Once a distant, fantastic and sometimes frightening concept enjoyed from the safety of a movie theater seat or worn pages of a favorite book, artificial intelligence is here, and advances are made every day. In “Virtual Reality” researchers within the Department of Computer Science describe work that may turn science fiction fantasy into a reality.
GREETINGS FROM WEST LAFAYETTE,

With a new strategic plan in place, 2017 is off to a productive start. This plan serves as a blueprint for strategic investment and continued excellence for the Purdue College of Science. With input from constituents of the college, a dedicated group of faculty and staff members from the college—and beyond—worked diligently to produce this plan, the first new plan in more than a decade. The plan is covered in this issue of Insights (see “On a mission” on page 21), and it can be viewed in full on www.Science.Purdue.edu.

The most significant growth in the college has been in the Department of Computer Science. The CS expansion plan is thriving as undergraduate and graduate student enrollment continues to increase. In this publication, we take a look at the artificial intelligence and machine learning areas. Our researchers are making our digital lives easier with breakthroughs for the web and the phones in our pockets.

Fundamental discoveries are the hallmark of our research agenda, which is exemplified by the many accomplishments of Michael Rossmann in structural biology. Professor Rossmann, the Hanley Distinguished Professor of Biological Sciences, has had an unbelievable career that spans several decades and many discoveries, and he continues to make headlines at age 86.

Members of the Department of Earth, Atmospheric, and Planetary Sciences are conducting climate change research in the far reaches of the planet. This spring, Professor Nat Lifton and graduate student Jenny Newall joined an international team in Antarctica, while alumnus Robin Blomdin’s field work in Mongolia and Kyrgyzstan became the focus of an international short form documentary titled “Through the Valleys.”

This academic year saw Purdue Science programs show well in academic online polls. The Department of Chemistry was lauded for having the second most female professors in the nation and the second highest percentage of female faculty. Purdue Actuarial Science was deemed the top in the nation. Within these pages you can read more about why these programs are so successful.

During the time that I have had the privilege of serving as the interim dean, it has been very rewarding to see up close the tremendous work accomplished by our faculty, staff and students. We look forward to welcoming the new Frederick L. Hovde Dean this fall and encourage you to keep connected through our social media outlets. We are grateful for your continued interest in and support of the College of Science and hope we have an opportunity to welcome many of you at one of the numerous events this fall. Hail Purdue!

CRAIG SVENSSON
Interim Dean of the College of Science

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The career of Michael Rossmann, the Hanley Distinguished Professor of Biological Sciences, spans more than 50 years. He continues to make discoveries that earn headlines, and his personal story is as interesting as his professional achievements. He survived World War II, learned from top 20th-century scientists and transformed not only Purdue’s program, but the entire field of structural biology. Learn more about this living legend in this issue of Insights.
As many students head to warm, sunny locations for spring break 2018, one alumnus will head into the cold, dark expanse of space. College of Science alumnus and astronaut Andrew Feustel's third NASA mission is scheduled to launch in March 2018.

Feustel will return to the International Space Station and will stay for six months—he's first long duration mission. He will serve as an engineer on Expedition 55 and as commander of the space station for Expedition 56.

Feustel's earlier missions were around two weeks' long, and he says what excites him about the long mission is the chance to live in space.

"What I look forward to most is being there long enough to know what it is like to be an off planet inhabitant of space, and really know what it is like to live and work there day in and day out," he says.

BOILER UP!

When he arrives at the International Space Station, Feustel will be met by fellow Builermaker Scott Tingle (Mechanical Engineering ’88), who will be finishing his first NASA mission and his 2011 mission to the Hubble Space Telescope. He has logged a total of 42 hours on six spacewalks.

"I really enjoy that work, the view is amazing," he says. "The satisfaction that I get from working outside in a space suit and making repairs to the space station is pretty wonderful and something that I look forward to, hopefully, doing again."

He says his favorite pastime in space is looking back on the Earth as it rotates beneath him.

"There is no way to describe what the sensation of seeing Earth from space is, but it is quite magical," he says. "That's probably the best thing about being there, being able to look back on the planet and see how beautiful it is."

A PURDUE LEGACY

Feustel earned a bachelor's degree in solid earth sciences in 1989 and a master's degree in geophysics in 1991, both from Purdue. He earned a doctoral degree in geological sciences from Queen's University in Kingston, Ontario, Canada, in 1995.

Purdue is an important part of the Feustel family history. His great great uncle graduated from Purdue in 1905, followed by his father and uncle. Feustel met his wife, Indira Devi Bhatnagar, while they were students at Purdue. They have two sons, Ari and Aden.

Once part of a Purdue Grand Prix legacy—his uncle won the race in 1965 and Feustel's goal growing up was to drive a kart there himself (which he did in 1998, 1999 and 2000) — Feustel is now a Purdue legend, adding to Purdue's reputation as the "Cradle of Astronauts."

AN UNFORGETTABLE VIEW

Feustel also looks forward to the opportunity for spacewalks, which he performed on both his 2009 mission to the Hubble Space Telescope and his 2014 mission to the International Space Station. He has logged a total of 42 hours on six spacewalks.

"I believe ... we will see the eventual and inevitable capability for humans to permanently live off the surface of our planet," he says. "I think human space flight is important to the survival of our species."

LOOKING TO THE FUTURE

Feustel believes manned missions will be a significant part of our future.

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To date, 23 Purdue alumni have been chosen for space flight, including Neil Armstrong, the first person to walk on the moon, and Eugene Cernan, the most recent person to do so. Purdue alumni have flown on approximately 35 percent of all manned U.S. space flights.

GEARHEAD

Feustel still thinks of himself as a mechanic and always has a project going in his garage. He has a passion for working on older BMWs.

"I don't really think of myself as an astronaut, I think of myself as an individual who has a really great job and was very lucky to have found it. But I am just as happy in the garage with tools in my hands as I am in space floating around doing research."

Instructor Chaubey, head of the Department of Earth, Atmospheric, and Planetary Sciences, says Feustel is a gracious and giving alumnus.

"Dr. Feustel is an incredibly personable human being," Chaubey says. "Despite his busy schedule, he makes time to meet with students and faculty, and attends special events on campus. We are grateful to him for his continued engagement and for the way he inspires the next generation of Purdue scientists and future astronauts."

Photo by iStock Photo

Follow Feustel’s journey from training to space on Twitter @Astro_Feustel and Instagram @astro_feustel.
By Tim Brouk

Artificial intelligence and machine learning benefit us every time we shop online, search on Google or ask Siri for help.

But before Siri, there was an obstinate, murderous program known as HAL 9000, a memorable spaceship computer in the classic 1968 film “2001: A Space Odyssey” by Stanley Kubrick. For millions of science fiction fans, HAL was their first exposure to artificial intelligence — a distant and fantastic concept.

Today, the machine intelligence program within the Department of Computer Science is taking on projects that make science fiction a reality.

“We’re not nearly in that area where AI will take over the world,” says Dan Goldwasser, assistant professor of computer science. “But we are at a point where we can understand and process massive amounts of data and someone is able to manipulate this data for their benefit. All of these Isaac Asimov-style movies say something deep about people, not the technology.”

Goldwasser’s research focuses on language. One goal is to build an algorithm that can represent meaning and intention in communication, which would translate into better-performing systems.

“Natural language processing is one of the main applications of machine learning,” he says. “The holy grail, so to speak, is to build a system that can seamlessly support interactions with human agents.

“ To some degree, this is happening now with Siri and Alexa, but these success stories still have a narrow field of application.”

Goldwasser wants the questions that Siri answers with sass and snark to be answered with real data. Siri is fun, but computer scientists see a lot of room for growth — better automatic translation, question and answering beyond search results, and analyzing conversation roles. He sees a Siri coming soon that will improve and learn from the user.

“You can give Siri training sessions,” Goldwasser says. “‘This is what I want you to do when I say X.’ It will be very exciting times when this is widespread.”

Kristen Johnson, one of Goldwasser’s graduate students, is looking at language 140 characters at a time. In fall 2016, she noticed an uptick in politicians flocking to Twitter to get messages to their constituents and potential voters. Could a mass analysis of these tweets be used as fuel for predicting the public’s outlook on elections or other political issues?

“We were curious to see if we could model politicians’ social media language and behaviors with computational methods,” she says. “So we designed our models to capture and use these aspects in order to analyze politicians’ stances and agreement or disagreement on important political issues, such as the environment or minority rights.”

Johnson hopes to publish her findings soon. There is no shortage of data for her to analyze, she says. She expects to be busy well beyond the next election cycle.

“This work also could be spread to social media outlets for better identifying ‘fake news.’

“I believe that is imperative for future elections,” Johnson says, “so that the public has the facts necessary to make the best choices for our communities and country as a whole.”

Photos by / Charles Jischke
“This same failure has another seemingly unrelated side. “Suppose you have an idea for a new gadget, an idea so good that you are willing to put your life on hold to pursue it. But first, you want to make sure the idea is novel. What would you do? Ask your friends? Google a few keywords that you believe describe the idea? What if you don’t use all the right keywords and spend precious time and resources inventing a gadget that already exists?”

The problem in both scenarios is the overreliance on keywords to deliver information, Ribeiro says. In the shopping scenario, the word “socks” triggered a tornado of socks ads; in the invention scenario, the word “catch-22” is that we need to know the right keywords to find information about an unfamiliar topic.

“Part of my research harnesses the collective power of a billion users navigating the internet every day to find better ways to deliver information — from what a specific user wants to buy after he or she buys socks to finding information without keywords,” he says.

Ribeiro is seeking a mathematical formula to better understand user navigation behavior that can help improve both a user’s experience as he or she searches for information on the web and the relevance of the advertiser offerings he or she sees. He explains that a system or model that understands the entire user trajectory on the web, where they start, where they want to go, and when they are looking for something else is possible and would soften the “force” of these ads that pop up for textbooks or socks. It’s all about that user experience.

“If we know the right way to get you to what you want, that will be really helpful. And the same mathematical model can be applied to detecting account hijackings and helping startups find new customers through social networks,” Ribeiro says.

Neville, associate professor and Miller Family Chair of Computer Science and Statistics, saw this AI breakthrough as a big one. Go is a board game that originated in China about 2,500 years ago and is still played today. The goal is to surround more territory than the opponent. She recognized Go as a good test for AI technology because the number of potential moves or game trees are astronomical — $10^{123}$, compared with chess’ game tree of $10^{40}$. To put this in perspective, $10^{10}$ is what scientists believe is the number of atoms in the universe.

“This success happened much earlier than anticipated,” Neville told her audience, adding that WIRED magazine dubbed the event “just a glimpse of how powerful AI will be.” Machine learning makes it possible for computers to outwit their human counterparts by combining deep learning and reinforcement learning.

But just 10 days after the AlphaGo victory, a chatbot named Tay took to Twitter and promptly brought programmers’ heads down from the clouds. After only 24 hours of Twitter interaction, the Microsoft-launched AI chatbot was transformed into a racist, hate-spinging jerk. “It was designed to mimic a young, teenage girl. The bot was supposed to interact with millennials and learn how to engage them,” Neville says. “The experiment went horribly wrong.”

Microsoft apologized and removed Tay from existence. What went wrong? Humans. And the fact that Tay was “still learning.”

As a dialogue system, Tay was surprisingly vulnerable to coordinated troll attacks by a subset of Twitter users. Fast systems showed much success, and Tay was counted on as being the next step after: Neville says many researchers did not see Tay as a total failure. The bot learned a lot, but at the level of a young, impressionable child.

Tay has helped its creators go back to humans for help. Improvisational actors have joined the AI show with the goal of the programming to adapt to different situations without having many examples — just like adult humans are capable of doing.

“Microsoft is trying to encode the success of this in its chatbots,” Neville says. “The actors are thrown into new situations all the time, and they have to keep the act going.”

**Eugene Goostman (2014)**, which convincingly 33 percent of judges it was human, passing Turing tests.

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A virtual reality video game developed by Purdue researchers offers an immersive, citizen-scientist tool to develop potential treatments for cancer and Alzheimer’s disease.

With an HTC Vive headset strapped on and controllers in both hands, the game player travels inside a biological cell. The goal is to find the right combination of molecules to combat a disease.

Gaurav Chopra, assistant professor of chemistry, collaborated with chemistry graduate student Jonathan Fine, staff members at the Purdue Envision Center for Data Perceptualization and computer science undergraduate students to develop the game.

A chemistry degree is not required to manipulate molecular models or dive into a colorful protein. Players create new molecules, and a skilled player could discover a molecular combination that leads to a potential drug. The player not only gets a high score, but he or she can get in on the research itself, which is where the true uniqueness of the game comes in.

With so many different routes to take in treatment of diseases like cancer and Alzheimer’s, the drug discovery field is still wide open,” Chopra says. “If I want to change a compound, I want to go and feel like I’m inside of the binding pocket, feel like I’m part of the compound. … You really feel like you’re in a different world.”

Chopra’s lab first makes predictions on the computer before testing promising candidates in the lab for the potential to develop new drugs that could fight cancer and Alzheimer’s.

The work focuses on protein targets and platforms that can identify those targets easily. The work also can help in fast treatments of epidemics, too.

Computer science student Wei Zhang is a front-end developer and worked on the game’s visualization. He sees great potential in the game and says it is the right combination of education, science and entertainment.

Zhang says he has enjoyed the collaboration with Chopra’s lab, which contains several chemistry and biochemistry students. He trusts their side of the science, which helps his work.

“VR is here to stay — not just for entertainment and science breakthroughs,” Zhang says. “There are just so many scientific VR applications that have started popping up in the last year. There are already a lot of killer apps out there, like the Oculus Medium, which enables 3-D modeling and sculpting in VR.

A passing fad in the early 1990s, VR is here to stay — not just for entertainment but also for education and science breakthroughs.

Chopra’s lab is for Drug Discovery in January, after a master’s degree and postdoctoral work at Stanford University under Michael Levitt, the 2013 Nobel Prize in chemistry winner.

DIGITAL EXTENSION OF RESEARCH

The VR game is the next step in Chopra’s research. The graphics and programming in the game explain the work done in the wet lab across from Chopra’s office in the Institute for Drug Discovery.

“My lab has two aspects: computational and experimental,” Chopra says. “This is a new, flexible docking and design program. This program essentially asks the question: How well does the molecule of a drug fit inside a binding pocket of a protein?”

Proteins within cells have binding pockets that allow them to connect with other molecules. These connections are involved in cellular functions, and some are important to disease development. Targeted drug molecules can attach to these pockets and block them, but molecules with the potential to bind to these pockets must first be identified.

“You need 3-D. You need to feel like you are part of that experience,” Chopra says. “I want to change a compound, I want to go and feel like I’m inside of the binding pocket, feel like I’m part of the compound. … You really feel like you’re in a different world.”

Chopra’s lab needs a high-powered computer along with the VR sensors. He hopes to make the game more online-friendly and more compliant with systems and mobile devices, but more funding will be required to meet those goals.

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For more than 50 years, Michael Rossmann, the Hanley Distinguished Professor of Biological Sciences, walked to his labs in Lilly Hall and Hockmeyer Hall of Structural Biology from his West Lafayette home. It was a leisurely 30 minute stroll, at just over a mile to the southern tip of the Purdue campus. However, if one adds up all of his trips, he has traveled a distance equal to a round trip to Rio de Janeiro, Brazil, and back again to his home.

During these walks down Grant Street past the blocks of homes built in the early 20th century as Purdue University grew and through an expanding campus — Rossmann’s mind stormed with ideas. Ideas mulled on these walks have led to monumental discoveries in the field of structural biology.

Rossmann’s discoveries have helped doctors understand, treat and even cure infections from alpha viruses, coxsackievirus B1, flaviviruses like dengue and Zika, and even the rhinovirus that causes the common cold.

His latest work has been a collaborative effort with Richard Kuhn, professor of biological sciences and director of the Purdue Institute for Inflammation, Immunology and Infectious Disease, to study Zika virus. The virus has received widespread attention because of an increase in microcephaly — a birth defect that causes brain damage and an abnormally small head in babies born to some mothers infected during pregnancy — and reported transmission of the mosquito borne virus in 33 countries.

On March 31, 2016, Rossmann and Kuhn’s team was the first to determine the structure of Zika virus and, in January, the team also revealed the structure of Zika’s immature form. Both are critical steps in the development of effective antiviral treatments and vaccines.

“The virus goes through a certain life cycle during its infection process,” Rossmann says. “Therefore, procedures that interrupt this process are likely to block viral replication.”

Rossmann, a spry octogenarian, has published nearly 600 papers and received numerous awards and honors, but his life has been more than these accomplishments. It has been a journey through 20th century science history.

Rossmann’s family emigrated from Frankfurt, Germany, to England in 1938, as World War II ignited. Rossmann clearly remembers the Blitz, the Nazi bombing campaign of London from 1940 to 41.

“There were bombs every night,” he recalls.

The family resided in London, but as the war raged, Rossmann spent many of his years at an English boarding school.

“I HAVE TOO MUCH WORK, TOO MANY PROJECTS THAT I WANT TO DO.”

— ROSSMANN ON WHAT DRIVES HIM TO CONTINUE HIS RESEARCH
school, where his talents for mathematics and physics were first realized. At home he built radios and played with chemistry sets.

In high school, Rossmann had the advantage of meeting some of the 20th century’s top scientists. Pioneering crystallographer Kathleen Lonsdale met with a teenage Rossmann after a talk. Lonsdale, the first woman inducted into the British Association for the Advancement of Science, inspired him to pursue structural science throughout his academic career.

Soon after the Allies’ victory, Rossmann enrolled in Regent Street Polytechnic and obtained bachelor’s and master’s degrees in math and physics from the University of London.

Then, while seeking a doctorate at the University of Glasgow, he heeded Lonsdale’s influence to jump into the quickly growing field of chemical crystallography. The roots of defining the structures of viruses started here. Crystallography was a hot field in the 1950s, as atomic theory was becoming atomic structure.

“We students were given crystals of small organic compounds and were expected to determine their structures,” Rossmann says. “The X-ray pattern is a bunch of spots, and from those spots, we deduced what the structures were like.”

Rossmann’s thesis is titled simply “A Study of Some Organic Crystal Structures.” It was the beginning of a tremendous career that would yield numerous accomplishments.

After finishing the doctorate, Rossmann had his first taste of America during a two-year postdoctoral stint under William Lipscomb, who would later win a Nobel Prize for his work on boron chemistry.

Then it was back to the United Kingdom for a research associate position under Max Perutz, who was to obtain a Nobel Prize in 1962 for his work on the structures of hemoglobin. Rossmann wrote most of the computer programs on an early electronic computer and worked closely with Perutz to interpret many of the results.

“I believe I got there because I was interested in solving the mathematics of protein structures,” he says. “I saw it as a mathematical problem.”

Also during this time, Rossmann had another fortuitous meeting with a name that has been in textbooks for decades — Francis Crick. The Crick who with James Watson discovered the double-helix structure of DNA in 1953.

“I had coffee with Francis and others every morning. He was a very stimulating figure,” Rossmann remembers. “Life is a set of circumstances.”

After much success with Perutz and a new direction into biology, in 1964 it was time to leave the nest for his first stop as a professor: Purdue University.

Rossmann works on a brass model of the molecular structure of a virus. Photo circa 1973 courtesy of the College of Science.
Michael Rossmann now lives at University Place, a retirement community in West Lafayette, significantly farther from Purdue than his old home. He accepts vehicular transportation to work these days, but he still cares out about 30 minutes per day to walk around Discovery Park. Ideas and solutions to problems are still being worked out during these strolls.

What drives him to continue his research at the age of 86 is the ever-evolving nature of viruses. Humans must stay a step ahead of these organisms.

“I have too much work, too many projects that I want to do,” he says. “Also, his dedication to his PhD students makes him want to keep working. He beams with pride when he speaks of these successful scien­

tists. His current crop of students and postdoctoral researchers represents an international family of students all over the world,” Rossmann says.

And the admiration is mutual. Liu is happy to still be in Hockmeyer, just several steps away from a structural biology icon.

“He’s always positive,” Liu says. “He always loves challenges, and he never gives up.”
It was a remarkable day in 2014 — the result of brilliant work. U.S. News & World Report was out, showing Purdue’s analytical chemistry graduate program ranked at No. 1.

Hilkka Kenttämaa, a previous head of the analytical division, already had 25 years with the program. Her award-winning work contributed to its top national ranking.

NO. 2 ON FEMALE LIST

Three years later, the American Chemical Society’s “Chemical and Engineering News” noted another high distinction for the entire Department of Chemistry. It ranked No. 2 in percentage of female faculty among national chemistry departments. With 37 men and 15 women, 28 percent of the current faculty are women. Kenttämaa — the second female faculty member hired in the department — says the distinction accurately depicts a place where the work of female scientists is as highly valued as that of men.

A CULTURE EVOLVED

Kenttämaa, of Finland, joined the department in 1989. “I felt very well,” she says. “I have always been able to work seamlessly with my colleagues.”

She also acknowledges that attitudes have improved since then. She cites an early experience as the lone woman on a search committee in a different department.

“I thought the men on the committee would recognize a talented female candidate without my help,” she says. “But that was not the case. We found a really good female candidate who eventually was hired. But one faculty member said, ‘Stop now. Do you realize you’re going to give an American man’s job to a foreign woman?’ Had I not been there, nobody would have reacted to it. But I, of course, said, ‘Well, I am a foreign woman who holds an American man’s job, and I think what you said is completely inappropriate.’

‘No one meant to be bad,’ Kenttämaa says. ‘But somebody points it out — just like in Finland — then it can’t be stopped.’

GLOBAL REALITY CHECK

Kenttämaa, whose storied career as a mass spectrometrist got early recognition when the Finnish Chemical Society named hers the best PhD thesis in Finland in 1985, says she routinely faced discrimination there.

“I was passed over several times when they hired less qualified male colleagues,” she says. “It happened to all women there.”

As the Frank Brown Distinguished Professor of Chemistry, Kenttämaa now has four patents and four patents pending. Among her myriad awards are the American Chemical Society’s Frank J. Field and Joe L. Franklin Award for Outstanding Achievement in Mass Spectrometry, and Purdue’s Seed for Success Award for grants of more than $1 million. She also has received the College of Science’s Leadership Award and its Interdisciplinary Award.

SUCCESSFUL FEMALE SCIENTISTS ATTRACT OTHERS

Chemistry department head Timothy Zwier attributes the department’s success in recruiting and retaining women to its female faculty “who demonstrated success, and were excellent champions of our department to other potential women faculty.”

“I have tried to follow the lead of previous department heads and senior faculty who built into our department over time a climate and culture in which gender diversity is valued and championed,” Zwier says. “We now have such a wonderfully diverse and successful faculty that they help recruit other outstanding faculty to our ranks.”

Zwier adds that students see gender equity “as the norm, and see the clear benefits in the quality of the education they have received.”

Continuing the trend of strong female faculty, Lyudmila Slipchenko is an outstanding scientist and vocal advocate for gender equality. INSIGHT Into Diversity magazine, which covers diversity and inclusion in higher education and business, named Slipchenko, an associate professor of chemistry, among its 2016 “Inspirational Women in STEM”.

Citing her involvement in gender equity and work-life balance panel discussions, the magazine also praised her work to train and mentor graduate students and postdocs, and her involvement in a STEM networking group for female faculty.

STUDENTS WIN

Slipchenko says when interviewed at Purdue in 2008, she could tell she would be comfortable here. “I had several interviews at high-profile institutions, but at Purdue, I noticed a large female population right away,” she says. “I had the opportunity to ask about day care, schools, about maternity leave — all questions that I didn’t discuss when I was in a male-dominated environment.”

Ultimately, Slipchenko says, the students benefit from a culture that invites top faculty of both genders. “It’s beautiful here. It’s very easy to work and live a full life here. And that makes it a very supportive environment for students. The students feel that. They see how their professors live and they learn from our example.”
Scientists have discovered the mechanism that hijacks the immune system’s response to tuberculosis, revealing an important new drug target for the disease, which kills more than 1 million people each year.

Harman Sanyal, Purdue’s Drug Discovery Professor of Chemistry, collaborated with scientists at Johns Hopkins University to determine how tuberculosis turns off a human cell’s signal to generate an immune response to the bacteria. Their findings were published in the journal Nature Chemical Biology.

Tuberculosis is a bacterial disease that results in coughing, fever, night sweats, weight loss and sometimes death. When Mycobacterium tuberculosis enter a human cell, the presence of its DNA and a molecule called cyclic di nucleotides (c-di-GMP) inactivates an immune system s response to the bacteria. The host cell responds by creating a messenger molecule, cGAMP, which signals nearby cells to mount an immune response to kill the tuberculosis bacteria. But the tuberculosis bacterium has found a way to shut off the call for help. By producing a protein called cyclic di nucleotides (c-di-GMP) the bacterium reduces the concentration of the cell’s messenger molecule, cGAMP.

The host cGAMP never gets to a high enough concentration to activate the immune response. Sanyal says, “This is a very effective mechanism the bacteria has developed to suppress an immune response.”

If a molecule could be developed that would either mimic or inhibit c-diGMP, it could improve immune response in tuberculosis patients, Britain says. So in a team identified several molecules that would bind with and inhibit c-diGMP, but they have not yet reached the capacity needed to create drugs. They will continue looking for new compounds that could potentially inhibit the newly discovered drug target.

Brian Wolfheimer

**A MISSION**

By Tim Brouk

Two major Purdue Science pursuits dominated 2016: the completion of a new strategic plan and the search for the next Frederick L. Hovde Dean of the College of Science.

The strategic plan was finished in January and will serve the college through 2022. The complete plan can be found at [www.science.purdue.edu/strategic-plan.html](http://www.science.purdue.edu/strategic-plan.html) but here are some highlights:

The Purdue College of Science’s official mission is “to foster a diverse, inclusive, and globally aware community of faculty, staff, students, and other partners, dedicated to advanced discovery, learning, and engagement in the fundamental sciences, and its translations, that expand the boundaries of knowledge, and prepare highly competent scientists and scientifically literate citizens.”

The vision calls the school to advance new frontiers “in fundamental and translational sciences with new knowledge and learning, by solving scientific and societal grand challenges, and by expanding science awareness at-large.”

Some key characteristics of the plan include:

- Distinguished faculty who conduct groundbreaking research of global impact, lead scholarship in teaching/learning, discovery/research/creative endeavors, and promote engagement/partnerships, recognized by scientific communities, and society.
- Transformational discovery with field-defining research, innovation, and invention that advances new and emerging fundamental and translational sciences that nurture human curiosity, expands knowledge, solves complex problems characterizing scientific and societal grand challenges, improves quality of life, and catalyzes business and industry development and economic prosperity.
- Leadership in innovative science engagement with sharing of science knowledge and applications toward Science Education — starting from the K-12 level to prepare future STEM students, all the way to professional and public levels — facilitating awareness of critical issues in science and society to inform science policy.

The plan’s goals include:

- **Integrated Learning** — Achieve excellence in integrating multiple learning approaches in science, with breadth and depth of knowledge and skills at the undergraduate through postgraduate levels.
- **Impactful Discovery** — Demonstrate leading-edge discovery and scholarship at the frontiers of fundamental sciences, science knowledge and learning, with worldwide impact.
- **Innovative Engagement** — Promote innovative public engagement facilitating science awareness and the societal impact of science.

The planning committee consisted of 16 major Purdue Science players — a mix of Science staff members, professors and Elizabeth Daparnovski, Science associate dean for research and graduate education.

EXTRATERRESTRIAL HABITAT

Engineering program proposed

A team of researchers proposing to create a program in Extraterrestrial Habitat Engineering believed to be the first such university program — with Purdue’s first New Ventures grant.

New Horizons is a competitive program launched by the Provost’s Office in 2016 to challenge established senior faculty at Purdue to create new academic areas for the coming decades. Winning projects receive funding for two years.

Jay Melish, Distinguished Professor of Earth, Atmospheric, and Planetary Sciences, and Physics and Astronomy, is one of five faculty mentors leading the team. In addition to Melish, the principal investigators are Antonio Bobet, professor of civil engineering; Shirley Dyke, professor of mechanical and civil engineering, and John Finley, professor of civil engineering and center director of the Purdue Coordination Office for the National Hazards Engineering Research Infrastructure.

This initiative will work to develop new technologies and systems that will allow humans to live on the moon or other planets. The team will develop both a research center and academic programs.

Beyond the protection of Earth’s atmosphere, space exploration and colonization face unprecedented difficulties stemming from the lack of resources, food, air, water, and oxygen, wild temperature fluctuations, intense particle radiation, intense solar and galactic radiation, intense cosmic rays, intense electromagnetic fields, extreme cold and heat, and dust storms, the team says. Confronting these challenges to provide comfort and sustainable living conditions in space will require aggressive applications of engineering, science, and social sciences.

Bobet says the program is an ideal match with Purdue’s research strengths.

We envision our Extraterrestrial Habitat Engineering initiative as a catalyst to ignite the inner passion for exploration in a prevalent new at Purdue and to create a sound, vibrant network of researchers and students, all committed to take humanity to the next great adventure, he said.

— By Steve Tally

Photo by / iStock Photos

**DEAN SEARCH UPDATE**

The beginning of 2017 saw a strong push to finding the next Frederick L. Hovde Dean.

According to the dean selection committee led by Nobel Prize winner Elia Ngella and Jay Abbe, the Glenn W. Sample Dean of Agriculture, initial contacts with potential candidates were made in late November and the application deadline passed Jan. 5. Preliminary phone or Skype interviews were held Feb. 7 and 8. Candidates were then selected for in-person interviews on Feb. 13. Most of those interviews took place March 23 through mid-April.

Former dean Jeff Roberts stepped down in July 2016. Craig Swenson, dean of the College of Pharmacy, immediately filled the opening on an interim basis and led the college through the 2016-17 academic year. Roberts served nearly seven years as dean.

We will introduce the new dean in the fall issue of Insights. Be sure to check [https://www.purdue.edu/provost/science/search-committee/posting.html](https://www.purdue.edu/provost/science/search-committee/posting.html) for updates.

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HIDDEN FIGURES

THE SUPERHEROES IN ONE OF THE HOTTEST MOVIES IN 2017 ARE REAL AND THEIR SUPERPOWERS ARE INSPIRATIONAL. THEY REQUIRED NO SECRET IDENTITY OR COSTUMES BECAUSE HISTORY KEPT THEM INVISIBLE UNTIL A COURAGEOUS AUTHOR, MARGOT LEE SHETTERLY, REVEALED THEM TO THE WORLD. SHE SPOKE AT PURDUE ON JAN. 25.

"Hidden Figures" is the story of unexpected and amazing heroines African American women in the early days of NASA. Working in the west computing wing, these bright ladies helped the United States during the heated trials space race between the Soviet Union. The film put the spotlight on Dorothy Vaughan, Mary Jackson and Katherine G. Johnson, a Presidential Medal of Freedom recipient in 2015.

That film stems from the 2016 book of the same name by Shetterly. The best-selling writer visited with Purdue College of Science students at the Black Cultural Center before her capacity talk at Loeb Playhouse.

"I knew a lot of the women growing up. I remember watching them. They set an example for me. They were some of the women who I knew going through was highly relatable. It makes me want to do better and upend all of our perceptions of what it means to be black, to be a female, to be a scientist and to be American," Shetterly told the audience at Loeb.

"I'm the only black woman in space in 2018. She revealed the roots of her book, which she autographed for fans for an hour after her talk. ‘The women of Hidden Figures’ upend all of our perceptions of what it means to be black, to be a female, to be a scientist and to be American,” Shutterly told the audience at Loeb.

Shetterly spoke on Purdue’s legacy for astronauts — including the College of Science’s own Andrew Foote, who will be returning to space in 2018. She revealed the roots of her book, which she autographed for fans for an hour after her talk.

Shetterly’s talk was the cherry on top. … For someone like me studying computer science, to see another computer scientist from 50 years ago struggle the way she did inspires me to want to be my own number one. "I'm the only black woman in space in 2018. She revealed the roots of her book, which she autographed for fans for an hour after her talk. ‘The women of Hidden Figures’ upend all of our perceptions of what it means to be black, to be a female, to be a scientist and to be American,” Shutterly told the audience at Loeb.

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Brown water gushed through the rickety floorboards of a Kyrgyzstani utility truck. The cigarette-smoking driver attempted a foolish fording of a river. The bridge had been washed away but he put the pedal to the metal anyway. In the back seat, Robin Blomdin, an Earth, Atmospheric, and Planetary Sciences alumnus, felt dread in the pit of his stomach, while filmmaker and fellow Swede Adam Stjärnljus was thrilled in the passenger seat.

With his handheld camera rolling, Stjärnljus was in the passenger seat. At the screening, attended by dozens of Purdue students, faculty members and community members, the Swedish duo was asked about that dramatic scene.

"Mongolia was one of the most interesting places I’ve ever done field work,” Callies says. “The landscape was spectacular and the people, both in our party and those that lived nearby, were extremely helpful.”

Blomdin’s research journey is far from over. He is still writing up his dissertation and plans to depart from the expedition, Blomdin says.

Conflict arose not only from the river. The rocky terrain all but eliminated any plans to make a direct route to the mountain. Digital tablets with topological maps weren’t always accurate. Some researchers’ technology showed different landscapes from others when they were looking at the same patch of Mongolia.

"When something bad happened, Adam was happy. When something good happened for my research, he wasn’t,” Blomdin laughed, noting that, in terms of film drama, collecting small samples of rock could not compare to almost being carried away by a river current.

"The movie is available at www.throughthevalleys.com"
Nathaniel “Nat” Lifton, professor of earth, atmospheric and planetary sciences, and graduate student Jennifer Newall spent the first few months of 2017 in Antarctica. The pair is part of the international team of the Mapping, Measuring and Modeling Antarctic Geomorphology and Ice Change in Dronning Maud Land, or MAGIC DML, project.

The team of researchers from the U.S., Sweden, Norway, Germany and the United Kingdom are researching the glacial history of Dronning Maud Land, or MAGIC-DML project.

The following is taken from Lifton’s Feb. 14 dispatch:

In our first major expedition from the Wasa Research Station in Antarctica, we visited Milorgfjella, the northeasternmost nunatak (an isolated peak of rock projecting above a surface of inland ice or snow) in the Hemelotentjellia range, looking for evidence of past glacial cover at a range of altitudes above the modern ice surfaces. Unfortunately, our Arctic trucks could not reach higher-altitude sites in that area due to deep, dry, sugary snow on steep ground, so we were forced to concentrate on lower-altitude samples.

After returning to Wasa on Jan. 26, our logistics team devised a hybrid plan for our next expedition to improve our ability to reach high altitudes. In a heroic effort, the three logistics personnel who had remained at Wasa for the Milorgfjella trip used both trucks and a trailer borrowed from the Finnish Aboa station next door to deliver two snowmobiles and extra fuel to an established fuel depot adjacent to the Svea hut — Sweden’s first outpost in Antarctica — in the Svegfjella range.

On our friends’ return, we loaded the trucks with new equipment and on Jan. 30 in sunny weather we set out on our second major expedition to explore the southern reaches of Hemelotentjellia — specifically the clusters of nunataks known as Tottanfjella.

We made good time to the fuel depot, arriving about eight hours after departing Wasa. We fueled up and drove another two hours south to our camp site at Kiberg, located along an established route to the high plateau passing between Svegfjella and Tottanfjella.

On our return trip, we loaded the trucks with new equipment and on Jan. 30 in sunny weather we set out on our second major expedition to explore the southern reaches of Hemelotentjellia — specifically the clusters of nunataks known as Tottanfjella.
Jonathan W. Amy passed away on Dec. 4, 2016, three days after attending the Amy Mellon Lecture and a celebratory dinner in his home with members of the Chemistry Department. His towering achievement was the conception and implementation of a chemical instrumentation facility that involved a partnership between faculty, graduate students and professional instrumentation staff. This model and facility, now named the Jonathan W. Amy Facility for Chemical Instrumentation, has been admired nationally and has made indelible contributions to research and industry over the past 50 years.

Amy worked with manufacturers including Fisher, Aerograph, Varian, Hewlett-Packard, Finigan, Perkin-Elmer, Galileo, IBM and Thermo in perfecting instrumentation. He made important contributions to mass spectrometry, electron spectroscopy, chromatography and nuclear magnetic resonance.

He was a problem solver par excellence, whether the problem was one of local fire service or the future direction of scientific research in the U.S. Amy was born March 3, 1923, and grew up in Delaware, Ohio, where his father was head of the English Department at Ohio Wesleyan University. He grew up in a house filled with books, some inscribed by visiting authors, and acquired a love of reading.

Amy’s education at Ohio Wesleyan University was interrupted by World War II, during which he served as a communication officer in the U.S. Maritime Service. He spent the war years in the Mediterranean and the Far East acquiring a taste for sailing and a passion for electronics and problem solving.

Following the war, he returned to Delaware, where he married Ruthanna Borden and completed a Bachelor of Arts degree from OWU. In the fall of 1948, the young family (later to include three children Bur, Jim and Tori) moved their house trailer to Purdue, where Amy was to start graduate studies in chemistry. He was assigned a teaching assistantship in physical chemistry. His electronic and mechanical skills were used building a experimental lab equipment.

Amy completed a Master of Science degree with Professor Thomas DeVinck in 1950. On the suggestion of Professor Guy Mellon, he stayed at Purdue and completed his PhD in 1955, working on spectroscopy with Walter Edgell, a young professor of physical chemistry. His PhD project involved building a microwave spectrometer, a new technique based on developments in military radar. Its gas-phase frequency resolution measurements produced data that could be used to determine bond length and angles in simple molecules, as well as more quantitative measurements. He also worked on new instrumentation for other spectroscopic techniques and developed special relationships with instrument manufacturers to specify instrumental performance, evaluate prototypes and make modifications.

He stayed at Purdue to plat a subdivision, set up a sawmill and build his home, and to direct the Department of Chemistry’s instrumentation facility.

Amy has been recognized by the American Chemical Society through its Chemical Instrumentation Award, by the Chemistry Department with the Wethersill Medal and the Amy-Mellon Lectureship, by Purdue University with an honorary Doctor of Science degree, as well as locally through the George Award for outstanding service to the community.

His pithy wisdom included items like “Tackles the problem, not the symptom” and “There is always time to do a job twice, but never enough to do it properly.” He spoke often of his mission to help people solve problems.

He is remembered with great love by Betty and his children, and by those whose lives he touched, including generations of graduate students, faculty and staff, for his wise counsel, technical expertise and gentle spirit.

A TRIBUTE TO JONATHAN W. AMY
By R. Graham Cook, the Henry Bohn Haas Distinguished Professor of Chemistry

IN MEMORIAM
Fred C. Leone (PhD ’40, Statistics), Galion, OH, July 14.
Sally E. Noyes (PhD ’70, Biological Sciences), Lewiston, PA, May 11, 2016.
Michael H. Piet (BS ’81, Biological Sciences), Mount HL, NC, Nov. 6.

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He is remembered with great love by Betty and his children, and by those whose lives he touched, including generations of graduate students, faculty and staff, for his wise counsel, technical expertise and gentle spirit.
Your granny’s attic isn’t the only place to find random relics from the past.

Earlier this year, a box of old photos dating back decades was found nestled in an office on the 10th floor of the Mathematical Sciences Building. Mostly black and white, the photos date back as far as 1897 and document pre-digital life in Purdue’s College of Science.

Over the next few issues, we will share some of those photos. From the cutting-edge equipment of the time to shots of star faculty members at the start of their careers, we are eager to share these treasures from the past.

Below are some former — and a couple of current — Purdue Science researchers at work.

1. H. J. Yearin, former professor of physics, works on some new equipment in his lab circa 1936.
2. A former Computer Science staff member creates a new beaker from scratch.
3. A Chemistry staff member loads tapes into an early computer in the 1970s.
4. A.J. Ullatrup, former professor of biological sciences, examines plants in a Lilly Hall greenhouse, which is still used today. He was a national plant physiology expert in the 1940s and ’50s.
5. Nicholas Giordano, former head of the Department of Physics, studies acoustical physics of the piano.
7. David Nolte, now the E.M. Purcell Distinguished Professor of Physics and Astronomy, poses in his early lab.
8. Philip Low, now the Ralph C. Corley Distinguished Professor of Chemistry and director of the Purdue Institute for Drug Discovery, works to make a drug discovery early in his Purdue career.
9. A former Computer Science staff member loads tapes into an early computer in the 1970s.
A FORMULA FOR SUCCESS AND SUPPORT FOR UNDERGRADUATE RESEARCH IN CHEMISTRY

In the Department of Chemistry, research is an integral part of training chemists. Working closely with faculty, graduate students and postdoctoral fellows, undergraduate students majoring in chemistry not only are exposed to what chemistry is, they begin to appreciate how new chemical knowledge is obtained. Independent research helps students feel confident and competent when performing tasks in their future career.

“In order to attract quality undergraduate students, you must offer research opportunities,” says Fred Falkner (BS ’64).

To provide that opportunity, Falkner and his wife, Jo Falkner, started the Falkner Fund for Undergraduate Research in Chemistry. They already had made the decision to provide for the College of Science through their estate plans but wanted to see the impact of their giving. They accomplished this by funding a portion of the endowment during their lifetime.

Thanks to Jo Falkner’s strong finance background, they are able to do this in the most cost-effective way. Instead of writing a check, the Falkners chose to give from an individual retirement account in order to receive maximum tax benefits. Federal legislation allows anyone 70-and-a-half or older to give money, up to $100,000, directly from their IRA to a qualified charity. These donations count toward the donor’s required minimum distribution, but not toward their taxable income.

By keeping required minimum distributions out of one’s taxable income, donors may be able to reduce Social Security benefit taxes and Medicare premiums and even sustain a lower tax bracket. Additionally, those that traditionally take the standard deduction can receive a tax benefit for their charitable giving.

The Falkners have enjoyed the opportunity to meet student recipients over the years and hear about their experiences. Thank-you notes that over the years and hear about their experiences. Thank-you notes that over the years and hear about their experiences. Thank-you notes that over the years and hear about their experiences. Thank-you notes that over the years and hear about their experiences. Thank-you notes that over the years and hear about their experiences.

If you would like to support undergraduate research, please see the attached reply card or visit Science.purdue.edu. If you would like to support undergraduate research, please see the attached reply card or visit Science.purdue.edu. If you would like to support undergraduate research, please see the attached reply card or visit Science.purdue.edu. If you would like to support undergraduate research, please see the attached reply card or visit Science.purdue.edu. If you would like to support undergraduate research, please see the attached reply card or visit Science.purdue.edu.

**VITAL STATISTICS**

The Actuarial Science Program at Purdue University continues to flourish. The program has approximately 100 students and is shared by the Mathematics and the Statistics departments. The program was recently ranked first in the nation by College Choice. Additionally, College Values Online ranked Purdue as the second-best value in actuarial science programs.

The Purdue program is successful for a number of reasons. First, the program provides a first-class undergraduate education. The faculty and instructors for these courses have many years of experience teaching actuarial courses at Purdue, as well as many years of experience working as practicing actuaries. The students are exposed to a rare combination of theoretical and practical applications of actuarial science. Purdue is one of only a few programs in the U.S. that have three accredited actuaries teaching courses.

Additionally, to become an actuary, a person must pass a series of professional exams. The Purdue program provides courses that cover the material for the first five exams. Most of our students graduate having already passed two or three exams and a few graduate having already passed four or five exams. The Purdue program is unusual as students start to take courses in actuarial science during their first year on campus. After completing their first year, the students are ready to take the first professional exam that following summer. This gives a student the opportunity to decide early in their academic career whether actuarial science is the right area of study. Also, once a student has passed the first exam, it becomes possible for them to apply for internships. Many students participate in internships after both their second and third years at Purdue.

A third reason for the success is that Purdue provides the other coursework that is necessary for an actuary while still in college. For example, actuarial students are required to receive coursework covering economics and accounting. Our program is able to take advantage of classes offered in the Krannert School of Management to meet these requirements.

A final reason for the success is Purdue’s ability to produce highly qualified graduates resulting in a strong relationship with potential employers, like consulting firms and insurance companies. Our many years of producing quality actuarial science graduates has built a loyalty among employers who want to hire additional graduates due to the success of past graduates.

The Purdue Actuarial Club further enhances this relationship. This student-run organization coordinates all on-campus recruiting for employers of new graduates. The employers find that the service and attention they get from the officers of the Actuarial Club far exceeds the service that they get at other universities. The club also helps students prepare for their job search by requiring the students to complete an interview workshop and resume workshop. The current students at Purdue find the club to be an invaluable asset just as the employers do.

Jeffrey Beckley

— By Jeffrey Beckley, continuing lecturer and co-director of the Actuarial Science Program
Purdue Math's help multiplies

Andrés Figuerola (standing) is one of dozens of Department of Mathematics graduate assistants who aid thousands of undergraduates from across campus in the new Math Help room, on the second floor of the Mathematical Sciences Building. In 2016, the wall between rooms 205 and 211 was opened up to make room for 10 tables with several chairs apiece, each waiting for a student seeking help with those tough calculus, algebra or trigonometry classes.

[Photo by Tim Brouk]