Notre Dame Science

The magazine of the College of Science at the University of Notre Dame

Fall 2013

VISION

Strategically thinking and investing for the future

Photo by Steve Toepp

GREGORY P. CRAWFORD
William K. Warren Foundation Dean
of the College of Science

We know the big challenges that our community and our world face today. We are committed to solving them, and we have the people with the expertise and passion to solve them. We also know that accomplishing the task calls for strategic planning to direct our resources where they will have the most impact. This issue of *Notre Dame Science* focuses on advancing our vision for the future.

The College of Science is now home to five "Advancing our Vision" projects that will receive substantial University funding, all because innovative colleagues in mathematics, applied mathematics and statistics, analytical chemistry, nuclear physics, and stem cell biology presented compelling cases for investment in their phenomenal work for the future. This issue of the magazine previews the impact of these interdisciplinary ventures in strategic hiring to engage extraordinary faculty and students in smart collaborations.

You'll also read about the college's role in the long-term quest to better understand the Higgs boson that's been in the news this year. A great team of physics faculty, post-doc researchers, engineers, graduate students, and undergraduates has placed Notre Dame among the leaders in a new era of fundamental discoveries about the universe.

This issue also welcomes the Global Adaptation Index (GAIN) to Notre Dame. Such an important tool for understanding climate change enhances Notre Dame's foundational and enduring call to advance knowledge and serve the world. ND-GAIN enables the college to continue setting priorities informed by our values.

I hope you enjoy this issue of *Notre Dame Science*, and that it equips and inspires you to spread the word about our incredible research and education.

Go Irish!

GREGORY P. CRAWFORD, PH.D.
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Front cover photo: The first half of the CMS inner tracker barrel is seen in this image consisting of three layers of silicon modules which are at the center of the CMS experiment at the LHC in CERN. Read about Notre Dame's work at CERN on page 8.
Photo credit: Maximilien Brice
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ALSO FIND US ON

This magazine is printed on Domtar Lynx Ultra paper.
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THROUGH THE NOTRE DAME QUARKNET PROGRAM THIS SUMMER, 17 high school teachers and 16 high school students conducted research with five mentors on nine different projects including investigating new scintillators, analyzing data from the Compact Muon Solenoid (CMS), studying cosmic rays, and presenting particle physics in the Notre Dame Digital Visual Theater.

Photo by Matt Cashore

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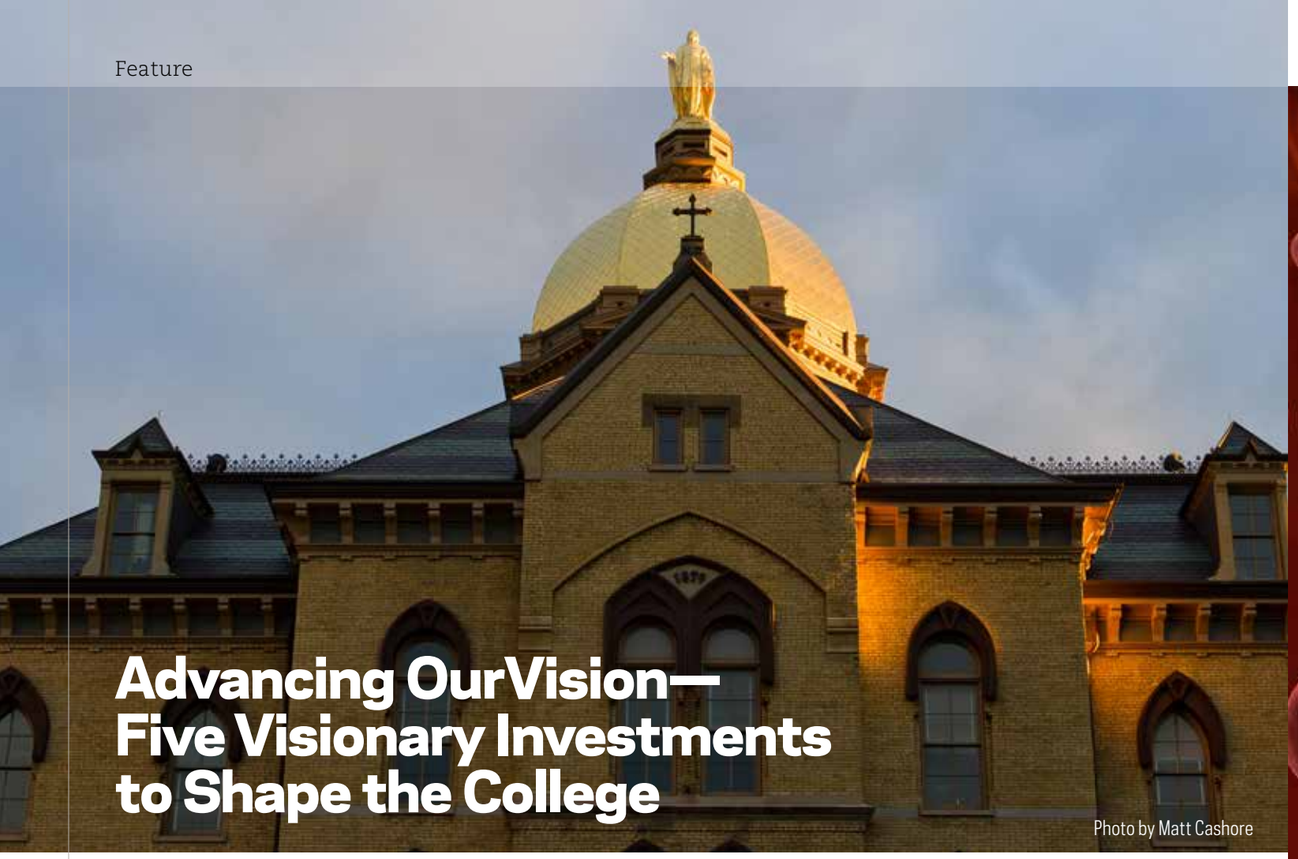
Contents

UNIVERSITY OF NOTRE DAME
College of Science



Advancing OurVision— Five Visionary Investments to Shape the College

Photo by Matt Cashore

To elevate Notre Dame's status as a research university, the University must have world-class programs of study and research. Through "Advancing Our Vision," clusters of faculty will be hired to advance programs to a premier level, such that they would be considered among the very best in the world.

By Bill Schmitt

University President Rev. John I. Jenkins, C.S.C., consistently makes it clear that Notre Dame must continue its momentum toward making a world of difference.

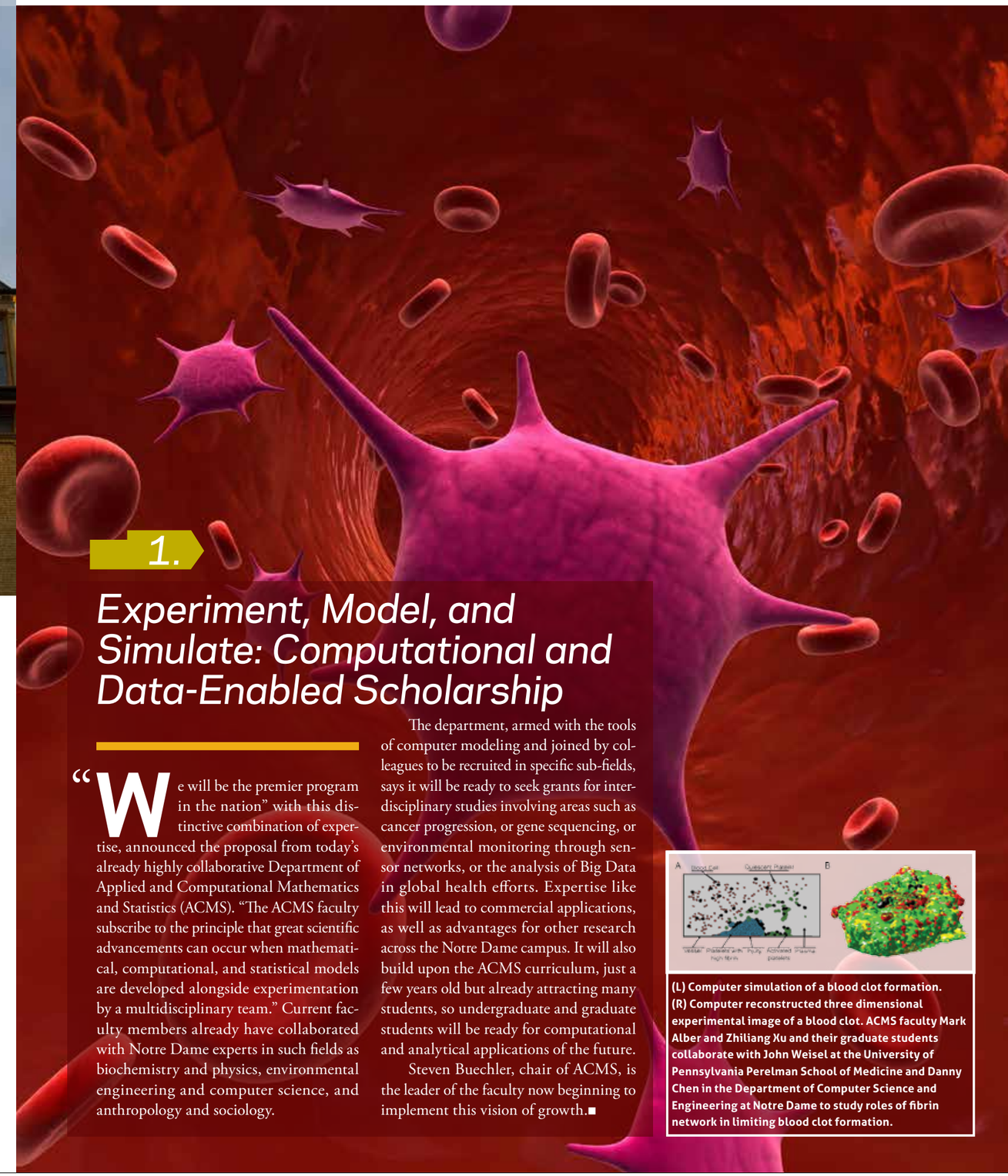
In a priority-setting message in autumn 2011, Jenkins announced that millions of dollars in recurring expenses and potential revenues would be redirected within the University's long-term budgeting under the rubric of "Advancing our Vision." He affirmed the imperative of making the outlays needed to meet the University's most strategic needs. But he added this imperative should not deter another ongoing endeavor—building Notre Dame's role as a distinctively Catholic university with unparalleled undergraduate education and world-class research and scholarship.

This endeavor involves the continued recruitment of world-class faculty talent, Father Jenkins explained in his Sept. 20, 2011, remarks: "We hope to address this challenge, using the [budget] reallocation to hire a substantial number of new faculty members over the next few years."

That aspiration prompted a diligent, focused effort to identify particular areas of research and teaching where targeted faculty hires would have major impacts on important global problems and trends. Starting in 2012, academic leaders— already engaged in pioneering efforts in various fields— prepared proposals for review by a committee of faculty across the University.

Through a competitive process, some preliminary proposals moved on to the next level of competition: following up with more detailed plans with particular faculty positions that, once created and filled, could trigger step changes in visibility and synergies, within and beyond the University. Those detailed plans entered the review process in early spring 2013, and the final ten interdisciplinary selections from across the University emerged a few months later. Nearly $10 million of the annual savings was redeployed to fund these initiatives.

Official recipients of funding under Notre Dame's "Advancing our Vision" Strategic Hiring Initiative now begin new projects of special purpose and promise. No one expects the leaders of these projects to make their numerous hires and complete their goals overnight. But the College of Science is a core participant in this exciting new enterprise, and five Science-led (but essentially interdisciplinary) projects are now under way.■



1.

Experiment, Model, and Simulate: Computational and Data-Enabled Scholarship

"We will be the premier program in the nation" with this distinctive combination of expertise, announced the proposal from today's already highly collaborative Department of Applied and Computational Mathematics and Statistics (ACMS). "The ACMS faculty subscribe to the principle that great scientific advancements can occur when mathematical, computational, and statistical models are developed alongside experimentation by a multidisciplinary team." Current faculty members already have collaborated with Notre Dame experts in such fields as biochemistry and physics, environmental engineering and computer science, and anthropology and sociology.

The department, armed with the tools of computer modeling and joined by colleagues to be recruited in specific sub-fields, says it will be ready to seek grants for interdisciplinary studies involving areas such as cancer progression, or gene sequencing, or environmental monitoring through sensor networks, or the analysis of Big Data in global health efforts. Expertise like this will lead to commercial applications, as well as advantages for other research across the Notre Dame campus. It will also build upon the ACMS curriculum, just a few years old but already attracting many students, so undergraduate and graduate students will be ready for computational and analytical applications of the future.

Steven Buechler, chair of ACMS, is the leader of the faculty now beginning to implement this vision of growth.■

(L) Computer simulation of a blood clot formation. (R) Computer reconstructed three dimensional experimental image of a blood clot. ACMS faculty Mark Alber and Zhiliang Xu and their graduate students collaborate with John Weisel at the University of Pennsylvania Perelman School of Medicine and Danny Chen in the Department of Computer Science and Engineering at Notre Dame to study roles of fibrin network in limiting blood clot formation.

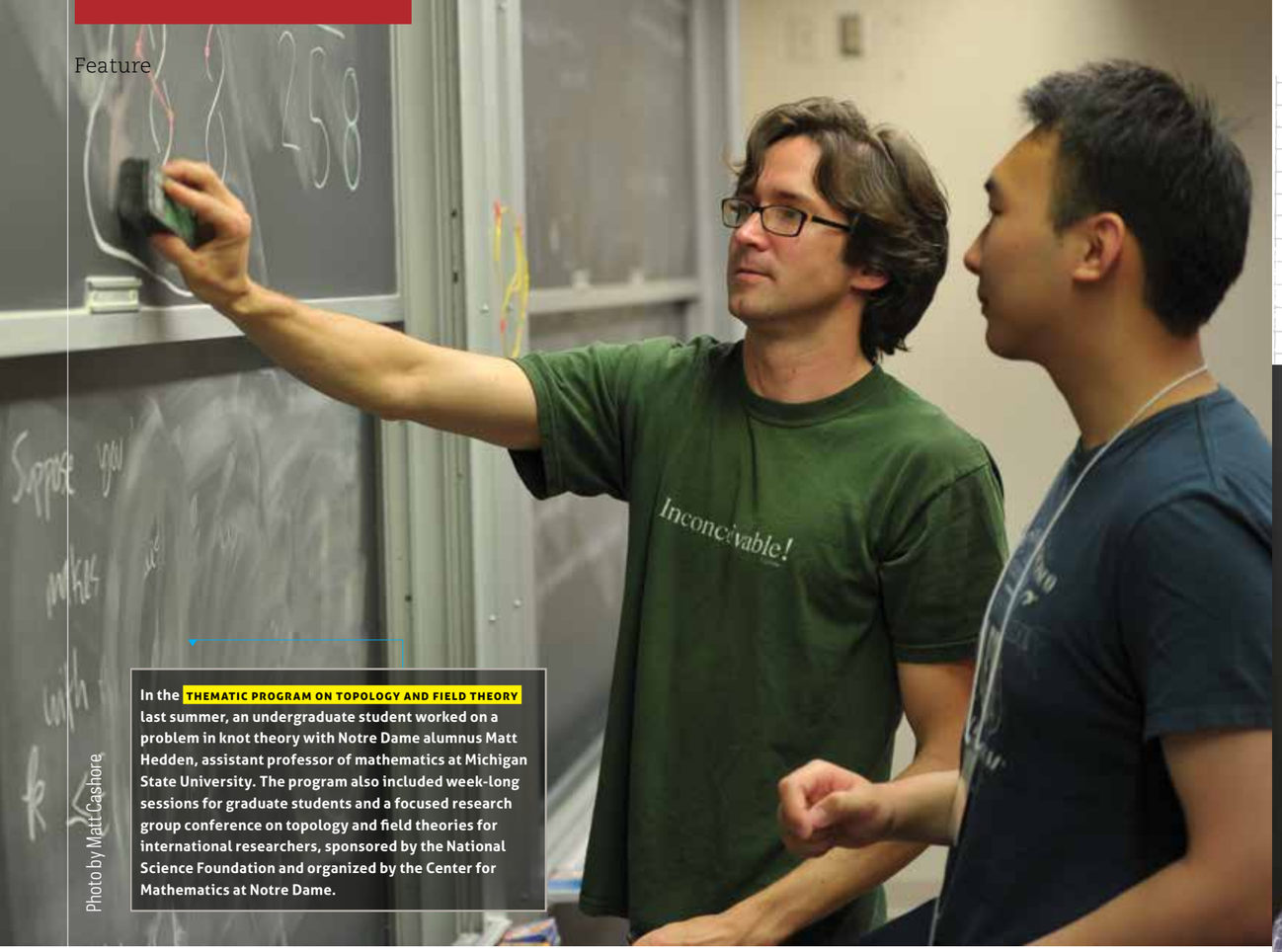


Photo by Matt Cashore

In the **THEMATIC PROGRAM ON TOPOLOGY AND FIELD THEORY** last summer, an undergraduate student worked on a problem in knot theory with Notre Dame alumnus Matt Hedden, assistant professor of mathematics at Michigan State University. The program also included week-long sessions for graduate students and a focused research group conference on topology and field theories for international researchers, sponsored by the National Science Foundation and organized by the Center for Mathematics at Notre Dame.

2.

Topology and Quantum Field Theory

A new research group will be exploring the intersection of mathematics and physics—long a fertile ground that has yielded insights into general relativity and quantum mechanics in the past. This time, the exploration will leverage five faculty positions and two post-doctoral positions to generate cutting-edge discoveries in quantum field theory, which expands upon quantum mechanics' insights into subatomic particle behavior. These discoveries, in turn, will fuel progress in computer science, theoretical physics, and especially topology—the mathematics of shapes that complements conventional geometry. Advances in physics and mathematics thus will continue to go hand in hand.

A world-class and highly visible research group in topology and quantum field theory, combining the strengths of physics and mathematics, will better compete for key research grants, and will raise the visibility of Notre Dame's Department of Mathematics, which is already highly ranked and strong in topology.

The department's undergraduates, particularly those seeking extra enrichment as honors students on their way to top-tier graduate programs, will gain from the extra course opportunities and research project options emerging from such an elite research group in physics. Notre Dame's reputation and role in advanced mathematics will thereby influence generations of students and teachers.

The initiative is led by Stephan Stolz, the Rev. John A. Zahm, C.S.C., Chair in Mathematics. Karsten Grove, the Rev. Howard J. Kenna, C.S.C., Memorial Chair in Mathematics, Matthew Gursky, professor of mathematics, and Liviu Nicolaescu, professor of mathematics, are co-leading the strategic hiring initiative. ■

3.

Achieving Preeminence in Analytical Sciences & Engineering

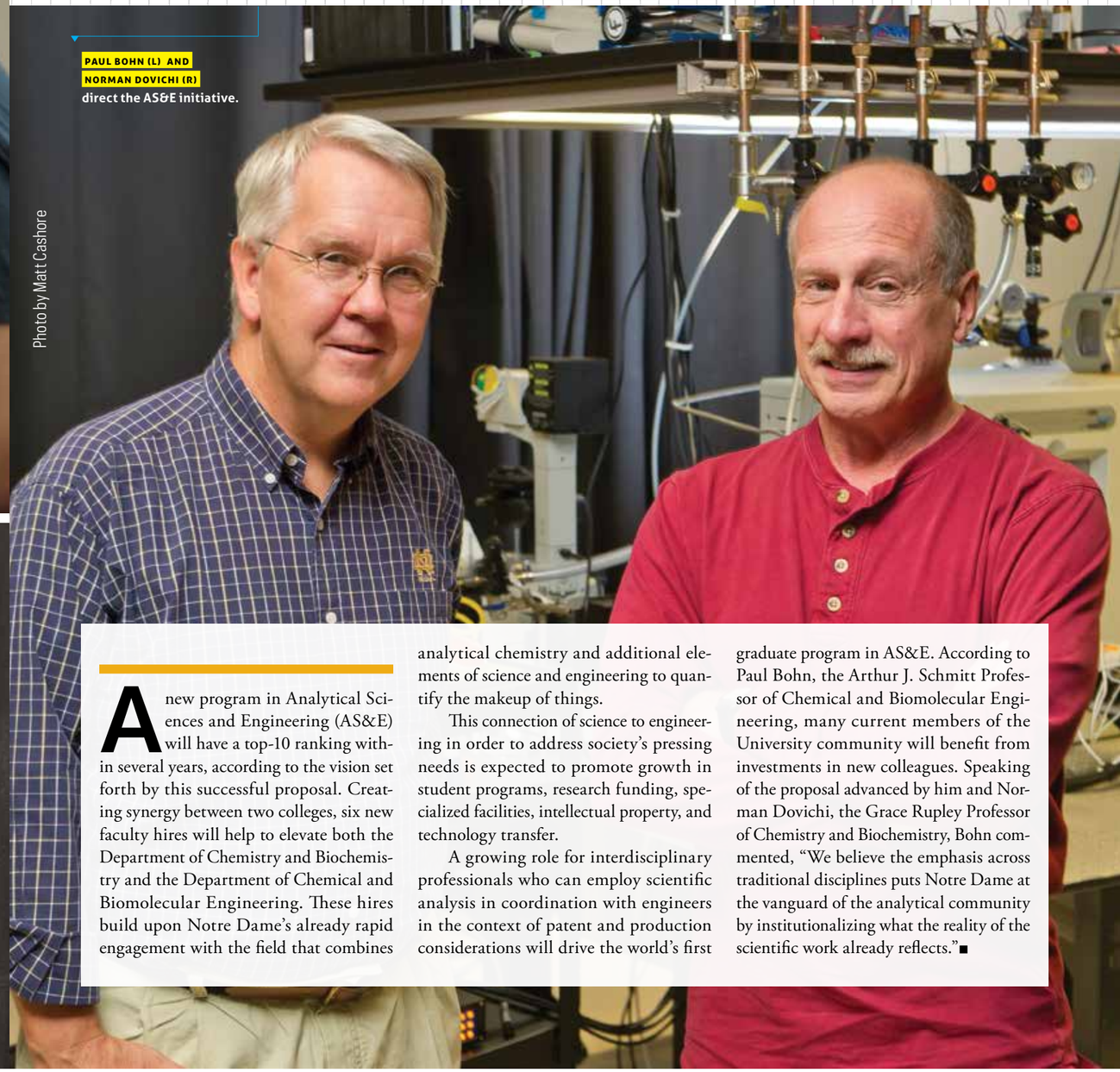


Photo by Matt Cashore

PAUL BOHN (L) AND NORMAN DOVICHI (R) direct the AS&E initiative.

A new program in Analytical Sciences and Engineering (AS&E) will have a top-10 ranking within several years, according to the vision set forth by this successful proposal. Creating synergy between two colleges, six new faculty hires will help to elevate both the Department of Chemistry and Biochemistry and the Department of Chemical and Biomolecular Engineering. These hires build upon Notre Dame's already rapid engagement with the field that combines analytical chemistry and additional elements of science and engineering to quantify the makeup of things.

This connection of science to engineering in order to address society's pressing needs is expected to promote growth in student programs, research funding, specialized facilities, intellectual property, and technology transfer.

A growing role for interdisciplinary professionals who can employ scientific analysis in coordination with engineers in the context of patent and production considerations will drive the world's first graduate program in AS&E. According to Paul Bohn, the Arthur J. Schmitt Professor of Chemical and Biomolecular Engineering, many current members of the University community will benefit from investments in new colleagues. Speaking of the proposal advanced by him and Norman Dovichi, the Grace Rupley Professor of Chemistry and Biochemistry, Bohn commented, "We believe the emphasis across traditional disciplines puts Notre Dame at the vanguard of the analytical community by institutionalizing what the reality of the scientific work already reflects."■

4.

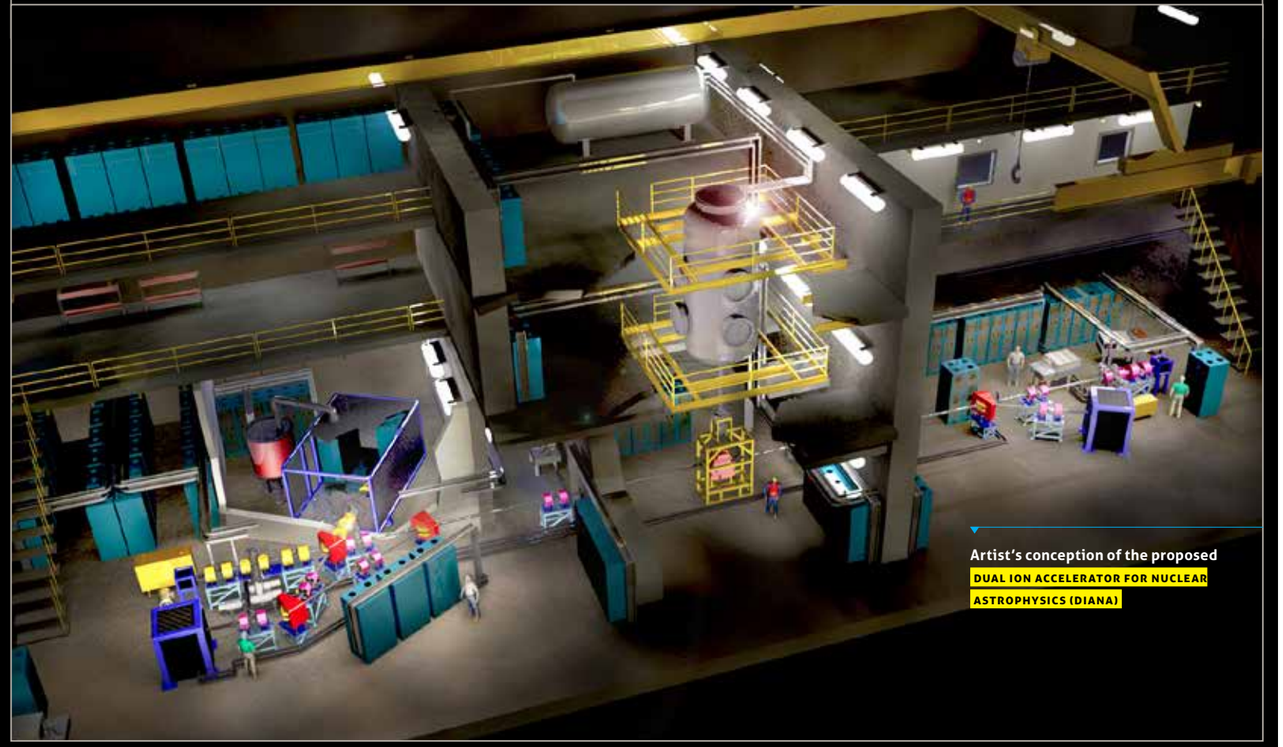
Nuclear Physics and Society

Notre Dame's internationally recognized Nuclear Science Laboratory will continue as a leader in nuclear astrophysics, nuclear structure, and radioactive beam physics while expanding its work in applied nuclear physics. With ten additional faculty positions (seven tenure-track and three research) funded by a combination of AOV, campaign, college, and externally-funded research dollars over the next few years, Notre Dame nuclear physicists will be ready to pursue large, collaborative grants in nuclear physics as well as those in areas of applied nuclear physics including medical physics, isotope production, forensics, and archaeometry for the dating of archeological specimens, to name a few. Notre Dame's work in medical applications may allow it to become a major supplier of a radioisotope needed by research oncologists.

Even more exciting are the plans for expanding nuclear physics research, including the development of designs for the construction of the Dual Ion Accelerator for Nuclear Astrophysics (DIANA). Notre Dame's major management role with this accelerator, which will be constructed several thousand feet deep underground in South Dakota, will help produce new insights into nuclear reactions as they occur in stars.

College of Science faculty will also continue their research at the National Ignition Facility at Lawrence Livermore National Laboratory, working on the production of fusion energy as well as applications in biophysics and astrophysics. Likewise, the faculty and students of the Nuclear Science Laboratory, with government support and other partnerships, will keep Notre Dame among the leaders of the Joint Institute for Nuclear Astrophysics (JINA) frontier center—the country's top nuclear astrophysics program—and continue development of a next-generation radioactive beam facility.

The initiative is led by Ani Aprahamian, the Freimann Professor of Physics, Philippe Collon, associate professor of physics, Umesh Garg, professor of physics, and Michael Wiescher, the Freimann Professor of Physics and director of the Nuclear Structure Laboratory. ■



Artist's conception of the proposed DUAL ION ACCELERATOR FOR NUCLEAR ASTROPHYSICS (DIANA)

5.

Bridging the Gap between Stem Cell Science and Society

The college's pioneering work in adult stem cell research, including the regeneration of neurons by adult stem cells in zebrafish, will be the basis for a distinctive interdisciplinary initiative gaining international visibility. The initiative already exists and embraces the College of Engineering, the College of Arts and Letters, and the Notre Dame Law School. Eight more faculty members, including senior science faculty and an expert in theology, will be hired. They will foster integrated global inquiry into the science, tissue engineering, law, and ethics related to stem cells for medical use.

"I think Notre Dame is unique in that we're taking such a broad approach," said David Hyde, a distinguished biologist who directs the Center for Zebrafish Research. He spearheaded the "Advancing our Vision" proposal on stem cells and society because he has seen the value in scientists and ethicists "learning from each other" in real time. "The University is making the very smart decision to make sure they're coming down squarely on the side of adult stem cell research and potential therapies," Hyde said. By producing new findings, as well as graduating students who understand the whole debate, there will be more equitable treatment of the ethically contentious issues in the arenas of public policy and research funding.■

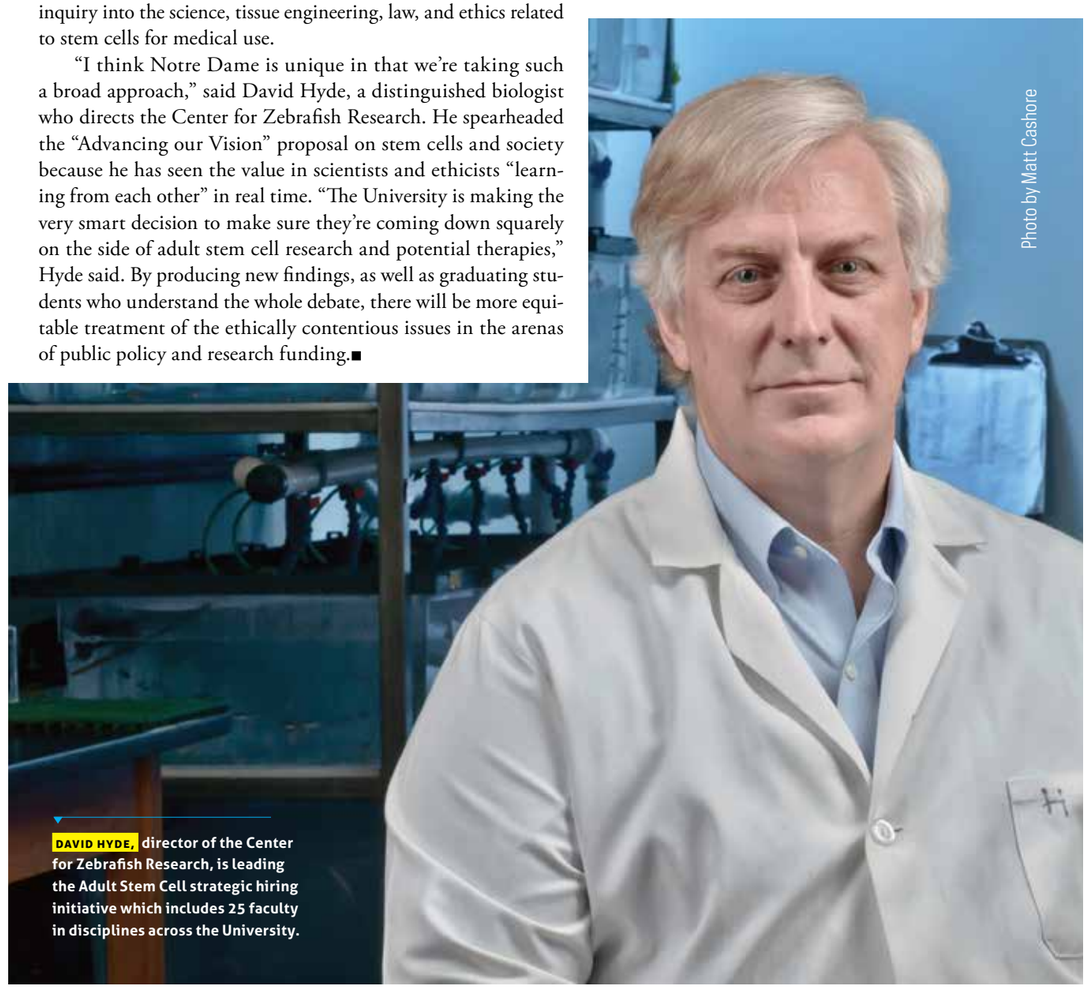


Photo by Matt Cashore

DAVID HYDE, director of the Center for Zebrafish Research, is leading the Adult Stem Cell strategic hiring initiative which includes 25 faculty in disciplines across the University.

Research *News*

Discovering the Higgs Boson

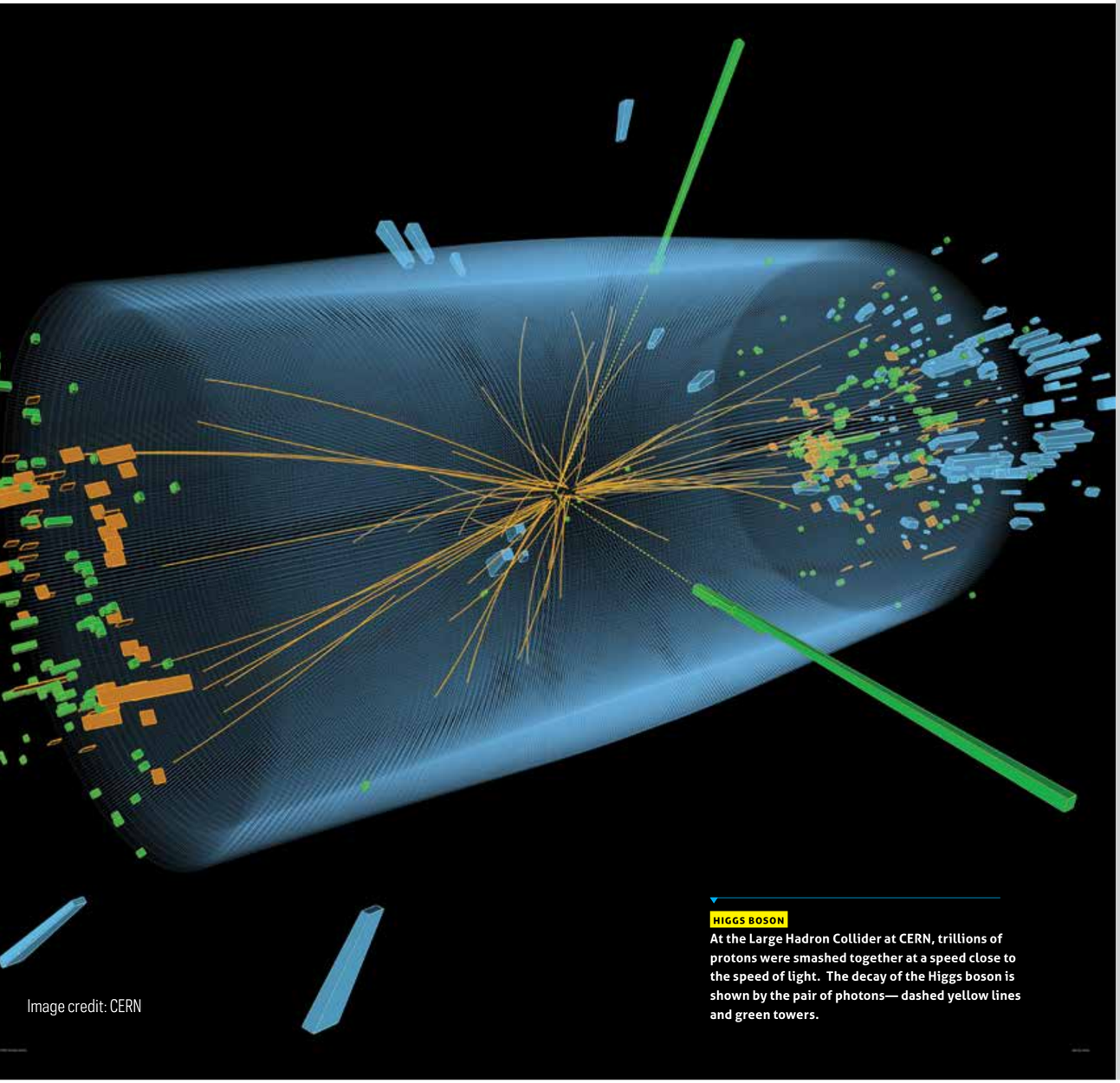


Image credit: CERN

HIGGS BOSON
At the Large Hadron Collider at CERN, trillions of protons were smashed together at a speed close to the speed of light. The decay of the Higgs boson is shown by the pair of photons— dashed yellow lines and green towers.

By Jason Kelly

AS FAR AS ACCOMPLISHMENTS TO INCLUDE on a CV, a particle physicist can't do any better than, "I discovered the Higgs boson." About 30 Notre Dame faculty members, postdocs, and graduate students can claim that achievement for their work that contributed to the 2012 detection of that missing piece of the Standard Model known as "the God particle."

Colin Jessop, professor of physics and one of four faculty who lead the Notre Dame team that works on the Compact Muon Solenoid (CMS) collaboration at CERN—one of two Large Hadron Collider (LHC) experiments that shared the Higgs discovery—finds the student participation especially gratifying.

The Higgs discovery had that effect on all its scientists, including many, like Jessop, who had spent their careers searching for the theorized particle and came to regard each new data set with a degree of pessimism. Last year, when the scientists unveiled new data, "all of a sudden I saw a peak that indicated the Higgs, and I fell off my chair, literally," Jessop said. "I was sort of walking around in a daze for a day because it was so stunning."

Confirmation that the particle behaves as a Standard Model Higgs boson should, announced in March, solidified the discovery and shaped research priorities for decades to come. Physicists at the LHC have begun to think about "physics beyond the Standard Model," including the theory of supersymmetry, which could help explain some of the paradoxes the Higgs introduces to the universe and perhaps help illuminate dark matter.

Notre Dame physicists Randy Ruchti, Mitchell Wayne, and Jessop are designing a detector to replace the existing system in 2025. "The idea is that we would produce enormous amounts of these Higgs bosons and that we could study in very, very precise detail," Jessop said. "Plus, if we find one of these supersymmetric particles, which we are hoping to do in the next run, then we would already have a plan in order to further study the properties of these particles."Kevin Lannon and Mike Hildreth are working to understand the Higgs properties.

Although Notre Dame's team is in the CMS "inner circle," the experiment's roster of 3,000 people reflects the collaborative nature of scientific advancement. Giving students experience in that environment is central to University's larger educational mission. Ph.D. student Doug Berry worked intensely as a member of the core analysis team, and made two of the critical plots shown at the announcement.

"Our students learn science, but they also learn how to deal with people in a collaborative way," Jessop said. "Some of them will go on to be scientists, but some of them will go into high-tech business, for instance, and will find that the skills that we have helped them develop— doing scientific research and dealing with people—are incredibly important."

A line on their CV that reads, "I discovered the Higgs boson" doesn't hurt either.■

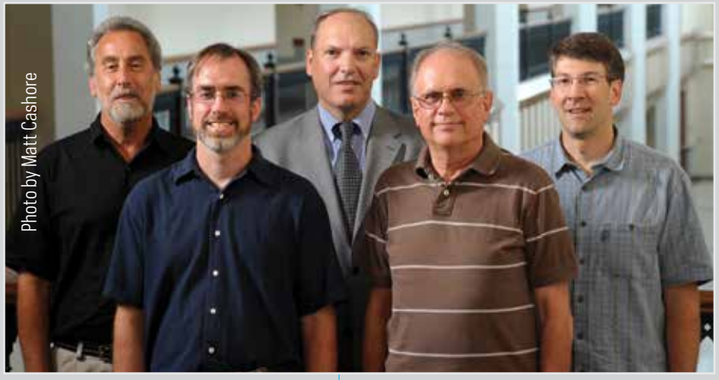


Photo by Matt Cashore

Notre Dame High Energy Physicists (L to R) **MITCHELL WAYNE, KEVIN LANNON, COLIN JESSOP, RANDY RUCHTI, AND MIKE HILDRETH** have just received a $2.4 million, three-year award from the National Science Foundation to continue their work on the CMS (Compact Muon Solenoid). Research faculty Dan Karmgard on campus and Nancy Marinelli at CERN, as well as recent hire Alexey Drozdetskiy are also part of the group.

New University of Geneva Program for Physics Majors

THE UNIVERSITY OF NOTRE DAME'S International Studies office has announced that it will offer three new opportunities for study abroad in South Korea, Spain, and Switzerland in spring 2014.

Notre Dame and Yonsei University in Seoul, South Korea, will begin a bilateral exchange program that will be open to undergraduates in all majors. Notre Dame and the Polytechnic Institute of Valencia in Alcoy, Spain, will begin a bilateral exchange program that is designed for sophomore or junior engineering majors.

Through Boston University's Geneva-Physics program, Notre Dame students will have the opportunity to study at the University of Geneva (UNIGE) and the European Organization for Nuclear Research (CERN) in Switzerland. The program, which combines coursework in quantum physics and electrodynamics at UNIGE and directed research at CERN, is open to physics majors who have completed at least two semesters of college-level French or the equivalent. Additionally, students will be required to complete a specially designed French-language tutorial before going to Geneva.■

ND-GAIN's country-level rankings indicate how vulnerable countries are to climate change and how ready they are to adapt. High readiness and low vulnerability have "better" GAIN scores. Low readiness and high vulnerability have "worse" GAIN scores.

JOYCE COFFEE, managing director of GAIN

Global Adaptation Index Moves to Notre Dame

By Peter Annin and Bill Gilroy

THE GLOBAL ADAPTATION INDEX (GAIN)—the world's leading index showing which countries are best prepared to deal with the droughts, super-storms, and other natural disasters that climate change can cause—has moved to the University of Notre Dame. GAIN, which ranks countries annually based on how vulnerable they are to climate change and how prepared they are to adapt, was formerly housed in the Global Adaptation Institute, a Washington, D.C.-based nonprofit.

GAIN is being given to the University by the Global Adaptation Institute with full support of its primary founding sponsor, Natural Gas Partners (NGP) Energy Capital Management, a $13 billion investment fund. The gift includes a $2 million donation from the NGP Foundation. To help draw attention to the importance of climate change adaptation, the chairman of the Global Adaptation Institute and NGP's CEO and founder, Ken Hersh, said, "The era of climate change denial is over, the world is getting warmer, and numerous countries are not ready for the chaos that climate change will bring."

"GAIN highlights those countries that urgently need help adapting to a warmer world," Hersh said. "We are thrilled about our new partnership with Notre Dame and its ability to help us take GAIN to the next level."

Notre Dame researchers will make GAIN more detailed by ranking the vulnerability of states within selected countries—as well as continuing to rank the countries themselves—making GAIN an even more important tool for disaster planning, infrastructure development, and ecosystem management around the world.

"At Notre Dame, we want to be the researchers who help solve climate adaptation problems, rather than fiddling while people suffer," said David Lodge, director of the Notre Dame Environmental Change Initiative (ND-ECI), where GAIN will be housed. "In just two years, GAIN has captured the attention of multinational corporations, NGOs, and government agencies—including those concerned with intelligence and security—and we will continue to get GAIN into the hands of those who can make a difference."

"Notre Dame is the best school to take GAIN closer to the people in need because of the University's track record of putting the human being in the center of their actions" said Juan José Daboub, GAIN's founding CEO, who currently serves as chair of the World Economic Forum's Global Agenda Council on Climate Change.

Joyce E. Coffee, who has extensive experience working on climate change and sustainability—particularly in the government and corporate sectors—has been named managing director of GAIN, which will now be called ND-GAIN. Key faculty working on GAIN include Nitesh Chawla, a renowned big data scientist and director of the Notre Dame Interdisciplinary Center for Network Science and Applications, and Jessica Hellmann, a leading climate expert, who directs ND-ECI's Climate Adaptation Program.

"This story is all about data—translating big data into real solutions that have real societal and global impact," Chawla said. "Notre Dame has a long and successful track record of translating big data into action on behalf of the private sector and government agencies alike—data and network science for the common good. Now we look forward to doing just that with ND-GAIN."■

Photo by Matt Cashore

JUSTIN CREPP, the Freimann Assistant Professor of Physics, has identified Earth-sized planets.

Astrophysicist Justin Crepp Discovers Earth-Like Planets in Star's Habitable Zone

By Marissa Gebhard

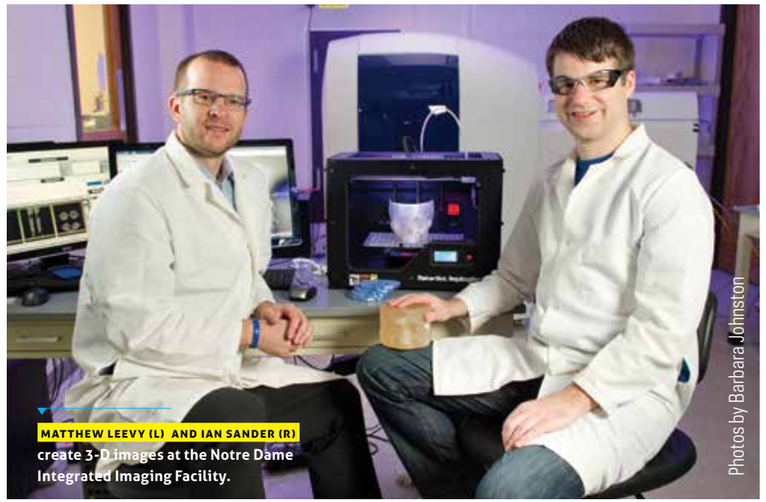
JUSTIN CREPP, THE FREIMANN ASSISTANT Professor of Physics, and a team of researchers have identified Earth-sized planets within the habitable zone of a Sun-like star. Examination of images from Kepler 62, including checks by Crepp to rule out other sources for the signal, confirmed five planets around the star, with two in the habitable zone. The results were published in the journal *Science*."A five-planet system with planets of 1.41 and 1.61 Earth-radii in the habitable zone of a K2V Star has been detected with the Kepler spacecraft and validated with high statistical confidence," the paper reports. Those two, called Kepler-62 e and f, are the outermost of the five observed planets and receive a solar flux from the star similar to that received from the sun by Venus and Mars. Their size suggests that they are either rocky, like Earth, or composed mostly of solid water. A planet discovered more than a year ago in the habitable zone of another Sun-like star, Kepler-22, has a radius 2.4 times the radius of Earth, leaving researchers unsure of its composition.

"From what we can tell, their radius and their orbital period, these are the most similar things to Earth that we have seen yet," Crepp said. "We don't know what they look like or what their properties are." Data from the Kepler mission, launched in 2009 to identify and measure planets, has accelerated recently, and several dozen of some 3,000 "Kepler objects of interest" have been studied in detail.

Researchers use fluctuations in the brightness of a star to identify the presence of a potential planet whose transit dims the light of the star. Crepp uses a large telescope to image the star and analyzes the system to determine that other astronomical features, such as nearby stars, are not causing the fluctuation, a common "false positive" encountered in the research. Crepp noticed a faint dot near Kepler-62, leading to months of detailed study to confirm the planet interpretation.

"What really helped is that this star has five planets," he said. "You can mimic one planet with some other event, but when you have five of them and they're all periodic, that helps to put the nail in the coffin. It's hard to make that kind of signature with anything else that you can dream up." ■

Imaging Facility Creates 3-D Printed Models for Physicians and Students



MATTHEW LEEVY (L) AND IAN SANDER (R) create 3-D images at the Notre Dame Integrated Imaging Facility.

Photos by Barbara Johnston

3-D MODELS printed at Notre Dame.

By Gene Stowe

UNIVERSITY OF NOTRE DAME RESEARCHERS have successfully created three-dimensional anatomical models from CT scans using 3-D printing technology, a process that holds promise for medical professionals and their patients, as well as anatomy students and others. A paper by the researchers, "3-D Printing of Preclinical X-ray Computed Tomographic Data Sets," was published in the *Journal of Visualized Experiments* (JoVE), and appeared on Wired.com in an article titled, "How to 3-D Print the Skeleton of a Living Animal."

The strategy was initiated by freshman Evan Doney, a Glynn Family Honors student, in the laboratory of W. Matthew Leevy, research assistant professor at the Notre Dame Integrated Imaging Facility. "It's a very clever idea," Leevy said. "He did a lot of it independently. He figured out how to convert the tomographic data to a surface map for editing and subsequent 3-D printing. Evan is a special talent and is a credit to Notre Dame and the Glynn Family Honors Program."

The paper reports results based on using X-ray CT data sets from a living Lobund-Wistar rat from the Freimann Life Science Center and from the preserved skull of a New Zealand White Rabbit in the laboratory of Matthew Ravosa. Coauthors of the JoVE article with Doney, Leevy and Ravosa are Lauren Krumdick, Justin Diener, Connor Wathen, Sarah Chapman, Jeremiah Scott, and Tony Van Avermaete, all of Notre Dame, and Brian Stamile of MakerBot Industries, LLC, a 3-D printing company.

"With proper data collection, surface rendering, and stereolithographic editing, it is now possible and inexpensive to rapidly produce detailed skeletal and soft tissue structures from X-ray CT data," the paper said. "The translation of pre-clinical 3-D data to a physical object that is an exact copy of the test subject is a powerful tool for visualization and communication, especially for relating imaging research to students, or those in other fields."

"Our project with 3-D printing is part of a broader story about 3-D printing in general," Leevy said, adding that the work has spawned several more ideas and opportunities, such as providing inexpensive models for anatomy students. "There's a market for these bones, both from animals and from humans, and we can create them at incredibly low cost. We're going to explore these markets."

A clinical collaborator, Dr. Douglas Liepert from Allied Physicians of Michiana, is enabling the researchers to print non-identifiable human data, expanding the possibilities. "Not only can we print bone structure, but we're starting to collect patient data and print out the anatomical structure of patients with different disease states to aid doctors in surgical preparation," Leevy said.

Notre Dame Biochemist Leads Multi-University Research Network

By Gene Stowe

PATRICIA CLARK, THE REV. JOHN CARDINAL O'HARA, C.S.C. PROFESSOR OF Chemistry and Biochemistry, has received a $3.8M award from the National Institutes of Health (NIH) to lead a pioneering model of collaboration that draws together seven institutions, eight co-principal investigators (PIs), and six postdoctoral associates to study macromolecular interactions in living cells. Norman Dovichi, the Grace-Rupley Professor of Chemistry, is also a PI focusing on separations and single molecule detection. Matthew Champion, research assistant professor in the Mass Spectrometry and Proteomics Facility, will serve as deputy director of the team.

The Protein Translation Research Network (PTRN) represents a new approach to collaborative research expressly designed to reduce barriers to collaboration between NIH-funded investigators at geographically distant sites. "NIH has made it very clear that they expect our operational model to reflect a highly interconnected web of interactions, rather than the more traditional 'hub-and-spokes' model for collaborative science," said Clark. PTRN researchers will interact mostly using technology like videoconferencing and cloud-based data storage, but will also travel to each other's laboratories to share equipment and expertise.

...a pioneering model of collaboration that draws together seven institutions...

"The purpose of the network architecture is to glue together labs that already have existing research programs in this area," Clark said. "By collaborating closely and dynamically, research questions that might be impossible for one lab to answer individually will now be accessible. This is particularly true because the eight laboratories are from widely different fields, ranging from bacterial genetics, computer simulations, biophysics, and everything in between, which we expect will facilitate new interdisciplinary collaborations."

The other PTRN laboratories are led by Rachel Green of Johns Hopkins University in biochemistry, Andreas Matouschek of University of Texas at Austin in biochemistry, D. Allan Drummond of the University of Chicago in molecular evolution and proteomics, Allen Buskirk of Brigham Young University in bacterial genetics, James P. Reilly of Indiana University in organic and analytical chemistry, and Adrian Elcock of the University of Iowa in computer simulations.

The network will study how proteins fold during their synthesis in living cells, specifically how the rate of synthesis affects the success of protein folding. Scientists have studied protein folding for decades by removing proteins from the cell. But in the past decade, research from Clark's laboratory has made it clear that proteins can begin folding while they are synthesized, using different mechanisms than those observed in the test tube.

"We want to understand how proteins fold as they are synthesized in the cell," Clark said. "It's a very complex problem. The goal of the network is to understand how the interactions in cells affect the rate that proteins are synthesized, and how the rate of synthesis affects the folding mechanism." Inaccurate protein folding is involved in a wide range of human diseases, including cancer, Alzheimer's, cystic fibrosis, diabetes, cataracts, Parkinson's disease, and Niemann-Pick Type C disease.■

PATRICIA CLARK (R) leads the NIH-funded Protein Translation Research Network that brings researchers from seven institutions together.

Photo by Matt Cashore

DNA LEARNING CENTER

DNA Learning Center Inspires Young Scientific Exploration

By Marissa Gebhard

In collaboration with Cold Spring Harbor Laboratory (CSHL), the College of Science dedicated a new DNA Learning Center in the Jordan Hall of Science on September 28, 2013.

A hands-on science center devoted to modern biology education, the DNA Learning Center will prepare local K-12 students to thrive in the gene age. This advanced science education center will be the ideal teaching tool to inspire young students to pursue careers in science and to build a knowledge base that will extend into their educational and post-educational careers.

The DNA Learning Center at Notre Dame fulfills the vision of benefactors John and Heidi Passarelli who saw how CSHL's DNA Learning Center (DNALC) was providing hands-on genetics education to children across the New York metro area, and envisioned partnering the research expertise of the University of Notre Dame with the teaching methods of DNALC to bring the same opportunity to K-12 students in the South Bend community. John Passarelli, College of Science advisory council member, said, "The collaboration between the University of Notre Dame and Cold Spring Harbor Laboratory will bring significant benefits to the University and the local community. The new center will bring a synergy between research, education, and outreach that will impact the local community and strengthen the Notre Dame community."

Leveraging Notre Dame's strength in molecular biology, the center plans to offer two-day workshops and resources for K-12 educators, one-week summer camps for high school students, DNA workshops for the general public, and laboratory field trips for K-12 students. As a licensee of the Cold Spring Harbor Laboratory DNA Learning Center in New York, the Notre Dame DNA Learning Center will utilize teaching methods, Internet technology, and intellectual property of DNALC such as specialized DNA learning kits which include reagents, supplies, equipment checklists, lab instructions and manuals for learning modern biology.

Greg Crawford, dean of the College of Science, said, "We are thrilled to open an advanced science education center to engage K-12 students. Through active, firsthand, investigative experiences, the students will ask questions, probe for answers, and develop an early understanding of basic science that will inspire them for the future." ■

THE DNA LEARNING CENTER will give K-12 students firsthand, investigative experiences to prepare them to thrive in the gene age.

Center for Mathematics' International Conference Attracts More Than 80 Mathematicians

By Gene Stowe

The Center for Mathematics at Notre Dame held an international conference with some 80 participants as the conclusion of its thematic program, *Motivic Invariants and Singularities.* The program included a week of summer school for undergraduates and another for graduate students and postdoctoral associates before the conference.

Nero Budur, an associate professor in the Department of Mathematics, organized the event with François Loeser of the University of Pierre and Marie Curie in Paris, and Mircea Mustata of the University of Michigan.

"This particular subject fits into what's called algebraic geometry," Budur said. "It deals with solutions to polynomial equations. Polynomial equations model a lot of things in real life and in theoretical sciences." Rather than use figures as in traditional geometry, the field uses equations accessible to computers.

Participants said the conference stimulates new ideas both in the lectures and in the informal discussions during breaks and meals, an important face-to-face dimension even in an age when Internet communication has enabled global collaboration. "It's very valuable to have a broad audience," said presenter Lars Halvard Halle of Oslo University in Norway. "At a conference like this with a main theme, there's a lot of variation within that theme so you get many different perspectives. You get interesting questions from people."

"Notre Dame has always been very strong in model theory," said presenter Julia Gordon of the University of British Columbia in Canada, who was a postdoc when she attended an American Mathematical Society meeting at Notre Dame in 2006. "Having a huge gathering like this is fantastic because you get to see people working on all aspects of these theories. My research is applications of model theory to representation theory. You get to see some European colleagues working on the same topics . It's always fantastic to have a chance to find out what they're doing now and see if there are any connections."

Presenter Ana Reguera of the Universidad de Valladolid in Spain, who specializes in arc spaces, said the conference was an important opportunity to engage American and international scholars. "You get contact; you know what your colleagues are doing," she said. "Sometimes the talks are the excuse to start speaking, but the important thing is when you start speaking, the questions you have from the talk. Then afterwards we will be in contact by email. We need these kinds of meetings."

Motivic Invariants and Singularities was the third thematic program by the Center for Mathematics, with different organizers and themes each year. Some 35 people attended the undergraduate session and 70 attended the graduate and postdoc session.■

Photo by Barbara Johnston

KIRAN KEDLAYA from the University of California, San Diego introduces other mathematicians to arithmetic D-modules at the Conference on Motivic Invariants and Singularities on June 6, 2013.

GREG CRAWFORD, dean of the College of Science, bicycled 3,700 miles from Long Beach, California to Baltimore, Maryland to raise awareness and funds to fight Niemann Pick Type C disease.

Photo by David A Martinez

Photo by Robbie McLean

Road to Discovery Ride Raises Over $500,000 for Clinical Trials

By Stephanie Healey

FOR THE PAST FOUR SUMMERS, DEAN GREG Crawford has embarked on a cross-country bike ride to raise awareness and funds for research to find a cure or treatments for Niemann-Pick Type C (NPC) disease, a rare and genetic cholesterol storage disorder that is always fatal. The National Niemann-Pick Disease Foundation estimates that there are approximately 500 NPC patients worldwide. Despite its rarity, NPC has had a significant impact on the Notre Dame family as former Notre Dame football coach Ara Parseghian lost three of his grandchildren to this devastating disease.

In 2003, Notre Dame formed a partnership with the Ara Parseghian Medical Research Foundation (APMRF) to fund NPC research. With APRMF's support, Paul Helquist and Olaf Wiest, professors of chemistry and biochemistry, and their collaborators have demonstrated the effectiveness of small molecule histone deacetylase inhibitors (HDACi) in correcting the NPC phenotype in cells in the laboratory.

The next step is to move toward a clinical trial. Notre Dame alumnus Norbert Wiech founded Lysomics, LLC, a company that will manage the clinical development needed to bring this promising treatment to market.

The goal of this year's Road to Discovery cross-country bike ride was to raise enough money to fund the clinical trials. From June 27 to August 2, Crawford biked over 3,700 miles from Long Beach, Calif. to Baltimore, Md., meeting with patients, families, researchers, and physicians affected by NPC, as well as Notre Dame alumni clubs across the country. Along the journey, generous people who were touched by the mission of the ride helped the college raise over $500,000 to cover the cost of a clinical trial for seven or eight patients.

"Greg Crawford continues to bring hope to all NPC patients and their families with his cross-country bike rides," said Cindy Parseghian, president of APMRF. "By meeting with families along his ride, Greg is a reminder that they are not alone in this fight to find a cure. Greg's dedication and commitment has a tremendous impact on NPC research, and we are forever grateful to him."

Crawford wrote a daily blog about his trip that chronicled his bike trek. Read more: http://roadtodiscovery.nd.edu.■

Summer Outreach Programs

Photo by Matt Cashore

SENSING THE COSMOS During week-long Sensing the Cosmos summer camps, 54 middle school students were exposed to the exciting world of science, mathematics, and technology.

Photo by Matt Cashore

Through the Research Experience for Teachers (RET) Program, nearly twenty high school teachers, such as **PETER HOFFMAN (L) AND LYNDA SMITH (R)** conducted research in Notre Dame science and engineering laboratories with faculty and graduate students.

Photo by Peter Ringenberg

ART TO SCIENCE CAMP In July, 120 children ages 8-13 used their own creativity and ingenuity to explore the analytical side of art and the creative side of science during the week-long camp which was organized by the Joint Institute for Nuclear Astrophysics (JINA).

Graduate *Research*

Fit2Cure: Reimaging Drug Discovery Through Gaming

By Gene Stowe

THREE GRADUATE STUDENTS AT NOTRE DAME have started the company Sayansia, aimed at using technology and crowdsourcing to solve scientific problems. The founders are Geoffrey Siwo and Victoria Lam, Ph.D. students in Biological Sciences, and Ian Sander, who recently received his Ph.D. in Biochemistry this year. The group's Fit2Cure game engages online players to find cures for diseases by identifying holes in protein molecules where drugs could fit to prevent the proteins' action.

"What we're trying to do in Fit2Cure is focus on rare and neglected diseases," said Sander, adding that more than half of the 10,000 diseases are rare and most have no cure. "What we need is a new paradigm in healthcare, a new way to do discovery for drugs. As you apply more and more people to a problem, the more discoveries you get."

The long process for drug discovery involves identifying a disease, isolating the protein involved, and finding an effective drug before going into preclinical and clinical testing aimed at FDA approval. Fit2Cure aims to reduce the time spent on determining a drug candidate, which typically takes two to five years. Game players can find the pocket where a ligand can bind to the target protein, a process called molecular docking, so that the protein can no longer act effectively.

"Fit2Cure is like having 1,000 people looking for Waldo," Lam said. "Players can do real science. No one person will find a cure to the disease. Instead Sayansia will take data from all players and analyze it in the search for new drug candidates." The process can also apply to personalized medicine. Individuals can acquire a copy of their genome that indicates diseases to which they are susceptible and participate in discovering cures specifically pertinent to them.

Sander said the number of scientific researchers has doubled since 1980, to more than 4 million, and the number of Internet users around the world has doubled in the past five years, adding more than 1 billion people mostly in the developing world. That multiplies the opportunities for "citizen science."

"This represents a huge potential source of collective intelligence," he said. "Knowledge spreads in new ways. We want to make it really easy and fun for people to engage and try to solve medical problems. This is going to be an explosion of engagement and tools that can scale discovery to a million people."

The team aspires to utilize Fit2Cure to find new active sites, which would be potentially new drug targets. They emphasize the importance of educating their players about diseases and making a direct impact on global health. In the future, the team would like to link their leaderboard to charitable giving, donated in the name of their top players, to research institutions that focus on rare and neglected diseases. ■

Learn more: facebook.com/Sayansia.

Photo by Matt Cashore

(L TO R) GEOFFREY SIWO, VICTORIA LAM, AND IAN SANDER are using the creativity of people combined with the speed of computers to find new drugs through their game Fit2Cure.
Try the game at www.fit2cure.com.

Photo credit: South Bend Tribune

WENZHAO SUN (L) presents his analysis with collaborator **JIAN XU (R).**

Wenzhao Sun Uses Big Data Science to Advance Communication Strategies

By Gene Stowe

WENZHAO SUN, A FOURTH-YEAR GRADUATE student in the Department of Applied and Computational Mathematics and Statistics, won the 2013 Schurz Innovation Award for his data-mining project that showed how Schurz Communications, Inc., a media firm, could more effectively use Twitter in its marketing. Sun's graduate research involves computational fluid dynamics (CFD) and fluid structure interaction (FSI), focusing on blood flow. His adviser is Zhiliang Xu.

"My research is related to what I'm doing for this award, but there are some differences," he said. "The work involves numerical simulations. It's still dealing with a lot of data, a lot of programming and a lot of simulating what's going on."Sun and his collaborator, Jian Xu, a graduate student in computer science, were taking a data mining class with Nitesh Chawla, associate professor of computer science and engineering, when they developed the project for the competition. "We thought that we would use this data science to help them get a better understanding," he said.

The researchers had access to data from more than 200 Schurz accounts with a total of more than 200,000 followers. They measured impact by retweets and favorites, a more reliable measure than the number of followers. One account, for example, had 60 times as much engagement as another account with the same number of followers. Sun and Xu evaluated 10 leading accounts with 32,000 followers and discovered that the most effective strategies involved tweeting on weekends and evenings, writing longer tweets, strategically encouraging retweets, using exactly one hashtag, and including the word "breaking."

"Our discovery, in short, is that there is a noticeable correlation between tweeting strategy and tweet effectiveness, and a company's Twitter marketing could potentially improve with better tweeting strategy," the report said.

Sun, who earned his bachelor's degree in engineering from Huazhong University of Science and Technology in China, spent the summer as an intern for Amazon, a leading big data user. "Big data is something that really helps people to better understand the world and helps companies to make real profits," he said.■

Students and Alumni Earn NSF Graduate Research Fellowships

By Stephanie Healey

TEN COLLEGE OF SCIENCE STUDENTS AND ALUMNI EARNED prestigious National Science Foundation Graduate Research Program Fellowships this past spring. The fellowships provide three years of support for the graduate education of students who have demonstrated the potential for significant achievements in science and engineering research. Past fellows include individuals who have made significant breakthroughs in research, as well as some who have been named Nobel laureates.

JENNIFER ARCEO studies glycosphingolipid metabolism within single cells. Aberrant metabolism of glycolipids has been associated with disease pathologies affecting the central nervous system such as Tay-Sachs and Sandhoff disease.

ERIC DELEON examines the oxygen "sensing" cells in vertebrates that monitor environmental oxygen and ensure adequate delivery to the tissues. His work focuses on the hypothesis that hydrogen sulfide is the unknown key in the oxygen sensing process.

RACHELSCHLUTTENHOFER researches mycobacteria, such as M. tuberculosis, that require the ESX-1 secretion system for virulence. She is interested in finding and characterizing novel genes required for secretion, which will aid basic understanding of mycobacterial pathogenesis.

Master's degree student **SHAYNA SURA,** studies brine shrimp *(Artemia Franciscan)* cysts that are used as food in fish and shrimp hatcheries. Current harvesting techniques collect cysts floating on the lake's surface, which pose a potential selective pressure against floating cysts and could affect population dynamics.

CARMELLA VIZZA is studying the effects of climate change on ecosystem processes, such as decomposition and biofilm nutrient limitation in the coastal wetlands in the Copper River Delta, Alaska. Her goal is to establish a link between these processes and methane production and emissions.

Alumni

BRITTANY ANGAROLA, '11 is investigating the novel mechanisms that support lysosome homeostasis at Yale University.

NICHOLAS MANCINELLI, '11 is analyzing seismic waves from earthquakes around the globe in order to determine the fine-scale structure of deep Earth. He is a Ph.D. student at the University of California, San Diego.

MURPHYKATE MONTEE, '13 completed a thesis project this spring which exposed the construction of a characteristic class of complex vector bundles through algebraic topology and classifying spaces. She is pursuing a Master of Advanced Studies (Part III) in Theoretical Mathematics at the University of Cambridge.

JESSICA PEARSON, '11 works with an instrument called SCRIBES (Sensitive, Cooled, Resolved Ion Beam Spectroscopy) that produces high-resolution vibrational spectra of molecular ions in the gas phase under astrophysically relevant conditions. She is a graduate student at the University of Illinois, Urbana-Champaign.

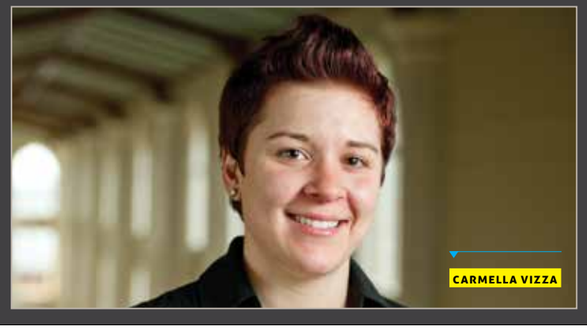
KIMBERLY SCHLESINGER, '11 is a graduate student at the University of California, Santa Barbara who is researching the progress of mutating infections in the human immune system using mathematical models of immune system cell population dynamics.■


JENNIFER ARCEO


ERIC DELEON


RACHEL SCHLUTTENHOFER


SHAYNA SURA


CARMELLA VIZZA

Photos by Barbara Johnston

Undergraduate *News + Research*

The Perfect Fit

By Gene Stowe

RECRUITING UNDERGRADUATE TALENT IS difficult. At the same time, many students have trouble finding the right company. Two students though may have found the solution. Their new, student-led program, ProMazo, matches companies with students who work virtually during the academic year. The program has secured IBM as its first partner, and is working on a project this fall with students from the colleges of science, engineering, and business.

ProMazo matches companies with students who work virtually during the academic year.

Senior Brett Hummel, a double major in economics and applied and computational mathematics and statistics, manages the program, which is a division of the Student International Business Council (SIBC). He developed it with junior Max Brown, director of academic affairs, Student Government.

Each semester, ProMazo works with partner companies to develop six or twelve-week projects for Notre Dame students and is exploring partnerships with Fortune 500 businesses, start ups, and non-profit organizations. At the end of each engagement, the student and company can decide to continue to work together or explore additional projects with other companies and students. This flexibility allows both parties to find the best fit, and once identified, potentially develop a multi-year relationship between the job candidate and potential employer.

While the program is open to all students, "ProMazo is meant to augment the excellent services Notre Dame already offers," Brown said, "and will assist students from lower income backgrounds, who must hold a paid position, or those who have learning disabilities and have previously encountered obstacles in their professional development."

ProMazo's virtual, results-oriented approach prepares students for the workplace of the future, while elevating Notre Dame's exposure to companies that do not traditionally recruit through campus job fairs. "Notre Dame students are qualified to handle any position, but sometimes they don't get a chance to compete for these jobs," Hummel said. "At the same time, companies especially alumni from smaller firms want the high-quality talent Notre Dame produces, but they can't afford to send people out here to recruit. We think with this system you can export Notre Dame's best product: its students, and along with it the Notre Dame brand, creating a win-win-win for companies, students, and the University."■

SENIOR BRETT HUMMEL (L) founded ProMazo with MAX BROWN (R).

Photo by Matt Cashore

Students Pursue Diverse Research Interests in Preparation for Future

By Gene Stowe

NOW IN ITS SIXTH YEAR, THE COLLEGE OF SCIENCE SUMMER Undergraduate Research Fellowship (SURF) program gives students opportunities to expand their research experiences, explore new fields, and gain insights that help them prepare to excel in graduate school and in their future scientific careers. This summer, 73 students received fellowships.

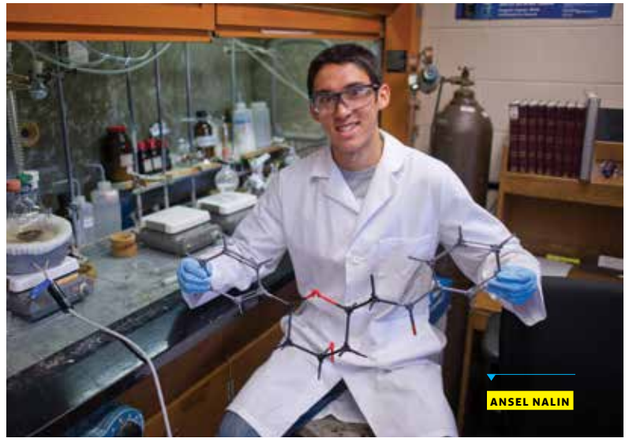
Senior **PATRICIA AMORADO**, a biological sciences major with a minor in medieval studies, conducted research on aquatic ecology with Stuart Jones, assistant professor of biological sciences. The work involved characterizing the resource uptake and growth rates of freshwater bacteria to assess what concentrations of glucose maximize their growth rates. The focus was different from her previous research, although she used similar techniques, and Amorado expects to pursue the new line in her ongoing work.

PAULINA DEL MAR RULLÁN, a senior science-business major from Puerto Rico, worked on identifying communication skills for terminally ill patients with the Palliative Medicine team at Lenox Hill Hospital in New York City. In doing so, Rullán pursued a passion imparted by her research mentor Dominic Vachon, director of the Hillebrand Center for Compassionate Care in Medicine, in his "Being With" class. "After this class, I started doing more research on this topic and became interested in palliative medicine," she said. "My overall interest so far is oncology and compassionate care. For me, this internship was not only an educational experience but also an opportunity for professional and spiritual growth."

Senior **ABRAHAM YU**, a biological sciences major working in the lab of Shaun Lee, conducted research on antimicrobial activity in different strains of staph. In the past, Yu had worked with zebrafish in David Hyde's lab. "This is a completely new area for me," he said. "It was a new side of the science and the biology that I hadn't experienced before." Yu expects to work in a clinic in Guatemala for a year after graduation before he enters medical school.

TAYLOR CORPUZ, a junior physics major working with Justin Crepp, is designing a study to develop a case for exoplanets around binary stars. She hopes to eventually visit the Large Binocular Telescope to make observations. "I have been interested in astrophysics for a very long time now," Corpuz said. "I like observing more than I like the theoretical work. I am very interested in binary stars."

ANDREW PIPER, a physics major with a concentration in advance physics, worked with Carol Tanner on research aimed at developing an atomic clock based on silver, which would be significantly more accurate than current cesium clocks. "If this increased accuracy could be achieved it would ultimately lead to an equally large increase in the accuracy of GPS units and increase the speeds of broadband communications," he said.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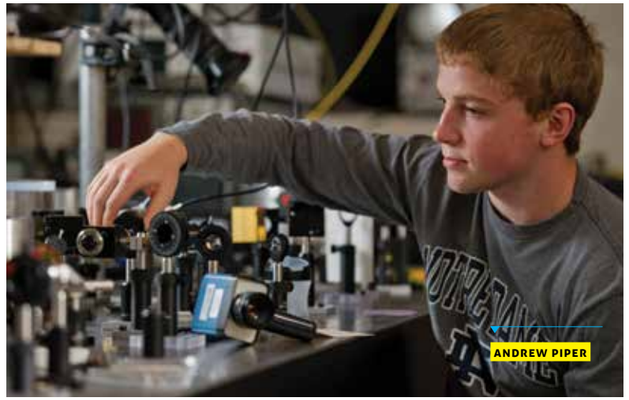

ANDREW PIPER


TAYLOR CORPUZ

MARIA MORENO CAFFARO, a biochemistry major from Guatemala, helped with cardiac fibrosis research, focused on histology, in the lab of Victoria Ploplis, research professor in the W.M. Keck Center for Transgene Research. "Working for a prolonged period of time in the lab has taught me things I wouldn't have learned otherwise, and it's always exciting to be part of some project and have something you worked with from start to finish," she said. "This experience is undoubtedly beneficial for my area of interest because I want to study genetics, and pathology could be a good complement to this area of research."

MITCHELL FAULK, a senior honors mathematics major, has been studying conformal field theory under associate professor of mathematics Katrina Barron, including the module theory for vertex operator algebras. "I have been able to think about current and interesting problems arising in the theory of vertex operator algebras," Faulk said. "I believe that this experience is a perfect step towards graduate studies in mathematical physics."

ANSEL NALIN, a senior chemistry major, has been conducting research in Prof. Richard Taylor's synthetic organic chemistry lab since 2011. "I am currently investigating the synthesis of the natural product ambruticin, a compound belonging to class of compounds with antifungal activity," he said. Nalin aims to complete an M.D./Ph.D. program and pursue translational research as a physician scientist.■


ABRAHAM YU


PATRICIA AMORADO

Photos by Matt Cashore

Chemistry Faculty Publish NMR Teaching Methods

By Gene Stowe

FIVE MEMBERS OF THE FACULTY IN THE DEPARTMENT OF Chemistry and Biochemistry wrote a chapter in the recently-published book *NMR Spectroscopy in the Undergraduate Curriculum,* part of the *American Chemical Society Symposium Series.* Steven M. Wietstock, Kathleen A. Peterson, DeeAnne M. Goodenough Lashua, Douglas A. Miller and James F. Johnson contributed "NMR Spectroscopy in the Undergraduate Curriculum at the University of Notre Dame."

The chapter tells how the Bruker 400 MHz Avance III NMR spectrometer with a 120-position BACS sample changer housed in Jordan Hall has been used in undergraduate teaching laboratories since it was acquired in 2006. Chemistry majors and others use the spectrometer for experiments, and generate and analyze data in lab courses throughout the year.


MITCHELL FAULK


MARIA MORENO

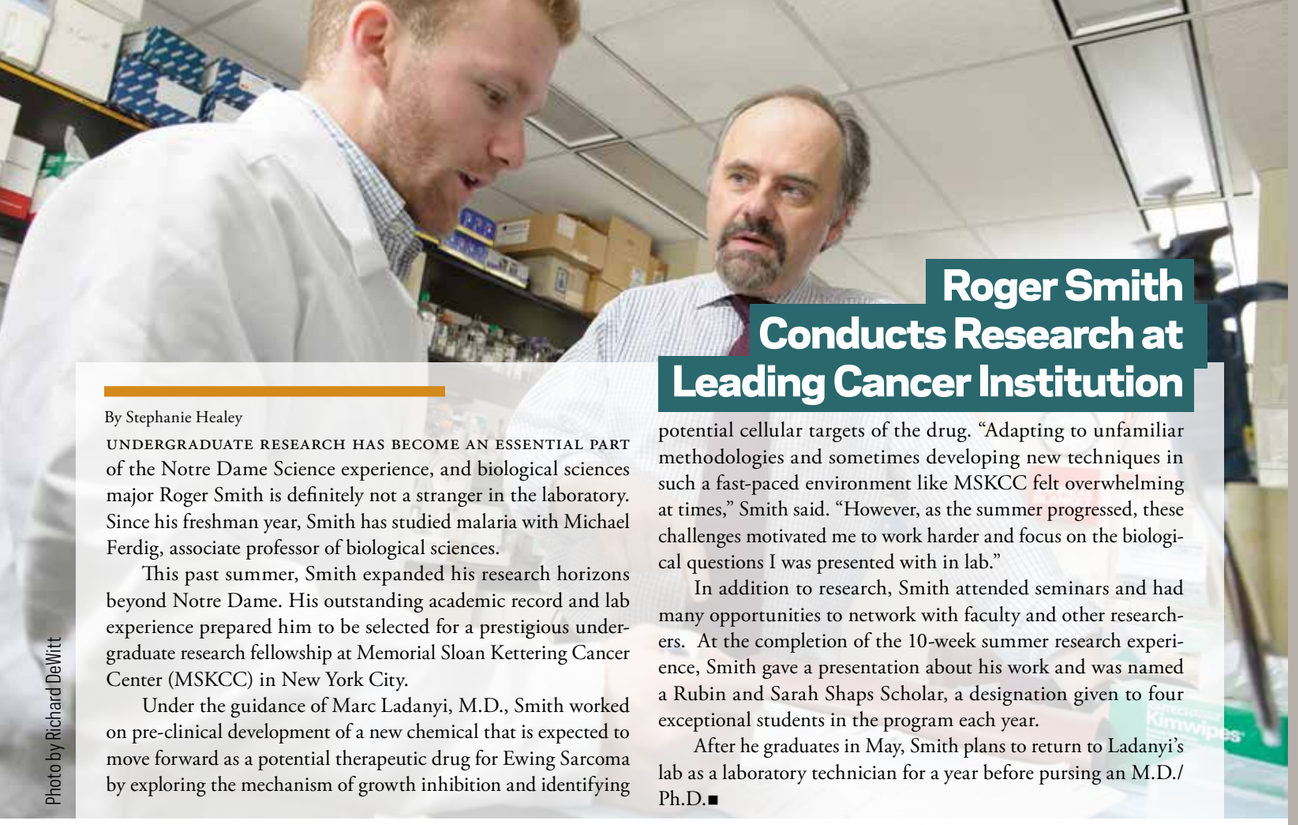


Photo by Richard DeWitt

Roger Smith Conducts Research at Leading Cancer Institution

By Stephanie Healey

UNDERGRADUATE RESEARCH HAS BECOME AN ESSENTIAL PART of the Notre Dame Science experience, and biological sciences major Roger Smith is definitely not a stranger in the laboratory. Since his freshman year, Smith has studied malaria with Michael Ferdig, associate professor of biological sciences.

This past summer, Smith expanded his research horizons beyond Notre Dame. His outstanding academic record and lab experience prepared him to be selected for a prestigious undergraduate research fellowship at Memorial Sloan Kettering Cancer Center (MSKCC) in New York City.

Under the guidance of Marc Ladanyi, M.D., Smith worked on pre-clinical development of a new chemical that is expected to move forward as a potential therapeutic drug for Ewing Sarcoma by exploring the mechanism of growth inhibition and identifying potential cellular targets of the drug. "Adapting to unfamiliar methodologies and sometimes developing new techniques in such a fast-paced environment like MSKCC felt overwhelming at times," Smith said. "However, as the summer progressed, these challenges motivated me to work harder and focus on the biological questions I was presented with in lab."

In addition to research, Smith attended seminars and had many opportunities to network with faculty and other researchers. At the completion of the 10-week summer research experience, Smith gave a presentation about his work and was named a Rubin and Sarah Shaps Scholar, a designation given to four exceptional students in the program each year.

After he graduates in May, Smith plans to return to Ladanyi's lab as a laboratory technician for a year before pursing an M.D./Ph.D.■

Michael MacGillivray Explores His Passion for Computational Biology at Cold Spring Harbor Laboratory

By Stephanie Healey

SENIOR HONORS MATHEMATICS MAJOR Michael MacGillivray has taken advantage of every opportunity to explore his passion for computational biology. Last fall, he learned about the Undergraduate Research Program at Cold Spring Harbor Laboratory (CSHL) and decided to see if it would be a good match.

"As I read through the lab's web page, I realized that what Alexander Krasnitz was doing the perfect combination of mathematics, computation, biology, and medicine for me," explained MacGillivray. The 10-week program is highly competitive: MacGillivray was one of only 27 students accepted.

MacGillivray spent the summer in Krasnitz's lab working on cancer research. As tumors develop, cells within the tumor mutate and form genetically distinct subpopulations. Krasnitz's group is developing methods to infer the evolutionary descent of the subpopulations from initial tumor cells by analysis of single-cell DNA sequencing. MacGillivray was responsible for implementing a new probabilistic model in the processing of DNA sequencing data to help the group select the most significant information.

"Being immersed in a research environment for an extended period of time provided invaluable lessons in the nature of scientific investigation," he said. "While you can learn a lot from taking classes, there is no substitute for diving in and engaging in real research firsthand."■

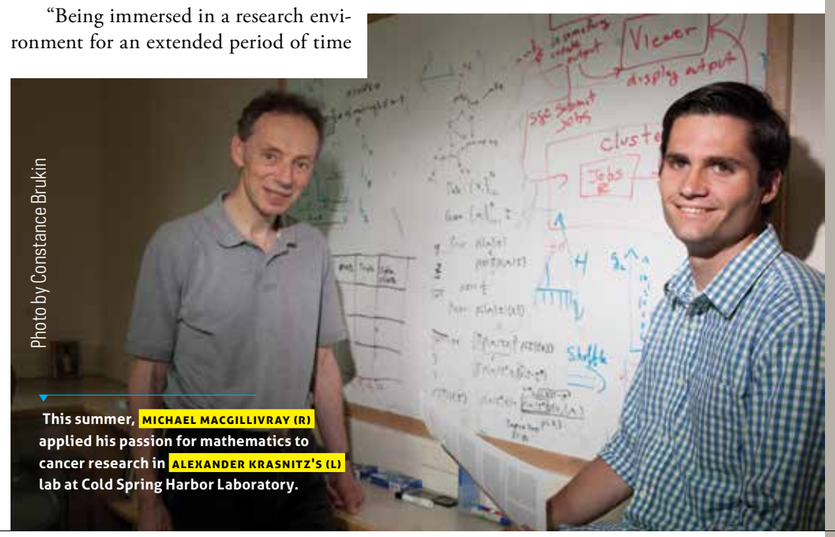


Photo by Constance Brukin

This summer, MICHAEL MACGILLIVRAY (R) applied his passion for mathematics to cancer research in ALEXANDER KRASNITZ'S (L) lab at Cold Spring Harbor Laboratory.

SUMR Program Challenges Most Talented Math Students

By Gene Stowe

THE SEMINAR FOR UNDERGRADUATE MATHEMATICAL RESEARCH (SUMR), established more than 20 years ago by professor emeritus Frank Connolly and now overseen by Jeffrey Diller, professor of mathematics, has guided dozens of Notre Dame undergraduates into graduate training in high-level mathematics.

The program provides support and direction to the University's most talented mathematics students, and prepares them for the nation's top graduate programs in the mathematical sciences—pure or applied mathematics, statistics, economics, physics, mechanical or electrical engineering, or finance. Since the first graduates in 1990, nearly all have pursued mathematics, although some have earned MBAs or MDs.

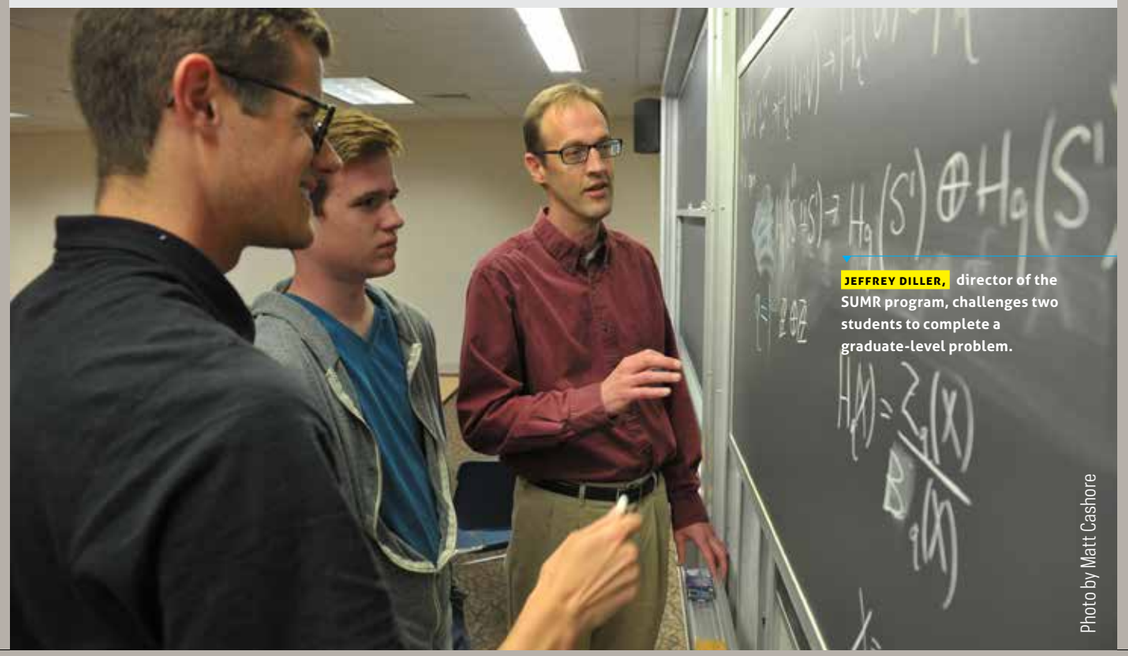
Sami Assaf, who graduated in 2001 in philosophy and math, earned a Ph.D. at the University of California, Berkeley, in 2007 and did postdoctoral work at M.I.T. for four years. After she worked for a year at a hedge fund in San Francisco, she became an assistant professor at the University of Southern California. Her research focus is symmetries, a change from her years at Notre Dame, but she says the SUMR program prepared her for the rigorous discipline.

"It basically gave me mathematically maturity, which is incredibly important," Assaf said. "It helped me understand what a good proof is. It also taught me the approach to learning mathematics. At the level I went to, it's not formulas any more –you do this, you do that, you're done. It's much more exploration. I learned how to do that – how to play with mathematics as a way to learn it and develop your understanding of it."

Adam Boocher, a 2008 Notre Dame graduate who is finishing his graduate work at Berkeley, continued his research focus on algebraic geometry that launched when he took a reading course with Claudia Polini during his junior year. "I would say that the SUMR program was absolutely essential to my going on to graduate school and pursuing a career in math. I saw how beautiful math could be, and I was in good hands. I knew the faculty took our education seriously, and I knew that many students had gone through the program and gone on to great grad schools and great postdocs. It was a very great environment for all of us."

MurphyKate Montee, who graduated in 2013 with a degree in math and music, will go to Cambridge University this year on a Churchill Scholarship and then pursue a Ph.D. at the University of Chicago. She says the SUMR program offered specially designed programs, such as a summer course after her freshman year, to ensure that she had sufficient preparation.

"There are special courses that are taught specifically for the students in SUMR," said Montee, who took six graduate courses while she was an undergraduate. "It's a really good way to make sure the top kids are doing everything they can to make themselves competitive for graduate school."■



JEFFREY DILLER, director of the SUMR program, challenges two students to complete a graduate-level problem.

Photo by Matt Cashore

Undergraduates Spearhead Creation of New Science Policy Course

By Stephanie Healey

Inspired by a lecture about federal research funding, Rachel Cotton recognized the need for a forum about science policy and the regulation of clinical research. Working in partnership with fellow biological sciences major Roger Smith, the students forged a collaboration with the College of Science and Center for Social Concerns to create the one-credit seminar, Science Policy Ethics: Guiding Science Through Regulation of Research and Funding.

Twelve students from science and engineering participated in the inaugural course, which included a week-long trip to Washington, D.C. The seminar explored how, and why funds are distributed to scientists by the federal government, the pathway between discovery in the laboratory to translational research, and the introduction of new technology and policy to the general public.

"I didn't initially foresee how timely the course would be—our group had discussions with leaders in science and government on how the sequestration might affect grant funding, and how scientific ethics and integrity are becoming even more important in the face of that competitive funding landscape," said Cotton.

Working closely with Notre Dame's Federal Relations Team in D.C., the students visited several federal agencies, including the FDA and NASA. They even had the opportunity to observe a meeting of the President's Council of Advisors on Science and Technology.

"We saw that major themes in science funding over the next 10 to 15 years will include the brain, big data sets and climate change," Cotton explained. "It was exciting to get a glimpse of where the next big breakthroughs could be," explained Cotton.

"It was really empowering and humbling to have the rare opportunity to create something from scratch," said Cotton. "The final product was distinctly representative of Notre Dame–a Catholic research university engaged in a national and global science agenda for the common good."■

Photo by Rick Stewart

RACHEL COTTON '14 (CENTER) worked closely with KATHIE OLSEN (L) AND LESLEE GILBERT (R) of the Notre Dame Federal Relations Team to plan the agency visits in D.C.

Student Athlete Spotlight

* * * *

Niall Platt

By Stephanie Healey

Senior applied and computational mathematics and statistics (ACMS) major Niall Platt has a very impressive résumé on the golf course. As a freshman, he recorded the second lowest 54-hole score in Notre Dame's NCAA history at the 2011 NCAA Southeast Regional and was named the BIG EAST Freshman of the Year. He was selected for the BIG EAST team three times and has earned three monograms.

Like many students, Platt has taken advantage of the opportunities to pursue many passions at Notre Dame. "I have always loved math. I've never really been interested in any other subject. I started out as a math major, but realized I was more interested in the application of math than the theoretical side, so I decided to become an ACMS major."

Platt's busy course schedule this semester includes Mathematical Statistics, Statistical Methods in Data Mining and Prediction, and General Physics II.

"Golf is a very time-consuming sport, so it is definitely difficult to balance golf and academics. Coach Kubinski always says that between golf, academics, and social life, you can only have two in one day. Most days, I make sure I take care of both golf and academics."

After graduation, Platt plans to become a professional golfer. "It's always been my dream to play on the PGA tour, so I figure I need to give it a shot."■

Photo by Michael Bennett

New *Faces*

Notre Dame Scientists Making a Difference

By Gene Stowe

Many college of science graduates go on to medical careers, and many of them are committed to improving medical care in developing countries. Three such alumni recently returned to campus for Reunion Weekend and participated in a panel discussion, "From ND Labs to Life in the Real World: How Notre Dame Scientists are Making a Difference," sponsored by the Eck Institute for Global Health.

"Health problems differ by country," said Dr. Michael C. Dugan, ('83), chief medical officer at bioTheranostics Inc. in San Diego, Calif., adding that people need tools as well as education to address and prevent disease. Among other things, automated diagnostic technology, such as high throughput systems, can help reduce the cost of diagnoses.

Dr. Kevin Olehnik ('78), orthopedic and hand surgeon at VA Maine Healthcare System in Augusta, Maine, added that an understanding of other cultures is a critical issue in global health. "It was amazing how we Americans want to go in and change a culture to make it our culture, do things our way," he said. "You have to be more tactful than that—use humility, compassion, patience, flexibility. I have seen the world from a totally different perspective. It changes your life because your perspective changes."

Olehnik and Dr. Mary O'Connor ('83), an internist and pediatrician at Seattle Children's and Group Health in Seattle, Wash., have made frequent trips to Haiti, recruited by professor emeritus Emil Hofman. "I've been [to Haiti] several times, initially in relief work and doing some mobile medical clinics and some teaching as well," Oconnor said. "What you do matters. I think Kevin and I both developed relationships with the Haitians to try to help them in a sustainable way with education and resources. I think there's an obligation to try to stay connected in some way.

"Doing something in the global health field has always been part of my passion, purpose, and drive. Notre Dame's been a large part of that desire. I think I have a personal obligation to continue my learning. Part of our obligation as an educational group is to try to educate others on what are the projects that deserve time and attention and resources."

"Those trips gave me the ability to do those three things I wanted—service, paying back this place, and then teaching," Olehnik said, adding that early reflection deepened his appreciation for his Notre Dame education. "It not only gave me the academic gifts but it gave me the moral gifts as well."■

Photo by Matt Cashore

KEVIN OLEHNIK '78, M.D. loosens the cast of a young girl in the field hospital near Leogane, Haiti.

College Expands Faculty

The following faculty joined the College of Science in fall 2013.

Daniel Bardayan
Associate Professor, Physics
Research: Exotic nuclei and reactions occurring in astrophysical explosions

Maxime Brodeur
Assistant Professor, Physics
Research: Precision experiments on exotic nuclei; development of a radioactive ion beam facility at Notre Dame

Manoel Couder
Assistant Professor, Physics
Research: Nuclear physics application (isotope production, imaging, etc.), nuclear astrophysics; nuclear physics in plasmas

Alexandra Jilkine
Assistant Professor, Applied and Computational Mathematics and Statistics
Research: Mathematical cell biology, pattern formation, nonlinear dynamics

Andrei Jorza
Assistant Professor, Mathematics
Research: Number theory, algebraic geometry, representation theory

Alan Lindsay
Assistant Professor, Applied and Computational Mathematics and Statistics
Research: Mathematical modeling; applied partial differential equations, computational mathematics

Adam Martin
Assistant Professor, Physics
Research: Theoretical high-energy physics

Athanasia Panopoulos*
Elizabeth and Michael Gallagher Family Assistant Professor of Adult Stem Cell Research
Research: Stem cells, reprogramming, cancer stem cells, blood cell development

John Parkhill
Assistant Professor, Chemistry and Biochemistry
Research: Theoretical chemistry—electronic structure theory

Anand Pillary
William J. Hank Family Professor of Mathematics, Mathematics
Research: Model theory, connections and interactions with algebra, geometry, number theory

*Begins January 2014

Additional faculty hires

Nicole Achee
Research Associate Professor, Biological Sciences

Earl Carter
Professional Specialist Assistant Dean, College of Science

Roya Ghiaseddin
Associate Professor of the Practice, Applied and Computational Mathematics and Statistics

Matthew Kloser
Concurrent Assistant Professional Specialist, Excellence in Science and Math Education Initiative, College of Science

Angela Laws
Assistant Director, UNDERC-West

Alexey Drozdetskiy
Research Assistant Professor, Physics

Faculty who have moved to a home department

Scott Egan
Research Assistant Professor, Biological Sciences, Advanced Diagnostics and Therapeutics

Christopher Jerde
Research Assistant Professor, Biological Sciences, Environmental Change Initiative

Jun Peng
Research Assistant Professor, Chemistry and Biochemistry, Harper Cancer Research Institute

Gregory Ragland
Assistant Professor, Biological Sciences, Environmental Change Initiative

Zonggao Shi
Research Assistant Professor, Chemistry and Biochemistry, Harper Cancer Research Institute

Christopher Sweet
Research Assistant Professor, Applied and Computational Mathematics and Statistics, Center for Research Computing

New Faces

Associate Dean for Undergraduate Studies

Photo by Barbara Johnston

MALGORZATA DOBROWOLSKA-FURDYNA, THE REV. JOHN Cardinal O'Hara, C.S.C. Professor of Physics, has been appointed associate dean for undergraduate studies in the College of Science. In this role, she will direct the undergraduate affairs of the College of Science, serve as chair of the college undergraduate committee, and will be the liaison to the Registrar's Office and the Office of Undergraduate Admissions.

As a member of the Notre Dame physics faculty, Dobrowolska served as associate chair and director of undergraduate studies in the Department of Physics from 2002 to 2006. She has earned several teaching awards including the Kaneb Teaching Award in 2005, the Shilts/Leonard Teaching Award in 2010, and the Rev. Edmund P. Joyce Award for Excellence in Undergraduate Teaching in 2008 and 2013.

Dobrowolska earned a Bachelor of Science and Master of Science in Physics from Warsaw University. She studied experimental condensed matter physics at the Institute of Physics, Polish Academy of Sciences in Warsaw and earned her Ph.D. in 1979. She joined the physics faculty at the University of Notre Dame in 1987.

Dobrowolska's research focuses extensively on a number of issues involving quantum structures based on diluted magnetic semiconductors. She has published over 240 journal articles in those areas. Her work has been cited over 3,400 times, with a Hirsch index of 34. In 1995, her research was distinguished by the National Science Foundation Creativity Award. Dobrowolska is a Fellow of the American Physical Society and of the American Association for the Advancement of Science. ■

Assistant Dean for Faculty Affairs and Special Projects

Photo by Barbara Johnston

By Gene Stowe

CAPTAIN EARL CARTER, FORMER PROFESSOR of naval science and commanding officer of the Naval ROTC Unit at the University of Notre Dame, has become assistant dean for faculty affairs and special projects in the College of Science, a newly-created administrative role. Carter, who came to Notre Dame in April 2011, retired from the Navy in August after more than 32 years.

Before he came to Notre Dame, Carter was executive assistant to the chief of naval personnel. Much of his earlier career was focused on submarine operations and maintenance. "Most everything about my business has involved science, technology, engineering and math," said Carter, who has an undergraduate degree in engineering and mathematics, and a master's in public administration. "I'm thrilled to have an opportunity to continue to contribute to the mission of the University."

A career submarine officer, Carter served on four, nuclear-powered submarines, commanded the attack submarine USS SCRANTON (SSN 756) and later commanding Submarine Squadron EIGHT. Among the highlights of his career, he cites "my trips to the North Pole, hosting a head of state underway on my ship, and the privilege of leading some of our nation's best and brightest men and women."■

Associate Dean for Research and Graduate Studies

By Gene Stowe

BRIAN M. BAKER, PROFESSOR OF CHEMISTRY and biochemistry, has been named the Associate Dean for Research and Graduate Studies in the College of Science beginning July 1. The role reflects the close link between research and graduate training, and is a key position in Notre Dame's research enterprise. "Reorganization of the Graduate School has given the college more responsibility for the graduate student element of the research enterprise," Baker said. "This makes sense, as the college establishes the size and resource allocation of research programs, and graduate programs are a fundamental component of the equation."

"Our goal is to emerge as a premier research university," he said. "Obviously, you can't excel in research without strong departmental and inter-departmental programs, but you can't have strong research programs without outstanding graduate students and superb training environments. That's a big part of this position—helping the college grow in both dimensions." This might include, for example, facilitating submission of large, collaborative grant proposals, but also helping to make strategic decisions in how departments in the college recruit, train, and support the best graduate student researchers. "This is an exciting time at Notre Dame," he said, "I'm excited to do what I can to enhance the impact of Notre Dame research and researchers." ■

Photo by Barbara Johnston

Assistant Vice President for Research

By Gene Stowe

RICHARD TAYLOR, WHO CAME TO NOTRE Dame in 1995 and became associate dean for research in the College of Science in 2008, became an associate vice president for research in July.

Taylor will focus on generating new research space for departments, as well as interdisciplinary research programs. He will have oversight of the Office of the Vice President for Research's internal competition and limited submission programs; and research proposal development and support. Under his leadership in the past five years, the College of Science's annual research awards increased from $33 million to $47 million. His own research program has produced more than 20 Ph.Ds. in the past decade. ■

Photo by Barbara Johnston

Faculty Spotlight

* * * *

Sharon Stack

CONTINUOUSLY FUNDED BY THE NATIONAL INSTITUTES OF HEALTH and the National Cancer Institute since 1993 for her research on mechanisms of metastasis, Sharon Stack is one of a handful of researchers in the U.S. who hold two research grants to study ovarian cancer, one of which is entering its fifteenth year. These awards, totaling over $2.8 million, enable researchers in the Stack lab to focus on developing new experimental approaches to more accurately model the complex environment of the abdominal cavity.

"While early detection of ovarian cancer is an urgent clinical problem, the majority of women with ovarian cancer die due to complications of inter-abdominal metastasis," says Stack. "A detailed molecular understanding of metastasis should lead to therapies aimed at blocking these processes and thereby extend the lives of women with ovarian cancer."

Because they have relatively vague symptoms, the majority of women with ovarian cancer already have advanced metastatic disease at diagnosis. The Stack lab is collaborating with Notre Dame colleagues in engineering and the Notre Dame Integrated Imaging Facility to better understand the microenvironment of the peritoneal cavity and the contribution of factors, such as obesity, to ovarian cancer metastatic success. The Stack lab also studies cancer of the oral cavity and the striking increase in oral cancer associated with oral human papillomavirus (HPV) infection.

Stack earned a Ph.D. in biochemistry from the University of Louisville, followed by a post-doctoral fellowship at Duke University. She joined the Northwestern University Feinberg School of Medicine, rising through the ranks to professor. She served as vice chair for research and professor of cancer research in the Department of Pathology and Anatomical Sciences at the University of Missouri School of Medicine prior to her recruitment to Notre Dame in 2011.

Stack is the inaugural director of the Mike and Josie Harper Cancer Research Institute (HCRI), a collaborative venture between Notre Dame and Indiana University School of Medicine-South Bend. She says, "Notre Dame offers a unique environment in which to conduct cancer research due to the strength and depth of the basic sciences and the collaborative nature of its faculty. Breakthrough level discoveries necessitate a novel approach conceived at the interface between chemistry, biology, physics, mathematics, engineering, and medicine. Combined with the spirit to do good works that pervades campus, Notre Dame is the perfect place for cutting-edge cancer research."

Stack is the Ann F. Dunne and Elizabeth Riley Director of the HCRI and professor of chemistry and biochemistry. The Dunne/Riley Directorship was established in 2008 by James J. ('78) and Susan Dunne and Richard T. ('78) and Constance Riley. Former Notre Dame roommates, Jimmy and Rich created this position to memorialize their mothers, both lost to cancer. ■

SHARON STACK, the Ann F. Dunne and Elizabeth Riley Director of the Harper Cancer Research Institute, was responsible for bringing over $2 million in new funding for cancer research to Notre Dame within the past year.

Photo by Ryan Dorgan

Graduate Student Spotlight

Wenrui Hao

By Gene Stowe

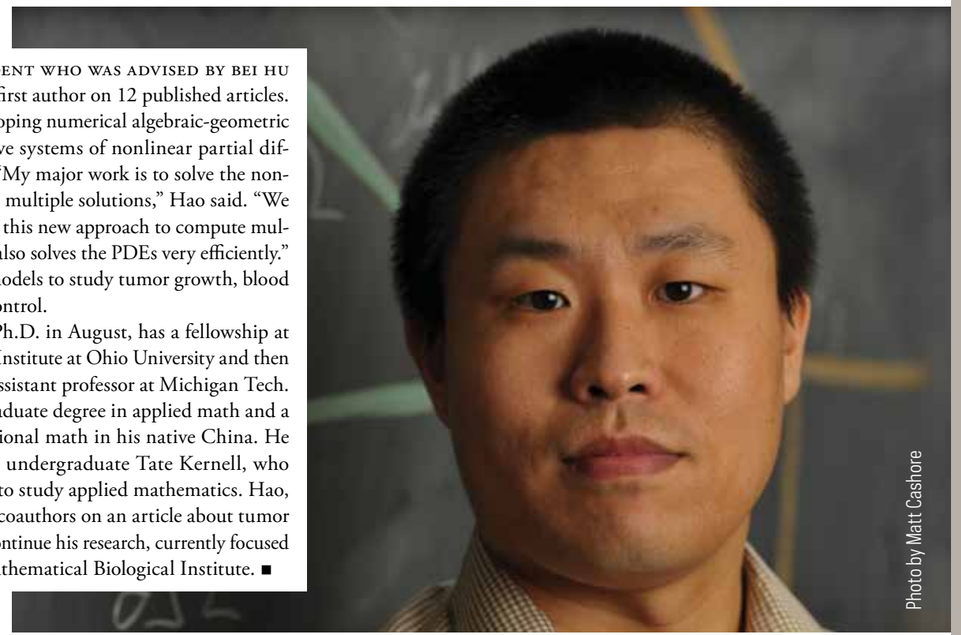


Photo by Matt Cashore

WENRUI HAO, A PH.D. STUDENT WHO WAS ADVISED BY BEI HU and Andrew Sommese, was first author on 12 published articles.

His work involved developing numerical algebraic-geometric methods to numerically solve systems of nonlinear partial differential equations (PDEs). "My major work is to solve the nonlinear PDEs and to compute multiple solutions," Hao said. "We are the first group to develop this new approach to compute multiple solutions. Our method also solves the PDEs very efficiently." He used the mathematical models to study tumor growth, blood coagulation and cell cycle control.

Hao, who received his Ph.D. in August, has a fellowship at the Mathematical Biological Institute at Ohio University and then will become a tenure-track assistant professor at Michigan Tech.

Hao earned an undergraduate degree in applied math and a master's degree in computational math in his native China. He and Sommese co-mentored undergraduate Tate Kernell, who has gone to graduate school to study applied mathematics. Hao, Sommese, and Kernell were coauthors on an article about tumor growth modeling. Hao will continue his research, currently focused on atherosclerosis, at the Mathematical Biological Institute. ■

Undergraduate Student Spotlight

Patrick Kramer

By Jason Kelly

Photo by Steve Toepp

DENGUE FEVER CAN CAUSE SEVERE complications and even death, but the treatment is the same as the common cold. "It's just fluids and bed rest. There is no vaccine," said Patrick Kramer '13, a Fulbright fellow at the National University of Singapore.

With his Fulbright research grant, Kramer is spending the academic year contributing to the long-term goal of developing medications or vaccines for dengue fever, the mosquito-borne tropical disease which afflicts 50–100 million people a year across the world.

Kramer, who received his undergraduate degree in chemistry, works in Thorsten Wohland's Biophysical Fluorescence Laboratory. He identifies dyes that bind to the dengue virus, allowing researchers to track how it replicates on a nanometer scale. "Other people could take this and say, 'the virus produces this protein, which produces this interaction, maybe we can stop this with a drug'," Kramer said.

After a scientific entrepreneurship course with Dean Greg Crawford introduced him to the uses of fluorescent dyes, Kramer asked to do laboratory research with Professor Bradley D. Smith. "It just took off from there," he said.

A former walk-on punter under football coach Charlie Weis, Kramer's focus shifted to research, which he hopes to incorporate into a future career as a physician. While applying to medical schools in August before leaving for Singapore, he envisioned international work blending infectious-disease research and treatment.

"Dengue fever is really prevalent in the tropics," Kramer said, "so I may be living there for an extended period of time."■

Alumni Spotlight

Physics Class of 1963

Sputnik-era Physics Majors Return for 50th Reunion

By Gene Stowe

THEY CAME TO NOTRE DAME IN THE LATE 1950s, in the wake of Sputnik, with a sky-high U.S. commitment to science education and the University of Notre Dame already recognized as a leading center for physics research. Ten members of the Class of '63 returned for Alumni Weekend, their 50th anniversary, for a tour of Jordan Hall of Science, the Museum of Biodiversity and the Digital Visualization Theater, and the new nuclear accelerator in Nieuwland.

"The Sputnik era fired up my imagination, it fired up the country and led to tremendous support for the sciences—no trouble [back then] getting financial support for graduate work," recalled Barry Burke, who pursued his longstanding interest in science at Notre Dame. "I remember a fabulous group of faculty who really gave us a very deep and very rigorous training in physics. That prepared me so very well for my career."

Burke earned a Ph.D. in applied physics at Stanford University in 1969 and enjoyed a long career at MIT Lincoln Laboratory in Lexington, Mass. He focused on charge-coupled devices with applications from the military to digital cameras, including the Chandler X-ray telescope. "It was the high point of my career—figuratively and literally. It was a big mission."

Lyle Pauer received a master's degree from John Carroll University and a Ph.D. from Case Western Reserve University. He was granted four U.S. patents in a career at aerospace firms, culminating as senior physicist at Lockheed Martin. His work in sonar, submarine simulation, aircraft missile defense, and free space optical communication included a position as the first technical director on a DARPA program to develop a system for combined, optical and radio frequency communication between aircraft and ground stations.

Charles Tilford earned a Ph.D. at Iowa State University and worked at the National Bureau of Standards as a physicist from 1970 to 2000. Since then he has been an independent consultant, using his ultra-high vacuum and instrumentation skills to develop and maintain encasements for the preservation of high-value historic documents, including signed originals of the Declaration of Independence and U.S. Constitution, a draft Declaration of Independence in Thomas Jefferson's handwriting, and two drafts of the Gettysburg Address in Abraham Lincoln's handwriting.

After the Soviet Union launched Sputnik in 1957, Bill Moran started an astronomy and rocket society with high school classmates Ed Siegfried and John McLeod. The three attended Notre Dame: Moran and McLeod majored in physics and Siegfried in math.

Other class members who attended the reunion included Kent Akerson, Charles Tilford, David Eartly, Denis Morrow, David DeMartini, David Fogarty, and Mike Connor. Connor served two years in the Navy after graduation, went to work for Westinghouse Electric as a manager of uranium supply for commercial nuclear power, and eventually started Nuclear Resources International Inc., with more than 100 clients in 14 countries on five continents. He came to Notre Dame on the advice of the *New York Times* science editor, who gave him a ride when he was hitchhiking to a high school track meet.

"I told him that I wanted to study nuclear physics," recalled Connor who listed top universities among his choices. "He said, 'Of that group there is no question where you should go—Notre Dame. It's the best kept secret in the country. Notre Dame has the finest undergraduate physics department in the country.' "■

Photos by Joe Raymond

(L TO R) MITCHELL WAYNE (DEPARTMENT CHAIR), EMERSON FUNK (EMERITUS FACULTY), CHARLES TILFORD, EDWARD SIEGFRIED, DAVID EARTLY, JOHN POIRIER (EMERITUS FACULTY), JOHN MCLEOD, DENIS MORROW, LYLE PAUER, MIKE CONNOR, DAVID DEMARTINI, BARRY BURKE, DAVID FOGARTY, AND WILLIAM MORAN

Standing Ovations

Faculty Accolades

* * * *

Eighteen University of Notre Dame faculty members received the Rev. Edmund P. Joyce, C.S.C., Award for Excellence in Undergraduate Teaching, including four science faculty: **PATRICIA CLARK, MALGORZATA DOBROWOLSKA-FURDYNA, J. DANIEL GEZELTER** and **JAMES F. JOHNSON.**

▲ **BRIAN BAKER,** associate professor of chemistry and biochemistry, was selected as an associate editor for *Journal of Immunology.*

▲ **KATHLEEN CANNON,** O.P. , D.Min., associate dean in the College of Science, received the 2013 Dockweiler Award for Excellence in Undergraduate Advising.

▲ **PATRICIA L. CLARK,** the Rev. John Cardinal O'Hara, C.S.C. Professor of Chemistry and Biochemistry, received a $3.8M award from the National Institutes of Health (NIH) to lead a pioneering model of collaboration that draws together seven institutions, eight co-PIs, and six postdoctoral associates to study macromolecular interactions in living cells.

▲ The Association of Analytical Chemistry (ANACHEM) selected **NORMAN DOVICHI** to receive the 2013 ANACHEM Award for his achievements as an analytical chemist and educator.

ALEXANDER HAHN, professor of mathematics, won the 2012 PROSE Award in the architecture and urban planning category for his book, *Mathematical Excursions to the World's Great Buildings.*

▲ **JESSICA HELLMANN,** associate professor of biological sciences, was named associate editor for the ecology domain in the journal, *Elementa: Science of the Anthropocene.*

▲ **DAVID HYDE,** the Rev. Howard J. Kenna, C.S.C., Memorial Director of the Zebrafish Research Center and professor of biological sciences, received the 2013 Schilts/Leonard Teaching Award, which is awarded annually to faculty member for exceptional undergraduate teaching in the College of Science.

▲ **COLIN JESSOP,** professor of physics, was appointed to two research management positions at CERN in Geneva, Switzerland. CERN is the world's leading high energy physics laboratory and home of the Large Hadron Collider (LHC).

▲ **PRASHANT KAMAT,** a Rev. John A. Zahm Professor of Science, was named a 2013 Langmuir Lecturer. He delivered a plenary lecture in a special session of the Colloid and Surface Chemistry Division program at the 246th ACS National Meeting.

Adjunct professor of physics **DON LINCOLN** was the 2013 recipient of the Outreach Prize from the European Physical Society, High Energy Physics Division.

KATHIE NEWMAN, professor of physics, was awarded the 2013 Director of Graduate Studies Award from the Graduate School.

▲ **ZACHARY SCHULTZ,** assistant professor of chemistry and biochemistry, was named a 2013 Cottrell Scholar. Cottrell Scholar Awards are given to early-career professors who have developed excellent research programs and excellent approaches to undergraduate teaching.

▲ **ROBERT V. STAHELIN,** adjunct assistant professor of chemistry and biochemistry at the University of Notre Dame and associate professor of biochemistry and molecular biology at Indiana University School of Medicine-South Bend (IUSM-SB), was selected as one of four inaugural Showalter Scholars at IUSM.

▲ *The Laboratory Rabbit, Guinea Pig, Hamster, and Other Rodents,* edited by **MARK A. SUCKOW,** research professor of biological sciences, has won the 2012 PROSE Award for Best Single Volume Reference in Science.

▲ **JENNIFER TANK,** the Ludmilla F., Stephen J., and Robert T. Galla Collegiate Chair in Biological Sciences earned the James A. Burns, C.S.C. Award, which is given annually to a faculty member for distinction in graduate teaching or other exemplary contribution to graduate education.

Undergraduate Accolades

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Mathematics major **DANIEL IRVINE, '14** and biological sciences major **REBECCA MARTON, '14** were named Barry M. Goldwater Scholars for the 2013-14 academic year. The prestigious scholarship is awarded to the top undergraduate scientists, mathematicians, and engineers around the country.

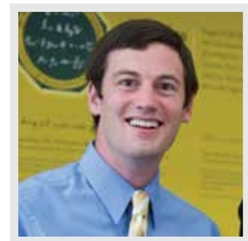
▲ **BROOKE CONTI, '13** earned the 2013 Dean's Research Award. She was a member of the Glynn Family Honors Program, and had extensive research experience in Zachary Schultz's lab and at institutions off-campus. She graduated with a degree in science-business and is now continuing her education at Graduate School of Biomedical Sciences at Gerstner Sloan-Kettering Cancer Center.

▲ **LEE HARUNO, '13** earned the 2013 Dean's Research Award. He worked with Kasturi Haldar on Niemann-Pick Type C disease research and took advantage of several clinical experiences during his summer breaks. He graduated with a degree in science preprofessional studies and is now attending the Baylor College of Medicine.

▲ **KEVIN KELLY, '13** earned the 2013 Dean's Research Award. As an undergraduate, he worked with Michael Hildreth on particle physics research. He also served as the drum major in the Notre Dame Marching Band during his senior year. Kelly graduated with a double major in mathematics and physics and is now pursuing a Ph.D. in particle physics at Northwestern University.

▲ **PATRICK KRAMER,'13** earned a Fulbright Scholarship to conduct research in Singapore and will work as an organic chemist at the National University of Singapore studying the virus that causes dengue fever. He graduated in May with a degree in chemistry.

▲ **MICHELLE LUNDHOLM, '13** was the recipient of the 2013 Dean's Award, which recognizes a graduating senior for exemplary personal character, service, and scholarship. She also earned the General Electric Prize for Senior Mathematics Majors, the William R. Wischerath Outstanding Chemistry Major Award, and the Outstanding Chemist Award. She graduated in May with a double major in chemistry and mathematics, and is now attending the Feinberg School of Medicine at Northwestern University.

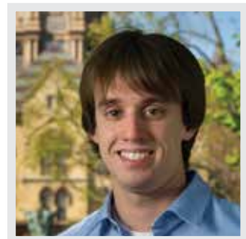


▲ **KEVIN MCDERMOTT, '13** earned the 2013 Dean's Research Award. He worked on various projects regarding the Higgs boson analysis on campus and spent a summer doing research at CERN on the ALICE project. McDermott was a member of the Glynn Family Honors Program and graduated with a degree in physics. He is now pursuing a Ph.D. in high energy physics at Cornell University.

▲ **MATTHEW METZINGER, '14** received a Batten Fellowship for cancer research over the summer at Notre Dame. He worked in Sharon Stack's laboratory at the Harper Cancer Research Institute.

▲ **MURPHYKATE MONTEE, '13** received a National Science Foundation Graduate Research Program Fellowship. She was also the recipient of the 2013 Dean's Award, which recognizes a graduating senior for exemplary personal character, service, and scholarship.

▲ Chemistry major **ANSEL NALIN, '14** received the 2013 Norbert L. Wiech Award which is presented annually to an outstanding junior who has excelled in academics and undergraduate research at the University of Notre Dame. Nalin also earned a Batten Fellowship to pursue cancer research at Notre Dame over the summer in Rich Taylor's laboratory.



▲ **PATRICK O'HAYER, '13** was the recipient of the 2013 Dean's Award, which recognizes a graduating senior for exemplary personal character, service, and scholarship. He is now attending the University of Michigan to pursue a joint M.D./Ph.D.

Graduate Accolades

AMY BUCHMANN, MATTHEW LEMING, DERRICK PARKER, ALI RAJA, SHAYNA SURA, CATHERINE CAMPOS, JEREMY EBERLE, IAN HARRIER, JOHN HERRINGTON, BRENDAN MAHONEY, NICOLE KROEGER, BRIAN SHOURD, WILLIAM BAUDER, KAREN OSTDIEK, and **ALLISON SHOWALTER** received 2013 Outstanding Graduate Teaching Awards. The awards are given annually by the Notre Dame Graduate School and the Notre Dame Kaneb Center for Teaching and Learning, honoring graduate student instructors and teaching assistants whose teaching demonstrates excellence in the classroom or laboratory.

BRANDON HAINES, MATTHEW MCDONALD, ERIN WILSON, AND MATTHEW WILSON attended the 63rd Lindau Nobel Laureate Meeting in Lindau, Germany. The purpose of the annual meeting is for young researchers and Nobel Laureates to come together to exchange knowledge and ideas, share their enthusiasm for science, and to establish new contacts.

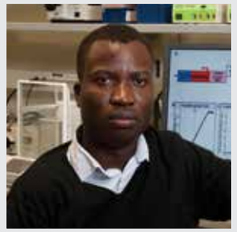
RENEE BOULEY was selected to receive a prestigious American Chemical Society (ACS) Division of Medicinal Chemistry Predoctoral Fellowship. This award supports doctoral candidates working in medicinal chemistry who have demonstrated superior achievements as graduate students and who show potential for future work as independent investigators.

AMY KLEGARTH earned a Fulbright Scholarship to study the population genetic structure of urban monkeys in Singapore by deploying GPS collars to track the movements and interactions of long-tailed macaque populations.

SHAILAJA KUNDA was awarded the Faculty for the Future Award. Faculty for the Future fellowships are given to women from developing and emerging countries who are preparing for Ph.D. or post-doctoral studies in the physical sciences at top universities abroad. This is her second year receiving the award.

NATHAN MEREDITH won a second place prize in the in the U.S. Department of Energy's Innovations in Fuel Cycle Research Awards competition for the Open Competition in the category of Used Fuel Disposition. His award-winning research paper, "Synthetic Influences on Neptunium Incorporation in Naturally Occurring Copper Uranyl Phosphates," was published in the journal *Crystal Growth & Design*.

REBECCA QUARDOKUS received the 2012-13 Rohm and Haas Outstanding Graduate Research Award. The award was given in recognition of her exceptional productivity in research.



GEOFFREY SIWO attended the entrepreneurial summer program at Singularity University, an institution founded by NASA, Genentech, Autodesk, Google, Nokia, Cisco, Kauffman Foundation, and ePlanet Capital. Siwo was one of only 80 people from 38 countries invited to participate in this exclusive program out of over 3,000 applicants.

ZACHARY TERRANOVA won the 2013 Center for Research Computing Award for Computational Sciences and Visualization. This award recognizes outstanding contributions in the areas of computational sciences and visualization.

Alumni Accolades

MICHAEL KRON, M.D., M.Sc., FACP, '76, was named a Jefferson Science Fellow by the National Academy of Sciences. As a Fellow, he will work with the U.S. Department of State to establish a new model for engaging the American science, technology, engineering, and medical academic communities in the formulation and implementation for U.S. foreign policy.

RICHARD D. CONNELL, Ph.D. '89, was named the Graduate School's 2013 Distinguished Alumnus. Connell was honored for his achievements in pharmaceutical research and development, as well as his accomplishments as a leader at two of the world's largest pharmaceutical companies: Bayer and Pfizer.

Photo by Kate Lewis

Finding a New Career Vision in Patent Law

Prior to becoming a patent agent, Kerisha Bowen had spent a majority of her life in an academic setting. After earning a Ph.D. in organic chemistry from Temple University, she became a post-doctoral fellow at the University of Pennsylvania School of Veterinary Medicine and taught at Penn State's Brandywine campus and Rowan University.

After a few years of teaching and research, Bowen realized she needed a new vision for her career path. "I wasn't satisfied with my career choice," she explained. "I looked for other career paths that were available to me with my training in organic chemistry and found patent law to be a viable option."

As a member of the inaugural Master of Science in Patent Law (MSPL) class, Bowen worked with Brandon Ashfeld, assistant professor of chemistry and biochemistry, to draft a patent application for small molecules that could be used as precursors for brain cancer chemotherapeutics. She also worked with William Schneider, professor of chemical and biomolecular engineering, to write a patent application for a refrigeration cooling system that utilizes ionic liquids as a refrigerant.

Bowen graduated in May and now works for Dentons, LLP in Washington, D.C. where she executes patent applications for the firm's clients in Europe. She credits the MSPL program for teaching her exactly what would be expected of her as a patent agent.

"What I liked best about the MSPL program is that the curriculum was practically centered. The assignments we did were directly related to the work I perform now as a patent agent," she said. "When I started at Dentons, I was just given cases to work on pretty much by myself because my coworkers were too busy with cases of their own. I don't think I would have known where to start had I not completed the MSPL program."

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THE SARAH L. KRIZMANICH TELESCOPE, one of the largest university telescopes, will provide undergraduate and graduate students with cutting-edge astrophysics research experience. With a 32-inch diameter mirror and 820mm f/8 optics, the research-grade telescope will also be used to test new instrumentation developed by Notre Dame physicists and graduate students.

Photo by Matt Cashore