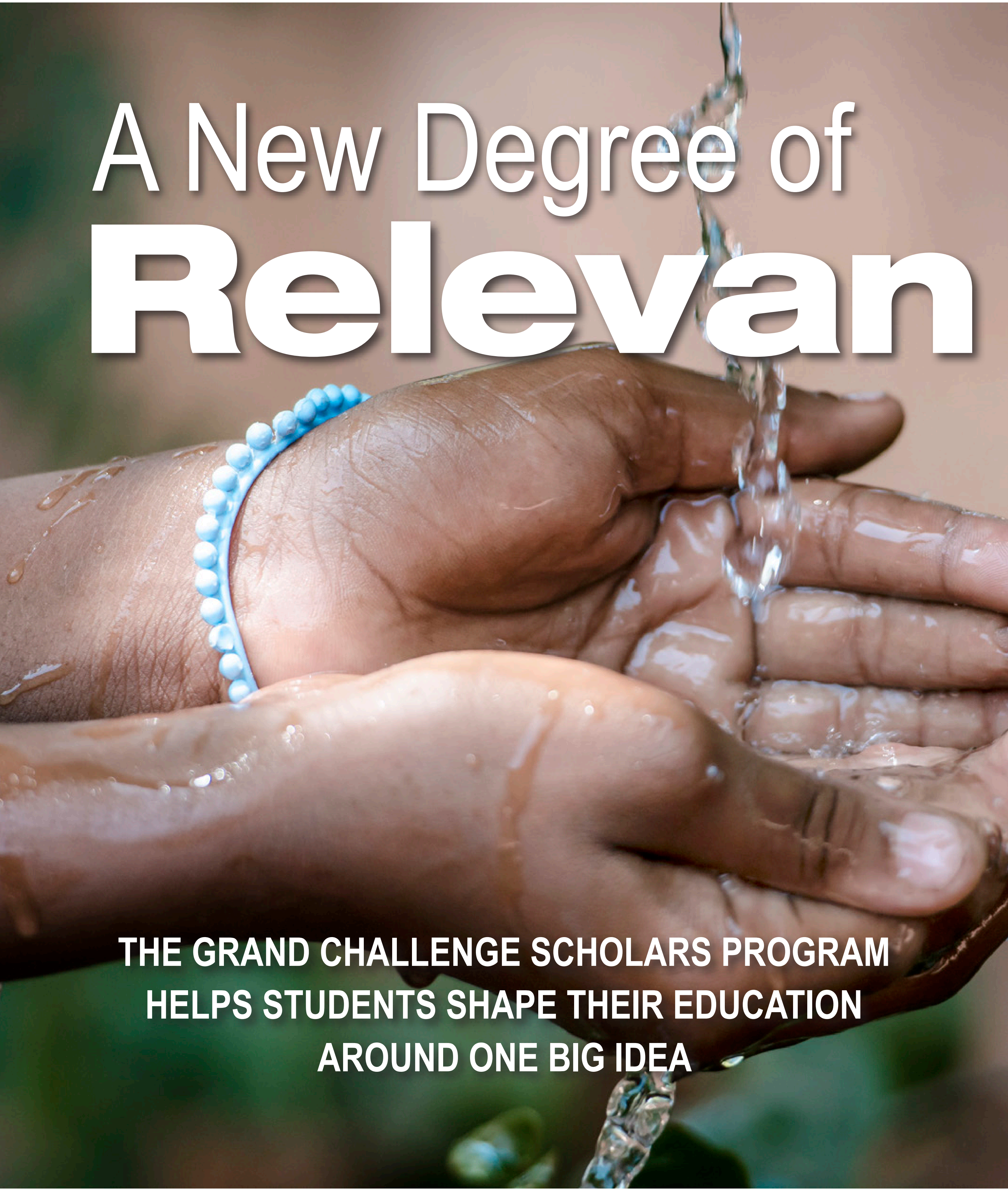
“Gary May has ensured that the College of Engineering has grown its focus on educating and developing the whole person to create the future leaders in our society,” she says.

May will take over at Davis on Aug. 1. And while he’ll have a loftier title and more responsibilities there, there are a few things Davis can’t match.

“To be the dean of engineering at a place where they sing about engineering in the fight song,” he notes, “is a pretty compelling story.” ▪

Polly Ouellette contributed to this story.

JOSH MEISTER



A New Degree of Relevan

THE GRAND CHALLENGE SCHOLARS PROGRAM HELPS STUDENTS SHAPE THEIR EDUCATION AROUND ONE BIG IDEA

by Desirina Frew

It will take years to determine just how much the people of Flint, Michigan were harmed from consuming water contaminated with dangerous levels of lead. And with millions of old lead pipes still used in cities across the U.S., what happened in Flint has many people asking, "Just how safe is *my* water?"

Angelique Johnson is working to answer that very question.

As a Grand Challenge scholar at Georgia Tech, Johnson is part of a team of seven undergraduate students developing an electrical sensor that people could install in their homes to test their water for the presence of lead and other heavy metals.

An affordable at-home sensor is important, Johnson explains, because of what might happen as water travels from a treatment plant to your home faucet. The water may test fine at the plant, but as it flows through the network of piping, it can pick up contaminants. That's exactly what happened in Flint.

"An electrical sensor that automatically tested for lead in the water could help avoid a crisis like Flint," says Johnson, a sophomore majoring in biomedical engineering. "Researchers say they don't have enough data about water in the home, so the sensors could aggregate data into a database. Then homeowners could access the data for the area. If there is a problem with the water, people could see it."

Johnson is one of Georgia Tech's first participants in the Grand Challenge Scholars Program launched last fall. The program offers undergraduates an opportunity to shape their education around tackling one of the 21st century's biggest engineering challenges.

The National Academy of Engineering chose the Grand Challenges in 2008 as a framework for promoting innovation and discovery in the 21st century. The 14 challenges include goals like "Make Solar Energy Economical," "Engineer Better Medicines," "Secure Cyberspace," and "Develop Carbon Sequestration Methods." Johnson's project falls under the challenge "Provide Access to Clean Water."

Building on this list of challenges, NAE launched the scholar program to involve college students. The program helps students gain the perspective and skills to solve the grand challenges facing the world today. More than 120 engineering schools across the U.S. have committed to participating in the program — with the aim of graduating thousands of Grand Challenge scholars over the next decade.

At Georgia Tech, the program is co-directed by the College of Engineering's Dr. Wendy Newstetter and the School of Electrical and Computer Engineering's Dr. Joy Harris. Eleven students applied in the first semester, and the program is quickly growing in popularity. "The interest is there," says Harris. "I think we are going to grow and scale very quickly. And I appreciate the level of resources that Georgia Tech has dedicated very early on."

The Grand Challenge Scholars Program offers undergraduates an opportunity to shape their education around tackling one of the 21st century's biggest engineering challenges.

Harris says there are no limits to how many students can participate. Georgia Tech has set a goal to enroll between 125 and 150 students in the program each year.

Sophomore Elizabeth Kappler, a biomedical engineering major and another Grand Challenge scholar, is working to "Reverse-Engineer the Brain." Kappler is particularly interested in improving the methods used to detect concussions in children. She's pursuing her goal through one of Georgia Tech's unique Vertically Integrated Project (VIP) teams, a collaborative research effort that brings together undergraduate and graduate students and faculty members across disciplines.

Kappler's team, Concussion Connect, is led by Dr. Michelle LaPlaca, who partnered with colleagues at Emory University to develop a patented concussion assessment test, DETECT. The test, which won a research award from the NFL, is already being used by sports teams to assess players for concussions right on the sidelines of the game, getting an immediate diagnosis that's essential for quick response and treatment.

Kappler and her VIP teammates are exploring how to modify DETECT so it could help children. They started by reviewing scholarly literature to gauge how a child's brain functions differently than an adult's and are using that data to recommend modifications to the adult version of DETECT.

Kappler's interest in concussion research is personal: As a senior in high school, she suffered a concussion while playing soccer. At the time, her family lived abroad, and the differences in medical care meant Kappler was not properly diagnosed.

"As a result, I went back to play too soon and actually got a repeat concussion, which worsened the symptoms," she says. Kappler's concussion symptoms were typical — dizziness, nausea, headache — but because her original injury wasn't managed correctly, the symptoms worsened, and she took longer to recover. If she'd been immediately diagnosed with DETECT, that "could have changed the entire situation."

The experience fueled Kappler's desire to develop better tools to assess and treat concussions. "Developing the pediatric DETECT system could keep a lot of kids from experiencing long-term effects through proper assessment of brain injuries," she adds.

Hands-on research is just one hallmark of the Grand Challenge Scholars Program. The

FITRAH HAMID

Georgia Tech's Michelle LaPlaca and Emory University's David Wright are part of the team that developed the concussion assessment test, DETECT. The VIP team Concussion Connect, led by LaPlaca, is now exploring modifications for a pediatric version of the device. VIP teams are one of many curriculum options available to fulfill Grand Challenge requirements.

"With the Grand Challenges, you have this focal point. Industry is always looking for people who have a sustained engagement with something. And students see an opportunity to bring together all these things they're doing, in a way that wouldn't have been possible otherwise."

– Wendy Newstetter

Angelique Johnson with her team, Hydrogauge, at the Grand Challenge Scholars Program annual awards banquet.

National Academy of Engineering outlined four additional "experiences" Grand Challenge scholars must fulfill: entrepreneurship, service and social action, cross-cultural interaction, and interdisciplinary learning. Each experience must relate to the core theme of the Grand Challenge chosen by the student.

But the program is extremely flexible, so requirements can be met in a number of ways. And Georgia Tech's abundant resources offer students a wealth of options. For example, there are more than 100 ways to fulfill the cross-cultural aspect alone.

Newstetter and Harris help Grand Challenge scholars capitalize on the opportunities. They mentor students on what kinds of activities are available and help them select options that best support their project's central theme. "At the beginning, we sit down and map out a pathway with each student that makes it possible for them to assemble an impressive portfolio," says Newstetter.

For entrepreneurship, Kappler plans to participate in 3-Day Startup, an intense, teamwork-oriented weekend workshop. For service, she hopes to volunteer in a clinic that specializes in traumatic brain injuries. Courses on topics like developmental and cognitive psychology will help Kappler build on her understanding of the brain — and these represent the interdisciplinary learning aspect of the program.

In addition to her work on the lead water sensor, Angelique Johnson is also finding interesting ways to fulfill the program's requirements. For the service requirement, she plans to join the Georgia Tech chapter of Engineers Without Borders, an organization that facilitates engineering-based service projects. And if her team can develop a successful prototype of the electronic water sensor, they'd like to participate in the InVenture Prize — and generate support to commercialize and market their invention.

"There are so many options to fulfill this program," Johnson says. "Since it's a new program, they're coming up with new ways to fulfill it every day." Her team is also exploring their project's potential close to home. "Since we live in Atlanta, we wanted to focus on the areas we know," she says. So they tested different water sources from across Atlanta, and toured the Atlanta water treatment plant to learn about how the plant conducts water testing.

What excites Johnson and Kappler about the Grand Challenge Scholars Program is the opportunity to unite their academic and extra-curricular work around a single theme, enhancing the learning experience and strengthening portfolios and resumes.

"It's is a touchstone for students because it's a structure, but it's a highly flexible structure," Newstetter says. "With the Grand Challenges, you have this focal point. Industry is always looking for people who have a sustained engagement with something. And students see an opportunity to bring together all these things they're doing, in a way that wouldn't have been possible otherwise." ▪

MASTER OF SCIENCE IN CYBERSECURITY

One Degree. Three Tracks.

Cybersecurity is no longer just a computer programmer's problem, it touches multiple disciplines, careers and nearly all aspects of society – from public policy to energy management to product design. In a time when connected devices could outnumber humans, there is an urgent need for 1.5 million cybersecurity professionals who can solve a multitude of challenges. At Georgia Tech, we are creating the next® cohort of cybersecurity experts.

Energy Systems

School of Electrical & Computer Engineering

Sample courses:

» Smart Grids
» Power Systems Protection
» Cyber-Physical Systems Security

Coming Fall 2018

Policy

School of Public Policy

Sample courses:

» Internet & Public Policy
» Challenge of Terrorism
» Privacy, Technology, Policy & the Law

Coming Fall 2017

Information Security

School of Computer Science

Sample courses:

» Applied Cryptography
» Network Security
» Secure Computer Systems

Underway Now

Next Steps for NEXTENG

Two of the program's leaders share ideas on its future.

by Camille Pendley

Dean Gary S. May heads the College of Engineering. He serves as the chief academic officer of the college, and he is a "big believer" in active learning.

Wendy Newstetter, a cognitive and learning scientist by training, is an assistant dean and director of educational research and innovation for the College of Engineering.

NICK BURCHELL

NICOLE CAPPELLO

WHAT IS NEXTENG?

Dean: Historically, what we've done in engineering is we've given the students a bunch of things we think they need for future use. We teach them how to do calculus and chemistry and physics, and all these different techniques, and then we finally let them do engineering at the end. If we taught people to play baseball this way, we'd have a throwing class, and a hitting class, and a catching class, and we wouldn't actually play a game until their senior year. So we're trying to kind of turn that on it's head and get the students actually doing engineering as early as possible and throughout their curriculum.

Georgia Tech has been in a leadership role in many of these active learning initiatives for a very long time, and there are so many different pieces. We had problem-based learning in biomedical engineering, and we had the InVenture Prize competition, we had flipped classrooms, we had capstone design, and CREATE-X. And all of them were great — they were doing really well. But they were related, and they weren't necessarily feeding off of each other in a tangible way.

What we're trying to do at NextEng is put the pieces together in a coherent fashion.

WHY IS ACTIVE LEARNING IMPORTANT TO ENGINEERING EDUCATION?

Asst. Dean: As a cognitive learning scientist, it's pretty clear that having students just sit and listen to lectures might make them successful on exams but it's not really good for the retention of knowledge. And the more opportunities students have to construct knowledge, to negotiate knowledge, to interact with other folks in the acquisition of knowledge, the more they can be sure that they're going to retain that knowledge.

Dean: For example, when you flip a classroom. We've done parallel studies where we've done a same class [where we] teach a section of traditional delivery and a section of flipped delivery, and the outcomes for the students — test scores, etc. — are better.

Like in a fluid dynamics class, with two of roughly the same size classes, where the students in the traditional delivery method had higher GPAs on average, and students in the flipped method had lower GPAs. (We didn't do that on purpose but it turned out to be useful for us.) When we gave the same final exam, the students in the flipped method were theoretically weaker students, but performed 5-10 points higher on their exam than did the stronger students in the traditional method.

WHAT DOES THE COLLEGE OF ENGINEERING AIM TO DO WITH NEXTENG?

Dean: Rather than the students being passive recipients of all the knowledge that is in the head of the professor, we want the students to be actively engaged agents in their own learning experience. So they're no longer just copying down notes from the whiteboard and having a quiz or homework; they're actually asking 'what if' questions, building things and learning things, and learning by what they're doing and not just learning by memorization or by repeating. In a nutshell, instead of teaching them what — like how to do a laplace transform (a mathematical tool used in electronics communications) — we're teaching them why.

Asst. Dean: One way to bridge the chasm between faculty and students is to have more interactive, constructivist learning environments where the faculty is now a mentor rather than a "sage on the stage."

We're trying to identify the educational innovators in the units, what I would call the "positive deviants." Are there people in every single unit of the College of Engineering that are doing really interesting things? Trying to find ways that are interactive, trying to think of novel ways to engage the students? Can we find those folks, and then can we celebrate and use them as mentors for other faculty?

WHAT EFFECT DO YOU THINK THIS WILL HAVE ON STUDENTS POST-GRADUATION?

Dean: I think that rapidly they'll go into their first job — well, they could create their first job, that's one possible effect — but even if they don't do that I think they'll go into their first job with confidence and experience and set up for leadership very quickly. I think they'll be easy to spot among their peers from other places at their workplaces. ▪

This Q & A has been lightly edited for clarity and conciseness.

Maker Space Menagerie

Look out, Invention Studio: You're not the only maker space on the block anymore.

The runaway success of the studio, which caters largely to mechanical engineering students, has helped inspire several other maker spaces around the College of Engineering. Now you can stroll through Georgia Tech's campus and check out the Biomedical Engineering Machine Shop, the Aero Maker Space, and the School of Materials Science and Engineering's MILL. (There are more to come, too.)

All the new spaces can be used for schoolwork, but the possibilities are as endless as students' imaginations. Even in the tiring, sometimes stressful life of an engineering major, there's always room for some fun.

Here are a few of our favorite creations — sometimes funny, often whimsical, and always exciting — to emerge from CoE maker spaces.

– Lyndsey Lewis

Photos by Gary Meek

Part of what makes the Invention Studio unique is that it originated as, and continues to be, a primarily student-run facility.


Machine
Shop


INVENTION STUDIO
DESIGN - BUILD - PLAY

Free to use for personal and class projects, campus maker spaces give students access to equipment such as 3D printers, laser cutters, water jet machines, and woodworking tools.

COLLEGE OF ENGINEERING

Dean Search

THE GEORGIA INSTITUTE OF TECHNOLOGY invites applications and nominations for the position of the dean of the College of Engineering. The selected individual will also hold the Southern Company Dean's Chair. The new dean will lead the Institute's largest academic unit and one of the nation's top-ranked colleges of engineering.

As chief academic and administrative officer of the College of Engineering, the dean is responsible for providing leadership for the following specific activities: strategic planning, academic programs, faculty appointments, budgetary and administrative oversight, stewardship and development, and multidisciplinary partnerships.

The ideal candidate will:

- Be an intellectual leader among faculty
- Be a strong advocate for the teaching and research mission of the College
- Be a preeminent university citizen
- Be an energetic and conscientious administrator, familiar with issues in higher education, engineering, science, and technology
- Share Georgia Tech's commitment to equity and increasing diversity, and the inclusion of under-represented groups on campus and in the engineering workforce.

All inquiries and correspondence should be directed in confidence to the search committee chair, Julia Kubanek, associate dean for Research, College of Sciences, professor of Biological Sciences, and professor of Chemistry and Biochemistry (julia.kubanek@biosci.gatech.edu).

The Georgia Institute of Technology is an equal opportunity/affirmative action employer.

Visit the search site at **http://www.provost.gatech.edu/dean-engineering.**

Georgia Tech | College of Engineering

Georgia Tech College of Engineering

The College of Engineering at Georgia Tech is the largest program of its kind in the country, with more than 13,000 undergraduate and graduate students enrolled. The college ranks among the top 10 programs in undergraduate and graduate engineering as determined by U.S. News and World Report.

Georgia Tech College of Engineering

Office of the Dean
225 North Avenue
Atlanta, Georgia 30332-0360

In time-honored tradition, ECE graduate student and former Buzz Benjamin Chang is carried across the graduation stage by the mascot.

DANNY KARNIK