RESEARCH THAT CHANGES THE WORLD

2012:2013
Office of the Vice President
for Research Annual Report

PURDUE UNIVERSITY™

“WE HAVE IT IN OUR POWER TO BEGIN THE WORLD OVER AGAIN.”

Thomas Paine

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WE LIVE IN A NEW GLOBAL PARADIGM where people can have their entire genome sequenced, drive cars that run completely on electricity and communicate with inhabitants of remote areas where telephone lines have never existed. And yet with all these advances, our world continues to struggle with challenges like hunger, poverty, disease and sustainability.

As a land-grant university of the 21st century, Purdue University is obligated to address these problems for the common good. Working in concert with other researchers and policymakers around the world, our faculty members and students seek to solve challenges that can't be solved by individual disciplines or nations alone. Read on to discover how their ideas are helping to improve quality of life, enhance sustainability, promote emerging technologies, and advance education and engagement. These stories are the future — and the present — of a university doing research that changes the world.

PURDUE UNIVERSITY™

"We hope to eventually be able to perform this analysis during surgery to help guide brain surgeons so that the borders of tumors can be identified."

Graham Cooks

RESEARCH THAT CHANGES THE WORLD

QUALITY OF LIFE

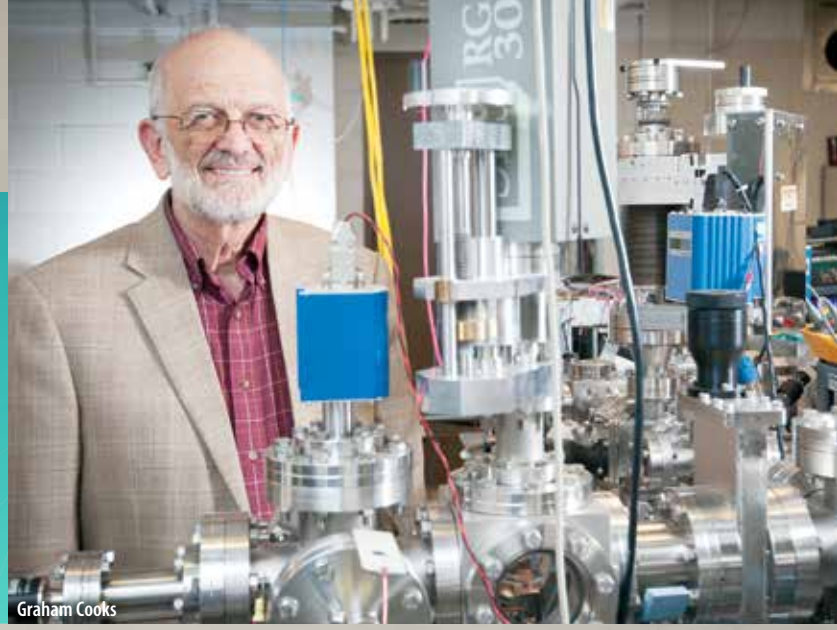

Graham Cooks

PHOTO BY VINCENT WALTER

MASS SPECTROMETRY FOR BRAIN CANCER DIAGNOSIS


Nathalie Agar

PHOTO BY VINCENT WALTER

Neurosurgery research scientist Nathalie Agar from Brigham and Women's Hospital at Harvard Medical School visits Discovery Park's Bindley Biosciences Center as part of her collaborative research with Graham Cooks.

Graham Cooks is convinced his research can have a significant impact across a host of disciplines. Therapeutic drug monitoring. Drug testing. The identification of food-borne pathogens, bacteria, pesticides and explosives residues. Molecular imaging for cancer diagnostics and surgery.

One of his latest research tools may help surgeons perform more comprehensive testing of cancerous brain tissue during surgery. The tool relies on an ambient mass spectrometry analysis technique developed by Cooks and his colleagues.

Called desorption electrospray ionization, or DESI, the technique involves spraying a microscopic stream of charged solvent onto the tissue surface in order to gather molecular makeup information. A color-coded image reveals the nature and concentration of tumor cells.

Already, researchers and physicians at Brigham and Women's Hospital at Harvard Medical School have used the tool to successfully identify the cancer type, grade and tumor margins in five brain surgery patients whose tissue was removed for analysis.

"We hope to eventually be able to perform this analysis during surgery to help guide brain surgeons so that the borders of tumors can be identified and the cancer status of a site can be established before any tissue is removed," says Cooks, the Henry Bohn Hass Distinguished Professor of Chemistry and winner of the biennial 2013 Dreyfus Prize in Chemical Sciences.

Dr. Nathalie Agar, director of the Surgical Molecular Imaging Laboratory within the neurosurgery department at Brigham and Women's Hospital, says the findings showed the analysis method's potential and achieved an important step in the path to assessing its value in improving patient care.

"This approach could lead to real-time, image-guided surgery without interference with surgical care and without the administration of labeling agents," says Agar, who co-led the study. "Such extensive and detailed information about the tissue was previously unavailable to surgeons and could lead to more precise tumor removal. In addition, having access to a detailed diagnosis on the day of surgery could help the oncologist more efficiently design the course of adjuvant therapy."

LEARN MORE ▶ **http://tinyurl.com/ba6neul**

PARTNERING FOR CLINICAL TRIALS

Philip Low

On a bitterly cold day in February, Dr. Wael Harb sits in a treatment room at Horizon Oncology in Lafayette, Ind., warming the hand of a patient whose intravenous line is hooked up to a chemotherapy drug. Right across the river, Harb's clinical-trial partner, Prof. Philip Low, will later review results of the patient's experience with Vintafolide, which Low developed for people with late-stage ovarian and lung cancers.

When Harb first set up practice in Lafayette 15 years ago, he discovered that a number of researchers at Purdue were engaged in groundbreaking cancer research, but few medical providers in town knew about it. So Harb worked with Marietta Harrison, associate vice president for research at Purdue, to form the Purdue Cancer Research Clinical Partnership Program. Since then, Lafayette physicians have not only participated in clinical trials of two of Low's compounds, but also collected blood and tissue samples for Purdue researchers studying biomarkers for colon cancer.

Ultimately, the biomarker research could lead to new guidelines for colonoscopy screenings. Already, in randomized phase II trials of Vintafolide, Harb and his colleagues have recorded a significant improvement in survival rates, a critical finding for the FDA approval process.

"We are only tapping the surface of Purdue's impact on biomedical science," enthuses Harb. "There is huge potential to translate more research from the lab to the clinic."

LEARN MORE ▶ **http://tinyurl.com/n6fqg8a**

Dr. Wael Harb

PHOTO BY VINCENT WALTER

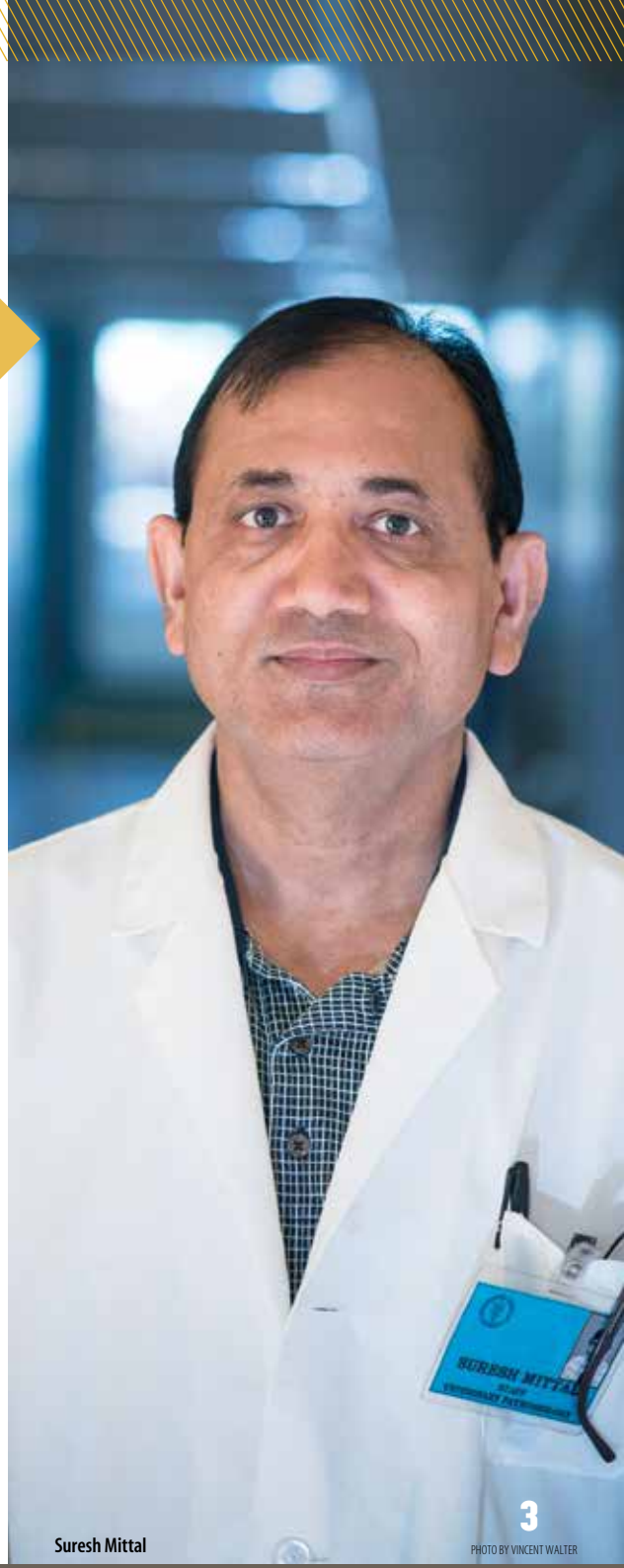
SOLVING THE FLU VACCINE CONUNDRUM

Nobody wants a repeat of the 1918 Spanish flu that killed an estimated 20-50 million people worldwide. But public health officials face a conundrum when confronted with a possible influenza pandemic — once they determine that the threat is real, it will take months before the vaccine can be stockpiled, and in the meantime, millions of lives could be lost.

Suresh Mittal may have found an answer to this dilemma: a broadly protective vaccine that simultaneously protects against H5, H7 and H9 influenza strains. Working with the Centers for Disease Control, Mittal has created a harmless adenovirus that delivers avian influenza genes into the body, which can then create antibodies and special T-cells primed to kill the virus and infected cells.

"We need a vaccine that protects against a spectrum of strains to prepare for a potential pandemic," says Mittal, a professor of comparative pathobiology in the College of Veterinary Medicine. "Even if the virus mutates, it should prevent infection. And even though it may not be the ideal vaccine, it could prevent mortality and lessen symptoms."

LEARN MORE ▶ **http://tinyurl.com/m2lumhm**



Suresh Mittal

PHOTO BY VINCENT WALTER

AVOIDING THE WATCH-AND-WAIT IN CANCER TREATMENT

Laurie Parker has watched several family members succumb to cancer in the prime of their lives. "My uncle and grandfather died of leukemia in their early 40s. My cousin died in her late 20s of adrenocortical carcinoma," says Parker. "I've seen how hard it is on my family to not have any control over what's going on with these diseases."

Some of that loss of control, of course, results from the waiting — for a diagnosis, for treatment to begin, for answers about the effectiveness of the chosen therapy. Even when treatment begins immediately, because of the limitations of current testing, physicians often don't know for weeks or months if it's working. That waiting not only increases anxiety for the patient and his or her family, but also can prevent doctors from altering the course of treatment when it could be most effective.

Parker, an assistant professor of medicinal chemistry and molecular pharmacology, wants to change that with a new diagnostic method. She's studying her technique on inhibitor drugs like fostamatinib, which blocks a kinase — an enzyme that is involved in the development of cancers such as chronic lymphocytic leukemia (CLL). The current treatment, Rituximab, is effective in many, but not all, CLL patients. Fostamatinib is effective in some of the remaining patients with CLL — particularly those who tried Rituximab and failed. "But physicians don't know right away if the drug hits the target enzyme and whether its success is being maintained over the course of the treatment," she says.

Using fluorescent metal ions that change the color of kinase enzyme substrates, Parker examines the current state of kinase activity in laboratory-grown cells. After she treats the cells with inhibitor drug, she checks to see if the color changes back to normal. Her results are available in hours or days compared to weeks or months.

Once Parker's technique is perfected, she will try to replicate her results using frozen cancer cells donated by patients to the Indiana University Tissue Bank. Ultimately, she hopes her technique could be used by physicians to monitor the response to drugs like fostamatinib early and often.

Laurie Parker

PHOTO BY VINCENT WALTER

ENRICHING THE POTENTIAL OF CANCER DRUGS

In the world of chemistry, nanopolymers are relative newcomers, having debuted only six years ago. But already, the titanium-coated versions developed in Andy Tao's laboratory at Purdue in 2010 have made great strides in the race to find new cancer treatments, thanks to their ability to test the effectiveness of a widely used class of inhibitors.

Because they're designed to attach only to phosphorylated proteins — which are responsible for a vast majority of cancers —

Anton Iliuk | Andy Tao

PHOTO BY JOHN UNDERWOOD

the polymers can be used in conjunction with color-changing chemicals to determine the effectiveness of different compounds. The lighter the color in each assay well, the fewer the proteins present, and the more effective the drug is.

The polymers, which are being marketed in assay kits by Tao's company, Tymora Analytical, are intended to replace costly antibody testing and potentially dangerous radioactive testing.

"We need a more efficient way, a more sensitive way, to analyze proteins," says Tao, an associate professor of biochemistry and analytical chemistry who founded Tymora Analytical with his former student Anton Iliuk. "This technology will help us enrich the potential of these protein inhibitors."

LEARN MORE ▶ **http://tinyurl.com/3odqcaa**

INDIVIDUALIZING CARE FOR LIVER CANCER

For people with inoperable liver cancer, a few hospitals around the country are offering new hope through internal radiation therapy and stereotactic body radiation. One of those is IU Health University Hospital in Indianapolis, which is piloting groundbreaking technology developed by Ulrike Dydak, an assistant professor of health sciences who is using a Purdue Cancer Center Challenge grant to support her research.

A former high-energy physicist who has spent the last 15 years working in medical physics, Dydak has created a new method for assessing treatment outcomes. Conventional imaging using CT or MRI can't detect changes in liver tumors until months after treatment begins — often too late for people with a life expectancy of around one year. While conventional MRI images use a signal from hydrogen nuclei, Dydak's method uses a novel coil wrap to detect a phosphorous signal to more accurately assess the patient's progress.

The coil, made of an array of eight loops of conductive wires, wraps around the abdomen and detects the small radio frequency signals that the liver's metabolites emit after having been excited by the MRI. While traditional phosphorous coils only allow clinicians to see superficially into the liver at disparate points, Dydak's coil allows for the first time a visualization of the energy household of the entire liver.

Dydak's team performs the MRI studies on patients during regular visits to University Hospital. "So far, we have very promising pilot data," says Dydak. If further research bears out, it could lead not only to more personalized radiation plans, but also to a new method of monitoring treatment in liver cancer that uses phosphorous to seek out biomarkers.

"My goal is to impact clinical care and diagnostic possibilities for cancers," says Dydak. "This research hopefully will allow us to implement better diagnostic techniques to improve individualized patient care."

"My goal is to impact clinical care and diagnostic possibilities for cancers."
Ulrike Dydak

Ulrike Dydak

PHOTO BY VINCENT WALTER

Stephen B. Kennedy | Kelly Vibber | Grace Yeanay | Agaptus Anaele | Valerie Coleman | Stacey Connaughton

PHOTO COURTESY OF STACEY CONNAUGHTON

PROMOTING PEACE THROUGH LOCAL ACTION

The College of Liberal Arts is filled with faculty members who study how others are contributing to social change. So it was a natural extension for the college to launch the Purdue Peace Project (PPP) in order to build knowledge about and contribute to effective peacebuilding around the world.

"We work with local citizens and organizations to develop strategies and activities to prevent political violence," says Stacey Connaughton, associate professor in the Brian Lamb School of Communication and Director of PPP, which is funded by retired businessman and philanthropist Milton Lauenstein. "We focus on results. The action — and the resolution — come from the communities."

For their first project, researchers have been working with locals in Berekum, Ghana, a town of roughly 62,000 people, to help resolve a chieftancy dispute that has left the community on the brink of political violence. They've also been working to prevent political violence in the transport sector in Liberia; facilitating Liberian citizens' involvement in natural resources management; and working to prevent violence and enhance university — community relationships in Nigeria.

Results are disseminated to the peacebuilding community through scholarly journals and books. "This work has tremendous potential to make meaningful impact on lives around the world," Connaughton says. PPP's first project recently helped to bring about a peaceful resolution to the 13½ year chieftancy dispute in Berekum, Ghana.

LEARN MORE ▶ **http://www.cla.purdue.edu/ppp/**

IPAD CHECKLIST HELPS ID RX SIDE EFFECTS

A few minutes using an iPad at the pharmacy could help spot medication side effects and improve medical treatment. That's the idea behind the Pharmaceutical Therapy-Related Quality of Life (PTRQol) screening tool developed by Matthew Murawski, associate professor of pharmacy administration.

Currently, seven Indiana pharmacies are using the PTRQol app on the 200 most-common prescription medications. When patients pick up a prescription, they answer a five-question checklist, which helps the pharmacist identify any inappropriate or harmful side effects and respond as needed.

"Many patients do not mention side effects to their doctor or pharmacist because they either don't recognize that they are connected to the medication or they consider them the cost they must pay to keep from being ill or dying," Murawski says. That may prompt patients to stop taking their medicine, an ill-advised choice, especially when pharmacists may be able to suggest simple changes like taking a medication after meals or avoiding certain foods. Pharmacists can even contact physicians to ask about changing medications, he says.

LEARN MORE ▶ **http://tinyurl.com/l98b9sz**

Matthew Murawski

PHOTO BY VINCENT WALTER

WATER LOGISTICS FOR A LANDLOCKED COUNTRY

Patrick Johanns

The nonprofit Integrated Community Development International (ICDI) is working diligently to bring clean drinking water to millions of citizens in Central African Republic. But in this landlocked country with no rail system and only 500 miles of paved roads across its rolling savannas, a truck breakdown could slow down progress for months as drivers wait for a missing part in a farflung country.

Patrick Johanns wants to aid the organization's cause while teaching his students some real-world lessons. For his fall 2012 logistics management class in the Krannert School of Management, Johanns addressed the organization's logistical issues through a classroom project.

After collecting information from ICDI administrators through Adobe Connect and Dropbox, the students made recommendations on improving data collection, vehicle maintenance and supply chain issues. Two ideas have already been implemented by ICDI officials — the purchase of motorcycles for quicker scouting expeditions to remote villages and the adoption of the ABC inventory system to prioritize shipments for critical supplies.

"This was better than a regular case study that already has a solution," says Johanns, a continuing term lecturer. "This was a chance to make a real impact."

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"To achieve the aim of better health by learning from routinely collected health data, we believe patients and clinicians alike should be full participants in viewing every health care encounter as an opportunity to improve outcomes, not only for the individual patient, but also for others like them."

Quote from the *Making the Case for Continuous Learning from Routinely Collected Data*

ANOTHER UP SIDE TO EMRS

Michael Murray

Most of us would rather not spend time in the doctor's office completing the same forms over and over, but there's another upside to the push toward EMRs (electronic medical records): We might also save ourselves some money.

"Large patient databases allow us to do comparative studies, such as whether treatment A or treatment B is more cost-effective," says Michael Murray, Distinguished Professor of Pharmacy Practice and Endowed Chair of Medication Safety Executive Director at Purdue and a Regenstrief Institute Investigator who led the team that wrote *Making the Case for Continuous Learning from Routinely Collected Data*, released by the Institute of Medicine.

Some consumers are reluctant to relinquish the paper-and-pencil method for fears over privacy, despite research and reassurances to the contrary. So Murray's team looked for other compelling reasons to digitize records. Analyzing scientific literature that had been covered in mainstream media, they found a host of uses for EMRs, from disease monitoring to the cost evaluation of novel treatments.

"The ultimate goal is to bend the healthcare cost curve," he says. "It's going to take really rich data sources to be able to do that."

LEARN MORE ▶ **http://tinyurl.com/plhrd5s**

INSTITUTE OF MEDICINE
OF THE NATIONAL ACADEMIES

PHOTO BY ANDREW HANCOCK

Jessica Huber

COMMERCIALIZATION WITH A CAUSE

Nearly 90 percent of the 1.5 million patients with Parkinson's disease have "soft voice," or hypophonia, a condition in which words are hushed, whispery or even hoarse.

Jessica Huber, associate professor of speech, language and hearing sciences, has invented a device that cues patients to speak louder and more clearly. Known as SpeechVive, the device rests in the patient's ear, providing a stream of noise similar to the background chatter at a party and cueing the person to talk louder.

"SpeechVive can really make a difference in people's relationships and their ability to participate in daily activities. It has the potential to be tremendously impactful," says Huber, the faculty entrepreneur-in-residence at Discovery Park's Burton D. Morgan Center for Entrepreneurship for 2012-13. The second version of the device has been tested in a second clinical trial, which is wrapping up. The new version is at least as effective as the original version of the SpeechVive.

SpeechVive is currently in production and will be sold on the market in the next two years. She's also teaming with scientists in the Department of Health and Kinesiology to study how they can improve gait and physical movement of people with Parkinson's disease.

LEARN MORE ▶ **http://tinyurl.com/lrxcvzr**

PHOTO BY VINCENT WALTER

Joseph Francisco

"It is a great honor, when you think about the high regard members think of your work."

Joseph Francisco

AWARD

FRANCISCO ELECTED TO NATIONAL ACADEMY OF SCIENCES

When Joseph Francisco learned he had been elected to the National Academy of Sciences — one of the highest honors a scientist or engineer can receive — he was surprised, excited and humbled. Francisco adds, "It is a great honor when you think about the high regard members think of your work."

Francisco, who is the William E. Moore Distinguished Professor of Chemistry and Earth, Atmospheric and Planetary Sciences, is known for new understandings of the atmosphere's chemical processes, its ability to break down and remove pollutants, and for identifying the molecule essential to break down nitric acid, which causes acid rain. He mapped atmospheric breakdown of chlorofluorocarbons, and he leads research on benign materials to replace them.

He also serves on President Barack Obama's Committee on the National Medal of Science, responsible for selecting recipients of the National Medal of Science.

LEARN MORE ▶ http://tinyurl.com/kbhxf9w

Ann Kirchmaier | Sophie Lelièvre | Joseph Irudayaraj | Amy Lossie

PHOTO BY VINCENT WALTER

AWARD

FIGHTING EPIGENETIC HEALTH CONDITIONS

Environmental factors can influence whether our genes turn on and off. Now, research to alter epigenetic markers in genomes — which could lead to advances in treating genetic health conditions — has received a shot in the arm with a $1 million W.M. Keck Foundation grant.

The research is the first to actively manipulate the epigenetic code, says Joseph Irudayaraj, biological engineering professor and principal investigator. He's collaborating with Purdue Profs. Ann Kirchmaier, biochemistry; Amy Lossie, animal sciences; Sophie Lelièvre, basic medical sciences; and Feng Zhou, anatomy and cell biology, Indiana University-Purdue University Indianapolis.

Already, researchers have completed parts-building and testing; over the next two years, researchers will detect and manipulate the epigenetic code. If their research bears out, Irudayaraj predicts a significant payoff. "Understanding epigenetic mechanisms at the single-cell level can lead to developing strategies to induce or reverse epigenetic modifications to control gene expression, allowing us to direct the fate of its progeny," he says.

LEARN MORE ▶ http://tinyurl.com/l3tb6cm

"When you can improve the livelihoods of people in the countryside, then they don't feel the need to move into cities."

Guri Johal

RESEARCH THAT CHANGES THE WORLD

SUSTAINABILITY & EMERGING TECHNOLOGIES

Brian Dilkes | Cliff Weil | Mitch Tuinstra

GENOMICS, HUNGER AND THE SCIENCE OF GROWING

Guri Johal

PHOTO COURTESY OF MITCH TUINSTRA

Lipid extraction from maize leaves subjected to high-temperature stress in Hyderabad, India.

Growing up in the Punjab province of northern India in the 1960s, Guri Johal remembers his mother making unleavened bread from flint corn, a staple crop in his region. But when higher-yield varieties of rice were introduced, the multicolored waves of maize in Johal's region were gradually replaced with verdant rice paddies.

Now, 40 years later, India's water tables are dropping precipitously, in large part because of rice production. Johal, professor of botany and plant pathology, believes the solution is to reintroduce maize, but in higher-yield, heat-resistant varieties. With a $1.1 million grant from the U.S. Agency for International Development, he and Mitch Tuinstra, the Wickersham Chair of Agronomy, are working with the International Maize and Wheat Improvement Center and collaborators in India, Pakistan, Bangladesh and Nepal to study how heat and drought affect different varieties of maize.

Findings could not only lead to new drought-resistant hybrids for those countries, but also critical knowledge for the United States. "There is a lot of concern about how climate change will affect crops, but we know almost nothing about thermal tolerance in corn," Tuinstra says.

Johal says the research also could help preserve subsistence farms in his homeland. "When you can improve the livelihoods of people in the countryside, then they don't feel the need to move into cities," he says.

LEARN MORE ▶ http://tinyurl.com/lwxo92g

BRIDGING THE GAP IN

While corn may be the No.1 cereal crop produced worldwide, sorghum is not far behind at No. 5. And in places like sub-Saharan Africa and southern India, where it's too hot and dry to grow corn, sorghum reigns king.

Mitch Tuinstra, the Wickersheum Chair of Agronomy, is interested in what makes sorghum such a viable crop. He's collaborating with Cliff Weil and Brian Dilkes on a $1 million Bill and Melinda Gates Foundation grant to identify sorghum gene functions, especially those that play a role in crop yield, protein and starch digestion, and resistance to the parasitic weed Striga. "The goal is to create a functional genomics

PHOTO BY VINCENT WALTER

GENOMICS INFORMATION

platform," says Dilkes, an assistant professor of horticulture.

Working with the West Africa Center for Crop Improvement in Ghana, the researchers are teaching students plant-breeding techniques using genomics and bioinformatics. They're also partnering with the Striga Research Unit in Burkina Faso to test new technology in Striga-infested fields. Ultimately, the knowledge could allow growers to plant varieties likely to grow best in their area.

"It's great that we have all this genomics information, but people need to know how to use it," says Weil, a professor of agronomy. "We are trying to bridge that gap."

LEARN MORE ▶ **http://tinyurl.com/lsdjhy5**

TAKING FLIGHT WITH GREEN FUEL

The dream to be the first university with a green training fleet may be within reach, thanks to two Purdue initiatives.

The National Test Facility for Fuels and Propulsion (NaTeF), funded by a $2.7 million agreement with the U.S. Air Force, seeks to improve the technology of fuels and propulsion using engine test cells and a materials test laboratory.

Officials are working with Swift Fuels LLC, a Purdue Research Park firm that developed an unleaded, high-octane aviation gasoline for piston-engine aircraft. "Our goal is to move this fuel across the final testing hurdles to full implementation," says David Stanley, NaTeF and the Air Transport Institute for Environmental Sustainability (AirTIES) researcher. He's collaborating with fellow aviation technology faculty members Denver Lopp, Mark Thom and Mary Johnson.

AirTIES is comprised of cross-disciplinary teams focusing on aviation fuel research, development and implementation. Working with Mercurius Bio-Fuels on a Department of Energy project, AirTIES researchers hope to establish a pilot plant and evaluate the use of hydrotreating technology to convert biomass to jet fuel. The Purdue team for the DOE project also includes Gozdem Kilaz (AirTIES post-doctoral researcher), Rich Simmons (AirTIES PhD researcher), Nathan Mosier of Agricultural and Biological Engineering, and Wally Tyner of Agricultural Economics

LEARN MORE ▶ **http://tinyurl.com/k4bnjn4**

David Stanley | Denver Lopp | Chris D' Acosta

PHOTO BY VINCENT WALTER

ECOCAR2 PUTS STUDENTS ON FAST TRACK

Hands-on learning, leadership and competition are merging into a single lane for dozens of Purdue students and leaders participating in the three-year EcoCAR2 challenge sponsored by General Motors and the U.S. Department of Energy. Their task: converting a Chevrolet Malibu into a hybrid/electric or fuel-cell vehicle to reduce its environmental impact without compromising performance, safety or consumer acceptability.

At the 2012 competition, which focused on design, analysis and simulation, Purdue team members won in several categories, including Best Controls Simulations and Women in Engineering. In 2013, they received second place in the controls presentation.

"We were fortunate to have both powertrains operational for the 2013 competition," reports faculty advisor Peter Meckl, mechanical engineering professor. "We also passed all the safety checks and were able to run the vehicle during the dynamic events."

In 2014, the Purdue team, which is comprised of students from engineering, technology, computer science, management, organizational leadership and other disciplines, will compete a final time against 14 other universities.

"We have many challenges ahead but we have a great team of students to work with," Meckl says.

PHOTO COURTESY OF VAHID MOTEVALLI

Purdue's EcoCAR2 team is converting a Chevy Malibu into a more environmentally friendly car.

LEARN MORE ▶ **http://tinyurl.com/mh832kw**

Alexandra Boltasseva

PHOTO BY VINCENT WALTER

INVESTIGATOR TAKES FAST TRACK TOWARD PHOTONICS SUCCESS

Growing up 400 miles from Moscow, Alexandra Boltasseva was steeped in the Soviet Union's tradition of Nobel laureates in physics. But in her third year at the Moscow Institute of Physics and Technology, when she joined a group studying quantum well semiconductor lasers, a light bulb went off in her head.

"I realized that this was where the skills to create, measure and interpret all came together," recalls Boltasseva, an associate professor of electrical and computer engineering. "Optics and photonics had revolutionized our world."

Less than 10 years after completing her Ph.D., Boltasseva has contributed a number of innovations to these fields, including semiconductor metamaterials components and plasmonic waveguides and circuits.

She is now focusing on new research directions: semiconductor-compatible metamaterial devices and metasurfaces that are extremely thin films of metamaterials and are capable of ultra-efficient control of light. Such novel components could dramatically speed up processes, leading to advances in solar cells, computers, telecommunications, sensors, microscopes and quantum information technology.

"I definitely expect and hope to see a lot of advances made in practical devices in real-life applications during my career," says Boltasseva, who received 2013 Young Investigator Awards from both the IEEE Photonics Society and the Materials Research Society.

LEARN MORE ▶ **http://tinyurl.com/odlv5o2**

ENGINEERING BETTER BRIDGES

Jason Weiss

When the mercury drops and ice coats Indiana's bridges, salt makes our thoroughfares more navigable. But de-icing compounds also break down the concrete and corrode the reinforcing steel. Specifically cracks in concrete accelerate this damage leading to costly and time-consuming repairs.

Jason Weiss knows that better engineering can prolong the life of concrete, saving money and reducing repair-associated delays. One of his high-performance concrete mixtures is being used by the state this year to rehabilitate and increase the lifespan of four Hoosier bridges.

The mixture contains aggregate that emits water during the curing process. More effective than flooding cement with water or spraying it with coatings, the internal-curing technique leads to concrete that is denser and more resistant to de-icing salt.

In the field of road construction research, "A lot of great ideas get written up and published," says Weiss, the Jack and Kay Hockema Professor in Civil Engineering and director of Purdue's Pankow Materials Laboratory. "But what we've done is take something from the lab trying to implement this in the field to improve the performance of the concrete and reduce maintenance costs for bridges."

Or, in this case, the roads right underneath our wheels.

LEARN MORE ▶ **http://tinyurl.com/mb4yskz**

Mitch House | Albert Miller

PHOTO BY VINCENT WALTER

Maureen McCann | Elizabeth Majewski

PHOTO BY VINCENT WALTER

C3BIO LEVERAGES ITS GAME-CHANGING APPROACH FOR SUCCESS

Game-changing was its goal. Game-changing it is.

The Purdue University-led Center for Direct Catalytic Conversion of Biomass to Biofuels, is advancing methods for converting plant lignocellulosic biomass — the bulk of the plant — to biofuels and other products derived from oil using chemical catalysts and thermal treatments.

C3Bio, affiliated with Discovery Park's Energy Center and Bindley Bioscience Center, also is investigating how to produce fuels closely resembleing gasoline in molecular makeup and energy density.

Since its launch through a $20 million grant from the U.S. Department of Energy in 2009, C3Bio and its team of researchers have filed patent applications for a:

- High-pressure, low-residence-time hydropyrolysis unit, essentially a "rocket reactor," to convert biomass compounds into fuel molecules, working with aerospace scientists at Purdue.
- Unique mass spectrometry system to provide structural information for molecules directly in complex mixtures, such as biomass degradation products that can consist of thousands of unknown compounds.
- A low-footprint prototype second harmonic generation microscope (SHG) has been designed, assembled and incorporated into the synchrotron Beamline 23-ID-D at Argonne National Laboratory. This complements X-ray studies, enabling detailed nanoscale characterization of cellulose structure but over a limited field of view.

The five-year project also has had a notable economic impact. C3Bio has trained 39 C3Bio early career scientists (graduate students and post-docs), secured 4 patents and has made 10 additional disclosures. One startup company has resulted from the project as well.

"If we are successful in this high-risk, high-reward research, it will result in job creation on a much wider scale as these technologies are implemented," says Maureen McCann, professor and assistant head of biological sciences and director of the Energy Center.

Joining Purdue as partners of C3Bio are the National Renewable Energy Laboratory, University of Tennessee, Northeastern University and Argonne National Laboratory.

HELPING HERITAGE TOURISM SURVIVE AND THRIVE

Sustainable heritage tourism might be called a balancing act — maintaining a site's cultural identity and environmental integrity while remaining welcoming to visitors. That's the research focus of Jonathan Day, assistant professor in hospitality and tourism management, who studies the travel industry's emerging Triple Bottom Line philosophy of "people, planet and profit."

"How can tourism make money, protect the environment and support the local people of a destination?" Day wrote in a 2012 editorial in the *Journal of Tourism Research & Hospitality*. "It's about maintaining a destination in a way that it can be resource — today and tomorrow — and that means protecting, even celebrating, the nature and the culture."

Born in Australia, Day is an industry veteran who has spearheaded marketing campaigns for New Zealand and the Great Barrier Reef. Now at Purdue, he's involved in the Indiana Sustainable Tourism project and the Heritage Tourism Initiative, a multi-state effort to identify needs, expand awareness, and develop resources and capacity, especially in rural communities.

"Sustainability looks at the reason people come to a destination, perhaps the beautiful natural environment, and recognizes these attractions must be nurtured — even while they are being experienced by visitors," he says. "You don't want to love a place to death."

PHOTO BY VINCENT WALTER

Jonathan Day

ELECTRONICS FOR A NEW ERA

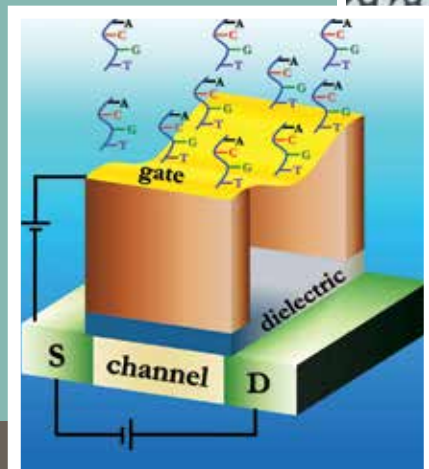
Someday, smart tattoos embedded in the skin might monitor heart rate, hydration and respiration in long-distance runners or alert people with diabetes that their glucose levels are dangerously high or low. But that future of personalized, on-demand medicine will require a tight integration of nanoelectronics and biology, a revolution that Mark Lundstrom hopes to enable.

"Experimental, theoretical, and computational research in nanoelectronics has produced an amazing array of new capabilities, now we need to connect those advances to circuit designers and biomedical engineers," says Lundstrom, the Don and Carol Scifres Distinguished Professor of Electrical and Computer Engineering and lead investigator of NEEDS (Nano Engineered Electronic Device Simulation), a Purdue-led initiative that includes MIT, Berkeley, and Stanford. "Our mission is to help circuit and system designers spark a revolution in electronics." On the Purdue campus, NEEDS is partnering with the Center for Implantable Devices, led by Professor Pedro Irazoqui, to realize a paradigm shift in medical care. Electronics for healthcare is one opportunity being explored by NEEDS.

While silicon transistor technology is the foundation of today's electronics, a palette of novel nanomaterials and devices will complement today's technology in new applications in healthcare, security, and energy. With $3.5 million from the National Science Foundation and another $2.5 million in joint support from NSF and the Semiconductor Research Corporation, NEEDS researchers will create the models that circuit and system designers will use to realize these new opportunities.

"The grand challenges society now faces require combinations of technologies, and electronics will play a central role," he says. "The goal of NEEDS is to help enable this new era of electronics."

LEARN MORE ▶ **http://tinyurl.com/nbysebx**



This graphic depicts a new ultrasensitive biosensor called a Flexure-FET biosensor that could open up new opportunities for early detection of cancer and "personalized medicine" tailored to the specific biochemistry of individual patients. (Alam group, Purdue)

Mark Lundstrom

PHOTO BY VINCENT WALTER

WINNING IN THE WINDY CITY

Clustered in the hundreds or standing alone, wind turbines are increasingly dotting America's landscape. But for all the promises of energy- and cost-savings, bearing-related gearbox failure costs $500-$700 million annually, making it the most expensive component of wind turbine maintenance.

Anurag Garg and his teammates in Bearing Analytics believe there is a more accurate way to predict bearing failure. Showcasing technology some of the students helped to develop in Profs. Dimitrios Peroulis's and Farshid Sadeghi's research groups, the team took their idea to Chicago, earning the $100,000 student grand prize in the 2013 Clean Energy Challenge.

Currently available technologies monitor bearings from the outside. The new sensors can be placed directly on the bearing cage — where they can more reliably detect temperature and vibrations that indicate impending failure.

"Undetected bearing failures can potentially lead to expensive downtime and occasionally catastrophic disasters resulting in the loss of an entire asset," says Garg. "If you can detect it early, it's relatively cheap maintenance and improved asset safety."

LEARN MORE ▶ **http://tinyurl.com/ltq7rn3**

PHOTO COURTESY OF ANURAG GARG

Amy Francetic | Andrew Kovacs | Jennifer Garson | Chris Ochynski | Anurag Garg | Lokesh Gupta | David Danielson

Michael Kane | Anthony Smith | Lonnie Bentley

PHOTO BY VINCENT WALTER

WIRELESS TECHNOLOGY ON LAND AND SEA

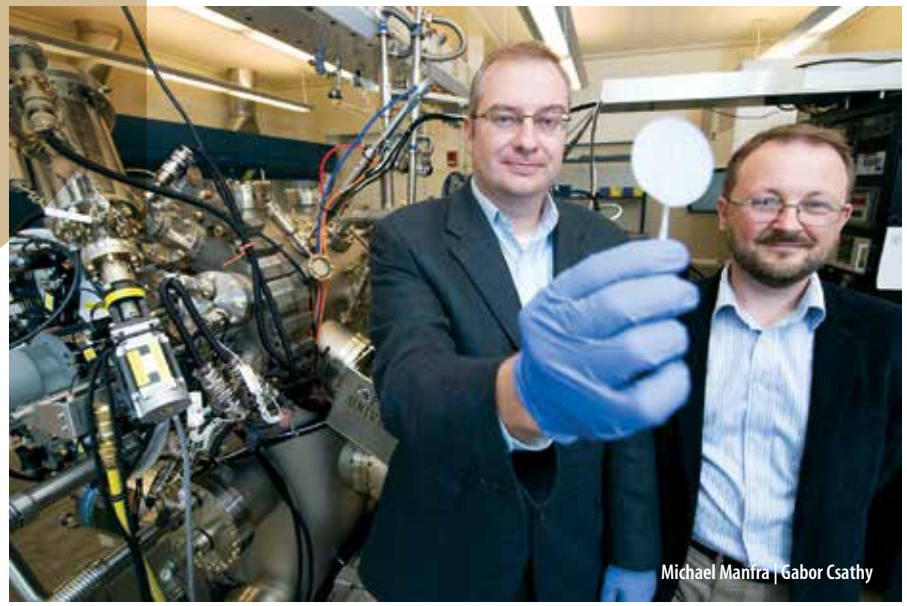
Deepwater structures in the Gulf of Mexico, U.S. Navy ships at sea, a sea salt recovery site in Israel, and mobile emergency command centers at disaster sites — these are all remote locations where people need high-bandwidth, uninterrupted wireless communication, and places where Purdue researchers have offered the solution.

It's now been five years since a team of Purdue researchers — Michael Kane, associate professor of computer and information technology; Anthony Smith, associate professor of computer and information technology; Lonnie Bentley, professor of computer and information technology in the College of Technology — took their research success to market. Since then, BATS (Broadband Antenna Tracking Systems Inc.) has achieved worldwide reach, enhancing electronic communications in countless locations on land and sea.

"BATS is effectively penetrating diverse markets worldwide, from oil and gas exploration, search and rescue, command and control systems, as well as maritime markets," says Kane, at Purdue who continues to collaborate with his co-developers both at Purdue and at the Indianapolis-based company they co-founded.

"Our technology developed at Purdue has translated into more than 20 new jobs," he says. "I'm proud that we're bringing revenues to Indiana from all over the world."

LEARN MORE ▶ **http://tinyurl.com/lvt6oaf**



Michael Manfra | Gabor Csathy

PHOTO BY ANDREW HANCOCK

EYEING QUANTUM COMPUTING'S NEXT GENERATION

Quantum computing may someday outpace the world's fastest digital machines, but not until some practical problems are solved. One of those is the mobility of electrons, the subject of a new $1 million W.M. Keck Foundation grant.

A group of Purdue researchers is developing technologies to improve electron mobility in the semiconductor gallium arsenide (GaAs). The technology could allow electrons to move freely without danger of bumping into impurities and scattering, says lead researcher Michael Manfra, the William F. and Patty J. Miller Professor of Physics and professor of electrical and computer engineering. He's collaborating with David Johnson and Kevin Trumble from the School of Materials Engineering and Gabor Csathy from the Department of Physics.

In GaAs quantum wells, electrons interact only with each other. "The cleaner, or more pure, the easier it is for the electrons to achieve new states," Manfra says.

In these correlated states, a change applied to one is reflected in the motion of all the others. Harnessing and controlling this behavior could lead to new ways to store and process information.

LEARN MORE ▶ **http://tinyurl.com/kpksnz2**

Thomas Hertel

PHOTO BY VINCENT WALTER

AWARD

HERTEL RECEIVES INAUGURAL RESEARCH AWARD

Global and economy-wide in scope, the research of Thomas Hertel, Distinguished Professor of Agricultural Economics, earned him the first-ever Purdue University Research and Scholarship Distinction Award in May 2013.

"His scholarship has significantly impacted the field of agricultural economics and has the potential to impact future generations," says Richard Buckius, vice president for research.

Created to complement the McCoy Award, which honors natural sciences research, the recognition comes with a $4,000 award for personal use and $7,000 for scholarly activities.

In 1992, Hertel founded Purdue's Global Trade Analysis Project, which facilitates analysis of trade and environmental policy by 10,000 network members in 150 countries. Hertel's recent work has focused on land and water use as well as climate change. While on sabbatical at Stanford University, he developed a new interdisciplinary course, "Global Land Use in 2050: Implications for Food Security and the Environment," which he now offers at Purdue.

Purdue established the award in 2013 and it is given in recognition of faculty whose recent research and scholarship have made a major impact on their field. Hertel was nominated by colleagues and chosen by faculty representatives and the university president.

LEARN MORE ▶ **http://tinyurl.com/l2agkzh**

AWARD

AGRAWAL HAILED BY AMERICAN ACADEMY OF ARTS AND SCIENCES

In less than a decade, Rakesh Agrawal leveraged a once-empty Purdue University lab into a hotbed of research on renewable energy production, a mandate he believes is critical to the nation.

His work earned him the 2011 National Medal of Technology and Innovation from President Barack Obama, the highest honor for technological achievement bestowed by the president, and two now-completed posts on national groups focusing on America's energy future.

His latest recognition, election to the prestigious American Academy of Arts and Sciences, enhances his opportunity to influence national energy policy. He joins 10 other Purdue researchers as members.

"Rakesh Agrawal has an extraordinary record of innovations, and his work has had a significant impact on manufacturing and in diverse industries," says Purdue President Mitch Daniels.

Agrawal, who is currently the Winthrop E. Stone Distinguished Professor in the School of Chemical Engineering, joined Purdue in 2004 after a 24-year career in industry. He holds 119 U.S. patents and has published more than 100 technical papers.

Rakesh Agrawal

PHOTO BY VINCENT VALTER

"Rakesh Agrawal has an extraordinary record of innovations, and his work has had a significant impact on manufacturing and in diverse industries."

Purdue President Mitch Daniels

LEARN MORE ▶ **http://tinyurl.com/k3kgrsm**

"We're trying to bridge the physical with virtual reality, to take what we've learned in ABIL and get it out there."

Brad Duerstock

RESEARCH THAT CHANGES THE WORLD

EDUCATION & ENGAGEMENT

Phillip Dunston | George Takahashi | Brad Duerstock

PHOTO BY VINCENT WALTER

WORLD WIDE LAB

Purdue's Accessible Biomedical Immersion Laboratory (ABIL) is a one-of-a-kind biology wet lab designed in part as a model for making science and medical careers more attainable for people with disabilities, including injured veterans.

Now, Purdue faculty and IT staff have developed a Web-enabled, 3-D virtual version of ABIL that can be toured from anywhere. Virtual ABIL allows anyone to experience features and best practices developed for Purdue's model lab, says Brad Duerstock, an associate professor of engineering practice in the Weldon School of Biomedical Engineering and School of Industrial Engineering.

"Not everyone can come see the physical space," says Duerstock, who partnered with civil engineering Professor Phillip Dunston and Purdue's Envision Center to develop the virtual lab. "We're trying to bridge the physical with virtual reality, to take what we've learned in ABIL and get it out there." ABIL is an initiative of the Institute for Accessible Science, which Duerstock directs. The lab is located at the Hall for Discovery and Learning Research in Discovery Park at Purdue.

ABIL and its virtual counterpart include accessibility features at seemingly every turn, including Braille signage and a wheelchair-accessible work triangle with lab bench, sink and fume hood. The 3-D virtual ABIL allows users to change perspectives from standing to sitting in a wheelchair, to experience the lab's accessibility features.

Avatars and plugins

To build the virtual ABIL, faculty and staff at the Envision Center — Purdue's high-end visualization facility — used Unity, a multiplatform computer game engine repurposed as an educational virtual simulator. George Takahashi, Envision Center technical lead, says that a key advantage to Unity is that people can run environments created with the program using a plugin on almost any web browser.

With James McGlothlin, a professor of health sciences, the virtual ABIL team is incorporating into the simulation a 3-D biomechanical model developed at the University of Michigan. The biomechanical model will allow avatars programmed with disabilities — for example, lower-limb paraplegia, a challenge faced by many wounded veterans — to interact with the lab space realistically. Such avatar models can be used to assess alternative space and equipment configurations during design and construction.

LEARN MORE ▶ **http://tinyurl.com/lg3v3ty**

Carol Handwerker | Shane Peng | Milea Kammer

PHOTO BY VINCENT WALTER

MELDING ELECTRONICS AND ENVIRONMENT

After a year studying the environmental impact of the electronics industry and its products, a group of Purdue and Tuskegee University graduate students along with faculty members from each university traveled to India in June 2013 to analyze its manufacturing operations.

Hosted by the Indian Institute of Management, Updaipur, the trip was the next step in the Purdue-Tuskegee Integrated Graduate and Education Research Training, a National Science Foundation program. It's directed by Carol Handwerker, the Reinhardt Schuhmann, Jr. Professor of Materials Engineering. The initiative involves materials engineering, mechanical engineering, political science, management, anthropology and natural resources.

"We are helping students become leaders for change," Handwerker says. "They have to know how to integrate the technical, political and management sides."

Students are now preparing assessments for the companies visited. "They are suggesting manufacturing and operations changes to take them to the next level in health and safety, to establish a dialogue with the companies," she says. "Many students are developing new materials, technologies and assessing how the political process affects the ultimate sustainability. I see the progress being made."

LEARN MORE ▶ **http://tinyurl.com/mwwdnxe**

Bridget Miller

PHOTO BY VINCENT WALTER

IPADS FOR DISABILITIES

Could technological supports, such as iPads and electronic notebooks, help students with cognitive barriers work more independently and achieve greater success in learning science, technology, engineering and math?

That was the question Bridget Miller posed. A special education doctoral student in the College of Education, she wanted to know if students with intellectual disabilities could overcome barriers in accessing STEM content, solving problems, meeting academic content standards and achieving independence after high school.

Seeking an answer, Miller worked with three secondary students with moderate intellectual disabilities, who were enrolled in a self-contained, functional curriculum classroom at West Lafayette Junior/Senior High School, West Lafayette, Ind.

Using guided-inquiry science instruction linked to grade-level standards, she put the students to work with self-monitoring checklists on iPads.

"The students all increased their independence in inquiry during science activities and daily problem-solving activities," reports Miller. Along with replicating her recent findings, she plans to work with a younger population and introduce electronic notebooks in student learning. All three students were able to fully engage in grade level standards and independently generate questions, observations, experiment design plans, and explanations related to the activities. Miller is currently developing a new application, geared on furthering this work with a school in South Carolina.

COMPUTER SCIENCE FOR EDUCATION PROJECT EXPANDS

In the last decade, the computer science field has experienced a devastating domino effect — fewer high school teachers qualified to teach advanced courses in the subject has led to a decline in undergraduate enrollment, and, consequently, a shortage of computer scientists.

For several years now, researchers with Purdue's Computer Science for Education (CS4EDU) project have been addressing this issue through teacher training programs. Their latest accomplishment is the Computer Science Teaching Supplemental Licensure Program. "Earning the licensure program is a key initiative of the project," says James Lehman, professor and associate dean in the College of Education.

The endorsement covers computer science content knowledge and pedagogical principles, preparing education majors to teach computer science in secondary schools. Two newly developed courses — Contemporary Issues in Computing and Methods of Teaching Computer Science — are required, along with four computer science courses in programming, discrete mathematics, data structures and algorithms.

CS4EDU, a collaboration between education and computer science funded by the National Science Foundation and State Farm, has also included in-service teacher workshops, field training and development of new modules on computer science for existing courses. Lehman's collaborators in these endeavors are Profs. Christoph Hoffmann, computer science, is the principal investigator. Also on the project team: Tim Korb and Voicu Popescu, computer science; and Aman Yadav, education.

PHOTO COURTESY OF ERIN BLAKESLEE

CS4EDU Workshop

PHOTO BY VINCENT WALTER

Ann Christine Catlin

STRENGTH IN NUMBERS

Thymic tumors are not only rare, affecting only a few thousand people worldwide, but also aggressive, difficult to treat and poorly understood. Even in the world's most prolific cancer clinics, oncologists see only a handful of cases annually, making it difficult for them to stage, classify and ultimately determine standard treatment protocols for their patients.

That may change in the future, thanks to the new ITMIG (International Thymic Malignancy Interest Group) International Prospective and Retrospective Patient Databases developed by Ann Christine Catlin, senior research scientist in Purdue's Rosen Center for Advanced Computing. Through the secure databases, ITMIG members are sharing patient information in the hopes of improving outcomes.

Over the last year, nearly 9,000 cases from 110 institutions in 21 countries around the world have been entered into the retrospective database. As it grows, hospitals are enrolling new patients into a prospective database with searchable demographics, pathology results and other metrics.

"This is an astonishing accomplishment," says Catlin. "Before, physicians had only a few cases to look at. Now they have a richer resource, across all nations, across all stages, across all treatments, and they can really begin to understand this disease."

PHOTO BY VINCENT WALTER

Dorothy Teegarden

DEEP AND WIDE

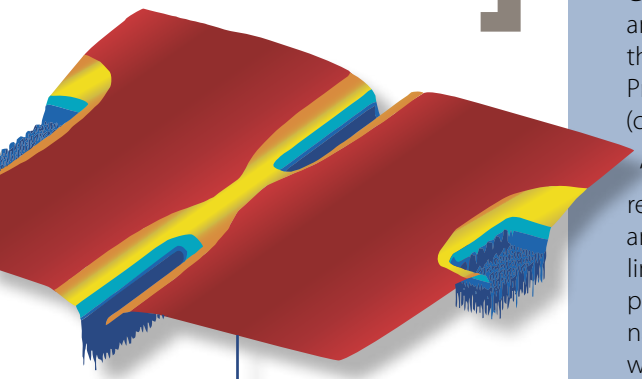
The phrase "cancer prevention research intern" probably conjures up images of white-coated chemistry students examining test tubes, not communications majors researching physician-patient relationships or aspiring anthropologists conducting nutrition interviews. But because cancer prevention is as much about understanding and influencing behavior as it is about analyzing molecular pathways, Purdue's Cancer Prevention Internship Program (CPIP) recruits from disciplines as varied as biomedical engineering and history.

Through CPIP, each student works alongside a Purdue cancer researcher, delving into a project of mutual interest. But the interns also are brought together for coursework, community service projects and guest lectures from oncologists and cancer survivors. Those interdisciplinary interactions — from distributing HPV vaccine literature on campus to talking with a father whose daughter died of cervical cancer — not only personalize the work the students are doing, but also illustrate the bigger picture: that more lives can be spared only when people are willing to change behaviors based on scientific discoveries.

That deep-and-wide approach enriches the year-long internship, and is likely a big reason that many former CPIP interns have pursued cancer-prevention careers. "As a basic scientist, I didn't know how impactful we could be," says Prof. Dorothy Teegarden, associate dean for research in the College of Health and Human Sciences and founder and director of CPIP. "But it's very rewarding to see their excitement about what we do."

"Our goal is to enable new users in the nano community to access tools and simulations that they normally have no access to and to advance their endeavors in teaching and research."

Gerhard Klimeck



Simulation of a single atom transistor using Klimeck's NEMO tool. The single atom transistor was listed among the top 100 inventions of 2012 in *Discover Magazine*

LEARN MORE ▶ **http://tinyurl.com/kuvlj2t**

ACCELERATING NANO'S FUTURE

If you had access to interactive modeling and simulation tools that run in any browser, could you introduce interactive learning into your classes? If you had easy access tools, which need no installation, could you use them to help guide your experiments? If you had your own tools and could easily share them with the community, would you do it? If you had access to advanced lectures in nano, would you use them in "flipped classroom teaching"?

For over a quarter million nanoHUB.org users these are no longer hypothetical questions; nanoHUB is actively being used in research and in education.

"Our goal is knowledge transfer between different nano science stakeholders, learners, teachers, researchers, and industry," says nanoHUB.org Director Gerhard Klimeck, a professor of electrical and computer engineering who also is the Reilly Director of the Center for Predictive Materials and Devices (c-Primed).

"Our vision going forward is to enable researchers to publish their simulation and experimental data on nanoHUB linking to live interactive journals, to personalize the learning experience on nanoHUB and to be in the day-to-day workflow of the overall nano community."

The National Science Foundation is funding the continued development towards this vision with a five year $14.5 million grant.

LEARN MORE ▶ **http://nanohub.org/groups/ncn**

PHOTO BY VINCENT WALTER

Gerhard Klimeck

AWARD

PURDUE POET WINS $100,000 KINGSLEY TUFTS POETRY AWARD

Marianne Boruch

My mother's body to wires, to tubes
and their liquid, days she turned toward me
or away, winter but so much sun
from car to door. I followed it past nurses

at their station talking movies, who's good
in one and not the other. Gown tied
at the back and neck, she slept beside
a window. I wedged my chair there, reading,

looking up, reading,—who knows what
I read—her legs bruised, thin, arms battered
by the doctor's needle. Her face. Can I
say this plainly now? There was light

as she grew less. She drifted to it.
I'm not hungry, not religious, I'm in a spot,
she told me one afternoon then
closed her eyes to that radiance again.

Page through Marianne Boruch's latest poetry collection, *The Book of Hours*, and you'll likely linger awhile with her complex, honest examinations of everything from a dying mother to saints, birds and war. Described as "endearingly strange, unsentimental, and uniquely structured," the book received the 2013 $100,000 Kingsley Tufts Poetry Award from Claremont Graduate University. The annual mid-career award is one of the largest monetary poetry prizes in the United States.

Boruch is a Chicago native who has taught at Purdue since 1987, developing and directing the MFA Program since its beginning in 1987 until 2005. Her poetry collections include *Grace, Fallen from, Poems: New and Selected, A Stick that Breaks and Breaks* and *Moss Burning*. Boruch has received Pushcart Prizes, a Fulbright/visiting professorship at the University of Edinburgh, fellowships from the National Endowment for the Arts and the Guggenheim Foundation, and residencies from the Rockefeller Foundation's Bellagio Center and Isle Royale National Park. Her work has appeared in the *New Yorker, Poetry, Paris Review, APR, the Yale Review* and the *London Review of Books*. *The Book of Hours* was published by Copper Canyon Press.

LEARN MORE ▶ http://tinyurl.com/m5dum9v

PHOTO BY VINCENT WALTER

Mikhail Atallah

HACKER PREVENTION, 200 MILLION COMPUTERS STRONG

Beware, cyber-criminals. That was the message from Mikhail Atallah, distinguished professor of computer science, when he developed technology for foiling hackers.

"If malware is difficult to detect and remove, so is 'goodware' injected into software that attackers will find difficult to detect and remove," says Atallah, who co-founded Arxan Technologies in 2001 to commercialize the technology. "The result is software that detects tampering and other policy violations and can respond with appropriate defensive actions."

At last count, more than 200 million computing devices were using Arxan's protection — an impact that earned Atallah the 2013 Outstanding Commercialization Award for Purdue University Faculty and a $5,000 stipend. Established a decade ago with an endowment gift from the Central Indiana Corporate Partnership Foundation, the award recognizes researchers whose discoveries strengthen the agriculture, communication, energy, healthcare, manufacturing or security sectors.

"Professor Atallah combines the best of both teaching and research," says Suresh Garimella, chief global affairs officer. "His work has resulted in a product that fights a problem threatening the technology that life in the 21st century so depends on. He has, indeed, helped make it a better world."

LEARN MORE ▶ http://tinyurl.com/cvzpx2f

PHOTO BY VINCENT WALTER

Fabian Winkler (back) | Shannon McMullen (second from right) are pictured with the University Honors College freshmen, who participated in the construction, presentation and public discussion of the project.

SOYBEANS, ART AND NATIONAL SECURITY

With purple phlox and pink dogwoods in bloom last spring, you wouldn't think a raised bed of edamame soybeans in Indiana would attract much attention. But National Security Garden — with its neat rows of bushy plants illuminated by solar-powered red and blue grow lights — was the subject of You Tube videos, Instagram photos and myriad conversations about everything from greenhouse roofing techniques to geopolitics.

"The idea was to create a space for social exchange," says Shannon McMullen, professor of electronic and time-based art and American studies and co-creator of the art installation. Part agricultural field and part representational garden, the temporary exhibition was designed to spark conversations about food security, biofuels, climate change, GMOs and the like.

"All of these issues are interconnected," says Fabian Winkler, co-creator and professor of electronic and time-based art. "We are seeing a shift of agricultural resources around the globe, which might lead to some future possible consequences or crisis. It initially sounds quite outrageous that something as innocent as a soybean could affect all of this, but there is, in fact, a connection."

LEARN MORE ▶ **http://tinyurl.com/m5tsdqd**

STUDY ADVANCES UNDERSTANDING OF SCHOOL READINESS

Family culture can influence school readiness and achievement gaps, and that's important information for professionals developing programs to enhance readiness and success.

That's what Aryn Dotterer, assistant professor of human development and family studies, discovered when she and her collaborators researched links between socioeconomic status and school readiness among 164 mother-child duos from African American and European American families.

The researchers found that in the European American families studied, maternal sensitivity — the ability of the mother to infer meaning from and respond appropriately to a child's behaviors — mediated the link between socioeconomic status and school readiness. They did not find the same phenomenon among the African American families they studied, indicating that the meaning and effects of parenting behaviors can vary by racial groups and that findings obtained for European American families cannot be assumed to apply to ethnic minority families as well.

"Programs that are aimed at increasing school readiness and closing the achievement gap need to be mindful of the cultural context in which children are raised, being sure to focus on culturally relevant practices that are beneficial for children's development," wrote Dotterer and co-authors Iheoma Iruka and Elizabeth Pungello, both from the University of North Carolina at Chapel Hill. Their findings are detailed in "Parenting, Race, and Socioeconomic Status: Links to School Readiness," and published in *Family Relations: Interdisciplinary Journal of Applied Family Studies*.

LEARN MORE ▶ **http://tinyurl.com/pf545ld**

Aryn Dotterer

PHOTO BY VINCENT WALTER

Sangtae Kim

PHOTO COURTESY OF SANGTAE KIM

AWARD

KIM RECEIVES TOP ENGINEERING PRIZE

For three decades, Sangtae Kim has been known across two continents as an influential chemical engineering scholar. Now, his homeland of South Korea has bestowed upon him its highest engineering research award, the Ho-Am Engineering Prize.

Kim, a distinguished professor of mechanical and chemical engineering who was honored in South Korea last spring, received an award of around $265,000, a gold medal and a laureate diploma.

Focusing on mathematical and computational methods for "microhydrodynamics," Kim employs computers and mathematics to study protein interaction with other microstructures inside cells. He also is helping design electronic radio frequency identification devices that self-assemble.

Kim also founded and serves as chairman of ProWD Sciences Inc., a Wisconsin drug discovery and development firm. He joined Purdue in 2003, bringing pharmaceutical industry experience gained at Eli Lilly, Pfizer and Parke-Davis.

LEARN MORE ▶ **http://tinyurl.com/o3sqtld**

AWARD

NINE PROFS ELECTED TO AAAS

Elected by peer members in recognition of notable scientific work, nine Purdue professors were named fellows in the American Association for the Advancement of Science in 2012.

Mahdi Abu-Omar, chemistry professor: for work in mechanistic inorganic chemistry, including atom transfer reactions of oxorhenium complexes

Nicholas Carpita, plant pathology professor: has made significant contributions to plant biology, especially structure and biosyntheses of cell walls, gene discovery, and improvement of grasses in lignocellulosic bioenergy crops

Mark Cushman, medicinal chemistry professor: for delivery of novel therapeutics, impact on fundamental science and other contributions to medicinal chemistry and drug discovery

Vincent Jo Davisson, medicinal chemistry and molecular pharmacology professor: for work in understanding and exploiting molecular specificity in pharmacological systems

continued

Avtar Handa, horticulture professor: has made distinguished contributions in postharvest biology, including discovering fundamental knowledge to develop fruit crops with enhanced shelf-life, phytonutrients and yield

David Nolte, physics professor: for achievements in optical interferometric devices, including developing and commercializing dynamic holographic films, the BioCD and motility contrast imaging

Ian Shipsey, the Julian Schwinger Distinguished Professor of Physics: for advances in particle physics, including heavy quark physics and leadership in the Compact Muon Solenoid experiment

Gabriela Weaver, chemistry professor: for work in transforming pre-college and undergraduate science education using inquiry-based pedagogies and innovative technologies

Howard Zelaznik, health and kinesiology professor and associate vice president for research: has made contributions to psychology and kinesiology, particularly in developing a theoretical framework in movement timing

LEARN MORE ▶ **http://tinyurl.com/oenlhy4**

PHOTO BY VINCENT WALTER

Andrew Weiner

AWARD

LIGHT PULSE EXPERT RECEIVES McCOY RESEARCH AWARD

Advanced sensors, more powerful communications technologies and more precise laboratory instruments may soon be on the horizon because of the light pulse shaping achieved by a team led by Andrew Weiner.

So significant is the team's fine control of spectral and temporal properties of ultrafast light pulses, Weiner has been named the 2013 Herbert Newby McCoy Award winner, Purdue's most prestigious research honor in the natural sciences. Weiner, who is currently the Scifres Family Distinguished Professor of Electrical and Computer Engineering, joined the university in 1992.

The team's recent work focuses on pushing the boundaries of optical science with line-by-line pulse shaping, ultra-broadband radio frequency photonics and microresonator-based signal processing.

Established in 1964 by Ethel Terry McCoy in memory of her husband, the award is given annually to a faculty member for outstanding contributions in the natural sciences. Weiner was nominated by colleagues and chosen by faculty representatives and the university president.

LEARN MORE ▶ **http://tinyurl.com/pduemez**

Yahya Kamalipour

AWARD

KAMALIPOUR NAMED RESEARCHER OF THE YEAR

For his work advancing international collaboration and understanding, Yahya Kamalipour has received the Information and Telecommunications Education and Research Association's 2013 Researcher of the Year Award.

The professor and head of Purdue University Calumet's Department of Communication and Creative Arts founded the *Global Media Journal*, published twice annually in 19 countries. He's written a dozen books, and his biography, *Traveler of the Global Village* by Negin Hosseini, was recently published.

Kamalipour joined the Purdue Calumet faculty in 1986. In 2006, he founded the Center for Global Studies. He also founded and chairs the Global Communication Association and is managing editor of the *Journal of Globalization for the Common Good*.

Born in Iran, Kamalipour immigrated to the United States in 1972. His goal is to focus on the common good and elements connecting people around the world. "I work toward building bridges of understanding and contributing to the communication discipline," he says.

LEARN MORE ▶ **http://tinyurl.com/no778hz**

George Bodner

Randy Roberts

AWARD

MORRILL AWARDS SALUTE TWO FOR CAREER SUCCESSES

George Bodner, the Arthur Kelly Distinguished Professor of Chemical Education, and Randy Roberts, distinguished professor of history, received Purdue's second annual Morrill Awards for excelling at all facets of the professoriate — as teachers and scholars and in engagement activities. The awards honor the 1862 Morrill Act, a step to assure education would be available to all social classes, which led to establishment of land-grant universities.

Committed to finding better methods to convey an understanding of chemistry to students, Bodner studies ways of improving students' problem-solving abilities, the role students' beliefs play in the teaching and learning of chemistry, and new approaches to teaching chemistry to students who are blind or have low vision.

A frequent resource for television documentaries, films and fact-finders on his sports, history and movie knowledge, Roberts has consulted for the History Channel, ESPN Classic, BBC, PBS and others. He's written 30 books; the latest, *Rising Tide: Bear Bryant, Joe Namath and Dixie's Last Quarter*. "History is not remembering facts," he says. "It's viewing the past as a story and discovering where we fit in the big picture."

FROM THE PRESIDENT

Purdue University has a mission to bring its research findings to the world. There is no greater societal contribution our researchers could make than to turn their discoveries into life-saving innovations.

Mitch Daniels, President

FROM THE PROVOST

Purdue faculty, staff and students are continually striving to make the world a better place. Working in world-class facilities on global challenges, they accomplish remarkable feats, sometimes against the odds, and often without precedent.

Tim Sands, Provost

FROM THE VICE PRESIDENT FOR RESEARCH

Purdue researchers are increasingly mindful of how their research can make a difference. With a particular focus on grand challenges such as hunger, poverty, disease and sustainability, they are bringing their discoveries to the far corners of the globe.

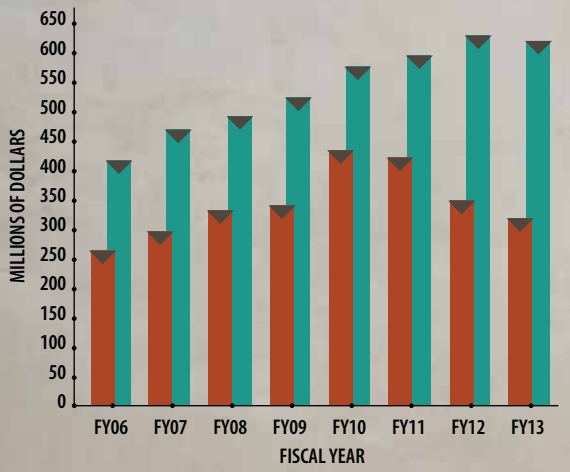
Richard Buckius, Vice President for Research

METRICS

As a leading research university in the state of Indiana with a global reputation of excellence, Purdue is dedicated to maximizing our resources to build a research enterprise that supports impactful research that changes the world.

Committed sponsors partner with Purdue enabling faculty and staff researchers to respond to grand challenges. During FY 2013, more than $320 million in sponsored program awards were received by Purdue.

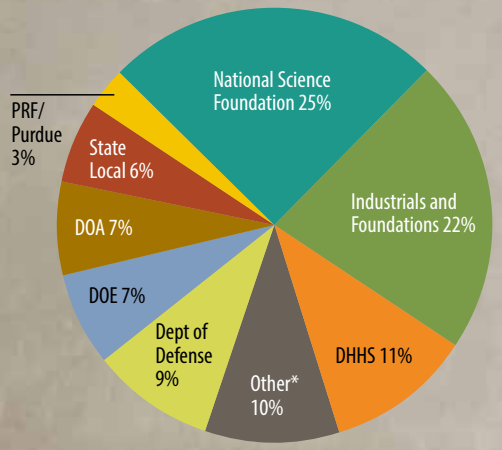
SPONSORED PROGRAM AWARDS



Purdue University sponsored programs continue to land significant funding.

TOTAL AWARDS
TOTAL SUPPORT EXPENDITURES

MULTIPLE SOURCES



Sponsored program funding for Purdue research activities comes from industry, government, and foundations.

KEY:

DHHS	U.S. Department of Health and Human Services
DOA	Department of Agriculture
DOE	Department of Energy
Other	Other Federal <$10M and Foreign Governments
PRF	Purdue Research Foundation

2012:2013
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