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THE MAGAZINE OF THE A. JAMES CLARK SCHOOL *of* ENGINEERING

Leaders *of* INNOVATION

CLARK SCHOOL THOUGHT LEADERS DISRUPT TECHNOLOGY'S STATUS QUO

What's inside this issue?

It's glass, it's plastic, it's ... wood? Clark School researchers have discovered a way to make wood transparent. It's just one example of how engineers at the University of Maryland are flipping the status quo on its head. Read more on page 2.

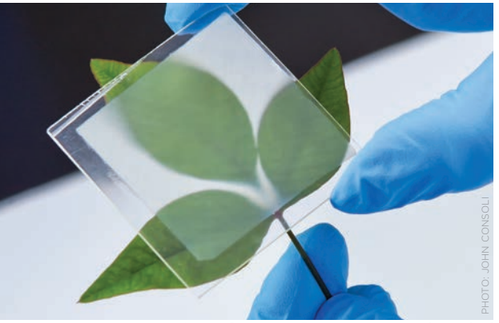

PHOTO: JOHN CONSOLI

Image from page 5, transparent wood over leaf

FEATURE

DEPARTMENTS

PHOTO: MIKE MORGAN

"Our classrooms, laboratories, and competitions challenge everyone to be a disruptor."

Dear Friends of the Clark School,

Disruptive is typically not something you'd like to see on a report card, but at the A. James Clark School of Engineering, we welcome it wholeheartedly in our approach to technology innovation. Our classrooms, laboratories, and competitions challenge everyone to be a disruptor.

In our feature story, you'll read about the game-changing people, research, and technology that hold the potential to shift entire marketplaces, including pharmaceuticals, computing, and transportation. Some of these technologies will transform the way we build, heat, and cool our homes. Other discoveries could even change the way we clean up oil spills.

Our own Robert E. Fischell, seen on the cover of this issue, embodies this disruptive nature. His inventions, such as the first implantable insulin pump, the rechargeable pacemaker, and the highly flexible coronary artery stent, altered our approach to human health. This year Dr. Fischell was awarded the National Medal of Technology and Innovation—the highest honor for technological achievement bestowed by the president of the United States.

Long before Harvard Business School Professor Clayton Christensen coined the term *disruptive innovation*, Dr. Fischell and those honored in our Innovation Hall of Fame were challenging the status quo. Sirius Satellite, the UPC barcode, Polycom, and many more created unforeseeable changes to our daily lives. Now the real question is: who from the Clark School community will create the next innovation that will radically alter the future? Is it you?

Sincerely,

Darryll J. Pines
DEAN AND FARVARDIN PROFESSOR OF ENGINEERING

Engineering @ Maryland is published twice a year for alumni and friends of the A. James Clark School of Engineering and the Glenn L. Martin Institute of Technology at the University of Maryland.

Letters to the editor and alumni notes are welcome. Please send them to ***Engineering @ Maryland*** Editor, 3228 Kim Engineering Building, 8228 Paint Branch Drive, College Park, MD 20742-2831. Information can be sent by fax to 301.314.6868 or by e-mail to mandreyc@umd.edu.

Please note that ***Engineering @ Maryland*** refers to the A. James Clark School of Engineering by that name in all cases, including stories that describe alumni who graduated before the name was established, in 1994, to honor Mr. Clark's outstanding philanthropy.

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DISRUPTING TECHNOLOGY

EVERY SO OFTEN, A TECHNOLOGY COMES ALONG THAT FLIPS THE STATUS QUO ON ITS HEAD.

Personal computers turned expert-only mainframes into dinosaurs. Netflix blew away Blockbuster. Smartphones crushed landlines, totally transforming our use of the phone.

Harvard Business School Professor Clayton Christensen coined the term "disruptive innovation" to describe the impact of these game changers in the marketplace. Rather than simply improving upon existing technology to satisfy the high end of the market, where profitability is highest, disruptive innovation creates new mass markets for low-end and mainstream customers.

While Christensen looks at the phenomenon from a market point of view, the culture of disruptive innovation can be found in research environments like the Clark School.

"We're always looking to support new avenues of research that have the potential to create technology that would disrupt the standard bearer," said Robert Briber, associate dean for research and professor of materials science and engineering. "It's hard, at the early stages of university research, to see how it might play out in the marketplace, but we do a lot to help faculty transition to enterprise from the lab."

One way the Clark School helps transition research to the marketplace is through the Maryland Technology Enterprise Institute (Mtech). Programs such as the Maryland Industrial Partnerships connect Maryland companies with university resources by providing funding for university-based research projects that help the companies develop new products.

To keep pace with a marketplace that is constantly evolving, Clark School researchers are leading cutting-edge innovations that have the potential to disrupt our daily lives.

Migraine Headache Device

ROBERT FISCHELL'S NEWEST MEDICAL DEVICE has the potential to change the way the 36 million Americans who suffer from migraines ease their pain. "We have a whole new concept that's disruptive to the current treatment options," said Fischell, professor of the practice and eponym of the Fischell Department of Bioengineering.

"The old concept is pills—but the more pills you take, the less they work," said Fischell. "A more recent treatment is Botox. Botox is an injection you go to your doctor for every 12 weeks. That's not really fun."

Small enough to carry around, Fischell's device delivers a safe magnetic pulse that can be applied as needed. "The headache sufferer applies it to the back of the head when the migraine aura, the warning that a headache is beginning, appears. A magnetic pulse generates electric currents in the brain that interferes with the aura and erases the migraine," he said. "And while it doesn't totally eliminate future headaches, it can reduce the incidence of the migraine headaches."

Fischell's migraine device will require a prescription, but using it will bring relief without repeated trips to the doctor or pharmacy, and with no side effects. "When you take a pill it goes all over your body, and when it goes to places other than where it's doing its job, there are adverse effects. In eight years of clinical trials on this device, there have been no adverse side effects," he said.

Fischell has been finding new ways to do things for most of his life. He holds more than 200 U.S. patents for inventions that include devices that treat epilepsy, diabetes, and heart ailments.

In May, President Barack Obama presented him with the National Medal of Technology and Innovation, the country's highest award for innovation, citing Fischell for "improving the health and saving the lives of millions of patients around the world."

At age 87, Fischell isn't done. This summer, the University of Maryland Medical Center began clinical trials on another magnetic pulse device aimed at easing pain in different areas of the body, an innovation he says could help turn around the country's opiate addiction crisis.

"When I hear of a problem, I begin to envision a solution," Fischell said. "You need to ask, 'How can I use my knowledge and training to find a solution that's better than what now exists?' That's how to improve the human condition. That's what inventing is all about."

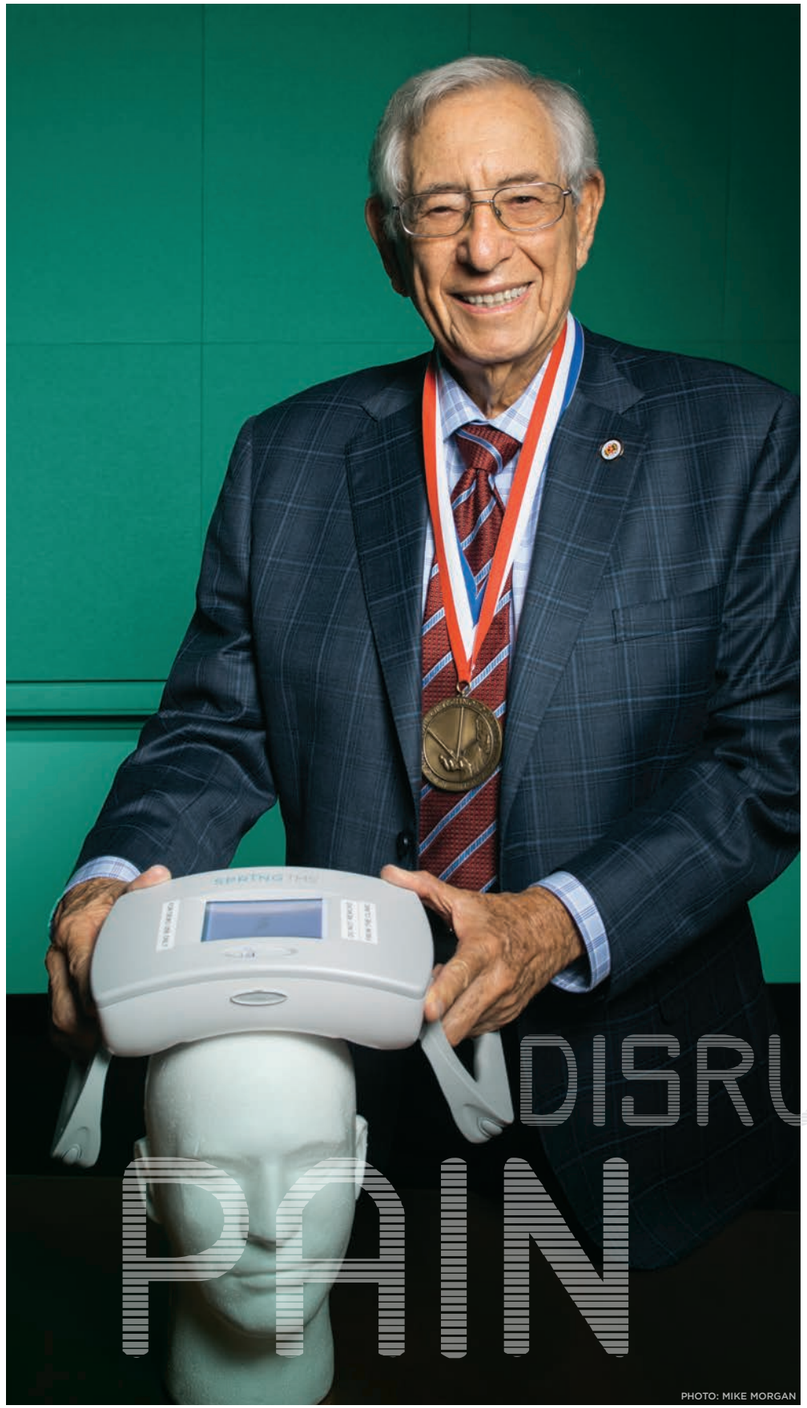


PHOTO: MIKE MORGAN

DISRUPTING PAIN

In May, President Barack Obama awarded University of Maryland physics alumnus and Fischell Department of Bioengineering eponym Robert Fischell the National Medal of Technology and Innovation.

PHOTO: RYAN K. MORRIS AND THE NATIONAL SCIENCE & TECHNOLOGY MEDALS FOUNDATION

This award marks the highest honor for technological achievement bestowed by the president of the United States. Fischell was one of just eight individuals awarded the National Medal of Technology and Innovation in 2016.

DISRUPTING MATERIALS

THE RESEARCHERS START WITH THIS NATURAL BASSWOOD BLOCK.

PHOTOS: JOHN CONSOLI

RESEARCH TEAM MEMBERS, FROM LEFT TO RIGHT: TIAN LI, POSTDOCTORAL ASSOCIATE; CHAO JIA, VISITING PH.D. STUDENT; AND AMY GONG, POSTDOCTORAL ASSOCIATE.

Transparent Wood

IMAGINE WOOD THAT YOU CAN SEE THROUGH like glass, is energy efficient, and is strong enough to be used as a car windshield. In the lab of Liangbing Hu, associate professor of materials science and engineering and member of the University of Maryland Energy Research Center, that's more than imaginary. Hu's team has created a transparent wood that could have disruptive possibilities for a range of industries.

"Transparent wood has the potential to replace many types of materials," said team member Tian Li, postdoctoral associate of materials science and engineering. "It distributes light evenly inside, and it has good thermal management capability. It rejects heat during the summer, and it will keep your house warmer during winter."

Hu's lab had already figured out how to create a transparent, paper-thin film by grinding up wood and removing the lignin, a polymer that gives wood its color. The leap to making a transparent material with the volume and strength of wood meant retaining the wood's microstructure, then refilling it with a clear polymer to transmit light.

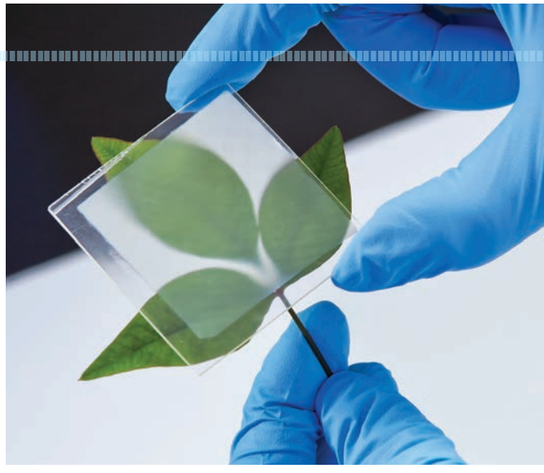
Explained team member and Ph.D. student Jiaqi Dai, "It's like you have a bundle of fibers held by the lignin, and when you remove the lignin, the fibers collapse. The breakthrough was figuring how to bind the cellulose fibers to hold the structure of the wood."

After a year, they had what they considered a success: a five-inch square about the thickness of a window pane that was 92 percent transparent and strong. "We used a hammer to test it, and it wouldn't break. It just left a dent," said Li.

The team has since tested their transparent wood in a bird house, and, in a paper published this summer in the journal *Advanced Energy Materials*, they report that it indeed has great potential. "With glass you always have areas of the house that are brighter, some that are dim," said Li, "but with transparent wood, you get very uniform light. It retains the wood's structure, so the wood's channels help guide the incoming light."

There's still a lot to figure out: how to create large-scale transparent wood, how to make it environmentally friendly. "We're working on using biodegradable polymers to put in the wood structure, for a totally biodegradable material," said Dai.

Looking ahead, the team imagines possibilities like an entire wall or roof of transparent wood, maybe with custom colors, to replace opaque building materials. Its thermal conductivity could reduce energy needs, and its strength holds possibilities for vehicle parts. Said Mingwei Zhu, visiting associate professor and a member of the research group, "You provide the material, and people will come up with different ideas about how to use it."



THE PROCESSED WOOD IS UNIFORMLY TRANSPARENT AND HAS MANY POTENTIAL APPLICATIONS.

DISRUPTING ENERGY

PHOTOS: JOHN CONSOLI

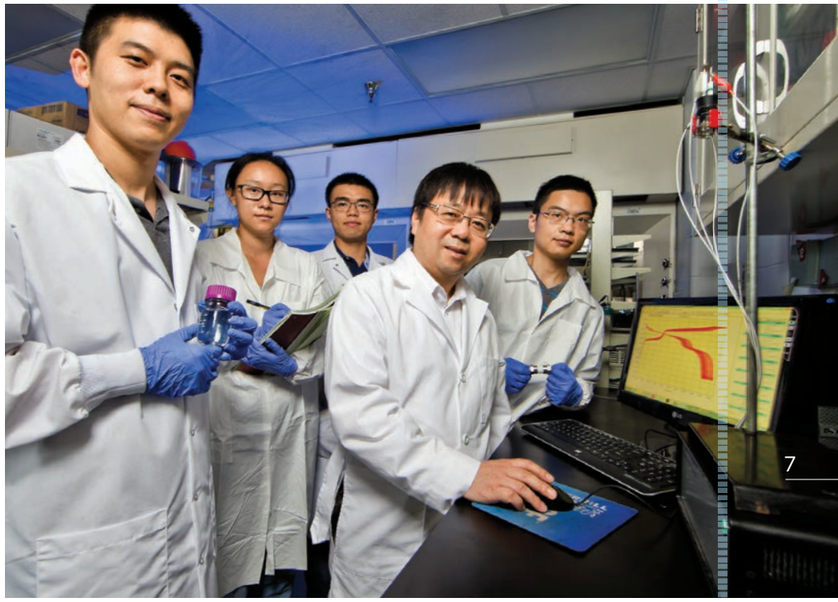
IN 2013, A STRING OF BATTERY FIRES on Boeing 787s led the Federal Aviation Administration to ground the entire Dreamliner fleet. Hoverboards, last year's hot seasonal gift, turned out to be way too hot when some of their lithium-ion batteries repeatedly erupted into flames.

Lithium-ion batteries are powerful, and have the energy density to hold a charge for a long time. But these batteries also run on an organic electrolyte, a fuel that can ignite—a big concern for large battery users. So big that the U.S. Department of Energy (DOE) is investing in finding a new type of battery that's powerful, but also safe and more environmentally friendly.

The lab of Chunsheng Wang, professor of chemical and biomolecular engineering and member of the University of Maryland Energy Research Center, came up with an idea for an ingredient that wouldn't burn, is abundant, and is better for the environment: a water-based electrolyte to create an aqueous lithium-ion battery. Some researchers jumped on the idea, using salt water, but hadn't been able to produce a battery with enough energy density.

POSTDOCTORAL ASSOCIATE FEI WANG HOLDS A TYPICAL THREE-ELECTRODE CELL, USED TO DETERMINE DETAILED AND ACCURATE ELECTROCHEMICAL PROPERTIES OF THE SALT WATER ELECTROLYTE. INSET: SAFE BATTERY CELLS ASSEMBLED USING THE SALT WATER ELECTROLYTE.

RESEARCH TEAM MEMBERS, FROM LEFT TO RIGHT: FEI WANG, POSTDOCTORAL ASSOCIATE; SINGYUK HOU, MASTER'S STUDENT; WEI SUN, VISITING PH.D. STUDENT; CHUNSHENG WANG, PROFESSOR; AND CHONGYIN YANG, POSTDOCTORAL ASSOCIATE.



Salt Water Battery

Then two years ago, Wang, postdoctoral associate Liumin Suo, and Kang Xu from the U.S. Army Research Lab took the research in a disruptive new direction. Said Wang, "Normally you have a lot of water and a small amount of salt, but why not reverse this ratio? It worked even better than we thought."

Last year, Chongyin Yang and Fei Wang, both postdoctoral associates, first succeeded in producing a surprising 50 percent more power than the level they'd set out to create. The results were so impressive that the DOE just awarded Wang's team, working with the Army Research Lab, small business Liox, and battery manufacturer SAFT, a grant for $3 million to increase the energy density by another 50 percent.

The team's saltwater solution could put their battery into a range of places, from consumer electronics to electric cars and buses, to large battery grids on submarines. Hoverboards could be back on the shelves with the salt water battery. Recycling and reclamation of salt water batteries are also likely to be more environmentally friendly.

"The battery of the future will deliver renewable energy, but we want it safe," Chunsheng Wang said. "We need innovative ideas to go a different way."

Hyperface

"WE ALWAYS THOUGHT MACHINE LEARNING WOULD BE A CUTE BOUTIQUE KIND OF AREA, BUT IT HAS BECOME REALLY HOT," said Rama Chellappa, Distinguished University Professor, Minta Martin Professor of Engineering, and chair of the Department of Electrical and Computer Engineering. "What's happening here in the last five years is amazing."

Much of Chellappa's excitement is about the disruptive technology of deep learning, a method of machine learning modeled on the human visual system. This past year, Chellappa's team applied deep learning to create Hyperface, a technology that could advance computer facial recognition from simply identifying a face, to deciphering pain, emotions, aging, and even objects like vehicles.

Hyperface came out of the team's work on a government project to develop technology that could recognize individual faces in a crowd. "The state of the art didn't produce reasonable results," said Vishal Patel, assistant research scientist, now assistant professor at Rutgers University. "It extracted information about gender, pose, and features in separate tasks that never interacted."

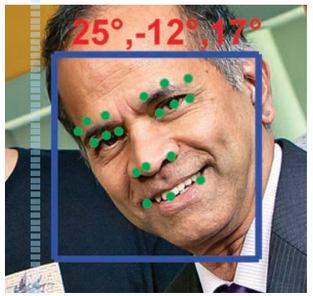
Just a year ago, Chellappa says his own researchers were working much like that. "One person was doing detection, one was doing fiducial extraction, another student doing gender, ethnicity, etc."

"But humans are capable of detecting faces and deciding gender and pose simultaneously," said team member Rajeev Ranjan, one of Chellappa's Ph.D. students. "That motivated me to ask, why don't we share the work among the tasks in a network? Can we build a network that not only detects where the face is in the picture, but can simultaneously tell if the person is a man or a woman and can pick up facial poses?"

After a week of loading vast amounts of data to "train" the network to detect faces and gender and determine poses and fiducial points simultaneously, they had their "Aha" moment. When Hyperface outputs were fed into a face matcher, Patel said, "It worked so well. That was a 'Wow!' experience. Hyperface is significant in terms of how much it pushed the recognition accuracy."

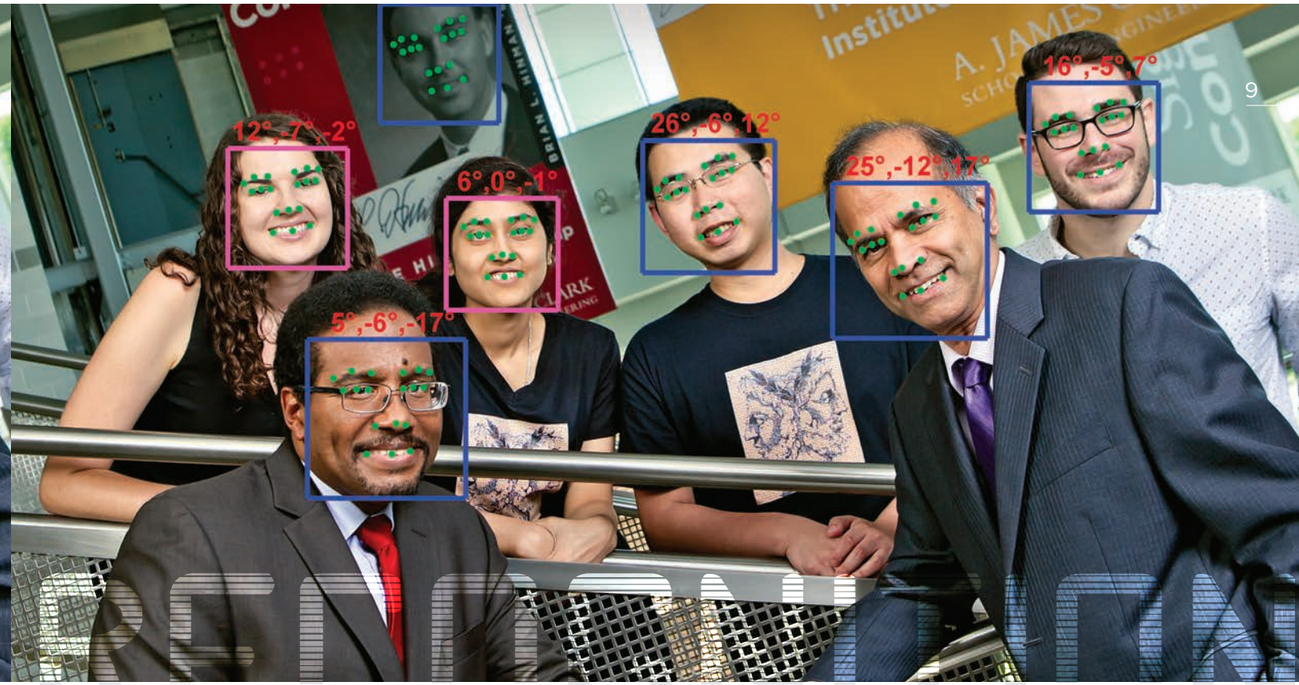
The team hopes to move Hyperface beyond recognizing a face to reading facial expressions. "For instance, for industry testing, a company could show people a commercial and analyze the facial reactions for engagement, boredom, excitement," said team member and assistant research scientist Carlos Castillo.

"We had no idea about Hyperface a year ago, but suddenly it happened," said Chellappa. "If it works very robustly, it can change interactions between humans and computers. Imagine a computer in your house that recognizes you. When you come home it sees your face and says, 'It looks like you've had a rough day, can I play something to cheer you up?' The machine learning field is in a very exciting place right now."



HYPERFACE CAN SIMULTANEOUSLY DETECT THE FACE, LOCALIZE FACIAL KEY POINTS, ESTIMATE POSE, AND RECOGNIZE GENDER. THE BLUE BOXES DENOTE DETECTED MALE FACES, WHILE PINK BOXES DENOTE DETECTED FEMALE FACES. THE GREEN DOTS PROVIDE KEY POINT LOCATIONS SUCH AS EYE CENTERS AND NOSE TIP. THE NUMBERS IN RED REPRESENT THE HEAD ORIENTATION ANGLES IN THE ORDER OF ROLL, PITCH, AND YAW.

PHOTO: JOHN CONSOLI



FROM LEFT TO RIGHT: GEORGIA WOOD, GRADUATE ASSISTANT; DARRYLL PINES, CLARK SCHOOL DEAN; ARTHITA GHOSH, PH.D. STUDENT; JUN-CHENG CHEN, PH.D. STUDENT; RAMA CHELLAPPA, PROFESSOR AND CHAIR, ECE; AND DANIEL GERZHOY, PH.D. STUDENT POSE FOR A HYPERFACE DEMONSTRATION. CHELLAPPA IS THE ONLY RESEARCHER PICTURED WHO IS AFFILIATED WITH THE HYPERFACE PROJECT.

ZERO GRAVITY

PHOTO: JOHN CONSOLI

ABOVE: SRIRAM BHARATH, MASTER'S STUDENT, WATCHES OVER A BLUE WHIRL. RIGHT: A FLAME TRANSITIONS TO A BLUE WHIRL.

Blue Whirl

WHEN A CLARK SCHOOL RESEARCH TEAM SET OUT TO EXPLORE the combustion and burning dynamics of fire whirls on water, they had no idea that they were on the brink of a discovery that would dramatically disrupt previous thinking about fire tornadoes.

"A fire tornado has long been seen as this incredibly scary, destructive thing. But, like electricity, can you harness it for good? If we can understand it, then maybe we can control and use it," said Michael Gollner, assistant professor of fire protection engineering.

Glenn L. Martin Professor of Engineering Elaine Oran and Gollner had viewed a YouTube video of a flaming lake, a result of a bourbon spill that had been ignited by lightning. They were curious whether they could recreate some of what they watched on a much smaller scale in Gollner's lab.

None of them could have predicted what happened next.

The pair, along with assistant research scientist Huahua Xiao, watched as a dazzling, swirling blue flame began to take shape. This was a flame that had never been seen before. The team decided to name it "blue whirl."

"A fire whirl is usually turbulent, but this blue whirl is very quiet and stable without visible or audible signs of turbulence," said Xiao. "It's really a very exciting discovery that offers important possibilities both within and outside of the research lab."

Not only was it mesmerizing to watch, the new blue whirl could also help meet the growing worldwide demand for high-efficiency, low-emission combustion.

"Blue whirls evolve from traditional yellow fire whirls. The yellow color is due to radiating soot particles, which form when there is not enough oxygen to burn the fuel completely," said Oran. "Blue in the whirl indicates there is enough oxygen for complete combustion, which means less or no soot, and is therefore a cleaner burn."

Some oil spill remediation techniques include corralling up the crude oil to create a thick layer on the water surface that can be burned in place, but the resulting combustion is smoky, inefficient, and incomplete. However, the researchers say blue whirls could improve remediation-by-combustion approaches by burning the oil layer with increased efficiency, reducing harmful emissions into the atmosphere around it and the ocean beneath it.

"Fire whirls are more efficient than other forms of combustion because they produce drastically increased heating to the surface of fuels, allowing them to burn faster and more completely. In our experiments over water, we've seen how the circulation fire whirls generate also helps to pull in fuels. If we can achieve a state akin to the blue whirl at a larger scale, we can further reduce airborne emissions for a much cleaner means of spill cleanup," explained Gollner.

PHOTO: CHRISTIAN K. LEE/THE WASHINGTON POST VIA GETTY IMAGES

ASSOCIATE RESEARCH SCIENTIST VIKRANT AUTE IS SEEN NEXT TO A PROTOTYPE PERSONAL AIR CONDITIONING ROBOT, ALSO KNOWN AS ROCO.

DISRUPTING DISCOMFORT

IT STARTED AS A ROUTINE LUNCH, BUT IT TURNED DISRUPTIVE—in a good way, says Vikrant Aute, associate research scientist in the Department of Mechanical Engineering (ME) and Center for Environmental Energy Engineering (CEEE). "Dr. Radermacher (Minta Martin Professor, ME, and director, CEEE) and I were chatting over lunch, and he said 'We need to be thermally comfortable no matter where we go.' One thing led to another, and that's how the whole idea about an air conditioner that follows you around was born."

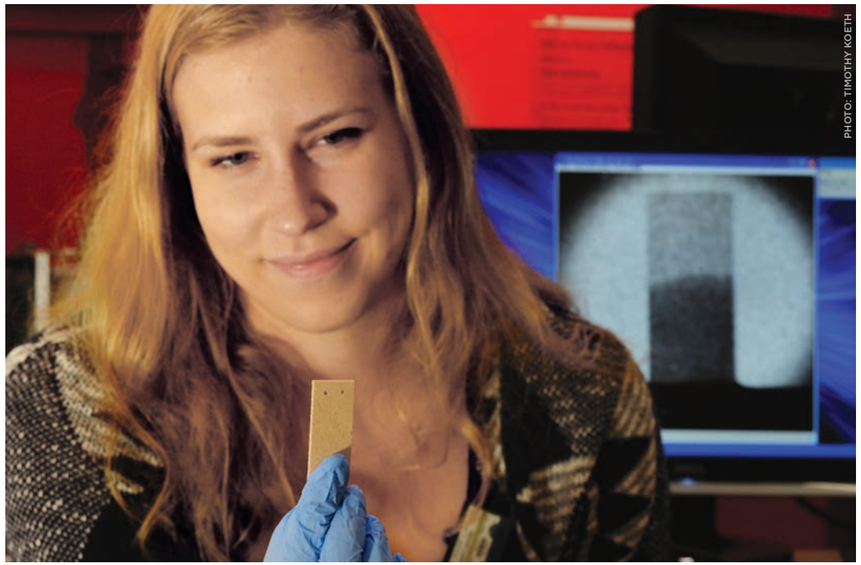
The goal for RoCo technology is bigger than just personal comfort, Aute says—it's about changing our entire relationship with the built environment. "The majority of the energy we use to keep people comfortable goes into cooling and heating the whole building. The idea here is that by keeping individual people thermally comfortable, we reduce energy needs overall. Our studies have found there is potential to reduce energy used in air conditioning by up to 30 percent if you can relax the building thermostat by four degrees. To compensate for that, you deploy these roving comforters to keep people comfortable."

RoCo

Along with ME and CEEE research assistant professor Jiazhen Ling and Jelena Srebric, ME professor who studies thermal comfort analysis, they formed a research team that includes Oak Ridge and Sandia National Laboratories. They won a grant from the Department of Energy's DELTA (Delivering Efficient Local Thermal Amenities) program for $2.5 million, and now—only months after that lunch—the robotic Roving Comforter, RoCo, is ready to test. Looking like a little cousin of the Star Wars R2D2, RoCo rolls around with its human, putting out just the right amount of cooling.

In coming generations of RoCo, the team plans to add heating, communication with readable devices like smartphones, and even storage space for tools. "Every time we talk about RoCo people's faces light up," said Aute. "They ask 'How much does it cost, and when can I buy one?'"

Engineering the Preservation of Cultural Heritage



Mimi Hiebert holds a limestone sample; behind her, a screen displays a limestone sample half-soaked with water.

MIMI HIEBERT, A THIRD-YEAR PH.D. STUDENT IN MATERIALS SCIENCE AND ENGINEERING (MSE), FIRST BECAME FASCINATED WITH STUDYING AND PRESERVING ANTIQUITIES THANKS TO AN EGYPTIAN MUMMY NAMED "TIA."

As an undergraduate, Mimi helped a visiting archeological conservator repair her school's resident mummy using chemical analysis. Through this newfound interest, Mimi discovered MSE Acting Chair Ray Phaneuf's work using atomic layer deposition (ALD), which creates a thin, protective film on flat surfaces, to coat and preserve silver artifacts. She came to the Clark School specifically to enter the conservation science field, and here she is able to use the University of Maryland's unique Radiation Facilities in her research.

A few times a week, Mimi heads to the Maryland University Training Reactor (MUTR) on campus to get to work. For her thesis project, Mimi is using nuclear radiation to learn how we can better preserve porous items such as stone and glass from water and erosion damage.

Mimi is studying limestone from Lecce, Italy; it is one of the city's main exports because of its beauty and pliability, making it ideal for sculptures. However, the stone is extremely susceptible to crumbling, so eventually these antiquities will be lost unless they can be protected.

Because there isn't a good way to see water inside an opaque substrate like stone, Mimi uses the neutron imaging facilities at MUTR to take pictures, much like an x-ray machine at a doctor's office. During the ALD process, the neutrons are stopped by water and the stone becomes virtually invisible, so Mimi can see how water is moving inside the stone.

MUTR not only serves as a research facility, but also trains undergraduates and graduates to become licensed reactor operators.

"It's a gem of the university," says Timothy Koeth, director of the UMD Radiation Facilities. "There are only 31 nuclear training and research reactors across the U.S., and only a handful are at schools. MUTR is a very small, low-power reactor that uses an inherently safe fuel called TRIGA built for training reactors."

As Mimi continues her research, she will move on to using the same ALD techniques in MUTR on corroded glass. She hopes to become a museum conservation scientist, and her hands-on research experience at the Clark School has set her up for success in this small but fascinating field.

>> LEARN MORE, VISIT http://go.umd.edu/conserve

CEE Team Captures Second Consecutive Concrete Canoe Win

The Department of Civil and Environmental Engineering's (CEE) Concrete Canoe team took the 2016 American Society of Civil Engineers (ASCE) Mid-Atlantic Regional Competition by storm, placing first in both the races and the design paper category, and second in the product display category.

Hosted by Drexel University in Philadelphia, Pa., the competition showcased the University of Maryland's competitive—and creative—spirit.

Led by project managers Danielle Neumeister (B.S. '16) and Demetra Tzamaras (B.S. '16), the team based the design of this year's canoe on an outside-the-box theme: a 1920s speakeasy. Dressed in era-appropriate fashion, the team members introduced spectators to their canoe, named "Whiskey River," with the hope that their performance in the competition would reflect the spirit of resilience and liveliness so commonly associated with the Roaring Twenties.

The canoe team also made a strong showing at the national competition hosted by the University of Texas at Tyler, placing 16th amid a new change to ASCE's Concrete Canoe Rules and Regulations.

>> LEARN MORE, VISIT http://go.umd.edu/concrete

WOMEN IN AERONAUTICS & ASTRONAUTICS

BUILDING A COMMUNITY OF SUPPORT & PROFESSIONAL OPPORTUNITY AT MARYLAND

Since spring 2015, a core group of women at the University of Maryland have been building momentum while creating the first ever Women in Aeronautics and Astronautics (WIAA) student organization on campus.

In just a short period of time, they have created a hub for more than 50 active members to support networking activities and training opportunities, and host guest speakers such as American Institute of Aeronautics and Astronautics Executive Director and former astronaut Sandy Magnus. In addition, they hosted WIAA Day 2016, an all-day event for female high school students interested in engineering, math, and science who wanted to learn more about aerospace engineering.

In the spring of 2016, the WIAA Executive Board received the Clark School's Women in Engineering Service Award for their efforts and success in building a professional and supportive community for female engineering students at Maryland.

>> LEARN MORE, VISIT http://go.umd.edu/wiaa

WIAA member and graduate student Lauren Trollinger helps high school students during WIAA Day at the University of Maryland.

PHOTO: EMILIA TANU

CLARK SCHOOL STUDENTS VISIT UNITED NATIONS WOMEN'S HEADQUARTERS

A United Nations department dedicated to gender equality gave more than a dozen University of Maryland students the opportunity to learn about potential career paths in August. Thirteen university students, 12 women and one man, went to UN Women's headquarters in New York City to hear from different leaders within the organization about their positions and different opportunities available.

Meeting with UN Women campaign managers allows students to "see other career pathways where they can use their technical training to really help people," said Sheryl Ehrman, professor and chair of chemical and biomolecular engineering. Students were able to hear campaign managers from four general program areas: youth strategy, HeForShe, statistics research and data, and sustainable development, Ehrman said, which allowed them to explore more opportunities.

"You can really see the connection between technology and the social sciences and anthropology, public health, public policy, all these people with different backgrounds coming together to solve a problem," said Emilia Tanu, a senior chemical and biomolecular engineering student. The Department of Chemical and Biomolecular Engineering and WIE sponsored the briefing.

This is an excerpt of an article by Rachel Kuipers originally appearing in *The Diamondback*.

>> LEARN MORE, VISIT http://go.umd.edu/unwomen

FLEXUS LIVING & LEARNING COMMUNITY HONORED BY WOMEN IN ENGINEERING PROACTIVE NETWORK

In June 2016, Flexus: The Dr. Marilyn Berman Pollans Women in Engineering Living & Learning Community was honored with a Women in Engineering Initiative Award at the Women in Engineering ProActive Network 2016 Change Leader Forum.

To date, almost 350 women have participated in Flexus, whose goal is to create a supportive community aimed at success in engineering. Living in the community helps women engineering majors connect with their peers while creating a setting conducive to study groups, networking, peer tutoring, and a variety of social activities.

"The best part about Flexus is its empathetic design," said Sarah Niezelski, a 2016 mechanical engineering alumna and Flexus graduate. "The education, support, mentorship, and friendship we get in Flexus meet us exactly where we are and fulfill significant needs that we all experience. From day one, we were taught about available resources and how to make connections in our departments."

>> LEARN MORE, VISIT http://go.umd.edu/flexus

UMD Students Zero in on SpaceX Hyperloop Competition

The University of Maryland was one of 120 teams selected to compete in the first ever SpaceX Hyperloop Design Competition held January 29–30, 2016, on the Texas A&M University campus. That weekend narrowed the field to a remaining 30 teams, which included UMD.

This summer, rather than taking it easy, more than 25 students from across the Clark School of Engineering and the College of Computer, Mathematical, and Natural Sciences held Sunday work sessions and logged long hours to test and refine their prototype pod, Prometheus. The pod, capable of exceeding speeds of 200 mph, features both magnetic levitation and magnetic breaking systems.

With their sights squarely set on the final competition, which will take place in California January 27–29, 2017, students have been working hard to realize the future of the "5th mode of transportation."

To accomplish this, students have been rapidly learning a variety of new skills from welding and dynamics testing to coding and magnet loading, and everything in between. According to team lead Erich Robinson-Tillenburg, their next major steps involve building a dynamic test rig for the pod's magnetic braking, control, and levitation systems while finishing the build on their braking system and designing a new frame—then putting it all together by January.

Despite the work ahead of them, they have no intention of slowing down. The team is not only currently recruiting students for the competition, but they are already looking ahead to field a team for SpaceX's recently announced Hyperloop Pod Competition II.

To learn more about the team and keep track of the latest UMD Hyperloop news, follow them on Twitter at @UMDLoop.

>> LEARN MORE, WATCH http://go.umd.edu/UMDhyperloop

PHOTO: JOHN CONSOLI

John Baras Inducted into Innovation Hall of Fame

The A. James Clark School of Engineering will be inducting Professor John S. Baras (Electrical and Computer Engineering/ Institute for Systems Research) into its Innovation Hall of Fame in late October. Baras and his students created algorithms and protocols by which Internet services can be delivered over satellite, beginning with the introduction and demonstration of the first working broadband Internet over satellite protocol in 1994. When the new technology was introduced, it was much faster than the fastest available broadband for consumers. This protocol, known as "asymmetric TCP/IP for Internet over satellite," was further developed by Baras and his students over several years in collaboration with Hughes Network Systems (HNS). This research and development effort resulted in several HNS award-winning products (Turbo Internet, DirecPC, DirecDuo, DirecWay) culminating with HughesNet®, which became the company's largest business. Baras' contributions enabled widespread, inexpensive connectivity to the Internet and enabled a large and growing industry.

Baras involved many graduate and undergraduate students in this research over the years. He graduated 22 M.S. and 11 Ph.D. students whose work was focused on the theme of Internet over satellite, all of whom joined the industry upon graduation. Baras is the Lockheed Martin Chair, the founding director of the Institute for Systems Research, and the co-founding Director along with Distinguished University Professor Anthony Ephremides of the Maryland Hybrid Networks Center (initially known as the Center for Satellite and Hybrid Communication Networks [CSHCN], a NASA center for the commercial development of space). Baras benefited from the emphasis on hybrid and satellite networks of CSHCN and the experiments of hybrid network concepts over the NASA ACTS satellite led by Ephremides. Baras is a Foreign Member of the Royal Swedish Academy of Engineering Sciences, and a Fellow of IEEE, SIAM, AAAS, NAI, and IFAC.

Fellowships, Societies, Honors & Awards




Professor **MIKHAIL ANISIMOV** (CHBE/IPST), Professor and Chair **RAMA CHELLAPPA** (ECE/UMIACS), Professor and Director of the Robert E. Fischell Institute for Biomedical Devices **WILLIAM BENTLEY** (BIOE), and Professor and Director of the Maryland Nanocenter **GARY RUBLOFF** (MSE/ISR) were selected as 2016–17 University of Maryland Distinguished University Professors.

Professor **SHAPOUR AZARM** (ME) won the 2016 American Society of Mechanical Engineers (ASME) Robert E. Abbott Award for serving the Design Engineering Division beyond the call of duty.

Professor and Lockheed Martin Chair in Systems Engineering **JOHN BARAS** (ECE/ISR) was elevated to the rank of Fellow in the International Federation for Automatic Control.

Visiting Professor **MARY BOWDEN** (AE) received the 2016 Aerospace Educator Award from Women in Aerospace (WIA) for her efforts in motivating interest in space systems, being an inspiring role model, and promoting the success of students at all levels.


Professor **HUGH BRUCK** (ME) and Professor **SENNUR ULUKUS** (ECE/ISR) received the University of Maryland's Distinguished Scholar–Teacher Award for outstanding scholarly accomplishments and excellence in Teaching.

Distinguished University Professor and Chair **RAMA CHELLAPPA** (ECE/UMIACS) was recognized as the inaugural recipient of the IEEE Biometrics Council Leadership Award.

CONTINUED ON NEXT PAGE

KEY TO DEPARTMENTS, INSTITUTES, AND CENTERS

AE: Aerospace Engineering

BIOE: Bioengineering

CHBE: Chemical & Biomolecular Engineering

ECE: Electrical & Computer Engineering

FPE: Fire Protection Engineering

IPST: Institute for Physical Science and Technology

ISR: Institute for Systems Research

JQI: Joint Quantum Institute

ME: Mechanical Engineering

MSE: Material Science & Engineering

UMIACS: University of Maryland Institute for Advanced Computer Studies

O'SHEA APPOINTED PRESIDENT OF UNIVERSITY COLLEGE CORK

Patrick O'Shea—University of Maryland vice president, chief research officer, and professor of electrical and computer engineering—has been appointed president of the University College Cork (UCC). A native of Cork, Ireland, and a UCC alumnus, O'Shea will be the 15th person to serve as the university's president, effective February 1, 2017.

Founded in 1845, UCC is one of Ireland's leading institutions for research and education. With more than 20,000 students, 2,800 faculty and staff, and 130,000 alumni, it is ranked in the top two percent of universities worldwide and was recently named University of the Year for a fourth time by Sunday Times Ireland.

O'Shea has served in his current role at UMD since 2011. Prior to his current role, O'Shea held several leadership positions in the Clark School, including chair of the Department of Electrical and Computer Engineering, co-director of the Maryland Cybersecurity Center, and director of the Institute for Research in Electronics and Applied Physics.

Among his accomplishments, O'Shea holds the title of UMD Distinguished Scholar–Teacher, an honor bestowed upon faculty members who demonstrate outstanding scholarly achievement along with equally outstanding accomplishments as teachers.

"It is imperative for our students to observe, ask questions, analyze problems, innovate solutions, and put their fearless ideas into action," said O'Shea. "As teachers at a research university, we are charged with the responsibility of leading the way to weave creativity, scholarly reflection, and independent thinking into our teaching, much like we do in research."

O'Shea holds a bachelor's of science in physics from UCC. He first arrived at UMD as a graduate student, earning his master's and doctoral degrees in physics.

>> LEARN MORE, VISIT http://go.umd.edu/oshea

Fellowships, Societies, Honors & Awards cont.

Distinguished University Professor and Director of the Alfred Gessow Rotorcraft Center **INDERJIT CHOPRA** (AE) has been selected by the American Society of Mechanical Engineers (ASME) as the 2016 Spirit of St. Louis Medal recipient.

The Biomedical Engineering Society (BMES), the lead society and professional home for biomedical engineering and bioengineering, recently named Fischell Family Distinguished Professor and Chair **JOHN FISHER** (BIOE) to its Class of 2016 Fellows.

A University of Maryland research team led by Assistant Professor **MICHAEL GOLLNER** (FPE/AE/ME) was awarded the 2016 Fire Protection Research Medal from the National Fire Protection Association.

Distinguished University Professor **ASHWANI GUPTA** (ME) was named a 2016 Honorary Member of ASME, the highest level of society membership offered. Gupta also received the Golden Elephant Award from Thailand's Surindra Rajabhat University for scientific achievements and collaboration with the university.

BIOE Assistant Professors **STEVEN JAY** and **CHRISTOPHER JEWELL** were named 2016 Young Innovators by *Cellular and Molecular Bioengineering*, a journal of BMES, making the University of Maryland the only institution to have two researchers named to the list this year.

Assistant Professor **MARINA LEITE** (MSE/IREAP) received the 2016 Ovshinsky Sustainable Energy Fellowship from the American Physical Society.

Professor and Chair **JAMES MILKE** (FPE) has been awarded the Society of Fire Protection Engineers (SFPE) 2016 Arthur B. Guise Medal by the Society of Fire Protection Engineers Foundation Board of Governors and Board of Directors.

Distinguished University Professor **EDWARD OTT** (ECE/IREAP) was named a 2016 Thomson Reuters Citation Laureate for his and colleagues' description of a control theory of chaotic systems, known as the OGY method.

Associate Professor **STANISLAV STOLIAROV** (FPE) was recently named the recipient of the 2016 Mid-Career Researcher Award by the International FORUM of Fire Research Directors for his extensive contributions to the science of fire engineering.

Assistant Professor **MOHAMMAD HAFEZI**, (ECE/IREAP/JQI) is leading a Department of Defense Multidisciplinary University Initiative (MURI) for "Photonic Quantum Matter."

PHOTO: JOHN CONSOLI

Read more about the salt water battery (above) on page 6 and Hyperface on page 8.

INVENTIONS OF THE YEAR

Each year, the University of Maryland honors exceptional inventions that have the potential to make an important impact on science, society, and the free market. Nominees are selected from a vast number of innovations produced by UMD's faculty and students. In 2015, researchers disclosed 186 inventions to the Office of Technology Commercialization within the Division of Research, a total of 30 technologies were licensed, and the U.S. Patent and Trademark Office issued 42 patents to UMD inventions.

At the Invention of the Year ceremony this May, two Clark School inventions were honored with wins: **CHUNSHENG WANG AND COLLEAGUES' SALT WATER BATTERY** in the physical sciences category, and **RAMA CHELLAPPA AND COLLEAGUES' HYPERFACE** in the information sciences category.

>> **LEARN MORE, VISIT http://go.umd.edu/inventions**

Feeding the Fire

As the president of a small business, Bill Koffel (B.S. '79 fire protection engineering) knows how important each employee is to his firm's success. That's why, he says, 28 of the roughly 40 employees and interns of Koffel Associates are Clark School graduates or students.

As a Clark School donor, Koffel is doing more than giving back to his alma mater. He's investing in the future success of Koffel Associates, his fire protection and life safety engineering design and consulting firm.

Bill is a long-time and loyal supporter of the Department of Fire Protection Engineering: he established the Donald W. Belles Endowed Scholarship, is a Fire Center Member (a departmental corporate partners membership program), and has contributed to the J.M. Patterson Renovation Fund and Clark School of Engineering Board of Visitors Endowed Scholarship. His most recent gifts to the department played a major role in successfully endowing a Professor of the Practice position that will allow future generations of students to benefit from contact with practitioners in the field and an applied curriculum.

Kenneth E. Isman (B.S. '86 fire protection engineering) was appointed the first Clinical Professor supported through the endowment in 2014, bringing a hands-on approach to the undergraduate curriculum.

"The department has provided Koffel Associates with some excellent engineers who are prepared to practice, and this position is just going to enhance the strength of those graduates even further," Koffel said.

Further contributions to the Legacy Campaign will help to strengthen the professorship's success in the coming years. Contact Allison Corbett at acc@umd.edu or (301) 405-5841 to learn how to make a gift to this fund or support other initiatives within the Clark School.

>> **LEARN MORE, VISIT http://go.umd.edu/fpe-legacy**

SCHOLARSHIP STUDENT PROFILE: BENJAMIN SEIBERT

Like most students in their senior year at the Clark School, Benjamin Seibert returned to campus already deeply immersed in classes, activities, and future plans. A SEEDS Research Fellowship recipient, QUEST Honors Program alumnus, project manager for the Steel Bridge team, and member of multiple societies, Benjamin has taken full advantage of the great opportunities on campus.

He also happens to be a scholarship recipient who's overcome a lot to get to the University of Maryland. An only child whose mother was diagnosed with cancer during his senior year of high school, he balanced caring for her with his schoolwork and college applications. He ultimately decided to enroll at the Clark School because of its proximity to his mom in his hometown of Williamsport, Md. and because of the aid he was offered to attend.

"I have been able to focus more on my studies without worrying about the financial burden of earning my education," he said recently at a scholarship luncheon. "I have worked very hard to make the most of the opportunity that I have been presented with, and I know every day that I am blessed to be a recipient of others' sincere generosity." Benjamin was awarded three scholarships last year: the Gossett TerpStart Endowed Scholarship, the Perry Laudenslager Memorial Scholarship, and the CEAM Roger H. Willard Scholarship.

A civil engineering major, Benjamin has plans to earn a master's degree after graduation and work as a transportation engineer—challenges he will no doubt take on with the same energy he's shown thus far.

>> **VISIT http://eng.umd.edu/giving TO LEARN HOW YOUR CONTRIBUTIONS COULD HELP CURRENT AND FUTURE CLARK SCHOOL STUDENTS SUCCEED.**

Terp Brewed & Engineered

The story of Diamondback Brewing begins a short stroll from the University of Maryland campus, in an apartment on Harvard Road. There, two friends—Francis Smith (B.S. '14 mechanical engineering) and Tom Foster (B.S. '13 economics)—took their love of beer and steeped, boiled, fermented, and bottled it into the homebrew venture that would eventually become a Baltimore-based business.

Smith was a Clark School student when he began brewing his own beer. To him, the parallels between the engineering curriculum and homebrewing are self-evident.

"In one class, we broke down the motor of an electric screwdriver, analyzed the ergonomics of the machine, and looked for ways to improve its overall performance," Smith explained. "It taught me how to increase the efficiency of a complex tool by breaking it down into smaller parts and individual processes. Just like brewing; understanding each part and process is vital to a great beer, from the size of your tanks to the gravity of your wort and everything in between."

Though it was only a few short years before the friends began contract brewing with Eastern Shore Brewing Company in St. Michaels, Md., and Beltway Brewing Company in Sterling, Va., beer wasn't yet their full-time vocation. After graduating from UMD, Francis worked as a project engineer for Whiting-Turner Contracting Company, an experience that would lay the foundation for Diamondback Brewing's own construction.

"The majority of my work at Whiting-Turner involved pre-construction planning and estimating. For young guys launching a business on limited resources, understanding our costs and keeping an accurate budget has been key," he said.

Soon, Smith and Foster decided to hang up their 9–5s and take a risk. Along with friend and co-founder Colin Marshall, they will open the doors to Diamondback Brewing's permanent 7,000-square-foot facility in Baltimore's Locust Point neighborhood in fall 2016. So far, they have six releases and hope to produce approximately 2,000 barrels of beer annually at their new facility.

"You know, the difference between having a pipe dream and achieving a pipe dream is persistence," noted Foster. "That's been our guiding principle—hitting the streets, getting it done, and doing (and drinking) what we love."

>> LEARN MORE, VISIT
http://go.umd.edu/brewing

Dear Clark School Alumni,

I am thrilled to be working as your Director of Alumni Engagement and Outreach! In the coming months, we'll be hosting many opportunities to volunteer and polish professional skills, as well as to network and have fun with fellow Terps. You can stay up-to-date by joining our communities on Facebook (go.umd.edu/ENGalumfb), Twitter (go.umd.edu/ENGalumtwtr), and LinkedIn (go.umd.edu/ENGalumlink).

I am looking forward to helping you stay connected to the Clark School as you advance in your careers. If I can help you in any way, please do not hesitate to reach out!

Heather Medina
Director, Alumni Engagement & Outreach

PHONE (301) 405-3303
EMAIL HMEDINA@UMD.EDU

Steve Stumpp

FIRE PROTECTION M.E., 2015

In his job as a fire protection engineer for the U.S. Naval Sea Systems Command, Steve Stumpp (M.E. '15) has become well versed in the basics of fire and melting temperatures—but, Stumpp says, seeing firsthand as an investigator the damage caused by a fire on a Navy ship was a "huge learning experience."

"A fire occurred in a space with a large amount of cleaning rags that had heated so much they smoldered, then transitioned to a flaming fire. The fire melted the large I-beam and the ceiling. There were clumps of aluminum that had dripped from what used to be a beam and solidified on the floor. Textbooks and PowerPoints teach you the science and math behind fire dynamics, but nothing gives you proper perspective until you see it in person."

Stumpp says another learning experience that made a difference in his work with the group that sets fire protection standards for U.S. Navy ships is the Clark School's Professional Master of Engineering in Fire Protection Engineering degree program he completed last fall. Having his B.S. in mechanical engineering, Stumpp says, "I had to get my master's or a certificate in fire protection engineering. Maryland is one of the top programs in the nation, and all of my superiors and co-workers have fire protection degrees from Maryland."

Choosing the online program because "it allowed me to balance work, life, and classes," Stumpp was impressed with the quality of faculty. "The professors actually work in the field, they have the real life experience."

The Clark School's M.E. will also make a difference in his career advancement, Stumpp says. "In my line of work, having a master's to keep moving up is critical. As the budgets get tighter, we have to explain the technology and detailed science of fires to leadership so they understand the cost versus benefit of a system or modification. What I learned in Maryland's master's program is directly applied to what I do on a daily basis."

ADVANCE YOUR CAREER

Offered through the Clark School's Office of Advanced Engineering Education, the Professional Master of Engineering and the Graduate Certificate in Engineering programs assist engineers in the development of their professional careers and provide the technical expertise needed in business, government, and industry. The online programs were ranked 16th in the nation by *U.S. News & World Report* for 2016.

>> LEARN MORE, VISIT
http://go.umd.edu/oaee

>> EMAIL oaee@umd.edu

Clark School Alumni Start Low-Emission Wood Stove Business

What started as a cleaner energy competition for two Clark School alumni has developed into a budding business with more than $200,000 in funding. Meet Ryan Fisher (B.S. '12, M.S. '13 fire protection engineering) and Taylor Myers (B.S. '12, M.S. '14 fire protection engineering), the founders of MF Fire, a company with one product: a really clean wood stove.

Traditional wood stoves produce a lot of soot, which is released into the air, said Myers, now a doctoral student studying mechanical engineering. Especially in areas where wood stoves are heavily used, this dirty air can cause health issues such as respiratory problems.

Their stove's story began in 2013, when the pair helped form a team to compete in the Wood Stove Decathlon. The competition, sponsored by The Alliance for Green Heat, pitted 11 teams against one another to design and build the most high-tech, efficient, and clean wood stove.

Though Fisher and Myers were members of the only team of college students, their stove won the Low Emissions Prize in 2013. The next year, after making some upgrades, they took home the Grand Prize.

With the help of Satish Tamboli, a ventures adviser for the Maryland Technology Enterprise Institute (Mtech), they worked to convert their idea into a viable business. Now, Catalyst—Fisher and Myers's "ultra clean" wood stove—is going to market, available to consumers just in time for this year's winter.

This is an excerpt of an article by Morgan Eichensehr originally appearing in *The Diamondback*.

>> LEARN MORE, VISIT http://go.umd.edu/catalyst

MAKING BETTER MAKERS WITH NEW 3-D PRINTING TECHNOLOGIES

Mechanical engineering senior student Brett Potter set out to fix the most nagging problems of consumer 3-D printers: speed, clogging, and sticky print beds. After seeing the limitations of popular consumer printers he created Readybox: a fast, accurate, low-maintenance, reliable 3-D printer that he hoped would move the consumer industry forward. Last fall, Potter launched a Kickstarter campaign for Readybox, raising $21,284 and exceeding his goal within 24 hours. This fall, Readybox is slated to release its printer parts for sale. The company plans to have the parts manufactured in the U.S. and assembled in-house. That assembly will likely occur at the new Startup Village, a house on the edge of the University of Maryland campus created to help student and alumni entrepreneurs as they grow their business ideas and work toward launching them in the market.

>> LEARN MORE, VISIT http://go.umd.edu/readybox

Entrepreneurs Disrupt the Status Quo in, around Silicon Valley

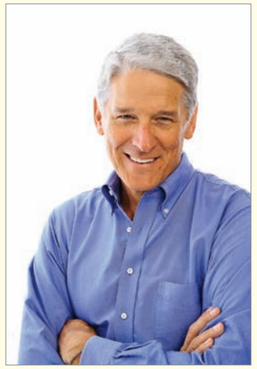
Silicon Valley's magnetic pull has captured some of the world's most creative and innovative thinkers looking to leave their mark on the technological world. High-tech research is responsible for nearly one-third of all the venture capital investment in America, according to PricewaterhouseCoopers and the National Venture Capital Association. This explains why droves of engineers have felt the gravitational pull of this legendary startup environment.

Steve Tjoa and Greg Reber are just two examples of Clark School alumni disrupting the technological status quo in and around Silicon Valley.

Violin.io is the brainchild of Steve Tjoa (B.S. '04 computer engineering; M.S. '06, Ph.D. '11 electrical engineering), an engineer with an aptitude for the violin. Tjoa struggled to learn new classical music from online videos because they were created for entertainment—not educational—purposes.

"Say you're learning a new song and want to focus on just four measures. You have a YouTube video, but where in the song are those measures? You have to click left, click right, and eventually—after considerable delay—you find what you're looking for," explains Tjoa.

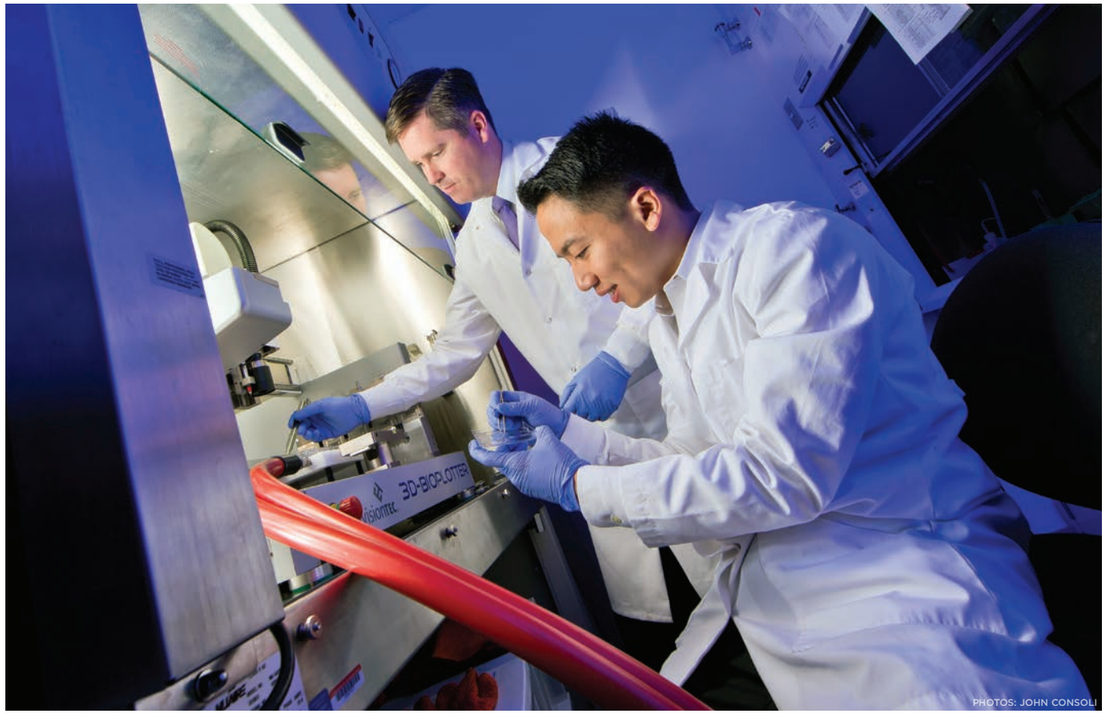
Violin.io streamlines that workflow by helping people visualize and search for classical music. It is, in essence, an interactive online library of scores synchronized with recordings of classical music. Intended for students, teachers, and performers of all levels, Violin.io helps musicians gain more insight from the music they're practicing, Tjoa says.



Greg Reber (B.S. '85 aerospace engineering) has also built his career on seeing the gaps in existing technology's capacities—albeit in a different context. Reber founded a San Francisco-based cybersecurity company called AsTech Consulting in 1997, when he saw an increasing need for programmers who could detect and mitigate Internet application vulnerabilities for businesses.

Of his team at AsTech, Reber says, "I would put them up against anyone in the world to look for security vulnerabilities in source code, whether it's Java, or C++, Ruby on Rails … I don't care what the language is. These people know what they're doing."

It's a good thing, too. As startups expand and "smart objects" become more integrated into peoples' lives, the need for internet protection and security only grows. Reber explains, "All these things are connected to the internet, and that means every one of them is vulnerable to bad guys. Every one."



John Fisher and Che-Ying Kuo, UMD researchers who helped create the 3-D bioprinted placenta model, use a 3-D bioprinter.

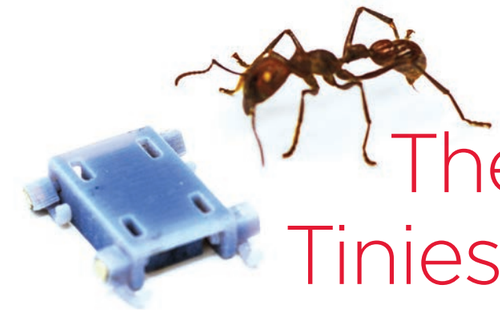
First 3-D Bioprinted Placenta Model for Study of Preeclampsia Created

Scientists at the Sheikh Zayed Institute for Pediatric Surgical Innovation at Children's National Health System, in partnership with the University of Maryland's Clark School of Engineering, are the first to create a 3-D bioprinted placenta model and use it to study preeclampsia, a life-threatening pregnancy complication.

Bioprinting is the three-dimensional printing of biological tissue and organs through the layering of living cells, with cell function and viability preserved within the printed structure. Because the bioprinted placenta model mimics the organ's complex cellular structure, the model creates unprecedented opportunities to understand and develop new treatments for life-threatening maternal conditions involving the placenta.

"Our study provides a proof of concept that a 3-D bioprinted placenta model is a viable way to study and understand the dynamics of cell migration in the formation of the placenta," said John Fisher, Fischell Family Distinguished Professor and chair of the Fischell Department of Bioengineering. "What we have learned from this initial study is a significant step toward understanding the cause of preeclampsia and a potential therapy."

>> LEARN MORE, VISIT http://go.umd.edu/placenta



The Tiniest Quadruped Robot You've Ever Seen

The fact that most insects are very small doesn't stop them from getting everywhere they want to, especially all of those places that you try to keep them out of. Roboticists have been experimenting with bug-sized robots, but they're still pretty large, about the size of giant beetles or moths. Most insects are far smaller than that, which means that they experience the world much differently, and that can be a hard thing to study effectively.

At the International Conference on Robotics and Automation earlier this year, mechanical engineering Ph.D. student Ryan St. Pierre and Sarah Bergbreiter, associate professor of mechanical engineering and director of the Maryland Robotics Center with a joint appointment in the Institute for Systems Research, presented a paper on the gait characteristics of magnetically actuated legged robots weighing less than two grams.

At these sizes (each quadruped is 20 mm long, with a hip height of 5.6 mm and weight of about 1.6 gram), traditional motors and batteries aren't going to cut it. Instead, the robot is magnetically actuated, using an externally generated magnetic field. Each of the robot's four hips has a 2-mm neodymium cube magnet embedded into it, and when you rotate a big magnet in close proximity to the robot, the magnetic field causes those little magnets to rotate as well, spinning the robot's legs. By changing the dipole orientation of the leg magnets in different combinations, you can cause the robot to move with different gaits, including trotting, waddling, bounding, and pronking.

This is an excerpt of an article by Evan Ackerman originally appearing in *IEEE Spectrum*.

>> LEARN MORE, VISIT http://go.umd.edu/tiny-robot

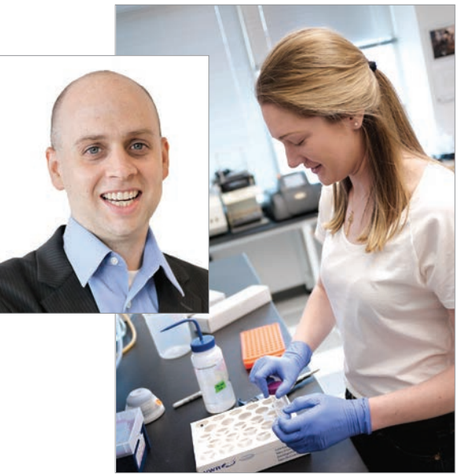
SCIENTISTS OBTAIN ALLOYS BETTER THAN GOLD

Scientists at the Clark School have developed a novel method for altering the light reflected or absorbed by a material by match-making combinations of gold, silver, and copper into various mixtures of metals, or alloys. The researchers say their findings have potential applications ranging from solar cells with improved performance to functional materials that clog light absorption for possible military usage (think: near-invisibility).

Previous work on tuning the amount of light materials absorb has been constrained by the inherent properties of pure metals. To overcome this limitation, Marina Leite, assistant professor of materials science and engineering, and Chen Gong, a graduate student of materials science and engineering, investigated how the alloying processes of these noble metals affect their optical response to identify combinations that enhance or inhibit the absorption of light.

"This work is a perfect example of the power of materials science and engineering: we discovered a way to control and change metals' optical properties by mixing them. These alloys obtain a unique functionality that is not achievable using their pure counterparts—making them a better, more powerful tool for tunable optical response than gold, silver, or copper alone," said Leite, corresponding author of a peer-reviewed paper based on the study published on the cover of the journal *ACS Photonics*.

>> LEARN MORE, VISIT http://go.umd.edu/alloys



ASSISTANT PROFESSOR CHRISTOPHER JEWELL AND PH.D. STUDENT LISA TOSTANOSKI LEAD WORK TO REPROGRAM LYMPH NODE FUNCTION TO FIGHT MULTIPLE SCLEROSIS.

Clark School Bioengineers Work to Fight Multiple Sclerosis

Researchers from the Fischell Department of Bioengineering (BIOE) have reported a new way to "turn off" the harmful immune attack that occurs during autoimmune diseases such as multiple sclerosis (MS), while keeping healthy functions of the immune system intact.

In MS, the immune system incorrectly recognizes myelin that insulates and protects nerve fibers in the brain. Immune cells enter the brain and attack, leading to slow loss of motor function and other complications. Current therapies for MS work by decreasing the activity of the immune system; but, they do so in a broadly-suppressive way that often leaves patients vulnerable to infection.

"Our lab is combining immunology and nanotechnology to reprogram how the immune system responds to self-cells in the brain that are mistakenly attacked during MS," said BIOE Assistant Professor Christopher Jewell. "The finding could lead to new approaches for reversing paralysis in MS, or better therapies for other autoimmune diseases."

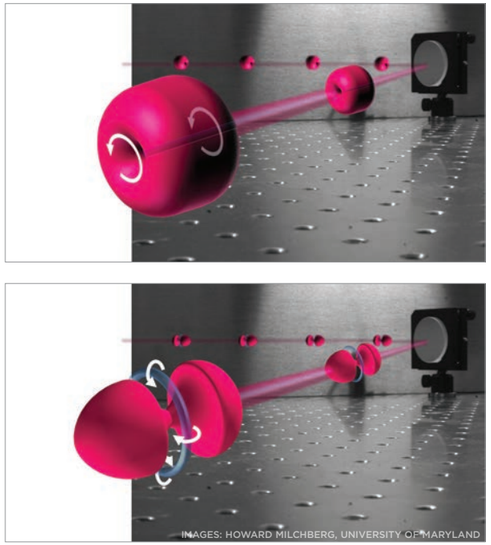
>> **LEARN MORE, VISIT http://go.umd.edu/sclerosis**

UMD Researchers Discover "Smoke Rings" Made of Laser Light

Most basic physics textbooks describe laser light in fairly simple terms: a beam travels directly from one point to another and—unless it strikes a mirror or other reflective surface—will continue traveling along a straight path, gradually expanding in size. But these basic rules go out the window with high-intensity laser light.

Powerful laser beams, given the right conditions, will act as their own lenses and "self-focus" into a tighter, even more intense beam. University of Maryland researchers—including Professor Howard Milchberg of electrical and computer engineering and the Institute for Research in Electronics and Applied Physics and graduate student Nihal Jhajj—have discovered that these self-focused laser pulses also generate violent swirls of optical energy that strongly resemble smoke rings. In these donut-shaped light structures, known as "spatiotemporal optical vortices," the light energy flows through the inside of the ring and then loops back around the outside.

>> **LEARN MORE, VISIT http://go.umd.edu/stov**



IMAGES: HOWARD MILCHBERG, UNIVERSITY OF MARYLAND

IN CONVENTIONAL OPTICAL VORTEX BEAMS (TOP), THE PHASE ROTATES IN A PLANE PERPENDICULAR TO THE PROPAGATION DIRECTION. IN THE NEWLY DESCRIBED SPATIOTEMPORAL VORTEX BEAMS (BOTTOM), THE PHASE CIRCULATION IS IN THE SAME DIRECTION AS THE BEAM'S PROPAGATION, AND FORMS TOROIDAL STRUCTURES, RESEMBLING SMOKE RINGS, AROUND THE CENTRAL SELF-FOCUSING LASER PULSE.

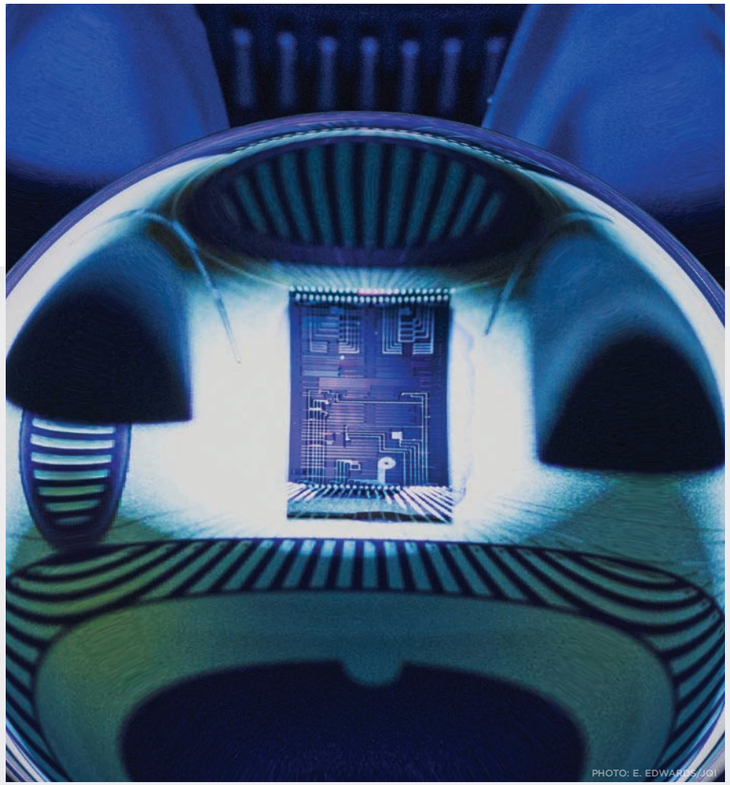


PHOTO: E. EDWARDS/JQI

A robust on-chip photonic transport with potential applications in classical and quantum information processing.

BIG QUANTUM

We are on the verge of a new technological revolution.

In July, the President's National Science and Technology Council issued a report saying the need for the kind of disruptive innovation quantum research could create should be a national priority.

The University of Maryland is leading that revolution as an established world leader in quantum research, putting the weirdness of quantum physics to work in new advances that offer the potential to disrupt in big ways. Researchers such as Mohammad Hafezi, Joint Quantum Institute (JQI) and Institute for Research in Electronics and Applied Physics (IREAP) fellow and assistant professor in the Department of Electrical and Computer Engineering, capitalize on the strange behavior of quantum systems, which can exist in two different states simultaneously, making new data processing advances that supersede the zeros and ones of binary code possible.

What does this all mean? In short, quantum engineering could change anything that has a computer inside it, which is practically all modern technology. "It can bring a lot of capabilities that we didn't have in the classical computing world," Hafezi says, "such as more secure communications, faster computation, and simulations at levels never before possible."

These colossal advances are being made at the microscopic level. Hafezi deals with photons, electrons, and atoms. "Before, we could only deal with big packets of photons or a lot of electrons at the same time. Now, we can manipulate single photons, single electrons, one by one."

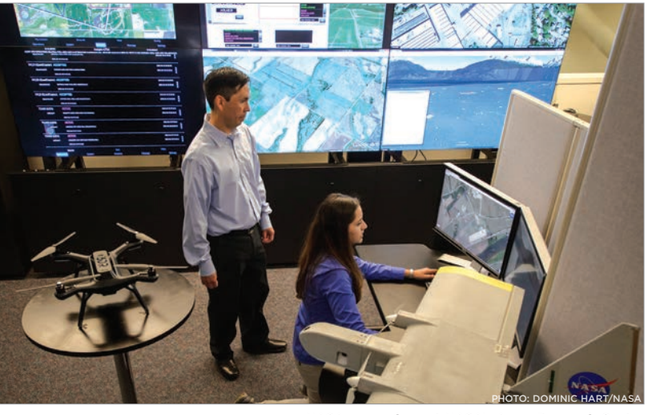
Hafezi is heading a project funded by a $7.5 million Air Force grant using quantum systems to study photon interaction, looking at making new exotic states of light. This program is a Department of Defense Multidisciplinary Research Initiative, entitled "Quantum Many Body Physics with Photons," with university partners including CalTech, University of Chicago, Harvard, MIT, and University of Colorado.

The convergence of quantum physicists, computer scientists, and engineers focusing on different aspects of quantum research is key to creating disruptive innovation. The applications of this research are so vast that they have the power to disrupt entire sectors.

Hafezi says it best: Laser was once a new form of light. That's a good example of disruptive innovation. No one knew laser would find applications in surgery, communication, pointers, almost everything around us. Is there another invention that could be so groundbreaking? It is difficult to predict.

>> **LEARN MORE, VISIT http://go.umd.edu/big-quantum**

Safer Skies for Unmanned Aircraft



NASA researchers at NASA's Ames Research Center in Silicon Valley, Ca., observe the UAS test.

As more unmanned aircraft take to the skies, what keeps them from crashing into each other? With help from the Clark School and others, NASA is hoping to make the skies safer for these aircraft commonly called "drones."

In the first and largest demonstration of its kind, the Clark School's Unmanned Aircraft Systems (UAS) Test Site—together with other UAS operators in Alaska, North Dakota, Nevada, New York, Virginia, and Texas—flew 22 drones simultaneously to test NASA's newly developed UAS traffic management system.

NASA says its system could help by providing services such as airspace design, dynamic geofencing, severe weather avoidance, congestion and terrain avoidance, route planning and re-routing, and contingency management.

>> LEARN MORE, VISIT http://go.umd.edu/nasa

LIFELINE ACROSS THE BAY

The Clark School's UAS Test Site and the University of Maryland Shore Regional Health recently conducted the state's first civil unmanned aerial delivery of simulated medical cargo. Engineers from UMD flew a Talon 120LE fixed wing aircraft across the Chesapeake Bay with saline solution simulating four vials of epinephrine to demonstrate the key role that UAS can play in emergency situations.

"We wanted to simulate a situation when weather, traffic, or other disaster made more traditional means of transportation impossible. UAS are faster to deploy, less weather dependent, and less expensive," said Matthew Scassero, Director of the UMD UAS Test Site.

>> LEARN MORE, VISIT http://go.umd.edu/uas-bay

The UMD UAS Test Site operations team, with director Matthew Scassero (front left), after a successful flight across the Chesapeake Bay.

The Rewards of PLANNED GIVING

Charitable Gift Annuity Funds Scholarships to Develop Innovative Engineers

It's no surprise that inventor and Sirius Satellite Radio co-founder Robert Briskman (M.S. '61 electrical engineering) believes that future economic growth in the United States and abroad is directly linked to continued innovation.

Impressed with how the A. James Clark School of Engineering is preparing the next generation of innovative engineers, Briskman has taken steps to ensure that students have opportunities to pursue their education and bring their innovative ideas to life.

Briskman and his wife, Lenore, established the Robert Briskman Scholarship Fund for undergraduates in the Department of Electrical and Computer Engineering through a $100,000 charitable gift annuity. "This annuity allows us to make a continuous contribution to the Clark School long after we are gone," says Briskman, "and it allows us to contribute in a way that does not impact our current lifestyle."

Briskman, who earned his master's degree at the Clark School while working full-time and supporting his young family, cites the value of a Clark School degree. "A Clark School education teaches students to apply their engineering skills to find improved solutions to the world's most challenging problems." Briskman credits Electrical Engineering Professor Henry Reed with helping him solve major challenges in satellite technology and advance his career at NASA and industry giants such as Communications Satellite Corporation. Briskman created innovative technologies that enable successful satellite transmission of continuous radio programming, formally known as Satellite Digital Audio Radio Service, across enormous geographical areas. To build and implement that service, he co-founded Sirius Satellite Radio.

The 2010 inductee into the Clark School Innovation Hall of Fame has closely followed the progress of the Clark School. "I've watched the Clark School rise in the engineering school rankings to its status now as one of the best engineering schools in the world," offers Briskman. "If our students can discover how to innovate, that is the greatest gift we can give them."

UNIVERSITY OF MARYLAND

To learn how you can make a charitable bequest today and make a significant difference in the future of the Clark School, or to explore other planned giving options, contact Leslie Borak, assistant dean for external relations, Clark School of Engineering.

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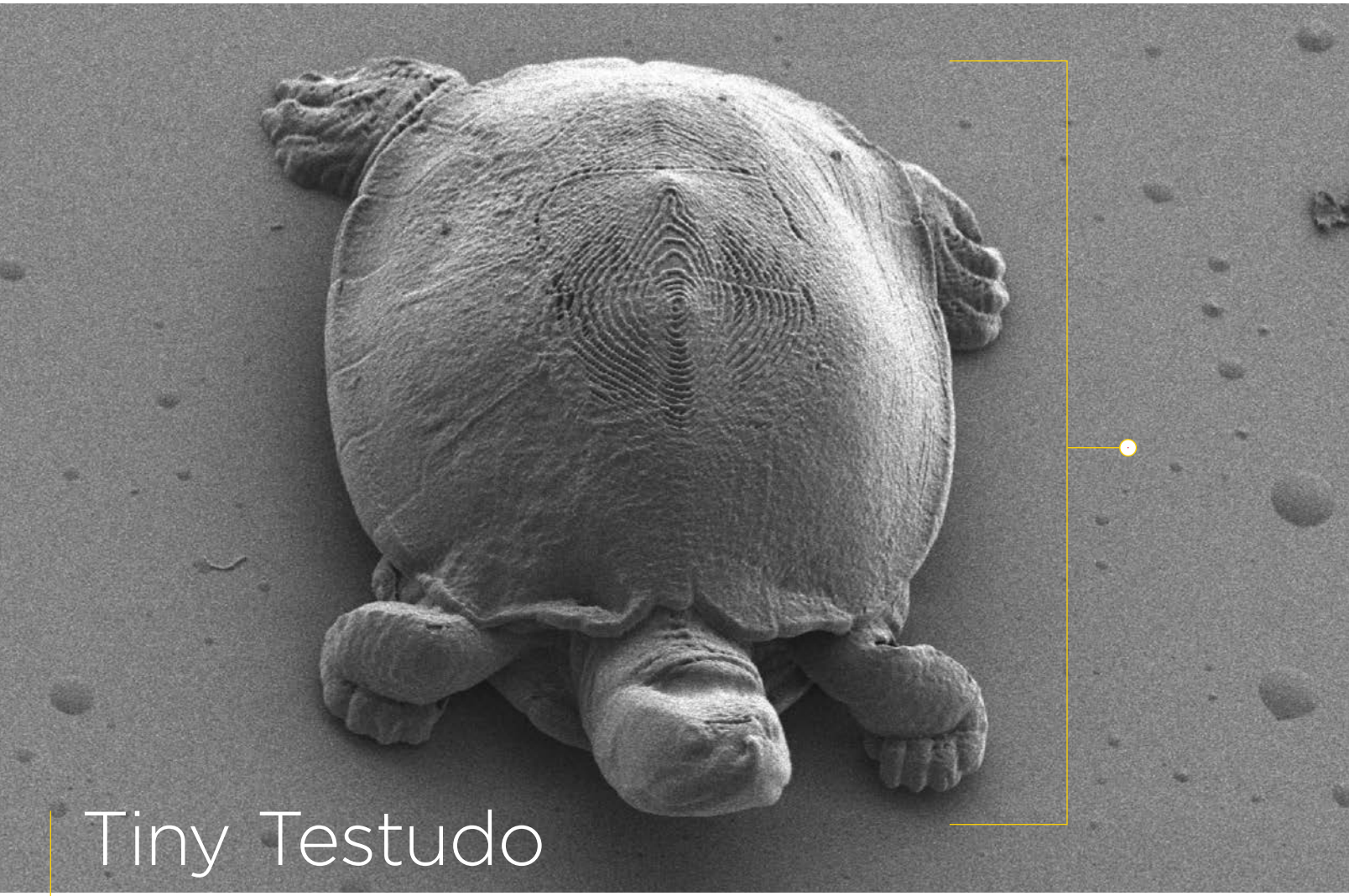

Tiny Testudo

Caroline McCue, an undergraduate mechanical engineering student and Terrapin Works employee, printed this micro Testudo using the Nanoscribe GT, a 3-D micro printer. The Testudo is 86 x 124 x 40 micrometers—12 orders of magnitude smaller than the original Testudo! It would take more than a trillion of these micro Testudos to make up one regular sized Testudo. After printing, it is impossible to see the print with the naked eye, so a scanning electron microscope was used to take this picture.