

CASE SCHOOL OF ENGINEERING ASKING BETTER QUESTIONS

ANNUAL REPORT 2011–2012



CASE SCHOOL
OF ENGINEERING

CASE WESTERN RESERVE
UNIVERSITY



Dear Colleagues and Friends:

If you spend any time listening to the conversations here at the Case School of Engineering at Case Western Reserve University, you'll notice that a lot of our sentences finish at a pitch slightly higher than they started.

That's because many of the sentences spoken here aren't statements, but questions. And not just any questions—they're really good questions. Since becoming dean of the Case School of Engineering in January, I've been astounded by the questions our faculty, students, alumni and staff ask, and even more impressed by the answers they find.

This past academic year, our faculty members questioned why LEDs can't be even more efficient than they already are, how wind turbine blades can be lighter yet stronger, how flow batteries can store energy longer at less cost, how medical diagnoses can be more precise, and even how robots can function more like creatures that have been around almost as long as this planet has. You can imagine the questions that have been raised on these topics and a plethora of others.

Our students' questions were just as bold. They questioned how to bring power to developing countries with no established energy sources, ways to power spacecraft without using toxic propellants—even ways to solve some of life's everyday annoyances like potholes.

Because when you shift your perspective and ask the questions that aren't obvious, you accomplish more.

The questions we ask at the Case School of Engineering lead to prestigious honors for our faculty members, including a presidential award for promising early-career research. They lead to new ways of teaching that turn our students into problem-solving, hands-on engineers from the first day they step on campus. They help break fundraising records. And they lead us to invent and license new technology at rates that far surpass the national per-dollar proficiency average.

Indeed, the 2011–2012 academic year was filled with stimulating questions. I hope you enjoy exploring some of them here—along with their innovative answers.

Warmest Regards,

Jeffrey L. Duerk
Dean, Case School of Engineering
Leonard Case Professor of Engineering
Director, Case Center for Imaging Research





CASE SCHOOL OF ENGINEERING

ANNUAL REPORT 2011–2012

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WHEN YOU ASK BETTER QUESTIONS, YOU GET BETTER ANSWERS.

It's the difference between "What do we teach to first-year students?" and "[How do you turn first-year students into engineers?](#)"

It's the space that separates "Where should we put solar panels?" and "How long will a solar panel really last?"

And the distinction that divides "What should we design?" from "How do you design for the real world?"

Better questions lead not just to innovations, but innovative solutions that matter. They create not just bright students, but bright engineers. They advance not just research, but answers for the real world. **They are the questions that matter most, and the answers we find every day at the Case School of Engineering.**

CAN LEDs BE EVEN MORE EFFICIENT?

A unique semiconductor micro-dome could significantly increase LEDs' light extraction efficiency.

Already six times more energy-efficient than incandescent light bulbs, and two times more efficient than compact fluorescent lamps, light-emitting diodes (LEDs) still have a way to go before reaching their full potential. They're already popular for electronic backlighting, traffic lights and medical phototherapy. But their high efficiency and long, nontoxic lifetime makes them a replacement candidate for incandescent and fluorescent lamps in residential, industrial and commercial applications as well.

Yet in **conventional visible LEDs, only about 20 percent of the generated light is extracted into the free space. In UV LEDs, the extraction efficiency is even lower**, going down to less than 5 percent in certain ranges of the spectrum.

Realizing that 20 percent of

the country's total electricity is consumed for lighting, officials at the U.S. Department of Energy have issued a goal of increasing white LEDs' capabilities from their current 90-130 lumens per watt (lm/W) to 266 lm/W by the year 2030—which could reduce lighting electricity consumption by nearly one half, leading to a savings of \$250 billion over two decades.

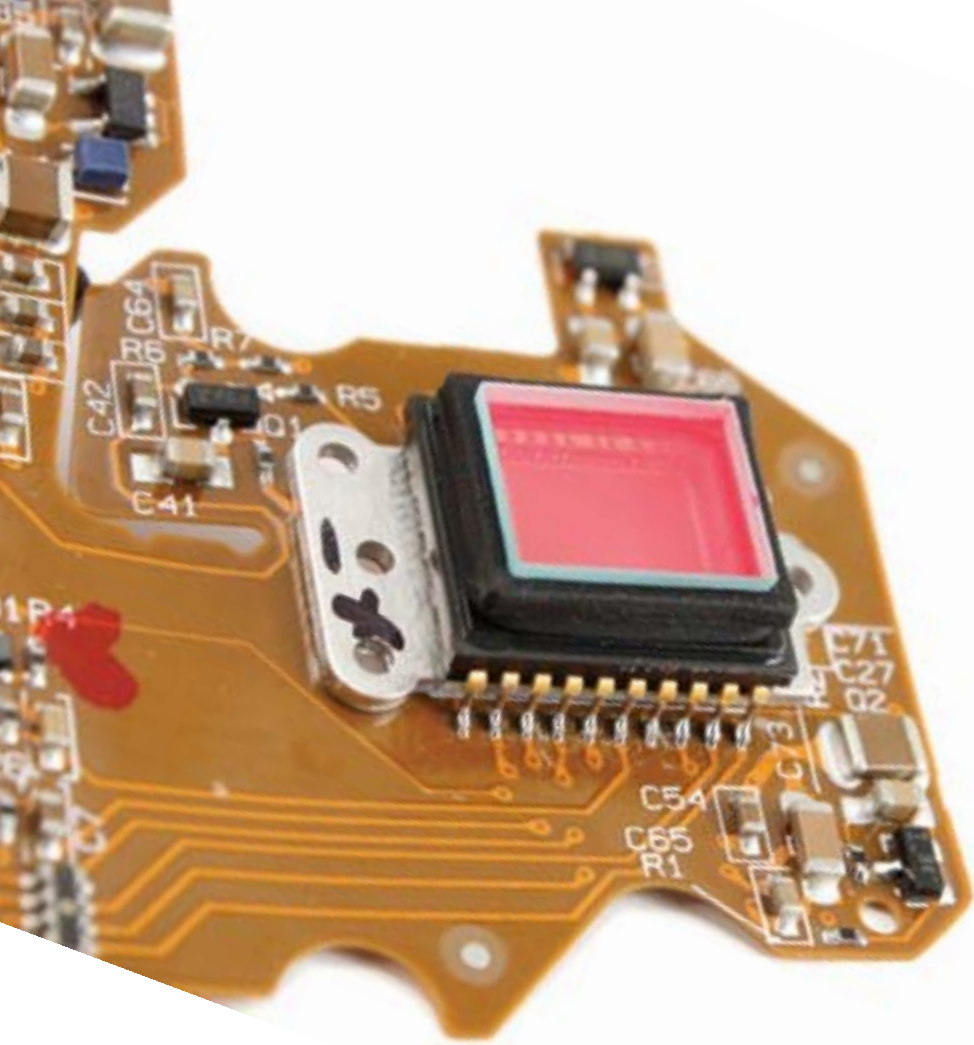
To meet this challenge, Case Western Reserve electrical engineering assistant professor Hongping Zhao has developed a **low-cost, scalable and reliable solution to increase the extraction efficiency of LEDs**. Manipulating the GaN semiconductor material, Zhao has created micro-dome structures that significantly enhance light extraction in both visible and UV LEDs, and can be optimized for different wavelengths. **Simulations show the micro-domes**



Hongping Zhao

triple light extraction for visible LEDs, and increase extraction sevenfold for deep-UV LEDs.

Utilizing the [facilities at the university's new Materials for Opto/Electronics Research and Education \(MORE\) Center](#), Zhao's group is working on incorporating the micro-domes into real LED devices.



CAN SENSOR CIRCUITS HOLD UP IN HIGH HEAT?

A silicon-carbide-based semiconductor keeps functioning—even up to 600 degrees Celsius.

Sensors currently used in high-temperature applications typically need long wires to connect them to the high-temperature zone. This leaves them susceptible to interference, and their physical enclosures and wiring add significant cost and weight.

An integrated amplifier circuit, though, can improve signal strength

and clarity, while also providing more reliable information. Electrical engineering and computer science professors Steven L. Garverick and Mehran Mehregany, the Goodrich Professor for Engineering Innovation, did just that, designing and fabricating one that can operate under extreme temperatures—up to 600 degrees Celsius—an impossible

feat in silicon, the most commonly used semiconductor.

The integrated circuits are constructed using silicon carbide and a wide-band-gap semiconductor, and **have applications in both aerospace and energy industries**, such as collecting data inside nuclear reactors and rocket engines.

HOW DO YOU GET MORE FOR LESS?

Dry ice mixed with a simple industrial process—voila! Mass-produced, high-quality graphene nanosheets.

Graphene, which is made from graphite, has been hailed as the most important synthetic material in a century. Graphene sheets conduct electricity better than copper; heat better than any existing material; and are harder than diamonds, but are still able to stretch.

Scientists worldwide speculate graphene will revolutionize computing, electronics and medicine, but the inability to mass-produce sheets of high quality has blocked widespread use.

Working together, Case Western Reserve's Liming Dai, the Kent Hale

Smith Professor in macromolecular science and engineering, and Jong-Beom Baek, professor at the Ulsan National Institute of Science and Technology in South Korea, developed a **low-cost, easier way to mass produce better-functionalized graphene sheets** than the current method of acid oxidation, which requires the tedious application of toxic chemicals.

By placing graphite and frozen carbon dioxide in a ball miller and turning it for two days, the mechanical force produces flakes of graphite. Once dispersed in a solvent, those flakes separate into

graphene nanosheets of five or fewer layers.

Multiple tests showed these **graphene sheets were better able to conduct electricity and withstand intense heat.** The simple production process also allows fabrication of customized graphene sheets for electronics, supercapacitors or metal-free catalysts to replace platinum in fuel cells and lithium-air batteries.

HOW DO WE ENHANCE COMPOSITES?

A new carbon-nanotube-reinforced material is lighter, tougher and holds up longer.

In wind turbines, the larger the blade, the more wind it can capture and the more electrical power it can produce. So why not just make larger and larger turbines? Because the forces and flexing generated by spinning too large and heavy of a blade can actually cause it to break apart.

Unless you invent new blade materials.

Macromolecular science expert Ica Manas-Zloczower—the newly appointed Thomas W. and Nancy P. Seitz Professor of Advanced Materials and Energy—and university vice provost and chemical engineering professor Donald Feke developed a polyurethane material reinforced with carbon nanotubes for wind-blade applications. It's lighter and tougher than resin counterparts currently used in the wind industry, outperforming

conventional materials in mechanical tests. The carbon nanotubes are also **lighter per unit volume than the carbon or glass fibers** commonly used for reinforcement, but **have five times the tensile strength of carbon fibers and 10 times the strength of glass fibers**. Fatigue testing showed the carbon-nanotube reinforced polyurethane composite **lasts about eight times longer than epoxy composites** currently used in wind turbine blades. The new material was also about **eight times tougher in delamination fracture tests**.

The material has applications well beyond the wind industry, from coatings to cars, tennis rackets and aircrafts.

The materials research was supported by a U.S. Department of Energy stimulus grant and Bayer Materials Science.



Ica Manas-Zloczower & Donald Feke

GECKO CLING

The key to geckos' high-cling gait may be cleanliness, according to postdoctoral macromolecular science and engineering researcher Shihao Hu. A gecko's specific stride helps keep its adhesive toe pads clean, preserving their stickiness and ensuring they can cling to just about any surface. As part of his doctoral research, Hu and colleagues constructed a foot cover that kept geckos from hyperextending their feet, and found that their subsequent self-cleaning rate was reduced by half. A theoretical model demonstrated that the intricate design of a gecko's toe pad structure perfectly combines with the dynamics of each attachment and detachment, making the lizard's feet sticky yet clean. Now, Hu is **developing gecko-inspired self-cleaning adhesives using carbon nanotubes**. The adhesives could work in extreme conditions, such as in outer space or underwater.



GRAPHENE-NANOTUBE HYBRID

Macromolecular science and engineering expert Liming Dai, the Kent Hale Smith Professor, won a **\$7.5-million grant from the Department of Defense Multidisciplinary University Research Initiative (MURI) to support work on building 3D graphene-nanotube hybrid structures** for thermal and other applications.

METALS RESEARCH

Three U.S. Department of Defense grants totaling more than \$1.3 million will support materials research at Case Western Reserve University. John J. Lewandowski, the Leonard Case Jr. Professor of Engineering and director of the Center for Mechanical Characterization of Materials, has received two grants—one from the Army and one from the Defense Threat Reduction Agency—that focus on amorphous metals. A third grant, from the Navy, targets the performance of aluminum alloys under extreme conditions.



HOW DO YOU KEEP UP WITH THE DEMANDS FOR NEXT-GENERATION MATERIALS?

\$40 million over 10 years funds breakthroughs in polymer science.

Begun in 2006 as a National Science Foundation (NSF) Science and Technology Center, Case Western Reserve's Center for Layered Polymeric Systems (CLiPS) won a **renewal award that has provided the center 10 years of NSF funding amounting to a \$40-million commitment.**

CLiPS researchers use ultra-thin polymer layers to develop new

materials and material systems for a range of applications, from bio-inspired lenses that could help solar panels capture more light to new capacitor films that increase energy storage density.

NSF Science and Technology Centers explore advanced research in technology through long-term interdisciplinary partnerships. The awards are highly selective—**CLiPS**

was one of six centers established in 2006 out of more than 160 applicants. There are currently 17 active centers in the country.

HOW DO WE STORE THE ENERGY RENEWABLES CREATE?

A low-cost, non-toxic, all-iron flow battery could be the key to large-scale energy storage.

The lack of reliable, low-cost energy-storage systems is one of the key challenges to the large-scale integration of renewable energy sources into the grid.

Current options for storing the intermittent power of wind and solar energy—including hydro stations and compressed air systems—are inefficient, costly, too slow or have environment-damaging properties. Contemporary flow batteries can be effective in storing and delivering energy, but use the metal vanadium, which costs roughly \$10 per kilogram, is mined overseas and requires a highly corrosive sulfuric acid for its electrolyte.

Robert Savinell, the George S. Dively Professor of Engineering, and research partner Jesse Wainright, chemical engineering associate research professor, are developing a flow battery that uses a low-cost, plentiful, non-toxic element: iron. **Abundant in this country, iron sells for about 20 cents per kilogram and**

can function in a flow battery with a benign, mildly acidic electrolyte.

In 2011, Savinell and Wainright received a Department of Energy Office of Electricity Program grant and have subsequently **improved the battery's round-trip efficiency from 55 percent to about 70 percent** and believe the battery can eventually reach 80 percent efficiency. They've also demonstrated that the energy density of the system is sufficient for large-scale applications.

Savinell and Wainright also received a Department of Energy STTR phase 1 grant in 2012 with **industrial partner Faraday Technologies to advance new designs to lower the production costs of flow batteries** by combining the functions of several components into one unitized structure.

They next hope to decouple the energy storage and power delivery capabilities of the iron battery



Robert Savinell

system to better suit long-term peak energy shifts—up to 12 hours from energy capture to supply.



Alexis Abramson

HOW LONG WILL A SOLAR PANEL REALLY LAST?

A grid-tied sun farm in conjunction with lab-based acceleration testing is poised to find out.

New designs of solar panels come out constantly, each one touting better results than the last. But how long will their promises hold true in application, after years of wear and exposure to the elements? Launched in 2011 under the faculty leadership of Roger French, the F. Alex Nason Professor, the [Solar Durability and Lifetime Extension Center](#) seeks to find out.

Combining laboratory-accelerated testing with real-world environmental exposure, the

center studies the durability and degradation of solar panel materials and components, and designs better materials and systems that will have a longer functional lifetime.

Laboratory-based options include **three varieties of solar simulators that can create the light of up to 1,200 suns**, as well as six environmental test chambers that can replicate intense light, humidity, and hot and cold temperatures.

The outdoor component, the Sun Farm, opened this summer. Sitting on one acre, the farm boasts 14 Opel SF-20 dual axis trackers for samples and photovoltaic modules, with a capacity of more than 8,000 samples at one- to five-times sun concentration, along with racking for 36 fixed-mount modules.

The trackers have been tied to the grid, allowing the modules to produce electricity while under outdoor exposure and testing.

HOW DO YOU SAVE MORE ENERGY?

Mechanical engineering professor's work at the DOE is stimulating energy-efficiency solutions.

Mechanical and aerospace engineering associate professor Alexis Abramson spent a year with the **Department of Energy's (DOE) Building Technologies Program**. **Abramson has been providing strategic leadership and oversight to the Emerging Technologies Team**, which invests about \$90 million per year in the research, development and commercialization of energy-efficient and cost-effective building technologies that are within five

years of being market-ready.

A main goal of the Emerging Technologies Team is to help bring to market inexpensive technologies that will enable a 50 percent energy savings in buildings by 2020.

Abramson's work has helped develop strategies that focus on quality public engagement, peer-reviewed quantitative analysis, and structured prioritization of federal investment in projects such as

next-generation HVAC, building envelope, and lighting and building controls. **The DOE has requested Abramson extend her leadership position with the program** to execute strategies and cultivate relationships with key stakeholders in the energy-efficiency marketplace, which she will do concurrent with her university activities in the 2012-2013 academic year.

WHAT'S THE BEST WAY TO ADVANCE WIND ENERGY?

With small, medium and large wind turbines, the university provides a range of research options.

Launched in 2010 with an on-campus wind turbine, the [Wind Energy Research and Commercialization \(WERC\) Center](#) at Case Western Reserve University was expanded in 2012 with **two additional research-based wind turbines, both of which are tied into the power grid.**

All three turbines function as working laboratories available to researchers at not-for-profit organizations and for-profit companies. The center's overall goal is to develop better products, from nuts and bolts to new technologies to manage the turbines and improve efficiency and longevity, and thereby **establish a wind-energy supply chain in Northeast Ohio.**

The three different sizes of wind turbines allow users to conduct their research and product development in line with their specific goals,



David Matthiesen & Michael Pollino

according to David Matthiesen, associate professor of materials science and engineering and faculty director of the WERC Center. The three turbines also have a variety of technologies between them.

The newest, 1-megawatt turbine has a hub height of 70 meters (230 feet) and sits on the property of industrial partner Stamco Industries, in Euclid, Ohio. It is a utility-scale power generator and includes monitoring features to allow researchers to

study how electricity generated by the turbine is integrated into the power grid. The mid-sized, 225-kilowatt turbine provides electricity to the adjacent William Sopko & Sons Co. manufacturing facility, and uses adjustable blade pitch control technology. The on-campus, 100-kilowatt turbine has a direct drive system and no gearbox in its drive train.

Assistant professor of civil engineering Michael Pollino embedded **structure-monitoring sensors on the new turbines**, including strain sensors on the foundation anchors to ensure appropriate tightening, and **tower sensors to assess fatigue damage**—allowing additional types of research to be conducted.



ENERGETIC VISIT

U.S. Secretary of Energy Steven Chu visited Case Western Reserve University in January to learn more about Department of Energy-funded and other energy-related research at the university. As part of his visit, he toured the new MORE (Materials for Opto/Electronics Research and Education) Center. The university currently leads six Department of Energy-funded research projects, including three Advanced Research Projects Agency-Energy (ARPA-E) grants.



DEGRADATION SCIENCE

Roger French, the F. Alex Nason Professor and director of the [Solar Durability and Lifetime Extension Center](#), received a **half-million-dollar grant from UL** to continue to develop the field of solar lifetime and degradation science of photovoltaic systems, components and materials.

ENERGY BOOST

The Cleveland Foundation recognized Case Western Reserve University's substantial efforts in energy with a **\$1.75-million grant to the [Great Lakes Energy Institute](#)** to advance research and bring breakthroughs to market. The award marked the foundation's second major investment in the university's energy programs over the past four years—bringing its total commitment to the institute to \$5.3 million. The new grant will enable existing programs to continue, and also support the recruitment of a senior professor with expertise in power grid technology.



CAN YOU DITCH THE METAL?

A plasma electrode can replace solid pieces of metal in an electrochemical cell.

Replacing a metallic electrode with one made of plasma is a good idea in theory: plasmas are a gaseous source of electrons where electrochemical reactions could be carried out at the free surface of solutions, including the reduction of metal cations to produce metal nanoparticles.

Unfortunately, plasmas formed at ambient conditions frequently turn into sparks that are uncontrolled, unstable and destructive.

Chemical engineering associate

professor R. Mohan Sankaran was able to **develop a microplasma source that is stable at atmospheric pressure and room temperature**, which allowed the study and transfer control of electrons across the interface of a plasma and electrolyte solution.

Sankaran and his research team filled an electrochemical cell with an electrolyte solution. In the cathode side, they pumped argon gas through a stainless steel tube containing a micron-sized hole placed above a solution

of potassium ferricyanide and potassium chloride buffer. When a microplasma formed between the tube and solution surface, they found that ferricyanide was converted to ferrocyanide by electrochemical reduction.

The technology opens new pathways for **battery and fuel-cell design, making fuel from water or carbon dioxide and synthesizing nanomaterials and polymers**.

CAN WE GET A BETTER PICTURE OF CANCER?

A new specific MRI imaging agent could be a powerful tool in the fight against malignancies.

MRI can be a highly effective imaging method, but all contemporary MRI imaging agents are non-specific, limiting their effectiveness when visualizing disease states. What's more, the contrast agents don't last long in the diseased tissues and therefore often need to be injected continuously, leading to higher dosing, which can have toxic side effects.

Case Western Reserve biomedical engineering faculty member Zheng-Rong Lu, the M. Frank and Margaret Domiter Rudy Professor, has **discovered a protein biomarker, fibronectin, that could lead to smarter MRI protocols.** Increased levels of fibronectin are an early biomarker of both cancerous tumors

and atherosclerotic plaques. In instances of malignancies, the biomarker congregates at high levels in the extracellular matrix of the tumor, which means it is an effective target for accurately characterizing the aggressiveness of a tumor.

Lu's research team **developed a class of new peptide-targeted Gd(III)-based MRI contrast agents that are specific to fibronectin, allowing for a clearer image of tumors and atherosclerotic plaques.** This can lead to earlier diagnosis and an easier way to check treatment success.

In a prostate cancer model, Lu has optimized the contrast agent so it can be used at a lower dose and



Zheng-Rong Lu

remain in the system for up to an hour, providing a clearer outline of the tumor than standard MRI imaging agents.

Lu is in talks with commercial partners to test the agent further and hopes to begin clinical trials in the next few years.



WHAT ARE THE REPERCUSSIONS OF A CONCUSSION?

After discovering modern-day football helmets are no better than historic leather ones in most collisions, the university partners with Cleveland Clinic to launch a head-injury consortium.

The finding was unexpected: **old-fashioned "leatherhead" football helmets protect as well as—and sometimes better than—the current models**, Case Western Reserve mechanical engineering professor Vikas Prakash found in conjunction with Cleveland Clinic and West Virginia's United Hospital Center after conducting a variety of impact tests.

While modern helmets are designed to prevent high-impact injuries such as skull fractures, they don't do well in providing protection from very common near-concussive

and subconcussive head impacts on the order of 60 g-forces and below—injuries that can still lead to anatomical and functional changes in the brain.

But returning to helmets of the past isn't the researchers' recommendation. In fact, more investigation is needed into the design of helmets for all applications—which requires a deeper understanding of head injuries themselves.

And so Prakash is partnering with the study's co-investigator, Adam

Bartsch, Case Western Reserve mechanical engineering PhD graduate and current director of Cleveland Clinic's Head, Neck and Spine Research Laboratory, to **launch the Cleveland Traumatic Neuromechanics Consortium**. The two will co-direct the group, which will pull together experts in medical research, engineering, materials science and imaging to gain a better understanding of the forces that cause injuries to the head, brain, neck and spine. Their findings may lead to the development of better-designed helmets for athletes and military personnel.

CARTILAGE REPLACEMENT

By permeating self-assembling sheets of mesenchymal stem cells with tiny beads filled with a growth factor, biomedical engineering associate professor Eben Alsberg was able to grow thicker, stiffer cartilage. The discovery puts researchers a step closer to developing implantable replacement cartilage, holding promise for knees, shoulders, ears and noses damaged by osteoarthritis, sports injuries and accidents.

The approach incorporates signals that promote cartilage formation into the sheets, allowing them to be implanted into patients more quickly than cartilage grown with more traditional techniques.



SMART PROBE

In the first test of a nanocomposite material inspired by the dynamic skin of the sea cucumber, a **hard probe was inserted in the cerebral cortex of a biologic model and, within minutes, turned as soft and pliable as the surrounding gray matter**—causing less scarring than traditional brain probes and promoting faster healing.

DIAGNOSING GOUT

Mechanical engineering associate professor Ozan Akkus received a **\$1.1-million NIH RO1 grant to improve the diagnosis of crystals in joint fluids leading to gout**. Working with MetroHealth Medical Center in Cleveland and the Henry Ford Hospital in Detroit, Akkus and colleagues are developing microfiltration devices and cost-efficient laser spectrometers to analyze clinical samples to determine whether a novel approach will reduce the current misdiagnosis rates that occur in 30 percent of patients.

CAN HEALTH ASSESSMENTS BE MORE HIGH-TECH?

A play-based, sensor-integrated game can measure cognitive, motor-control and learning skills.

Block design tests are used in several intelligence tests, as well as for assessing fine motor skills, cognitive problem-solving skills and working memory. Because the tests are effective at assessing the parietal and frontal lobes, they also are useful in the evaluation and rehabilitation of head injuries, Alzheimer's disease and stroke.

The tests require the user to arrange colored blocks into various patterns, and are evaluated based on accuracy and speed. Yet the tests are limited by having a well-trained administrator to manually record results.

Kiju Lee, the Nord Distinguished Assistant Professor in mechanical and aerospace engineering, has developed an **electronic, interactive version of the block test that can assess an individual's abilities as**

well as the manual version, but eases the requirements of the administrator and eliminates the possibility of human error.

Lee's Tangible Geometric Games (TAG-Games) uses blocks with built-in sensors that record results and submit them wirelessly to a computer or portable device. **The blocks are able to measure accuracy and speed, as well as additional data that human administrators cannot**, including reaction times, step-by-step correctness, behavioral patterns and the overall strategy or approach the individual is using.

TAG-Games could be effective not only for cognitive assessments, but also for individualized rehabilitation and educational programs where clinicians or teachers can program tests best suited to specific individuals and advance the tests'



Kiju Lee

difficulty as the subjects advance in their rehabilitation or learning.

The project, done in collaboration with co-investigators Elizabeth Short, professor of psychological sciences, and Francis Merat, associate professor of electrical engineering and computer science, is funded by a two-year NSF grant received in August 2011.

NANOCHAIN CHEMOTHERAPY

A research team led by assistant professor of biomedical engineering and radiology Efsthios Karathanasis has developed a novel **nanochain-targeted delivery system to get anti-cancer medicine to hard-to-reach areas of a tumor**. In pre-clinical tests, the medicine-toting nanochains took out far more cancer cells, inhibited tumor growth better and extended life longer than traditional chemotherapy delivery—while using far less of the drug doxorubicin than traditionally used in chemotherapy. The key to the therapy was the iron oxide “tail” of the nanochain. Once the nanochains penetrated the tumor, external radiofrequency detonated the chemotherapeutic drug, which spread throughout the tumor.



INTERMOLECULAR FORCES

Photovoltaics and lifetime degradation expert Roger French, the F. Alex Nason Professor, has received a **half-a-million-dollar Department of Energy Basic Energy Sciences grant** to study the long-range intermolecular forces that drive assembly and metastability of biomolecular and inorganic materials.

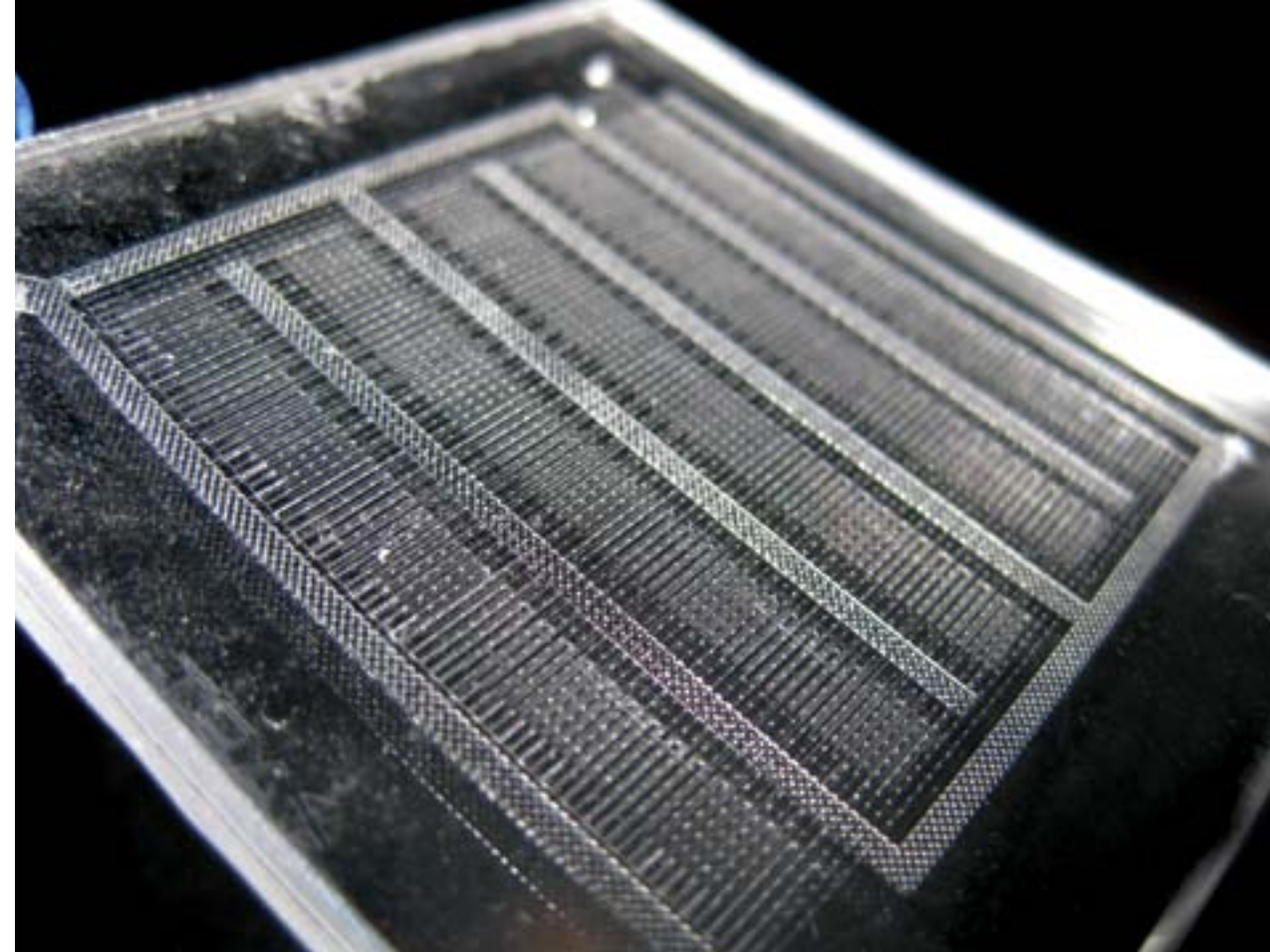
GREEN POWER

Biomedical engineering assistant professor Nicole Steinmetz has **embedded cancer-fighting medicines in a plant virus**—and found it effective in delivering medication to cancer cells in vitro. Tumor-targeting studies in pre-clinical models of brain, breast, colon and prostate cancer are under investigation.



QUICK ANALYSIS

Biomedical engineers at Case Western Reserve University have developed a **new computer-modeling method to help researchers quickly evaluate how nerves respond to electrical stimuli**. Analysis with traditional modeling methods took weeks, but the new program does so in just seconds. More efficient computer modeling could help researchers build better electrodes to stimulate nerves in paralyzed patients and amputees.



HOW DO YOU HELP OTHERS BREATHE EASIER?

New artificial lung uses air—not pure oxygen as current man-made lungs require.

A new prototype of a small artificial lung takes its cues from the genuine organ. It works with air—not pure oxygen as current man-made lungs require. It also uses **breathable silicone rubber versions of blood vessels** that branch down to less than one-fourth the diameter of human hair.

Though it is still years away from use in humans, the device is a major step toward creating an easily portable and implantable artificial lung—and could help bring relief to the 200 million lung-disease sufferers worldwide.

Working with colleagues at the Louis Stokes Cleveland Veterans Affairs Medical Center and Case Western Reserve School of Medicine, Case School of Engineering research assistant professor Joseph Potkay sought to improve artificial lung design from current models, which require heavy tanks of oxygen and can only be used on patients at rest, not while active.

The research team is **configuring the implantable device to be about 6 inches by 6 inches by 4 inches tall—about the volume of the human lung**. They also are designing it to be

driven by the heart, and not require a mechanical pump. They envision patients would use the device while allowing their own diseased lungs to heal or have one implanted while awaiting a lung transplant.



HOW DO WE REACH PLACES PEOPLE CAN'T?

A crafty robot gets its inspiration from the movement of worms.

An unlikely role model, the lowly earthworm has proven to be a mighty inspiration to Roger Quinn, the Arthur P. Armington Professor of Engineering, and biology professor Hillel Chiel. Their **worm-like robot can wend its way through rubble as an emergency responder or sneak into buildings through pipes to gather intelligence.**

Soft-bodied animals like worms are some of nature's best at navigating rough and rugged terrain. Translating this ability to robots, the researchers used a flexible braided mesh material and steel cable to replicate the smooth, fluid motion of the robot's counterparts in nature.

In addition to navigating through collapsed buildings and leaky water mains, **researchers hope that a**

smaller-scale version of the hollow robot could even be used inside the body to take biopsies and help diagnose diseases like colon cancer.

The researchers next plan to develop biologically inspired controls for the robot, based on the study of worm and slug movements. Such a control system may also be useful for other robots that need to perform a variety of different behaviors using the same body, and thus could increase the flexibility of many different kinds of robots.

The creation of the robot prototype and accompanying research was supported by a \$1.1-million National Science Foundation award.



Roger Quinn

RADIATION-RESISTANT DEVICES

A research team including Case Western Reserve computer engineering associate professor Daniel Saab and University of Utah electrical engineering professor Massood Tabib-Azar has designed **microscopic mechanical devices that can withstand intense heat and radiation**—allowing for their use in circuits for robots and computers designed to function in harsh environments: radiation in space, damaged nuclear power plants or during a nuclear attack.

The design also features significantly simplified FPGA and ASIC circuitry. In the FPGA circuitry, a four-input configurable logic block (CLB) requires only nine mechanical switches and, at most, two mechanical delays per computation. Traditional CLBs require more than 150 switches and more than two mechanical delays. The reduction improves yield, reproducibility, speed and power, and simplifies implementation.



SPACE BATTERY

For NASA to send a spacecraft to distant planets, all onboard equipment must be able to withstand acceleration as high as 20 times that of gravitational acceleration during takeoff and landing—and be able to function properly afterward. Using a centrifuge in the Geotechnical Research Lab at the Case School of Engineering, civil engineering chair David Zeng, the Frank H. Neff Professor, **tested the performance of next-generation NASA batteries to withstand accelerations up to 20 g while working at a temperature of 800 degrees Celsius.** The batteries also were tested to ensure they could hold up over 20 years for a similarly hot and impactful landing.



HOW DO WE PREVENT MORE AUTOMOBILE ACCIDENTS?

A new 360-degree driving simulator monitors how drivers truly behave on the road.

A new driving simulator at Case Western Reserve University not only **creates a lifelike environment for drivers, but also incorporates a host of sensors that calculate how well they are performing.**

The simulator features the front end of a car, including the hood, windshield and both front seats. A 360-degree projection broadcasts changing road conditions, from city to country roads, and weather from snow to rain to sunshine. Real-world events, such as a deer darting in

front of the car or a pedestrian who crosses the street without looking, provide a multitude of conditions for testing.

The simulator's applications include not just the testing of vehicle safety features, but also driver training and rehabilitation. Driving instructors could use the machine to teach younger and inexperienced drivers about the basics before driving on real streets. It also can be used to rehabilitate drivers who have suffered a serious injury, such as the

loss of a limb, or whose driving skills have diminished with age.

Xiong "Bill" Yu, associate professor of civil engineering, also is developing a sensor that monitors the physiological signals of a driver (e.g., ECG, heart rate, breathing rate and eye blinking)—without any contact with the body. **The goal is to assess—with no interference to the driving actions—the driver's current state,** detecting whether or not he or she is becoming drowsy.

CAN COMPUTERS WASTE LESS?

Fine-grained power gating produces less energy and heat.

Today's computers and other electronic devices waste much of the power put into running the processor. But fine-grained power gating, a novel idea developed by electrical engineering and computer science associate professor Swarup Bhunia, has the potential to save both power and money for many electronic devices.

Lowering a system's power usage produces less heat, which in turn means less cooling is needed. And avoiding the need for a large fan to cool the processor saves money in the design and manufacturing of the device.

Contemporary processors are wasteful because of their design. Two parts of a processor mainly consume power: the datapath,

which performs computations, and the memory, which stores data. Computing rarely requires everything that a processor is capable of all the time, but all of the processor is fully powered just the same. **Fine-grained gating is more efficient because it shuts off small parts of a datapath that are not currently in use.** The same methods can be applied to the machine's memory as well.

Processors are used in a variety of electronics, from computers to cell phones. Estimates by the research team indicate that fine-grained power gating could cut operational costs by more than one-third, on average. In a desktop computer, the total power savings would be about 40 percent.



Swarup Bhunia

The research was funded by the Intel Corporation, and presented at the 25th International Conference on Very-Large-Scale Integration (VLSI) Design, where it received the **award for best paper at the conference.**



CAN WE DO BETTER FROM THE START?

Cube, triangle and other-shaped gold catalysts grow nanowires twice as fast and twice as long.

The standard process for growing nanowires uses spherically shaped catalyst metal nanoparticles. But chemical engineer R. Mohan Sankaran, physicist Xuan Gao and their research team demonstrated that triangular, cubic and other higher-order-shaped gold catalysts are capable of growing nanowires about two times faster and longer.

Using arsenic and indium, the research team applied a bottom-up approach, which is necessary to create nanowires at less than 45 nm.

The findings, published in *Nano Letters*, **highlight a way to grow nanowires for sensors that can detect changes in white and red blood cells**, and thus determine different types of cancer. These tiny nanowires also

hold potential for advanced 'invisible' computer chips.

Visual Computing

Electrical engineering and computer science associate professor Mike Lewicki received a **\$1.8-million, four-year grant from the National Science Foundation to study how vision works in nature and apply that information to computer systems**. Lewicki is working with colleagues at the University of Texas at Austin and the University of California at Berkeley to understand more about how human brains process and interpret vast amounts of visual information by studying motion in natural scenes. A better understanding of the science behind perception could help computer engineers design programs that “see” more naturally.



Spacecraft Propulsion

As an aerospace engineering PhD candidate at Case Western Reserve, Matthew Deans collaborated with NASA Glenn Research Center to develop a **catalytic igniter that could be part of a propulsion system in the next generation of spacecraft**.

Engineers want to design propulsion systems that weigh less, require less energy than past models and use safer fuels. Deans' igniter is part of a system that uses oxygen and methane instead of the ultra-combustible—but toxic—hypergolic propellants that powered the space shuttles.

Since completion of the research and his doctorate, Deans has been hired by NASA Glenn Research Center to work on chemical rockets for in-space propulsion needs.



Wrench design by CJ Valle



RECORD-SETTING CLASS

Case Western Reserve set a record this spring by recruiting and **enrolling the largest, most diverse and most academically accomplished first-year class in history**. In the fall of 2012, the university welcomed 1,372 students—about 200 more than the previous record class, which enrolled in 2005. More than 12 percent come from underrepresented minority groups. And their SAT scores at the 25th and 75th percentiles are 1280 and 1450. (A perfect SAT score is 1600).

What's more, **almost half of the incoming class—45 percent—have expressed an interest in engineering**. That's 605 engineering-minded students, compared with 350 students who entered the Case School of Engineering in fall 2011. Almost three-quarters of those students are coming to Case Western Reserve from out of state. More than three-quarters of them were in the top 10 percent of their high school classes.

WIRELESS HEALTH

In 2011, the Case School of Engineering launched the **first-ever graduate education program in wireless health**, offering a graduate certificate as of the fall 2011 semester and a Master of Science degree as of fall 2012. The program provides expertise in an emerging trend that promises to improve health care quality, coverage and cost.



HOW DO YOU TURN FIRST-YEAR STUDENTS INTO ENGINEERS?

New inventor's studio and experiential classes teach students to tinker, design and solve problems.

The opening of the university's new inventor's playground, think[box], is helping to usher in a new era at Case Western Reserve that promotes hands-on, experiential learning for first-year engineering students.

Think[box] is a space where students are encouraged to collaborate on classroom and personal projects—and gives them the tools to brainstorm, design, create prototypes—everything required to bring ideas to market.

The first iteration of the lab opened its doors in January and welcomed a deluge of students, faculty and staff from across campus. The **3,000-square-foot space boasts 3D printers, a computerized printed circuit board router, laser cutters,**

a microscopic soldering iron, a computerized embroidery machine, a ShopBot computer-controlled router and a 3D microscope among its high-tech offerings.

The next step for think[box] is a new seven-story, 50,000-square-foot facility on campus—and the school has already raised more than \$15 million for the project.

The idea behind think[box] is to allow students to get their hands on the same tools professional engineers use and get them designing their first semester on campus. The approach fits well with the **curricular updates occurring at the undergraduate level, which encourage active, hands-on learning beginning the first year**

of college. Three such courses were piloted this spring, combining introductory engineering principles with real-world problems and experiential problem-solving. The classes cycled through the think[box] facility so students could engineer answers to the challenges presented in lessons.

The three piloted classes were so successful that **19 experiential classes for first-year students that utilize think[box] have been launched in fall 2012**, with more planned for future semesters.

Take a tour of think[box] at engineering.case.edu/thinkbox-video



WHERE DOES THE BEST LEARNING HAPPEN?

A capstone design project gets students engineering solutions for a rural village in Senegal.

All chemical engineering undergraduate students at Case Western Reserve take a capstone design course that pairs them with companies such as Lubrizol, Marathon Oil and Avery-Dennison to help the corporations solve a current design issue while students get practical experience.

This past spring semester, one senior design team looked a little further to find their real-world pairing. Teaming with a teacher in a rural village in Senegal, the five students, along with Daniel Lacks, the C. Benson Branch Professor of Chemical Engineering, and adjunct

professor Mamadou Sow, used their **capstone project as an opportunity to make life a little easier for residents of the remote village of Ngohe, Senegal.**

There, they met with villagers to learn about local culture and the challenges of daily life without electricity or running water. They learned that many residents rely on cell phones, but with no access to electricity, they have to make a daylong trip to the nearest city just to charge their batteries.

The students' solution was to design a low-cost, pedal-driven device

that converts mechanical energy to electrical to power the phones.

The success of the project has spurred not only the inclusion of another international project for the next class cohort, but also the **creation of a first-year course that focuses on designing ultra-affordable pedal-driven devices for low-load applications in the developing world.**

CURRICULUM UPDATES

Not only have first-year seminar classes for all undergraduate engineering students been updated to provide more opportunities for hands-on learning (see page 37), but **department-specific courses at the undergraduate and graduate level have been revamped this year, streamlining coursework and integrating more experiential learning and research.**

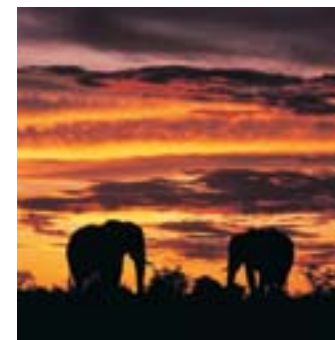
Biomedical engineering's undergraduate coursework was shifted from nine sequence options to four tracks in order to focus on core skills and keep graduates more marketable when job hunting. The new tracks have been designed to align well with minors. At the same time, the department **received an NIH grant* to integrate even more active, interdisciplinary learning across the undergraduate curriculum**, including a summer clinical-immersion fellowship.

In another example of increasing experiential learning, the mechanical and aerospace engineering department deepened its design work with the introduction of a design and manufacturing track.

At the graduate level, a proposal-writing course has been introduced and department-specific learnings have been strengthened, such as the introduction of half-semester elective courses for macromolecular science and engineering students to allow for more timely, interesting and useful courses while giving students a chance to take on a larger number of topics.

**NIH grant R25 EB014774*

GLOBAL STUDY



The Case School of Engineering took one of its core engineering courses—ENG 225B: Thermodynamics, Fluid Mechanics, Heat and Mass Transfer—**out of the lecture hall and across the globe during a three-week summer session at the University of Botswana.** Traveling with chemical engineering professors R. Mohan Sankaran and Daniel Lacks, students were able to see how the technical content plays out in regional issues, such as a visit to a local village water well to learn about fluid mechanics.

HOW DO YOU GET INNOVATIONS TO MARKET FASTER?

A new \$20-million endowment by the university and the Coulter Foundation supports biomedical advances.

To support the translation of ideas that address unmet medical needs into treatments and devices that improve human health, Case Western Reserve and the Wallace H. Coulter Foundation have established a \$20-million endowment.

This endowment advances the Coulter Foundation's original \$4.8-million partnership grant, which funded projects at the university from 2006 to 2011. The new joint endowment will enable the Wallace H. Coulter Translational Research Partnership program at

Case Western Reserve to continue in perpetuity.

Case Western Reserve was one of only nine universities in the country selected to participate in the Coulter Foundation's Translational Research Partnerships in Biomedical Engineering, and one of only six to receive endowment funding.

The program at Case Western Reserve has helped launch six start-up companies and has funded 62 translational research projects to date. Such projects range across

a broad spectrum of biomedical disciplines—from advanced imaging technology techniques to thermally stable insulin development—and each is founded on an active collaboration between a biomedical engineering researcher and a practicing clinician.



DRUG-DELIVERY INNOVATIONS

Biomedical engineering associate professor Horst von Recum and research associate Julius Korley were **among the first 100 researchers in the country to receive a grant and training in the National Science Foundation Innovation Corps program,** a new effort to help develop scientific and engineering discoveries into useful technologies, products and processes. The researchers co-founded the polymer-based drug delivery company Affinity Therapeutics to commercialize technologies to deliver HIV therapies and localized chemotherapy, prevent surgical site infections and more.

TECH TRANSFER

In FY2012, Case School of Engineering faculty contributed to:

- **67 invention disclosures**—4.2 times the national per-dollar proficiency average*
- **66 patent filings**—2.6 times the national per-dollar proficiency average*
- **11 deals** (options and non-exclusive and exclusive licenses)—2.75 times the national per-dollar proficiency average*

*AUTM U.S. Licensing Activity Survey, FY 2008, FY 2009 and FY2010.



SMART WATCH

A new smart watch designed by 2009 Case Western Reserve computer engineering graduate Andrew Witte promises to get folks actually wearing watches again. The Pebble E-Paper Watch interfaces with both the iPhone and Android operating systems to play music, alerts you to incoming calls and emails, and much more. Hoping to raise around \$100,000 to launch manufacturing, the company turned to Kickstarter, an online platform where individuals can post ideas and solicit support, and ended up with more than \$10 million. The team expects to ship its 85,000 pre-ordered Pebbles by the end of 2012.



SMALL, POWERFUL CAPACITORS

Fueled by funding from ARPA-E, AVX Corporation, the National Reconnaissance Office and others, materials science and engineering professor Gerhard Welsch has **launched a capacitor technology company called Titanium Power Technologies.** The company seeks to produce materials and devices for the power electronics industry constructed with titanium alloys and titanate oxides on geometrically designed electrodes—resulting in capacitors that are high on power and energy, but small in volume.

HOW CAN YOU HELP A START-UP START UP?

Blackstone LaunchPad brings regional institutions together to help ignite new companies.

Case Western Reserve University is one of four area higher education institutions to be named part of Blackstone LaunchPad, an initiative to give university students, faculty and alumni the skills, knowledge and guidance they need to start new companies.

Blackstone LaunchPad aims to present entrepreneurship as a viable

career path and offer students, faculty and alumni concrete tools and guidance to transform ideas into thriving businesses, including commercialization project management support for energy-related activities. The initiative is open to all students, regardless of major, and engages local entrepreneurs to mentor students.

The program is launching at Baldwin-Wallace University, Case Western Reserve, Kent State University and Lorain County Community College. The Blackstone Charitable Foundation and the Burton D. Morgan Foundation contributed \$3.2 million toward the partnership.



HOW DO YOU DESIGN FOR THE REAL WORLD?

Student project invents a simple solution to one of life's greatest annoyances—potholes.

A quick fix for potholes? **A bag of batter-like liquid, called a non-Newtonian fluid, that turns rigid under pressure.** Toss in as many bags as needed to fill the chasm. The fluid-filled bags settle into the topography of the hole, much as if poured in. When a car tire crosses them, the fluid hardens, providing a smooth ride to the other side.

For this solution to a real problem, an interdisciplinary team won the 2012 Saint-Gobain Student Design Competition at Case Western Reserve University, including \$9,000 in prize money. They also bested teams from eight other

Northeast Ohio universities to win the Entrepreneurship Education Consortium's ideaLabs competition and a \$6,500 award this year. Most recently, they were awarded a \$25,000 grant from the Great Lakes Innovation and Development Enterprise.

Their product, **Hole Patch, is reusable and environmentally benign, quick and easy.** The status quo: shoveling a mix of tar and gravel into the pothole, tamping it down, and often returning to do the same job as mother nature and traffic loosen the mix, costing up to \$5 billion annually nationwide.

The project team includes students Curtis Obert, Nicholas Barron, Chimadika Okoye, Mayank Saxena and Noah Gostout.

The team is working with an Ohio tent maker to produce a more durable bag. They plan to fine-tune, cut costs and broadly test the fix this academic year.

Watch a video at engineering.case.edu/pothole-patch

SIGNAL MASTERS

A Case Western Reserve undergraduate student engineering team was a **2012 finalist in the popular Texas Instruments Analog Design Contest Engibous Summit**. Of 140 teams nationwide that entered the contest, only the top 12 designs were invited to the finals this summer in Dallas.

The Case School of Engineering team entered a device they had created for their EECS senior design project. **The USB Signal Master is a small, modular, USB instrumentation platform with three instrument modules, a 200 MHz oscilloscope, a 40 MHz arbitrary waveform generator and an 11-channel digital logic analyzer.** The device has further potential applications as a network analyzer, biological interface, semiconductor parameter analyzer, digital multimeter or even for custom instruments.

Building the device in only one semester, the team received support from the SAGES Capstone Fund and the Sears Undergraduate Design Lab, and built part of the instrument in think[box].

Watch a video of their design at engineering.case.edu/TI-student-design-contest

MISSION ACCOMPLISHED

Case School of Engineering undergraduate student Josh Schwarz set out this past year to **create a new Facebook application every week for an entire year**—that's 52 apps in 52 weeks! Fulfilling his 2011 New Year's resolution, Schwarz completed his 52nd app on Dec. 30, 2011.

AWARD-WINNING PUZZLE

A lithograph-sketched 2D logic puzzle game, called "The Bridge," created by Case Western Reserve computer science master's student Ty Taylor and drawn by undergraduate computer science student Mario Castaneda, was a **winner at the 2012 Independent Games Festival Student Showcase**, the Indie Game Challenge and the Independent Propeller Awards. [Check out a preview of the game at thebridgeisblackandwhite.com](http://thebridgeisblackandwhite.com)

Electrical engineering and computer science PhD student Tina He was the recipient of the **first annual Keithley Graduate Fellowship Award** from Keithley Instruments.

Three Case Western Reserve University graduate students, Brian Michal, Adriana Popa and Brian Tietz, were selected as **members of the inaugural class of the NASA Space Technology Research Fellows**.

HOW DO YOU GROW THE BEST TEAM?

Strategic hiring initiative features clustered themes within advanced materials, energy, and human health and technology.

Continuing its faculty recruitment efforts, the Case School of Engineering hired five new faculty members under its Strategic Hiring Initiative in FY2012. **These strategic hires bridge departmental boundaries to bring together research “clusters” to tackle real-world challenges**—centered on themes of advanced materials, energy, and human health and technology.

Abidemi Bolu Ajiboye, assistant professor in the Department of Biomedical Engineering, joined the Brain Interfacing and Signal Analysis cluster, which is championed by BME interim chair Robert Kirsch, and includes fellow BME and electrical engineering and computer science faculty. In the same department, **assistant professor Nicole Seiberlich joined the Biomedical Imaging cluster**, championed by Dean Jeffrey L. Duerk and associate professor James Basilion.

In the Department of Chemical Engineering, new associate professor Rohan Akolkar joined the Electrochemistry cluster, led by Robert Savinell and including faculty from chemical engineering, materials science, biomedical engineering, and macromolecular science and engineering.

Rigoberto C. Advincula, professor of macromolecular science and engineering, joined the Layered Polymeric Systems cluster, which is championed by department chair David Schiraldi and incorporates faculty from macromolecular science and engineering and physics.

Assistant professor of electrical engineering and computer science **Hongping Zhao joined the Photovoltaics and Lifetime Degradation cluster**, led by materials professor Roger French, who was the school's first hire under the new initiative in FY2011.

Additionally, the school recruited new faculty talent in 2011–12 utilizing other hiring resources, including assistant professor **Kurt R. Rhoads, who joined the Department of Civil Engineering**, and assistant professor **Jon Pokorski, who joined the Department of Macromolecular Science and Engineering**.

[Learn more about the school's hiring initiative at \[engineering.case.edu/strategichiring\]\(http://engineering.case.edu/strategichiring\).](http://engineering.case.edu/strategichiring)



EDUCATION OUTREACH

Case Western Reserve University reinforced its commitment to community advancement in 2012 by **establishing an office of Engineering K-12 Outreach to enhance and expand its activities**. The engineering school offers a variety of mentoring and tutoring programs, such as the Center for Layered Polymeric Systems' envoy program, which reaches out to promising Cleveland high schoolers to teach them how to do scientific research, write science papers and make presentations. Such programs not only help K-12 students excel, but also create a pipeline of students who might not have otherwise considered attending college or pursuing a degree in the STEM fields.

WHAT HAPPENS WHEN YOU ADVANCE RESEARCH AND EDUCATION?

The university is ranked among the best in the nation by multiple sources.

Case Western Reserve University's reputation got multiple shots in the arm this past year, soaring to the top of several news outlets' college ranking guides.

In 2012, ***U.S. News & World Report* ranked the university's graduate biomedical engineering program the No. 10 program in the country**. The engineering school overall ranked in the top 50 for graduate-level education. Case Western Reserve's **undergraduate biomedical engineering program was ranked No. 8 nationally**, and in the top 50 overall for undergraduate engineering schools.

But the positive endorsements don't stop there. ***Washington Monthly* ranked Case Western Reserve the No. 7 university in the country** in August 2011, a 10-spot jump from the previous year. The university maintained that position in the 2012 rankings. The publication ranks universities based on social mobility, research production and success at sending undergraduates on to doctoral programs, and commitment to community service.

***The Huffington Post* ranked the university as one of the nation's "Trendiest Colleges,"** recognizing the university as the trendiest "School that Flies Under the Academic Radar

... But Shouldn't" in 2011. And in February 2012, the online news source again lauded Case Western Reserve, naming the university to its list of 15 colleges where "Geek is Chic," putting the university in rank with MIT, Johns Hopkins, Carnegie Mellon and California Institute of Technology.

THE BIG 5-0

In the spring of 1963, the **country's first stand-alone polymer science and engineering department was organized at the Case Institute of Technology**. Eric Baer, a polymers expert who went on to achieve international renown, served as the first chair. The department initially offered both doctorate and masters' degrees; an undergraduate degree was added a decade later. The department's 50-year history, including nearly 300 BS, 400 MS and 500 PhD graduates, has included a number of research breakthroughs in polymer science and composite materials. **The department is home of the first ABET-accredited BS degree in Polymer Science & Engineering, and the only materials-focused NSF Science and Technology Center.**





HOW DO YOU MAKE YOUR UNIVERSITY EVEN MORE IMPACTFUL?

A \$1-billion capital campaign launches for the university.

The university publicly launched a \$1-billion capital campaign in October 2011. **Forward Thinking: The Campaign for Case Western Reserve University seeks to capitalize on the university's existing strengths to become a more collaborative, global and high-impact campus.** Following the university's strategic plan, the campaign is focused on enhancing scholarship support and increasing the number of endowed professorships. Other key areas include capital projects and academic programs and centers.

The campaign chair is Frank N. Linsalata, a 1963 Case Institute of Technology graduate who also served as chair of the university's Board of Trustees from 2004 to 2008,

and who continues to serve as a trustee. President Barbara R. Snyder announced the campaign on Oct. 13, 2011, along with \$80 million in new commitments to the university. By the close of FY2012, the university had already raised \$717.5 million toward its \$1-billion goal.

The **Case School of Engineering seeks to raise a minimum of \$170 million** toward the campaign goal to advance education and strategic hiring at the school—and has raised more than 65 percent of that amount already.

To support educational endeavors, the school hopes to expand its active-learning models and lab and classroom spaces to incorporate the

most advanced technology into student programs. The school also needs philanthropic support for scholarships and fellowships to continue to attract high-caliber students at both the undergraduate and graduate levels. Additionally, the school is committed to recruiting new faculty talent at all ranks to enhance the learning environment, bolster key areas of research and garner new recognition.

[Learn more about the university's campaign at case.edu/forwardthinking.](http://case.edu/forwardthinking)

RECORD-SETTING PHILANTHROPY

In fiscal year 2012, the Case School of Engineering, in conjunction with the Case Alumni Association, **raised more than \$27 million in dollars, pledges and commitments, breaking the school's fundraising record for the second consecutive year.**



SUPPORTING THINK[BOX]

In February 2012, university trustee **Lawrence M. Sears (CIT '69) and his wife, Sally Z. Sears (FSM '72) pledged \$5 million as a challenge grant for think[box]**, the university's new tinkering lab that encourages creativity, invention and the commercialization of technology. (Read more about think[box] on page 20.) The challenge grant builds upon a separate **\$5 million commitment made in 2011 by Invacare leaders A. Malachi Mixon III and Joseph "J.B." Richey II (CIT '62) and a \$1 million commitment from Barry Romich (CIT '67) in 2010.** These and other gifts will help move think[box] from its initial 3,000-square-foot space in Glennan Hall to a stand-alone, seven-story, 50,000-square-foot facility.



WIRELESS HEALTH CHAIR

The **Veale Foundation endowed the Veale Professorship in Wireless Health Innovation** at the Case School of Engineering in the summer of 2012 to help advance the field of wireless health through professional education and purposeful research.





WHAT DOES PROMISING RESEARCH LOOK LIKE?

Faculty member receives Presidential Early Career Award for pioneering work connecting artificial implants to human body.

This summer, President Barack Obama named Case Western Reserve University **biomedical engineering assistant professor Jeffrey R. Capadona one of the nation's 96 most promising young scientists** for his pioneering work in bridging connections between artificial implants and the human body.

The Presidential Early Career Award for Scientists and Engineers (PECASE) is the **highest honor the U.S. government bestows upon promising scholars** beginning their careers.

Capadona, also a research health scientist at the Louis Stokes Cleveland Veteran's Administration Medical Center, was nominated by fellow faculty and colleagues for his ability to merge the disciplines of biology and engineering to help restore those injured by war, accidents and disease. He was also cited for his instrumental work in helping to develop a fabrication technique that produces materials that change from rigid to flexible and vice-versa, depending on cues from the environment. Capadona is exploring this new class of materials for applications in medical

devices, including electrodes to record or stimulate the nervous system—linking the brain to machines, artificial joints and prosthetic sockets.

Mechanical and aerospace engineering associate professor **Ozan Akkus** was elected a **fellow of American Society of Mechanical Engineers**. Akkus also received the **J.R. Neff award from the Musculoskeletal Transplant Foundation**.

Biomedical engineering associate professor **Andrew Rollins** and radiology and biomedical engineering associate professor **Mark Griswold** were elected **fellows of American Institute for Medical and Biological Engineers**.

Zehra Meral Özsoyoğlu, the Andrew R. Jennings Professor of Computing, was named a **fellow of the Association for Computing Machinery**.

Liming Dai, the Kent Hale Smith Professor in macromolecular science and engineering, was elected to the **American Institute for Medical and Biological Engineering's College of Fellows** Class of 2012.

R. Mohan Sankaran, associate professor of chemical engineering, received the **2011 Peter Mark Memorial Award from the American Vacuum Society**. The award recognizes outstanding theoretical or experimental work by a young scientist.

Electrical engineering and computer science associate professor **Pedram Mohseni** took top honors at the **Medical Device Entrepreneur's Forum at the American Society for Artificial Internal Organs** annual conference in June 2012. Mohseni and colleagues devised a plan to commercialize their technology to enhance functional behavioral recovery from brain injury. In 2011, Mohseni also was selected as a **senior member of the Institute of Electrical and Electronics Engineers (IEEE)**.

Mario Garcia-Sanz, the Milton and Tamar Maltz Professor in Energy Innovation, served as the **keynote speaker for the IEEE National Aerospace and Electronics 2012 conference**, speaking on "Advanced Control Engineering for Energy and Space Applications."

LaShanda Korley, the Climo Assistant Professor, was one of 78 young engineers selected to take part in the National Academy of Engineering's 18th annual **U.S. Frontiers in Engineering symposium**.

Associate professor of macromolecular science and engineering **Lei Zhu** won the **National Science Foundation's Creativity Award** for his work in polymer ferroelectricity confined in nanospaces.

Ica Manas-Zloczower, associate dean of faculty development and the Thomas W. and Nancy P. Seitz Professor of Advanced Materials and Energy, won the **Rubber Division of the American Chemical Society's 2012 George S. Whitby Award** for Distinguished Teaching and Research.

ADMINISTRATION

Case Western Reserve University

Barbara R. Snyder
President

William "Bud" Baeslack III
Provost and Executive Vice President
Professor of Materials Science and Engineering

Case School of Engineering

Jeffrey L. Duerk
Dean and Leonard Case Professor of Engineering

Patrick E. Crago
Associate Dean
Professor of Biomedical Engineering

Clare M. Rimnac
Associate Dean
Wilbert J. Austin Professor of Engineering

Ica Manas-Zloczower
Associate Dean, Faculty Development
Professor of Macromolecular Science and Engineering

Laura Bulgarelli
Associate Dean, Finance and Administration

Daniel Ducoff
Associate Dean of Development and External Affairs

Lisa Camp
Associate Dean for Special Initiatives

Deborah J. Fatica
Assistant Dean for Engineering Student Programs



FACULTY

Biomedical Engineering



Robert F. Kirsch
Interim Chair and Professor



Abidemi Bolu Ajiboye
Assistant Professor



Eben Alsberg
Associate Professor



James Basilion
Associate Professor*



Jeffrey R. Capadona
Assistant Professor



Patrick E. Crago
Associate Dean and Professor



Jeffrey L. Duerk
Dean and Leonard Case Professor of Engineering



Dominique Durand
Elmer Lincoln Lindseth Professor of Biomedical Engineering



Steven J. Eppell
Associate Professor



Miklos Gratzl
Associate Professor



Kenneth J. Gustafson
Associate Professor



Efstathios "Stathis" Karathanasis
Assistant Professor*



Melissa Knothe Tate
Professor



Erin B. Lavik
Elmer Lincoln Lindseth Associate Professor of Biomedical Engineering



Zheng-Rong Lu
M. Frank and Margaret Domiter Rudy Professor



Roger E. Marchant
Professor



P. Hunter Peckham
Distinguished University Professor and Donnell Institute Professor of Engineering



Andrew M. Rollins
Associate Professor



Gerald M. Saidel
Professor



Nicole Seiberlich
Assistant Professor



Anirban Sen Gupta
Assistant Professor



Nicole Steinmetz
Assistant Professor*



Dustin J. Tyler
Associate Professor



Horst von Recum
Associate Professor



David L. Wilson
Robert J. Herbold Professor



Xin Yu
Associate Professor

Chemical Engineering



Uziel Landau
Chair and Professor



Rohan Akolkar
Associate Professor

* Case Western Reserve University School of Medicine campus

Chemical Engineering, continued



Harihara Baskaran
Associate Professor



Donald L. Feke
Vice Provost and
Professor



Daniel J. Lacks
C. Benson Branch
Professor of Chemical
Engineering



Chung-Chiun C.C. Liu
Distinguished
University Professor
& Wallace R. Persons
Professor of Sensor
Technology & Control



Heidi B. Martin
Associate Professor



Syed Qutubuddin
Professor



R. Mohan Sankaran
Associate Professor



Robert Savinell
George S. Dively
Professor of
Engineering

Civil
Engineering

Xiangwu "David"
Zeng
Chair and Frank H.
Neff Professor



Dario A. Gasparini
Professor



Arthur A.
Huckelbridge Jr.
Professor



Aaron A. Jennings
Professor



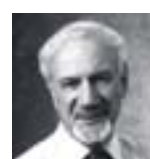
Brian Metrovich
Associate Professor



Michael Pollino
Assistant Professor



Kurt R. Rhoads
Assistant Professor



Adel S. Saada
Professor



Banu Sizerici Yildiz
Assistant Professor



Xiong "Bill" Yu
Associate Professor

Electrical
Engineering and Computer
Science

Michael S. Branicky
Chair and Professor



Swarup Bhunia
Associate Professor



Marcus R. Buchner
Associate Professor



M. Cenk Cavusoglu
Associate Professor



Vira Chankong
Associate Professor



Harold
Connamacher
Assistant Professor



Philip X.L. Feng
Assistant Professor



Chris Fietkiewicz
Assistant Professor



Mario Garcia-Sanz
Milton and Tamar
Maltz Professor in
Energy Innovation



Steven L. Gaverick
Professor

Electrical Engineering and Computer Science, continued



Mehmet Koyuturk
Theodore L. & Dana J.
Schroeder Associate
Professor in Computer
Science and Engineering



Michael Lewicki
Associate Professor



Jing Li
Associate Professor



Vincenzo Liberatore
Associate Professor



Wei Lin
Professor



Kenneth A. Loparo
Nord Professor of
Engineering



Behnam Malakooti
Professor



Mehran Mehregany
Goodrich Professor
for Engineering
Innovation



Francis L. Merat
Associate Professor



Pedram Mohseni
Associate Professor



Wyatt S. Newman
Professor



Gultekin Ozsoyoglu
Professor



Z. Meral Ozsoyoglu
Andrew R. Jennings
Professor of
Computing Sciences



Christos A.
Papachristou
Professor



H. Andy Podgurski
Professor



Michael Rabinovich
Professor



Soumya Ray
Assistant Professor



Daniel G. Saab
Associate Professor



Narasingarao
Sreenath
Professor



Guo-Qiang "G.Q."
Zhang
Professor



Xiang Zhang
Assistant Professor



Xinmiao Zhang
Timothy E. & Allison
L. Schroeder Associate
Professor in Computing
Science and Engineering



Hongping Zhao
Assistant Professor



Christian A.
Zorman
Associate Professor

Macromolecular
Science and
Engineering

David Schiraldi
Chair and Peter
A. Asseff, PhD,
Professor of Organic
Chemistry



Rigoberto C.
Advincula
Professor



Eric Baer
Distinguished
University Professor
and Herbert Henry
Dow Professor of
Science & Engineering



Liming Dai
Kent Hale Smith
Professor



Hatsuo "Ken"
Ishida
Professor

Macromolecular Science and Engineering, continued



Alexander M. Jamieson
Professor



LaShanda T.J. Korley
Climo Assistant Professor



João Maia
Associate Professor



Ica Manas-Zloczower
Associate Dean of Faculty Development & Thomas W. & Nancy P. Seitz Professor of Advanced Materials & Energy



Jon Pokorski
Assistant Professor



Stuart J. Rowan
Kent Hale Smith Professor



Gary E. Wnek
Joseph F. Toot Jr. Professor



Lei Zhu
Associate Professor

Materials Science and Engineering



James D. McGuffin-Cawley
Chair and Arthur S. Holden Jr. Professor in Engineering



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Provost and Executive Vice President and Professor



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Frank Ernst
Leonard Case Jr. Professor of Engineering



Roger French
F. Alex Nason Professor



Arthur H. Heuer
Distinguished University Professor and Kyocera Professor in Ceramics



Peter D. Lagerlof
Associate Professor



John J. Lewandowski
Leonard Case Jr. Professor of Engineering



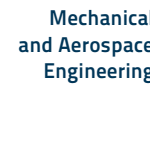
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Associate Professor



Pirouz Pirouz
Professor



Gerhard E. Welsch
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J. Iwan D. Alexander
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Alexis Abramson
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Mechanical and Aerospace Engineering, continued



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Clare M. Rimnac
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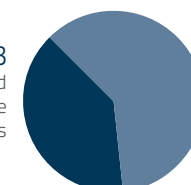
Gregory S. Lee
Assistant Professor, Electrical Engineering and Computer Science

CASE SCHOOL OF ENGINEERING AT A GLANCE

Enrollment | Fall 2012

1,621 Total*

633
Graduate and professional-degree students



988
Declared undergraduate engineering students

*In addition, 714 undergraduate students expressed interest in engineering majors but are not expected to declare majors until the end of their sophomore years.

Fundraising | FY 2012

Total: \$27.6 million

\$26.5 million

Case School of Engineering

\$1.1 million

Case Alumni Association

In FY2012, the Case Alumni Foundation/Association provided \$1.5 million from its endowment to the Case School of Engineering.

U.S. News & World Report rankings

Top 50

For undergraduate and graduate engineering programs

10th

for graduate biomedical engineering programs

8th

for undergraduate biomedical engineering programs

Total revenue | FY 2012

\$82.7 million

Research and training revenue | FY 2012

\$44.7 million

Full-time faculty | Fall 2012

118

PROGRAMS AND COMMITTEES

Departments

- Biomedical Engineering
Chemical Engineering
Civil Engineering
Electrical Engineering and
Computer Science
- Macromolecular Science and
Engineering
Materials Science and Engineering
Mechanical and Aerospace
Engineering

Centers and Institutes

- Advanced Platform Technology
Center
Case Center for Surface Engineering
Case Metal Casting Laboratory
Cell and Tissue Imaging Center
Center for Advanced Polymer
Processing
Center for Biomaterials
Center for Mechanical
Characterization of Materials
Center for Modeling Integrated
Metabolic Systems
Cleveland Functional Electrical
Stimulation Center
- Control and Energy Systems Center
Electronics Design Center
Great Lakes Energy Institute
Institute for Advanced Materials
Materials for Opto/Electronics
Research and Education (MORE)
Center
Microfabrication Laboratory
Neural Engineering Center
NSF Center for Layered Polymeric
Systems (CLIPS)
Solar-Durability and Lifetime
Extension Center
- Swagelok Center for Surface Analysis
of Materials
The Institute for Management
and Engineering
think[box]
Wind Energy Research and
Commercialization Center
Yeager Center for Electrochemical
Sciences

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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.