IMPACT
FROM THE DEAN

That’s our charge as an academic and research institution—translating our efforts in ways that make people’s lives better. Smart, secure and connected devices are going to be pervasive in our society in the coming years, and the data created will open limitless possibilities. We’ve launched a new institute, created a new undergraduate degree and formed new partnerships to be at the edge of this new frontier.

We’re also committed to innovation as a way to solve some of society’s most pressing problems. That is why we led a university-wide innovation summit and opened the doors to the new, 50,000-square-foot home of Sears think[box], our innovation and entrepreneurship center with unprecedented scope, scale and access.

In research, we strive to meet some of humanity’s greatest needs in the realms of health solutions and advances for our growing society’s energy needs.

We want to make a difference. We have committed to ensuring that what we do matters. And we are here to make an impact.

Jeffrey L. Duerk
Dean, Case School of Engineering
Leonard Case Jr. Professor of Engineering

Our ultimate goal is to have a meaningful impact on society.
You’re probably online right now. Even if you’re reading this the old-fashioned way, you’re most likely still connected. As the world’s wireless devices proliferate, the internet isn’t necessarily somewhere you go anymore; it’s somewhere you already are. There are nearly 6 billion networked devices out there wirelessly gathering, recording and transmitting a practically boundless amount of information. Digital TMI? Not according to industry experts, who see it as a powerful tool to tackle the world’s biggest challenges in energy, manufacturing, health care, education and more.

The explosion in the sheer number of networked devices has given birth to a whole new kind of the networked revolution: the Internet of Things (IoT), big data and augmented reality are transforming our physical world. With the launch of a new IoT institute, a strategic partnership with Cleveland Clinic and Microsoft HoloLens, a new ARPA-E grant to develop software for virtual energy audits and more, Case Western Reserve University is poised to capitalize on high-tech opportunities.

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Big data, big deal The explosion in the sheer number of networked devices has given birth to a whole new kind of internet: the Internet of Things—a new frontier of constant digital connection. “We’re looking at a time in which you have things in homes, factories, commercial buildings, infrastructure and power delivery systems that are all going to be connected,” says Kenneth Loparo, chair of Case Western Reserve University’s Department of Electrical Engineering and Computer Science. “That’s the good news. The bad news is that they’re all going to be connected—the complexity of this network becomes mind-boggling.”

So far, the Internet of Things has sprung up something like a city before the advent of urban planning—a bit wild and unchecked. Case Western Reserve has launched a new institute dedicated to putting infrastructure around this new frontier so that society can put this powerful connected network to work.

Led by the Case School of Engineering, the Institute for Smart, Secure and Connected Systems, or ISSACS for short, will provide a physical home for the university’s virtual initiatives in data science, IoT, cybersecurity, embedded systems, data analytics and more. “The whole idea is to look at all these connected opportunities holistically,” Loparo says. “From devices to data to the algorithms and software to user interfaces and cloud infrastructure, we’re looking at this as an end-to-end system.” The institute will bring all the university’s IoT-related research projects and academic programs under one umbrella. That kind of big-picture thinking is what’s going to drive innovation in this space, he says.

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KENNETH LOPARO

Industrial applications Media stories about the IoT tend to focus on nifty consumer applications, but Loparo says advances in industry will dwarf consumer IoT innovations in terms of impact, particularly in the manufacturing and energy sectors. Bob Herbold, former CEO of Microsoft and Case Western Reserve alumni, agrees. “If you think about the ability to outfit a power plant with sensors and measure various aspects of its performance in real time, or monitor a refinery for signs of trouble before things slide out of control, the impact of this technology is massive,” he says. Herbold has been one of Case Western Reserve’s chief supporters in advancing IoT and data science initiatives. “Bob is one of the world’s premier industrial innovators,” Loparo says. “Bob Herbold is one of Case Western Reserve’s chief supporters in advancing IoT and data science initiatives. Read more about his gifts establishing a dedicated professorship and supporting graduate scholarships on page 9.”

Automation has already transformed modern factories, and the IoT promises to up the ante in terms of the control systems that manage industrial-scale equipment, helping companies get their products to market faster, lower the costs of equipment ownership, improve asset

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utilization and maximize an entire operation's efficiency, says Ian Winder, vice president of operations, architecture and technology at Rockwell Automation, an industrial automation and information company that’s implementing its own take on the IoT through an initiative it calls the Connected Enterprise.

Basically, rewiring a plant gets everything talking to each other—which essentially makes the whole operation run more smoothly, Winder says. With sensors monitoring equipment performance in real time, operations managers don't have to wait for machinery to break down to know there's a problem. It also helps companies manage diverse operations across the globe like never before.

IoT technology also has the potential to transform the way electricity is distributed, according to John Varian, who by creating a system in which energy is dynamically controlled—where smart buildings can tell the system how much energy they need and the system can distribute accordingly, adjusting remotely to make the most efficient use of the generated energy. A smart energy system could even reroute power if a certain section of the grid gets knocked out by a storm, Loparo says.

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Diverse operations across the globe like never before.

metroLab is just one example of how Case Western Reserve is using data to solve energy problems. With the help of a $1.6 million grant from the U.S. Department of Energy’s Advanced Research Projects Agency-Energy (ARPA-E), researchers are developing a unique software platform capable of translating years of building-generated data into virtual energy audits that could help building managers manage energy use more efficiently and reduce costs.

"What we're doing is essentially mapping the building generation, says Alexis Abramson, director of the Great Lakes Energy Institute and the Milton and Tamar Maltz Professor of Energy Innovation at Case Western Reserve. "Just like mapping the human genome is uncovering characteristics in DNA that correspond to traits like hair and eye color, Abramson and her team are creating software that identifies patterns and signatures in building-energy data that correspond with building characteristics and performance. "Without setting foot in a building, we can tell you how good your insulation is, how much lighting you are using, and if your heating or cooling system is sized incorrectly," Abramson explains. Current energy audits are conducted by a cumbersome combination of multiple systems and tests and physical walkthroughs. Abramson and her team, including Roger French, the Hyraxia Professor of Materials Science and Engineering, are looking to streamline the entire process using data already collected by smart meters installed in buildings. "With no disturbance to your operations, no extra costs in adding additional sensors, you can simply take your data and diagnose the problem," she says.

And the program can do more than just diagnose a drawback or poor insulation. It can also incorporate weather data to predict a building's energy usage. "For instance, we can predict the energy use patterns and total consumption in your building on a specific Monday, in January, based on the expected weather," Abramson says. "It's amazing how accurate predictions can be when they're developed from a significant amount of prior data."

That's the power of big data gathering, processing and information, and patterns begin to emerge. In addition to predicting overall potential energy savings, by changing variables like the heating system, insulation or windows, building owners can also see how much energy—and money—they can save in your building by enacting specific changes. That kind of information will help building owners make the most informed and impactful choices when it comes to building energy upgrades.

Reality check While energy researchers are using virtual information to create real changes in physical spaces, another set of scientists is introducing the university and the world to a piece of technology that's literally altering the reality you see with your own eyes. With the sleek black headband andvisor, Microsoft's HoloLens looks like a piece of virtual reality equipment. But unlike VR, when you put on a HoloLens headset, your reality stays the same. This piece of augmented reality technology brings digital information into real space as holographic images, allowing users to see and interact with 3-D images—and other people—at the same time.

That ability to collaborate over shared virtual information is what makes the technology so unique, according to Erin Henniger, executive director of the university's InterActive Commons. "Allowing people to visually connect with data in this way makes the technology so unique, according to Erin Henniger, executive director of the university’s InterActive Commons. "We’ve been looking to visually connect with data in this way for a long time,“ she says. "And when they can look at it together, it changes their understanding of it and changes how they see the world,“ she says. "I think of it as the first step to a more interactive interaction." It’s a different kind of experience than virtual reality, adds Mark Griswold, professor of radiology, biomedical engineering, electrical engineering and computer science, and physics, who serves as the faculty lead on the university’s HoloLens initiatives. "People in virtual reality are totally immersed,“ he says. "That’s not the way it is."
Researchers at Case Western Reserve and partners are developing Microsoft HoloLens applications for classroom use and research.

Right: Mark Griswold, professor of radiology, biomedical engineering, electrical engineering and computer science and physics, and Eric Varsinger, executive director of the university’s Interactive Commons, are leading university initiatives to visualize data.

Students use HoloLens devices to access virtual reality, augmented reality or mixed reality environments and assets.

Buchner is working with a colleague in the biology department to design a learning experience using HoloLens and augmented reality.

“Beyond understanding the math, what our networked future will look like? This new world order is moving so fast, experts can’t even agree on how fast it’s growing—estimates vary from 20 billion to 40 billion. But they can agree that a world in which the Internet of Things (IoT) will involve the Internet of Things, according to tech firm Gartner. Moreover, security for IoT will comprise about 20 percent of organizations’ total security costs—that’s up from just 1 percent last year. This information shortfall translates into a pressing need for a specialized workforce equipped to handle this massive amount of data.

This is the promise of the IoT: to continue and intensify the connectivity revolution that started in the early 1990s. The early 1990s. The early 1990s when the world was opened up to virtual and physical continue to grow closer in one of vast opportunities and challenges.

"This space is evolving fast, and one of the biggest bottlenecks is talent—skilled personnel," says Bob Herbold, former Microsoft COO and Case Western Reserve alumnus. Herbold made a $2.75 million pledge this year toward graduate student scholarships, a key component in the establishment of Case Western Reserve’s Institute for Smart, Secure and Connected Systems (ISSACS) that will provide essential support for educating the exact kind of workforce a data-science- focused future requires. "For any organization to take advantage of these IoT capabilities you need two things: the talent to actually do it, but maybe more importantly you need leadership that understands that these new capabilities exist and wants to embrace them. Both are happening. From the standpoint of education, the future’s here in something Case Western Reserve has to be a leader in terms of qualifying these kinds of people."

The commitment builds on Herbold’s 2014 gift that established an endowed professorship in data science and analytics at the university.

SUPPORTS DATA SCIENCE STUDY

ALUMNI, FORMER MICROSOFT COO SUPPORTS DATA SCIENCE STUDY

Big data is a big deal for businesses: by 2020, more than half of all business processes and systems will involve the Internet of Things, according to tech research firm Gartner. Moreover, security for IoT will comprise about 20 percent of organizations’ total security costs—that’s up from just 1 percent last year. This information shortfall translates into a pressing need for a specialized workforce equipped to handle this massive amount of data.

This is just the beginning. We are at stage zero: think about how a 1985 cell phone compares to today’s iPhone."
DATA

BEAR NECESSITIES

We all crave connection, and sometimes, those closest to us are just too far away. Student and entrepreneur Xyla Foxlin invented a way to send long-distance hugs via wirelessly connected teddy bears. A patent-pending sensor system detects when one bear is hugged and transmits those warm fuzzy feelings via haptic vibrations to its pair-bear anywhere in the world. The mechanical engineering major has been hitting the road promoting her startup, Parihug, garnering attention, top prizes and funding from CES, Disrupt NY, Her Startup Global—and bringing home the Reader’s Choice Award in Tech.Co’s Startup of the Year contest at South by Southwest. Her next step? Launching her crowdfunding campaign and expanding the product line beyond bears. Learn more at engineering.case.edu/Parihug.
Big data vs. disease: biomedical engineering researchers mine medical images for information to guide better cancer treatment

Since the moment the first X-ray gave the world a sneak-peek at the body’s inner workings, medical images have become a vital tool in the clinical arsenal. Now, thanks to the advent of big data analytics, these images are becoming even more powerful in their ability to help scientists and physicians better diagnose and treat a variety of deadly diseases.

Biomedical engineering researchers at Case Western Reserve University’s Center for Computational Imaging and Personalized Diagnostics (CCIPD) are developing a suite of high-tech tools and analytical techniques to mine the wealth of information contained in magnetic resonance images (MRIs) and put that data to work to make faster, more accurate diagnoses and predict the most successful treatment options.

A research team led by Anant Madabhushi, center director and the F. Alex Nason Professor II of Biomedical Engineering, discovered changes in textural patterns that turned up in the MRIs of breast cancer patients coincided with variations in gene expression that differentiated between aggressive and nonaggressive forms of the disease. Their findings, published in Nature Scientific Reports, could lead to a cheaper, faster way to determine how aggressive a patient’s cancer is that’s just as accurate as current biopsy analyses, which could help clinicians predict which patients need chemotherapy and which could be successfully treated with hormone therapy alone.

Madabhushi also led another team that developed a tool that aligns and fuses MRIs of the prostate before and after laser ablation treatment for cancer, allowing them to quantitatively evaluate the physical effects of the treatment, which could better inform the risks and long-term outcomes associated with ablation, an increasingly common treatment for prostate cancer that serves as something of a middle-ground approach in low-risk cases between watchful waiting and radical actions like surgery and radiation.

And Satish Viswanath, a research assistant professor in biomedical engineering and CCIPD researcher, won a three-year grant from the Department of Defense to develop a way to use data analytics to guide better treatment for rectal cancer.

In addition, center researchers secured 10 U.S. patents to advance digital pathology technology.

Learn more about how big data is pushing better diagnoses at engineering.case.edu/centers/ccipd.

Augmented reality check: engineering students create virtual sheet music and more using Microsoft HoloLens

For most college seniors, graduation day can’t come fast enough. But a group of engineering students at Case Western Reserve University would have preferred to slow down the clocks on their senior year to have more time to work with some seriously cutting-edge technology.

On the heels of Cleveland Clinic and Case Western Reserve University announcing their partnership with Microsoft to develop the company’s augmented reality technology HoloLens into a teaching tool, engineering students got to work directly with Microsoft HoloLens to create their senior design projects. The results of mixing innovative young minds with radically disruptive technology eureka-worthy apps that make it easier to play music, track energy usage and more.

One group of musically minded engineering students sought to eliminate the nuisance of constantly having to flip sheet music—they developed a program that displays rolling virtual sheet music, allowing the performer to follow along, hands-free, at a speed they control as they play. Another group created a 3-D rendering of campus that could capture energy-use data—providing a real-time energy-usage snapshot to help inform sustainability initiatives. And another student is using HoloLens as a tool in cooperation with the university’s psychology department to help with cognitive behavioral therapy sessions.

Learn more and watch the students’ apps in action at engineering.case.edu/HoloLens-app-development.
Sense4Baby capability in the new Apple Watch has roots at Case Western Reserve

Apple debuted a number of new technologies last fall, including the latest version of its Apple Watch, which includes a health monitoring capability that traces its roots to Case Western Reserve University. The device got its start in 2009 when Mehran Mehregany, the Veale Professor of Wireless Health Innovation, was on leave at the West Health Institute. Sense4Baby monitors fetal heart rate and contractions in pregnant women. The application, device development and the name were originated by Mehregany. Learn more at engineering.case.edu/Mehregany-Sense4Baby.

Introducing Gecko Hamaker

A new software tool developed by researchers at Case Western Reserve University gives the scientific community a powerful, open-source tool capable of calculating the long-range intermolecular attractions between materials and using that data to predict how materials will assemble. The Gecko-Hamaker program specifically evaluates a physical phenomenon called van der Waals forces, the attractive forces that pull molecules and materials together. Researchers can use the program to predict molecular organization and even evaluate whether new or not new combinations of materials will stick together—essential knowledge for chemists, physicists and materials scientists designing nano- and meso-scale materials for use in molecular-level electronics, photonic and biological devices.

Learn more at engineering.case.edu/Gecko-Hamaker.

Data science degree launched

Case Western Reserve University officially launched one of the country’s few undergraduate Bachelor of Science degrees in data science and analytics to help prepare students for careers in the new big-data-dominated world. According to reports, the United States alone will need to increase the number of its data-savvy graduates by as much as 40 percent in the next five years to keep pace with industry demand for employees who can put big data to work. Housed in the engineering school, the new degree program expands on the success of the university’s data science minor, which launched in 2013, and will focus on real-world applications and include a curriculum built around essential elements of this emerging field, including mathematical modeling, data analytics and visual analytics.

Learn more at engineering.case.edu/SunShot.

DIGITAL FIRM SPONSORS SUMMER TECH CAMP

Case Western Reserve University hosts a series of technology-based summer camps each year to give local third through 12th-grade students the chance to explore high-tech topics, from computer programming to robotics. This year, thanks to data company Vertical Knowledge, 20 Cleveland-area high school students were able to attend a coding-specific camp for free. A special curriculum designed to familiarize the students with the programming language C# was developed in collaboration with Hyland Software. In addition to the free camp sponsored by Vertical Knowledge, Case Western Reserve hosted eight other TECHie Camps in partnership with TECH CORPS for students in third through eighth grades.

Built to Last

According to a report from the Solar Energy Industries Association, the price for an average photovoltaic system installation has fallen by more than 50 percent since 2010, putting this particular brand of renewable energy technology on its way to successfully competing with traditional fossil fuels. With the help of a $1.35-million U.S. Department of Energy SunShot Initiative grant, researchers at Case Western Reserve University will help close the gap by undertaking a massive study of more than 5 million solar panels from hundreds of power plants around the world to get a better handle on the specifics of how these modules degrade over time and under different conditions.

Learn more at engineering.case.edu/SunShot.
Jeff Hoffman, co-founder of priceline.com, spoke at the university’s innovation summit, encouraging innovators to think about the customer's needs first.

“Fueling innovation is to be the driver for solving modern society’s complex problems, then systems are needed to teach, explore and nurture innovation and entrepreneurship. Case Western Reserve has dedicated itself to these pursuits—hosting a national summit and growing an ecosystem of innovation featuring Sears think[box] as the cornerstone.”

Innovation

Jeff Hoffman, co-founder of priceline.com, spoke at the university’s innovation summit, encouraging innovators to think about the customer’s needs first.

“We start with something cool we came across, and then we hope someone out there in the world wants it,” said Jeff Hoffman, co-founder of priceline.com, describing the typical approach to innovation. “The best entrepreneurs start at the other end.”

Gallup CEO Jim Clifton agreed. “If you follow innovation around, it has absolutely no value whatsoever until it has a customer standing next to it.” Clifton additionally stressed the need for extreme determination and an ability to spot disruptions in order to be a successful entrepreneur.

Atari founder Nolan Bushnell went further, encouraging the use of crowdfunding as the litmus test for product profitability, and saying this ability is creating a “golden age” for innovators.

This advice came in keynote addresses during Case Western Reserve University’s inaugural Innovation Summit, which featured three days of exploring where and why innovation thrives. The event, entitled “Models of Innovation,” included a special spotlight on new resource to support budding innovators: the first phase of Case Western Reserve’s Sears think[box]—one of the world’s largest university-based innovation and entrepreneurship centers.

Hosting an international exploration of innovation

“Our university has made a serious commitment to innovation and entrepreneurship,” says Joe Jankowski, the university’s chief innovation officer and co-chair of the summit. “On a local, national and international level, we want to be a resource for innovation and entrepreneurship and we want to collaborate with others on this topic.”

And so, for three days in the fall of 2015, more than 500 attendees visited the Case Western Reserve campus to participate in the summit and explore the opportunities and challenges of various models of innovation at the global scale. “We noticed that innovation was becoming too much of a buzzword,” says Lisa Camp, associate dean of strategic initiatives at the Case School of Engineering and co-chair of the summit. “And that groups were trying to pigeonhole what innovation means—that there were separate flavors of innovation: energy innovation versus medical innovation versus innovations in manufacturing. We felt it was important to have a national summit to talk about innovation being a multidisciplinary, multifaceted endeavor, and one that is needs-based.” And so, the idea for a summit percolated up from the engineering school, which provided strong leadership for the event. Some of the minds behind Atari, Gallup, priceline.com, Samsung, Microsoft, MAKE magazine, America Makes, the Smithsonian, Goldman Sachs, the U.S. Department of Commerce and BAA-4 served as speakers and panelists guiding discussions around the processes and workflows that encourage innovation. A goal was to dissect approaches to innovation both by geographic region and by industry sector. Those discussions helped drive at commonalities. “Collectively we realized that, at the end of the day, innovation is a way of improving and meeting the needs of a group, whether that is society as a whole or a specific population such as cancer patients,” says Jankowski. An ability to iterate quickly and change direction appropriately when faced with challenges were markers of success that were noted to permeate all industries and geographies.

The summit also provided an opportunity to dive deeper into specific areas, with the second day

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Lisa Camp

The Innovation summit featured panels such as exploring innovation by sector opportunities, which included Marco Momma of University Hospitals, Jack Daly of Goldman Sachs, Chuck Fowler of Fairmont Santrol, Mike Charbonneau of Microsoft and Ellen Williams, director of ARPA-E.

Innovation
offering multiple breakout sessions on health consumer empowerment, the Internet of Things, additive manufacturing, finance models, intellectual property (IP), energy and more, allowing attendees to supplement big-picture ideas with real advice and tangibles they could readily implement.

In the realm of energy, Ellen Williams, director of ARPA-E, discussed innovations helping to move the field forward—from applying the Internet of Things to transportation, to advancing light-weight metals or very small production runs. On the fifth floor, project space is provided for student groups and senior projects, such as the Baja SAE team’s off-road vehicle. "We agreed that it should be a campus-wide resource for any student or researcher, to support their design and making activities. And we agreed that it should be freely open not only to all of campus, but to the whole community,” says Charnas.

For projects that harbor commercial potential, the sixth floor will provide resources for business plan development, fundraising, intellectual property (IP) protection, intellectual property management, and mentorship. Alumni keen to support students with startups will be able to keep office hours to provide advice useful to early-stage ventures. Currently, floors four through five are open, with six and seven scheduled to open in the fall of 2017, and floor one to follow.

Liisa Camp, associate dean of strategic initiatives at the Case School of Engineering and co-chair of the innovation summit, developed as exploration of innovation by industry and by region.

Left, Sears think[box] offers budding innovators all the resources needed to take an idea through the commercialization process.

Finally, the seventh floor will provide incubator space for burgeoning startups to have office space, support and mentorship. Alumni keen to support students with startups will be able to keep office hours to provide advice useful to early-stage ventures.

Currently, floors two through five are open, with six and seven scheduled to open in the fall of 2017, and floor one to follow.

The seven-story innovation hub is a huge ramp-up from its more modest beginnings, which grew out of a desire to provide a space for engineering students to design and make things, initially for capstone design projects, which had previously been paper exercises only. "We realized pretty quickly that this had a scope well beyond engineering and student design," says Cooke. "We agreed that it should be a campus-wide resource for any student or researcher, to support their design and making activities. And we agreed that it should be freely open not only to all of campus, but to the whole community."
and patent applications, and have projects that have spurred dozens of jobs in the phase of commercialization. These initiatives give faculty members the opportunity to purchase or maintain it themselves.

Charnas notes that think[box] gives faculty members a much greater chance of “sticking.” In the realm of research, Sears think[box] gives faculty members instant access to state-of-the-art equipment, without having to purchase or maintain it themselves. A third goal is support for entrepreneurship. Charnas notes that more than 100 projects developed using the resources of think[box] and CBWR LabSuite are now at some phase of commercialization. These projects have spurred dozens of jobs and patient applications, and have received more than $5 million of external funding.

Malcolm Cooke, Sears think[box] executive director, and Ian Charnas, think[box] manager, are helping develop an ecosystem of innovation that provides everyone with free access to all the support needed to take a concept from ideation to commercialization.

Carbon-dioxide removal, 3-D printing and more.

Workplace flexibility and a stronger connection to the next stages of innovation.

As such, the innovation ecosystem needs to create connections to the next stages of development. As such, the university collaborates with entities like JumpStart and BioEnterprise, which serve as venture development organizations for the region.

Indeed, Sears think[box] is a resource open to them. When it’s time for your startup to do light manufacturing, and raise millions of dollars of investment capital to get to the ground, we’re linked into the rich ecosystem of accelerators in Northeast Ohio who do a great job of supporting that,” says Charnas.

JumpStart CEO Ray Leach agrees. “We are fortunate enough to be one of the nearest 10 universities in the country and the connections we’ve led to directly major successes. One such example is CardioHealth—a Cleveland startup that was acquired by medical technology giant Medtronic in a deal worth more than $92 million. The technology and team originated at the university, and JumpStart helped fund and support the startup.

“This is how it’s supposed to work,” says Leach. “Institutions like Case Western Reserve can output innovative ideas and motivated entrepreneurs from its accelerators, with innovation systems, from top universities to two-year colleges to high schools and Fortune 500 companies—everywhere from Nevada to Akron, India to New Zealand. We are trailblazers and many see us as the gold standard on how to set up ecosystems around innovation and entrepreneurship,” says Cooke. “That’s great feedback to know we have created something really special here.”

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The Sears think[box] model has replicated think[box]'s success.

Additional important support for Sears think[box] includes:

1. The $50,000-square-foot structure, the Richey Mixon Building, which was renovated with the support of Joseph B. Richey ’75 ‘72 and A. Malcolm Milken.

2. Floor 1, Community—the Richey Mixon Floor

3. Floor 2, Collaboration—the Wyant Collaboration Floor

4. Floor 3, Prototyping—the Prentke Romich Floor

5. Floor 4, Fabrication—the Lubrizol Foundation and Kent H. Smith and Kelvin Smith Fabrication Floor

6. Floor 5, Project Space—the Eric T. Nord Project Space Floor

7. The Reinberger Design Studio

8. The Mandato Family Innovator Office

9. The Hunter Cray Center for Innovation and Entrepreneurship, including the Reinberger Design Studio

10. The Eric T. Nord Project Space Floor

11. The Hunter Cray Center for Innovation and Entrepreneurship, including the Reinberger Design Studio

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#NATIONOFMAKERS

It’s a fact—Adam Savage, former host of the popular TV series “Mythbusters,” visited Case Western Reserve University’s Larry Sears and Sally Zlotnick Sears think[box] this spring, with Cleveland serving as the first stop on a national tour of makerspaces. Organized with the White House Office of Science and Technology Policy, the visit was part of a national initiative to promote the maker movement as a driver of economic development. Participants live-tweeted throughout the day as they led Savage (seen here at right with Sears think[box] manager Ian Charnas) and other local stakeholders on a tour of Cleveland makerspaces and innovation hubs, propelling #NationofMakers to the top of the city’s trending list on twitter by afternoon. Check out highlights from the day at engineering.case.edu/Adam-Savage-visit-highlights.
The new industrial revolution: researchers tackle advanced manufacturing projects in lightweight and orthopedic materials and digital production

Advanced manufacturing has the potential to revolutionize the way products are made in the United States, and historical industrial powerhouses like Northeast Ohio are poised to lead in advancing new techniques and technologies. Case Western Reserve University researchers are collaborating on a number of projects across the nation to advance research in manufacturing innovation.

Within Lightweight Innovations for Tomorrow (LIFT)—part of the Obama administration’s National Network for Manufacturing Innovation program, recently renamed Manufacturing USA—university researchers are carrying out multiple validation experiments to ensure the reliability of aluminum-lithium alloys in critical applications, as well as methods to maintain the performance of aluminum silicon carbide composites while reducing costs. Both projects have important ramifications for next-generation aerospace and automotive applications.

Materials researchers at the engineering school won more funding from America Makes, the National Additive Manufacturing Innovation Institute, to use additive manufacturing and experiment with powder reuse to find a more economical way to make orthopedic materials. Researchers at Michigan State University and Duke University ranked their top 25 institutions in Quartz, an online business publication affiliated with The Atlantic magazine. They based their list on lasting contributions to society using a unique system that accounts for undergraduate alumni who have won the most prestigious academic awards—including Nobel Prizes, Fields Medals and Turing Awards—and those who have gained membership in the National Academies.

Case Western Reserve counts three Nobel laureates among its undergraduate alumni—Donald A. Glaser (CIT ’41), Polykarp Kusch (CIT ’31) and Paul C. Lauterbur (CIT ’51, HON ’00)—and a Turing Prize winner in Donald Knuth (CIT ’60). Twenty-eight undergraduate alumni have earned admission to the National Academies. An additional 13 graduate/professional school alumni and faculty have earned Nobel Prizes, and many others have been inducted to the National Academies.

High-tech detectives: Sears think[box] helps Cleveland Museum of Art match missing piece to ancient statue

A piece of 21st-century technology at Case Western Reserve University’s Larry Sears and Sally Zlotnick Sears think[box] helped solve a 6th-century puzzle at the Cleveland Museum of Art. Curators and conservators at the art museum had been trying to match a fragment to a stone statue of Krishna for decades, but the pieces never seemed to fit together correctly, leaving experts wondering if they were indeed part of the sculpture in Cleveland’s collection or if they belonged to similar statues at a museum in their country of origin, Cambodia.

When additional historical documentation on the sculpture provided important clues as to how the fragment might fit on Cleveland’s statue, the museum turned to Sears think[box] which used 3-D imaging technology to scan the pieces and compare the fragments to the full sculpture in digital form, proving they did indeed match. Full-scale prints made from the scan will aid conservators in reconstructing Krishna and reuniting the long-missing fragment: the crowning element of the sculpture.

Learn more about how 3-D scans proved a match between an ancient sculpture and its missing pieces at engineering.case.edu/thinkbox-CMA.
Clean water and commercialization

NASA Glenn Research Center scientists are teaming with students from the university’s Fusion program to commercialize a technology that could save millions of dollars spent each year cleaning up drinking water. The lab has patented a device that provides rapid diagnosis of sickle cell disease and other hemoglobin disorders. The fully implantable system uses neurostimulation to restore muscle function in patients with paralysis.

Biomedical translation

Two biomedical engineering faculty members received funding from the state to help move their technologies from campus to marketplace. Grants from both the Ohio Third Frontier Technology Validation and Start-up Fund and the state Department of Education’s I-Corps Ohio program will help biomedical engineering professor Hunter Furbush with both testing and prototyping, as well as hands-on training in innovation. Furbush’s team at Case Western Reserve University are collaborating to commercialize the third generation of neurostimulation technology pioneered by biomedical engineering professor Hunter Furbush and his team at Case Western Reserve. The fully implantable system uses neurostimulation to restore muscle function in patients with paralysis.

Startup boost

The Ohio Third Frontier Commission awarded $100,000 each to four early-stage tech companies developed at the university. Led by mechanical and aerospace engineering’s Jiajian Guan, HomeCity is a device that provides rapid diagnosis of skin cell diseases and other hereditary disorders in newborns. Biomedical engineering’s Abhishek Bhatia is developing a removable device that uses electrical currents for pain control. SynthoPlate, artificial blood platelets that can reduce bleeding in instances of traumatic injury, is being developed by biomedical engineering’s Anirban Sen Gupta. Electrical engineering’s Philip Young has developed self-powering wireless sensors that could turn conventional buildings into energy-efficient “smart” buildings.

Thomson Reuters named Case Western Reserve one of the world’s top 100 most innovative schools.

Neurostimulation advancement

With the support of a $1.5-million National Institute of Biomedical Engineering Program grant, Synapse Biomedical and the Institute for Functional Restorations at Case Western Reserve University are collaborating to commercialize the third generation of neurostimulation technology pioneered by biomedical engineering professor Hunter Furbush and his team at Case Western Reserve. The fully implantable system uses neurostimulation to restore muscle function in patients with paralysis.

A startup worth seeing

LYGENT, a startup founded by Techna VanDellen as a Case Western Reserve biomedical engineering graduate student, is developing a new vision test for eye misalignment—and has won a grant from ventureBeat to help move it toward product launch. Learn more at engineering.case.edu/TechWeek-meet-the-startups-lygent.

Everykey starts shipping

Everykey, a startup launched by Case Western Reserve University alumnus Chris Wentz during his senior year, started shipping its signature product: a small Bluetooth device that stores and secures complex passwords to unsecure a whole host of digital devices, from computers to online accounts. Learn more at engineering.case.edu/meet-our-innovators/everykey.

As part of the second national Week of Making, the White House announced Case Western Reserve University’s Sears think[box]'s dreams.
Whether hyperactive or interrupted, brain activity is a bundle of secrets. Untangling the mysteries of the brain requires tapping deeper into our body’s most complex organ.

Epilepsy, the brain and the heart

Epilepsy’s devastating effects on the brain have been well documented clinically. Seizures come recurrently, unprovoked, and can lead to severe cognitive dysfunction. SUDEP (Sudden Unexpected Death in Epilepsy) is the No. 1 cause of death in epilepsy patients. Now, research is uncovering how epilepsy affects more than the brain; how, even in the absence of seizures, it impacts the autonomic nervous system—including critical heart function.

Roberto Fernández Galán, assistant professor of electrical engineering and computer science at Case Western Reserve University, has been exploring epilepsy’s connection to the heart and how enhanced parasympathetic tone and epilepsy could be a key to better understanding—and preventing—SUDEP. After the exhaustion of a seizure, an epileptic patient’s heart rate tends to go down. So if the patient already has a low baseline heart rate due to an overly active parasympathetic nervous system, their heart is at risk of slipping down to a rate that can’t support the body. “If your baseline heart rate is too low, you’ll be at a much higher risk for SUDEP,” says Galán. “We may be pointing to the mechanisms for SUDEP, the cause of which is not currently known.

Sitting at the stem of the brain is the vagus nerve, which controls the entire autonomic nervous system—including parasympathetic tone. The more active the vagus nerve, the slower your heart rate, the stronger your sinus arrhythmia and the longer your diastole. So a hyperactive vagus nerve, Galán suspects, could be a precursor to epileptic seizures.

Galán is looking at ways to monitor this part of the brain to document any connection between a hyperactive vagus nerve, increased parasympathetic tone and epilepsy, which could open a pathway to new treatments for epilepsy.
Brain wave propagation

If epilepsy does begin with hyperactivity in the vagus nerve, how does this condition also create seizures in other parts of the brain? To understand this, other mysteries of the brain need to be unraveled, including how electrical signals in epilepsy propagate. Electrical fields are known to exist in the brain and to affect neighboring cells, but they’re often not studied to transport information. Durand took a closer look at these fields to see if they could be used as a channel of transmission.

Through computer simulations, he modeled large numbers of brain cells and illuminate all known possible interactions between them—only allowing communication through electrical fields. He found that neurons could indeed transmit a message to their neighbors via the electrical field, and also recruit their neighbors to continue disseminating the message through a process called “volume conduction.” The model confirmed that the signals would propagate as the speed Durand had observed in vitro. Adjustments for space between neurons and field size confirmed that the brain spikes were indeed propagating via electrical fields.

“Imagine a car putting out flashes of light as it drives,” says Durand. “We’ve discovered a new way that neural signals can propagate. And it’s quite exciting because it means there is a mechanism by which parts of the brain can be synchronized without any other mechanism than being next to another area of the brain.”

From observation to action: rewiring the brain to restore movement

Recording the brain’s electrical signals has led to one application of advancements in brain monitoring and electrical arrays. In instances of healthy brains that have been silenced by injury to the spinal cord, brain recordings can translate artificial signals, such as shrugging the shoulder, into computer commands. Human BrainGate2 seeks to use BCIs to recreate movement cues using artificial signals, such as stimulating the hand to return movement to an injured arm. Functional electrical stimulation (FES) technology was pioneered at Case Western Reserve in the mid-1990s by a team of colleagues at Brown, Stanford and the Department of Defense and Massachusetts General Hospital.

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We are currently where the computer was in 1980. Look how far computing has come since then. Our understanding of the brain in the next 20, 30, 40 years will be astronomical.”

A. BOLU AJIBOYE

In a medical first, an FES+BCI system has allowed this volunteer, who was paralyzed from the neck down, to use his own thoughts to move his arm and hand once again.

A. BOLU AJIBOYE, assistant professor of biomedical engineering, is combining FES and BCI technology to restore movement to paralyzed individuals.

“Right, Robert Kirsch, chair of the Department of Biomedical Engineering at the university and director of the Cleveland FES Center, and I. Bola Ajiboye, assistant professor of biomedical engineering, are combining FES and BCI technology to restore movement to paralyzed individuals.”

If he could no longer move his body below the neck, he volunteered to be the first to undergo the joint BCI+FES system. “It was exciting to be the first to try this,” says the patient. “Someone has to go first, otherwise research would never get done.”

In December of 2014, he underwent surgery to receive two recording silicon electrodes, each just 4 by 4 millimeters, placed in his primary motor cortex. The multichannel array penetrates a millimeter into his brain, just below the skull, and records from hundreds of neurons. The array’s wires emerge from his skull and link to a port, which can be plugged into a computer to record and interpret the signals. Over the next six months, a team from Case Western Reserve, led by Robert Kirsch, chair of the Department of Biomedical Engineering at the university and director of the Cleveland FES Center, worked with the patient, recording his brain signals and teaching him to control a virtual arm on a computer screen. Then, in April 2015, 16 FES electrodes were implanted percutaneously in the patient’s right shoulder, arm and hand muscles. The next week, for the first time in eight years, he moved his hand and elbow. Since then, the volunteer has worked with the research team to improve his control. He’s now able to command simple movements of his wrist, elbow and shoulder in multiple directions, grasp with his hand, and combine these to perform functional and meaningful activities, such as taking a drink from a cup.

“It’s just amazing,” says the patient volunteer. “Every time I move my arm, I’m still so amazed that I can.” At first, he says he had to think about each individual movement specifically—breaking down a fluid motion into a dozen individual components. With time, he’s been able to think about solely the end goal, though he admits it’s not the simple process it was prior to his injury. “It’s our first pass, so the degrees of freedom are limited,” says A. Bolu Ajiboye, assistant professor of biomedical engineering and a member of the Case Western Reserve BrainGate team. “He can make multiple movements at the same time. He won’t be able to play the piano, though that’s not our goal. It’s to restore functional activity, so he can pick up a cup and drink from a straw, grasp items and the like.”

The current fine-wire intramuscular implant of the FES system, while minimizing risk of infection, has limitations in muscle selectivity and in the proportion of a muscle that is activated compared to more fully implanted systems—but it serves as a fully reversible proof-of-concept of the FES+BCI system. In future iterations, the research team hopes to utilize a more sensitive and effective FES system.

Another next step is to make the technology wireless, so patients won’t have to plug into record brain signals. Ajiboye is working on a multi-institutional NIH grant led by Brown University to develop a 24/7 wireless recording system. There are hurdles to overcome, such as maintaining the quality of the signal within the reduced bandwidth of wireless technology.

Challenges aside, the life-changing advances of this technology are incredible. “We’re definitely in a golden era of neural engineering now,” says Kirsch. “We better understand the fundamentals, and now it’s a matter of applying them appropriately to these disorders. There’s so much untapped potential with recording and stimulating the brain.”

Ajiboye likes the next decade or two in brain research: “The rise of the computer was in 1980. Look how far computing has come since then. Our understanding of the brain in the next 20, 30, 40 years will be astronomical.”

We are currently where the computer was in 1980. Look how far computing has come since then. Our understanding of the brain in the next 20, 30, 40 years will be astronomical.”
When Igor Spetic lost his right hand in an industrial accident six years ago, he also lost part of his ability to interact with the world around him. With the help of $15.9 million in funding from DARPA, researchers at Case Western Reserve and the Louis Stokes Cleveland Veterans Administration Hospital have developed an advanced prosthetics system that actually restores some of that lost sense of touch, allowing him to distinguish between some 19 different sensations via a collection of pressure sensors tapped into the residual nerves in his upper arm. MIT Technology Review heralded the project, led by Kent H. Smith II Professor of Biomedical Engineering Dustin Tyler, as one of the best biomedical stories of 2015, and the work made national headlines with features in TIME and the New Yorker.
Battling sickle cells: researchers win NIH grant to study cellular adhesion

Healthy blood vessels run like a well-maintained highway—blood cells zip along throughout the body unimpeded, delivering vital oxygen and nutrients to our tissues. But in sickle cell disease, an abnormal type of hemoglobin causes usually disc-shaped red blood cells to change shape into sickles, which become sticky and block the flow of vessel traffic, creating dangerous complications in the body. The disease impacts some 3 million people around the world and has no cure.

Researchers at Case Western Reserve University have received a $2 million R01 grant from the National Institutes of Health to take a closer look at how those misshapen cells stick together in blood vessels to see if adhesion properties might indicate effectiveness of treatment.

Umut Gurkan, assistant professor of mechanical and aerospace engineering, is serving as the project’s principal investigator, along with Jane Little, an associate professor of biomedical engineering at the Case Western Reserve School of Medicine.

The research team hopes to gain a better understanding of the abnormal adhesion events that take place in sickle cell disease and aims to use adhesion levels as a means to measure the progress of treatment.

Learn more about how high-tech sensors can help protect firefighters at engineering.case.edu/firefighter-sensors.

Early detection tool: Biomedical engineering researchers develop MRI contrast agent that detects tumors at the smallest level

Novelty nineteen percent. That’s the five-year survival rate for breast cancer patients if the cancer is caught before the tumor spreads. Once cancer cells metastasize, however, that number drops rapidly, which means early detection saves lives.

Biomedical engineering researchers at Case Western Reserve University have created a new contrast agent that lets clinicians use MRI to spot tumors with metastatic potential at unspottably small sizes—as tiny as just a few hundred cells—allowing for faster detection, diagnosis and treatment.

The small peptide gadolinium-based MRI contrast agent developed by Zheng-Rong Lu, the M. Frank Rudy and Margaret Domiter Rudy Professor of Biomedical Engineering, and his team binds to molecular markers that are expressed in aggressive tumors, particularly the ones on the verge of metastasizing. Once adhered to the contrast agent, these markers then pop up on the MRI, allowing clinicians to detect the burgeoning tumor itself and gauge its aggressiveness.

Lu and his team hope to begin clinical trials within three years and are also refining the agent to make it more tumor-specific, honing the technology to detect prostate cancer as well.

Learn more about how a new contrast agent could help detect tumors at the earliest stages at engineering.case.edu/ Lu-contrast-agent.

Breathing easier: Case Western Reserve researchers team up with NASA and fire departments to protect firefighters

Fire consumes everything in its path, and it thrives on dangerous chemicals and particulates it burns, releasing them into the air and putting firefighters at risk even after the flames have been extinguished.

Researchers from Case Western Reserve University have teamed up with scientists at NASA Glenn Research Center and fire departments across the country to design and test special sensors aimed at protecting firefighters from these airborne toxic substances.

A well-contained breathing apparatus and a carbon monoxide detector come in standard in firefighting equipment. Once carbon monoxide readings are clear, firefighters often remove the gear during the cleanup phase that follows a fire less intensively. But since carbon monoxide isn’t the only danger in the air, they could be exposing themselves to a variety of particulates that could lead to respiratory problems.

Fumio Takahashi, professor of mechanical and aerospace engineering, is leading a team of researchers designing sensors that will detect other substances like formaldehyde and acrolein that can be released during structural and forest fires. They will build on sensor technology NASA uses to detect fires aboard the International Space Station with the help of a $1.5-million Assistance to Firefighters/Fire Prevention and Safety Grant from the Department of Homeland Security.

Learn more at engineering.case.edu/annualreport-2015-16.

Plant viruses vs. cancer

In the typical health care story, viruses usually play the villain. But a biomedical engineering researcher at Case Western Reserve University is flipping the script and turning plant viruses into powerful weapons in the fight against human cancers.

Nicole Steinmetz, associate professor of biomedical engineering, has made a career out of manipulating plant virus nanoparticles and putting them against human diseases. This year, she won more than $5 million in federal and foundation funding to advance two specific projects. In the first, funded by the NBA’s National Institute of Biomedical Imaging and Bioengineering and National Cancer Institute, Steinmetz and her team are using tobacco mosaic virus to deliver a contrast agent—also developed by her lab—to track two particular biomarkers that distinguish between aggressive and slow-growing prostate cancer. In a second, American Cancer Society-funded project, Steinmetz is using a potato virus to deliver chemotherapy drugs to combat triple-negative breast cancer.

Working in collaboration with researchers at Dartmouth University, Steinmetz also discovered that co-ops virus-based nanoparticles trigger the body’s immune system to fight off cancer cells when injected into tumors. The work was published in Nature Nanotechnology.

Learn more at engineering.case.edu/Steinmetz-research-cancer.
Detecting unsafe meds
Researchers at Case Western Reserve are developing a low-cost, portable device that can test minute blood samples for dangerous toxins, including colleagues at the University of Florida, were using a low-cost, portable device that can root out tainted medications. Researchers at Case Western Reserve are developing a low-cost, portable device that can root out tainted medications.

Super-sensitive cancer detector
A team of engineers and physiologists from Case Western Reserve University has developed an “optical biosensor” that’s one million times more sensitive than currently available technology that can detect a single molecule of an enzyme produced by cancer cells. Learn more at engineering.case.edu/sensitive-biosensor.

New diagnostic technologies
Fasting from NIH’s National Institute for Accelerated Innovation can help speed the diagnosis of two serious diseases. Khalid Ghalal, associate professor of biomedical engineering, is developing a device that detects system threats in infants as early as two weeks of age. Unal Kutlar, assistant professor of mechanical and aerospace engineering, is testing his nanotechnology, a mobile device that can rapidly test at a low cost—a detection of a cancer cell.

Detecting unsafe meds
Researchers at Case Western Reserve are developing a low-cost, portable device that can test minute blood samples for dangerous toxins. Researchers at Case Western Reserve are developing a low-cost, portable device that can root out tainted medications.

ZIP IN CHARGE
Researchers at Yokela University and Case Western Reserve University are taking a nanoscopic look at charge distribution on the surface of nanoparticles. With the help of a grant from the National Science Foundation, they are developing the first instrument capable of measuring these tiny charges under water. Nanocharge distribution is the primary driving force in a wide range of self-assembling systems, from cancer-targeted nanotherapeutics to the construction of natural extracellular matrices. Better understanding of these forces will lead to advances in biology, materials science and engineering, and improved medical treatment.

A paralyzed athlete head to Cybathlon
A paralyzed athlete who developed a steering device for electric wheelchairs has become an ambassador for the Case School of Engineering for new graduates as well as an ambassador for the Case School of Engineering in Shanghai and serves as a leading the expanding alumni network in Shanghai and serves as an ambassador for the Case School of Engineering in Shanghai.

Alumnus and international health care innovator Qiang “Al” Zhang, who earned his PhD in biomedical engineering from Case Western Reserve University in 2000, is co-president of United Imaging Healthcare, a Shanghai-based company that provides innovative medical solutions, including diagnostic imaging devices, radiation therapy equipment, and medical IT solutions. In addition to providing valuable financial support to the department with his commitment this year, offering crucial support to the next generation of biomedical engineering innovators.

Researchers have won a $2.8M NIH grant to build a stealthy drug-delivery system that essentially smuggles the medication across the blood-brain barrier to attack tumors directly. Learn more at engineering.case.edu/stealth-brain-tumor-treatment.

Creating clot-busters
The body’s ability to heal hinges on blood clotting, but a single clot in the wrong place can trigger a deadly event. Blood in a heart attack or stroke. Ashutosh Sen Gupta, associate professor of biomedical engineering, and his team won a $5.8M NIH grant to turn artificial platelets originally designed to form dots into clot-busting drug delivery tools that can lock onto and destroy dangerous clots. Their breakthrough on Sen Gupta’s ongoing efforts to refine his synthetic platelet technology called SynthPlate. Sen Gupta won two patents this year for his synthetic platelet technology, as well as an award for his research efforts to refine his synthetic platelet technology called SynthPlate.

Case School of Engineering > Annual Report 2015-16 > engineering.case.edu >
Any chef knows you need two things to make an excellent meal: high-quality ingredients and a solid recipe. Concentrate solely on one or the other and you'll miss a chance to make the best meal.

Revolutionizing our approach to energy requires a similar strategy, according to Alexis Abramson, director of Case Western Reserve’s Great Lakes Energy Institute and the Milton and Tamar Maltz Professor of Energy Innovation. The world needs better renewable technology and advances in storage and distribution, but just finding all the pieces won’t solve the puzzle. “We need to look at the whole picture together to optimize the system: the hardware, the software, renewables, controls. It’s a whole new paradigm in terms of energy,” she says.

So Abramson and other energy researchers at Case Western Reserve are waging a two-front campaign on energy challenges: teaming up to improve components while simultaneously exploring how to fit those pieces together to create a more optimized whole.

Marija Prica, assistant professor of electrical engineering and computer science, is working on a DOE project to make photovoltaic technology more affordable and reliable. Advances are happening all over the energy map—from building wind farms, to improving the reliability and affordability of solar energy, to developing sun-powered cars, and to making the grid smarter. Researchers at Case Western Reserve are taking a system-wide approach to advance these critical components and explore how best to fit them together in the bigger energy picture.
The team will add solar panels and energy storage into the building that houses the university’s social work academic program, the Jack, Joseph and Morton Mandel School of Applied Social Services—50 kilowatts of PV generation paired with 500 kilowatts/1200 kilowatt-hours of storage—which they will use to test their control system in a real environment.

A smarter charge

Harnessing the sun’s rays can make a big impact not just on the power delivered to our homes and businesses; it can also radically change how we drive.

Consumers depend on vehicles to go hundreds of miles without stopping for refueling. The call of the open road is part of our culture, and it’s part of why many consumers shy away from electric vehicles (EVs)—which, depending on driving speed, make and model, might only be able to travel 50 or 50 miles between charges.

But what if you didn’t need to stop to recharge? A researcher at Case Western Reserve is testing a new type of solar cell coupled with a lithium-ion battery that could power the way for solar-powered EVs that charge up on the road, no pit stops required.

There’s no shortage of barriers to the mass adoption of electric vehicles, says Liming Dai, the Kent Hale Smith Professor of macromolecular science and engineering, is using perovskite solar cells to better charge electric vehicle batteries.

Looking offshore

An optimized energy system would be able to incorporate multiple sources of intermittent power generation to maximize the potential of all the world’s renewables. Wind energy is another important piece of the power puzzle, and—in a little more than two years, there will be a six-turbine pilot wind farm operation up and running off the shores of Lake Erie, thanks to the efforts of a local wind technology company and researchers at Case Western Reserve.

Project Icebreaker has spent four years in the making across LEDCO—the Lake Erie Energy Development Corporation—and Case Western Reserve first won a $5 million grant from the Department of Energy to design and develop a system of gas stations, not electrical charging stations. So a continuous charge could help solve these issues.

Even if you had batteries with a high enough energy density for auto applications, you’ve got a system of gas stations, not electrical charging stations. So a continuous charge could help solve these issues.

Liming Dai, the Kent Hale Smith Professor of macromolecular science and engineering, is using perovskite solar cells to better charge electric vehicle batteries.
As favorable as the wind and geography of Lake Erie may be, Zeng says there are any number of challenges with freshwater wind turbines. Chief among them off the shores of Cleveland and its often punishing winters is: "The potential for damage and accelerated wear-and-tear is a significant concern," Zeng says. Bridges in warmer climates are subjected to ice loading, so there are civil engineering precedents for dealing with it. But there just aren’t that many of these structures around yet—there are some offshore wind farms off the coasts of Nordic countries in Northern Europe, but they are built in saltwater seas, not freshwater. And wind farms off the coasts of Nordic countries in Northern Europe, but they are built in saltwater seas, not freshwater.

An offshore freshwater wind farm on Lake Erie holds tremendous potential for the project, according to David Zeng, chair of the Department of Civil Engineering at Case Western Reserve, who has been working with LEEDCo on the project since the beginning. Lake Erie strikes a balance between a workable water depth and adequate availability of wind, according to Zeng. “Anyone who’s been out on the lake knows you get out a mile or two and the wind’s always blowing,” he says. Other great lakes might boast even stronger winds off their shores, but “they’re too deep to make a wind farm practical,” he adds.

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The distributed sensor network provides real-time data to a control system, and each distributed energy resource includes a custom-designed inverter to dynamically control power to manage system voltage, power quality and service quality.
Case Western Reserve University has agreed to join forces with three other research powerhouses to put energy innovations on the fast-track to commercialization as part of the Tri-State University Energy Alliance. The research consortium includes Case Western Reserve, Carnegie Mellon University, the University of Pittsburgh and West Virginia University.

Each member brings its own specific area of energy expertise to the group: Case Western Reserve, through its Great Lakes Energy Institute, has a particular flair for electrochemistry research, materials in applied energy storage and a growing reputation for strength in big data analytics used to explore the lifetime reliability of energy technologies. The other members bring strong work in electric power delivery, smart grid development, carbon management, energy policy and more.

Moreover, all four players have overlapping initiatives in key research areas like grid modernization, energy storage and oil and gas—which means by pooling their resources and collaborating, they could produce results, faster technology commercialization, increased industry partnerships and more.

Learn more about how the Tri-State Energy Alliance will help move energy innovations to market quicker at engineering.case.edu/Energy-Alliance.

Team energy: Case Western Reserve University joins Tri-State University Energy Alliance

Portable power: Polymer researchers develop flexible microsupercapacitors that could be woven into fabrics

Wearables are everywhere—from nifty consumer gadgets like fitness trackers to life-saving biosensors. And while these devices are designed to go wherever their users go, they can only travel so far before they need to recharge. A research team led by Liming Dai, the Kent Hale Smith Professor in the Department of Macromolecular Science and Engineering at Case Western Reserve University, has developed a power source for these electronics that’s just as portable as they are.

Their microcapacitor is small enough and flexible enough to actually be woven into fabrics, which could lead to clothing that’s just as functional as it is fashionable—a closet full of seamlessly wearable power sources that can take their charges to match the load demands of different devices.

Made from titanium wires wrapped with carbon nanotubes, this new supercapacitor can be bent up to 180 degrees hundreds of times with no loss of performance. Researchers say they are also adjustable—by connecting several microsupercapacitors in a series or in parallel, they can scale up the voltage or current.

Learn more about new microsupercapacitors that could lead to charge-carrying clothing at engineering.case.edu/wearable-power-source.
Solar-powered plane
Around the world fuel-free: Solar Impulse 2—an experimental solar-powered aircraft—completed its record-breaking trip this summer. In the midst of its record-breaking trip, Case Western Reserve University Professor of Macromolecular Science and Engineering Rigoberto Advincula was tapped by the American Chemical Society to offer insights on the advanced materials that made the flight possible, sharing his expertise during a National Press Club briefing in May.

Undergraduate computer engineering major Jean Castillo spent the fall working on an emissions-free controlled flight project at the National University of Singapore.

Student entrepreneurs shine
Student startup CrystalE pitched its self-powered building monitoring sensor technology on the national stage at two major competitions: the final round of the Clean Energy Trust Challenge and the Rice Business Plan Competition.
Learn more at engineering.case.edu/CrystalE-competitions.

Engineering students install solar panels in Namibia
Only 34 percent of Namibia’s population has access to electricity, which creates a whole host of power-related problems for residents and farmers—particularly in rural areas.

A trio of Case Western Reserve University students—two engineering and a business major—traveled to the small African nation in January and installed solar panels on several homes in a rural village, bringing reliable—and renewable—electric power to people’s homes for the first time. The trip was organized by Daniel Lacks, chair of the Department of Chemical and Biomolecular Engineering, and Michael Goldberg, assistant professor of design and innovation at the Weatherhead School of Management.
Learn more and watch highlights from the trip at engineering.case.edu/Namibia-solar-panels.

Best seat on the quad
The Case Western Reserve University community now has a new place to take a seat and recharge—literally. This spring, Elizabeth Stricker (Freund) and Jason Pickering, along with other members of the university’s new ThinkEnergy Fellowship Program, built a picnic table outfitted with two 90-watt solar panels and a battery pack to serve as an outdoor charging station.

The battery contains multiple USB ports and AC plugs, and it packs enough power to allow multiple users to charge their devices simultaneously.
The project was the pilot for the ThinkEnergy Fellows program—a new initiative spearheaded by the Great Lakes Energy Institute designed to connect Case Western Reserve’s top students with faculty, companies and communities around energy topics to bring energy literacy to campus.
Learn more at engineering.case.edu/solar-powered-charging-table.

Better batteries
Energy researchers at Case Western Reserve University won a $1.6MM State of Ohio Federal Research Network grant to develop better batteries for defense and aerospace industries.
The funding will create a new research consortium—the Partnership for Research in Energy Storage and Integration for Defense and Space Exploration (PRESIDES)—Center of Excellence within the university’s Great Lakes Energy Institute. Initial projects include developing a high-energy-density lithium-ion battery, exploring a new approach to developing a lithium-sulfur battery, and investigating the potential impact of embedded batteries on energy storage.
Learn more at engineering.case.edu/PRESIDES.

A new carbon nanomaterial developed by polymer researchers at Case Western Reserve holds its conductivity in three dimensions, which could lead to advances in battery storage capability, more efficient energy conversion in solar cells, lightweight thermal coatings and more.
Learn more at engineering.case.edu/nanomaterial-3D-conductivity.
Burning to learn: CWRU teams up with NASA to perform the largest-ever fire safety experiment in space

Space is an unforgiving environment, and a fire on board a spacecraft is one of the most dangerous situations astronauts can face. So why on Earth—let alone off it—would researchers light one in space on purpose? Because a better understanding of how flames behave in microgravity could help keep astronauts safer.

Two aerospace engineering researchers at Case Western Reserve—professor James T’ien and assistant professor Ya-Ting Luo—launched with NASA Glenn Research Center along with scientists around the world to perform the largest fire safety experiment ever conducted in space when the unmanned Cygnus cargo module disembarked from the International Space Station earlier this summer.

The experiment, called Saffire-I, was the first in a series of six to be conducted over the next five years that will give scientists valuable data on how large-scale fires grow and spread in space, which will help improve fire safety protocols and guide the development of new materials for the ISS and future manned missions to Mars.

The team envisions swarms of these hybrid ‘bots scouring the ocean floor in search of a black box—American officials are now trying to develop airframe technology that will allow the robot to crawl when stimulated by an external electrical field. But the researchers hope to control future iterations by incorporating living neurons into the robot as well.

The robot is built around a single muscle from a sea slug’s mouth, which provides the movement—the robot can crawl when stimulated by an external electrical field. But the researchers hope to control future iterations by incorporating living neurons into the robot as well.

Why put organic tissue in the mix? Because in the case of Webster’s robot, sea slug tissue is designed by nature to function underwater. Electronics? Not so much.

Two generous alumni: Bill Kerler (CIT ’51) and Charles Phipps (CIT ’49). The latter earned his bachelor’s degree from the Case Institute of Technology in 1949 before launching a successful career that includes positions at General Electric, Motorola and Texas Instruments. Kerler earned his bachelor’s degree in chemical engineering 50 years ago. Now, thanks to a new international partnership, polymer science students in Brazil can take advantage of that academic and research pedigree through a new dual PhD degree program.

Saffire-I

Polymer science goes global: CWRU launches dual-PhD program in Brazil

Case Western Reserve University boasts a track record of fruits when it comes to polymer science, including launching the country’s first accredited undergraduate polymer degree program more than 50 years ago. Nine, thanks to a new international partnership, polymer science students in Brazil can take advantage of that academic and research pedigree through a new dual PhD degree program.

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Funded by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, or CAPES, the Brazilian equivalent of the National Science Foundation, the program will eventually reach a steady state of supporting 60 PhD students in polymer science.

Students will start the program at their home institution in Brazil, conduct their second and third years in residence at Case Western Reserve, and complete the program in a four-year fall at home.

The first 12 students started the program this spring and another seven joined this fall. The partner institutions expect to expand the program to biomedical engineering students as well.

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Non-woven nanofiber processing A new approach to the production of non-woven materials has been developed by researchers in the Department of Macromolecular Science and Engineering at Case Western Reserve—one that is entirely free of the organic solvents required in traditional electrospinning nanofiber production. Formed through a continuous, multi-layering co-orientation process, the polymer nanofibers, which have a diameter of around 10 nanometers—1000 times thinner than a human hair—feature an unusual rectangular cross section that provides a high surface area-to-volume ratio and strong mechanical properties. Potential applications for these nanofibers include air filters, fuel filters, water filters, lithium-ion battery separators and drug delivery substrates. The manufacturing process is highly flexible, making it easily scalable to produce large amounts of nanofibers. The research team—which includes faculty members Eric Baer, LaShanda Korley and Gary Wnek, and graduate student Jia Wang—has recently received a patent for this novel process.

Learning for chocoholics What goes better with a mouthful of chocolate? How about learning with it? The unlikely subject matter is actually a great way to introduce students to concepts in macromolecular science and engineering. It is an interesting physical and chemical properties of plastics, coatings, rubber and composites. Certain companies have not yet been able to use them for commercial applications. IgloiSochts-Arkadiou, professor of macromolecular science and engineering, has received a National Science Foundation grant to explore the design and synthesis of advanced polymer and block copolymer compositions, and utilize Knot Theory to produce various knotted macromolecules that could bring these structures closer to commercial use. Learn more at engineering.case.edu/knot-polymers.

A faster chemical imager Dran Akkos, the Leonard Case Jr. Professor of mechanical and aerospace engineering, received funding from the National Science Foundation and the Air Force Office of Research to turn a Roman microscope into a FastRAM—a chemical imager that can provide images of materials in seconds instead of hours to days. Akkos’ goal is supported by 17 fellow professors from various disciplines, as well as an art conservation group at the Cleveland Museum of Art—all of whom signed on to express their interest in using the new device. Learn more at engineering.case.edu/FastRAM.

A greener way to fire-proofing Professor Prakash is studying the remains of ancient earthquake epicenters to better understand modern seismic events.

New biomedical, chemical textbook Professors Gerald Saidel and Harihara Baskaran have co-authored a new textbook titled Physicochemical Principles of Pharmaceutical Manufacturing, which teaches the rationale and practice of mass transport with an approach emphasizing engineering fundamentals for transmission with biopharmaceutical applications. The textbook is intended for undergraduate and graduate students in chemical and engineering programs and includes material not found in existing text books. Learning for chocoholics What goes better with a mouthful of chocolate? How about learning with it? The unlikely subject matter is actually a great way to introduce students to concepts in macromolecular science and engineering. It is an interesting physical and chemical properties of plastics, coatings, rubber and composites. Certain companies have not yet been able to use them for commercial applications. IgloiSochts-Arkadiou, professor of macromolecular science and engineering, has received a National Science Foundation grant to explore the design and synthesis of advanced polymer and block copolymer compositions, and utilize Knot Theory to produce various knotted macromolecules that could bring these structures closer to commercial use. Learn more at engineering.case.edu/knot-polymers.

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Three biomedical engineering professors—Eben Alsberg, Horst von Recum, and Cameron McIntyre—were elected to the College of Fellows of the American Institute for Medical and Biological Engineering (AIMBE), an elite group of scholars that is comprised of the top 2 percent of the country’s medical and biological engineers.

The Indian government named Assistant Professor of Biomedical Engineering Pallavi Tiwari one of the top 150 Women Achievers in India.

Alp Sahinoglu, the Warren E. Rupp Assistant Professor of Materials Science and Engineering, was named a senior member of the Institute of Electrical and Electronics Engineers (IEEE).

James Tien, the Leonard Case Jr. Professor of Engineering in the Department of Mechanical and Aerospace Engineering, won the 2015 Space Processing Award from the American Institute of Aeronautics and Astronautics.

Liming Du, the Kent Hake Smith Professor in the Department of Macromolecular Science and Engineering, was named a Highly Cited Researcher by Thomson Reuters for his research contributions in the fields of chemistry and materials science and engineering.

Four Case School of Engineering junior faculty members won National Science Foundation CAREER grants: Nicole Seiberlich, associate professor of biomedical engineering; Umut Gurkan, assistant professor of mechanical and aerospace engineering; Jennifer Carter, assistant professor of materials science and engineering; and Xiang Zhang, assistant professor of electrical engineering and computer science. The funding will support research exploring advanced materials and energy, changing tissue properties in disease, new medical imaging techniques, and improving the efficiency of large network analysis.

Associate Professor of Biomedical Engineering Nicole Seiberlich was elected to the Board of Trustees of the International Society for Magnetic Resonance in Medicine and named associate editor of IEEE Transactions on Medical Imaging.

Umut Gurkan, assistant professor of mechanical and aerospace engineering, received the Rising Star award at the 2016 Biomedical Engineering Society-Cellular and Molecular Bioengineering and Advanced Biomaterials (Joint Conference held in January).

Dominique Durand, the Elmer Lincoln Lindsell Professor of Biomedical Engineering, was named a fellow of the American Association for the Advancement of Science and elected to serve on the administrative committee of the IEEE Engineering in Medicine and Biology Society, the world’s largest international society of biomedical engineers.

The Indian government named Assistant Professor of Biomedical Engineering Mustafa Unal for his research entitled “Assessment of Bone Quality by Novel Spectroscopic Biomarkers,” and biomedical engineering graduate student Arna Oskina for her research entitled “Engineering Cartilaginous Tissue: Replacement; Vascular Tissue Incorporation and Epithelialization.” Unal also received the Orthopaedic Young Investigator Award from the Orthopaedic Research Society.

Macromolecular science and engineering PhD student Symone Alexander received a National Science Foundation Graduate Research Fellowship for her research into polymer composites that respond to heat, light and other stimuli.

Three engineering students won Department of Defense Science, Mathematics, and Research for Transformation (SMART) Scholarships: mechanical and aerospace engineering undergraduate Diana Illingsworth, chemical engineering undergraduate Lauren Anderson and macromolecular science and engineering PhD candidate Michelle Leslie.

Mechanical and aerospace PhD student Peng Wang won the Best Student Paper Award at the IEEE International Conference on Automation Science and Engineering.

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- Bachelor of Science in Chemical Engineering
- Bachelor of Science in Biomedical Engineering

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- Bachelor of Science in Electrical Engineering (BSE/EE)
- Bachelor of Science in Computer Engineering (BSE/CE)
- Bachelor of Science in Civil Engineering (BSE/CIV)
- Bachelor of Science in Chemical Engineering (BSE/CHI)
- Bachelor of Science in Biomedical Engineering (BSE/BME)

Available programs:
- Bachelor of Science in Energy Innovation (BSE/ENI)
- Bachelor of Science in Materials Science and Engineering (BSE/MSM)
- Bachelor of Science in Mechanical Engineering (BSE/ME)
- Bachelor of Science in Electrical Engineering (BSE/EE)
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- Bachelor of Science in Civil Engineering (BSE/CIV)
- Bachelor of Science in Chemical Engineering (BSE/CHI)
- Bachelor of Science in Biomedical Engineering (BSE/BME)

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- Advanced Platform Technology Center
- Case Metal Casting Laboratory
- Center for Advanced Polymer Processing
- Center for Advanced Science and Engineering for Carbon
- Center for Biomaterials
- Center for Computational Imaging and Personalized Diagnostics
- Center for the Evaluation of Implant Performance
- Cleveland Functional Electrical Stimulation Center
- Control and Energy Systems Center
- Electric Car Racing for Sustainable Energy Solutions
- Electronics Design Center
- Great Lakes Energy Institute
- Institute for Advanced Materials
- Magnetic Materials Characterization Laboratory
- Materials for Opto/Electronics Research and Education (MOERE) Center
- Microfabrication Laboratory
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- Solar-Disability and Lifetime Extension Center
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- The Institute for Management and Engineering
- Wind Energy Research and Commercialization Center
- Yager Center for Electrochemical Sciences

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Total: $33.4 million

In FY2016, the Case Alumni Foundation/Association provided $3.9 million from annual and endowed gifts to the Case School of Engineering.

TECHNOLOGY TRANSFER

In FY2016, Case School of Engineering faculty contributed to:

- 81 invention disclosures—4.39 times the national per-dollar proficiency average*;
- 139 patent applications—8.28 times the national per-dollar proficiency average*;
- 17 deals with industry—3.22 times the national per-dollar proficiency average*;
- 2 startup companies—2.54 times the national per-dollar proficiency average*.

*AUTM U.S. Licensing Activity Survey, FY14 (latest data available)

FY 2016 Full-time faculty
124

Total revenue
$99 million

Research, training and grant revenue
$66.3 million

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Every effort has been made to ensure the accuracy of this report. If you have any questions or concerns, please contact Christine Coolick, director of marketing and communications, Case School of Engineering, Case Western Reserve University, 10900 Euclid Ave., Cleveland, Ohio 44106-7220; 216.368.8694; cmc174@case.edu.