

# AEROGRAM

PURDUE UNIVERSITY SCHOOL OF AERONAUTICS AND ASTRONAUTICS / FALL 2016



## PURDUE LIGHTS (AND LEADS) THE WAY

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## REMOTE RESEARCH

AAE alumnus Alexander Finch (MSAAE '11) recently returned from 15 months in the Antarctic working at the Halley Research Station (above), which is run by the British Antarctic Survey (BAS). The remote location is being used, in part, to study the potential impact on astronauts of a future mission to the Moon or Mars.

The European Space Agency has several experiments at Halley Research Station to evaluate how isolation affects human physiology and psychology.

“When you’re (in the Antarctic) you feel like you’re on another planet,” says Finch. “You’re isolated, cut off from the world, in a hostile environment, without a normal day and night cycle — this collectively is the best simulation we have on Earth replicating the environment on Mars or even on spacecraft on the way to Mars.”

Finch says his time at Purdue gave him the start he needed to pursue a career he loves. He studied with Professor Daniel DeLaurentis and earned a master’s degree in 2011.

PHOTOS PROVIDED BY ALEXANDER FINCH



## AEROGRAM

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### COVER STORY

AAE senior Gabby Feldman bears the Indiana bicentennial torch. Feldman was a member of the interdisciplinary student team that developed the high-tech torch, which was used in a relay that traversed all 92 Indiana counties. See story on page 24.

PHOTO: CHARLES JISCHKE

### GIANT LEAPS

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MESSAGE FROM THE HEAD

**WELCOME TO AEROGRAM** — the annual magazine of Purdue University's School of Aeronautics and Astronautics. In this issue, we are excited to share some news and stories from the 2015-16 academic year.

Our students and faculty continue to innovate and do exciting things. As you'll read in this AeroGram, many were honored with awards from within and outside of Purdue. While we were sad to say goodbye to Professor Alten "Skip" Grandt after 36 years of distinguished service to our School, we are delighted to welcome Dr. David Spencer as our newest associate professor. Dr. Spencer comes to us from Georgia Tech, where he was a professor of practice, and we look forward to his contributions to Purdue and AAE.

In education, research and engagement, there have been some exciting developments. The expansion of the Maurice J. Zucrow Labs is progressing. This effort, made possible as part of a \$40 million Lilly Endowment, will secure the facility's place as one of the nation's foremost propulsion laboratories. The Indiana Manufacturing Institute (IMI) is now fully operational, after a ribbon-cutting in July 2016. The facility serves as Purdue's headquarters for its role in the national Institute for Advanced Composites Manufacturing Innovation (IACMI). The institute will support research and development on composite materials to



**TOM I-P. SHIH**  
PROFESSOR AND HEAD,  
SCHOOL OF AERONAUTICS  
AND ASTRONAUTICS

increase energy efficiency of transport vehicles, wind turbines, and other applications. Finally, but not least, Purdue University is combining resources with Rolls-Royce to form a \$33 million jet engine research and development program to create next-generation aircraft propulsion systems. This collaboration will be part of the University's new Aerospace District, where our school will play a major role.

Our alumni continue to be a source of great pride. In 2015-16, we honored nine highly accomplished alumni with our Outstanding Aerospace Engineer Award. Two AAE alums, C. Douglas Ebersole and Wayne Tygert, won the Distinguished Engineering Alumni Award, the highest honor our college can bestow upon an engineering alum. Our alumni also play an influential role in our School's strategic growth with their generous contributions, including the impressive \$565,000 raised in 24 hours through Purdue Day of Giving!

This AeroGram will give you more details about these stories along with more news about our distinguished faculty, outstanding students and accomplished alumni. We thank you for your support throughout the past year. If you're ever on campus, please stop by and visit. As always, please keep us informed of the exciting things happening in your lives so we can share that news in future issues.

Hail Purdue!

Tom I-P. Shih  
Professor and Head



# LEGEND meets LEGACY

## Buzz Aldrin reviews students' lunar-base design

In a first-ever collaboration, AAE students combined efforts with students in Purdue's Earth, Atmospheric, and Planetary Sciences program for a senior design project.

Known as Project Legacy, the 2016 Purdue senior design course used the vision that Gemini and Apollo astronaut Buzz Aldrin outlined in his book "Mission to Mars: My Vision for Space Exploration" to develop plans for a lunar base that would serve as a steppingstone for a human mission to Mars. The proposed moon base would be used to test technologies that eventually would be needed for astronauts to establish a base on Mars.

Students in AAE 450: Senior Spacecraft Design and EAPS 391 presented their senior design project to Aldrin on April 22. The class was taught by AAE Professor James Longuski and EAPS Assistant Professor David Minton.

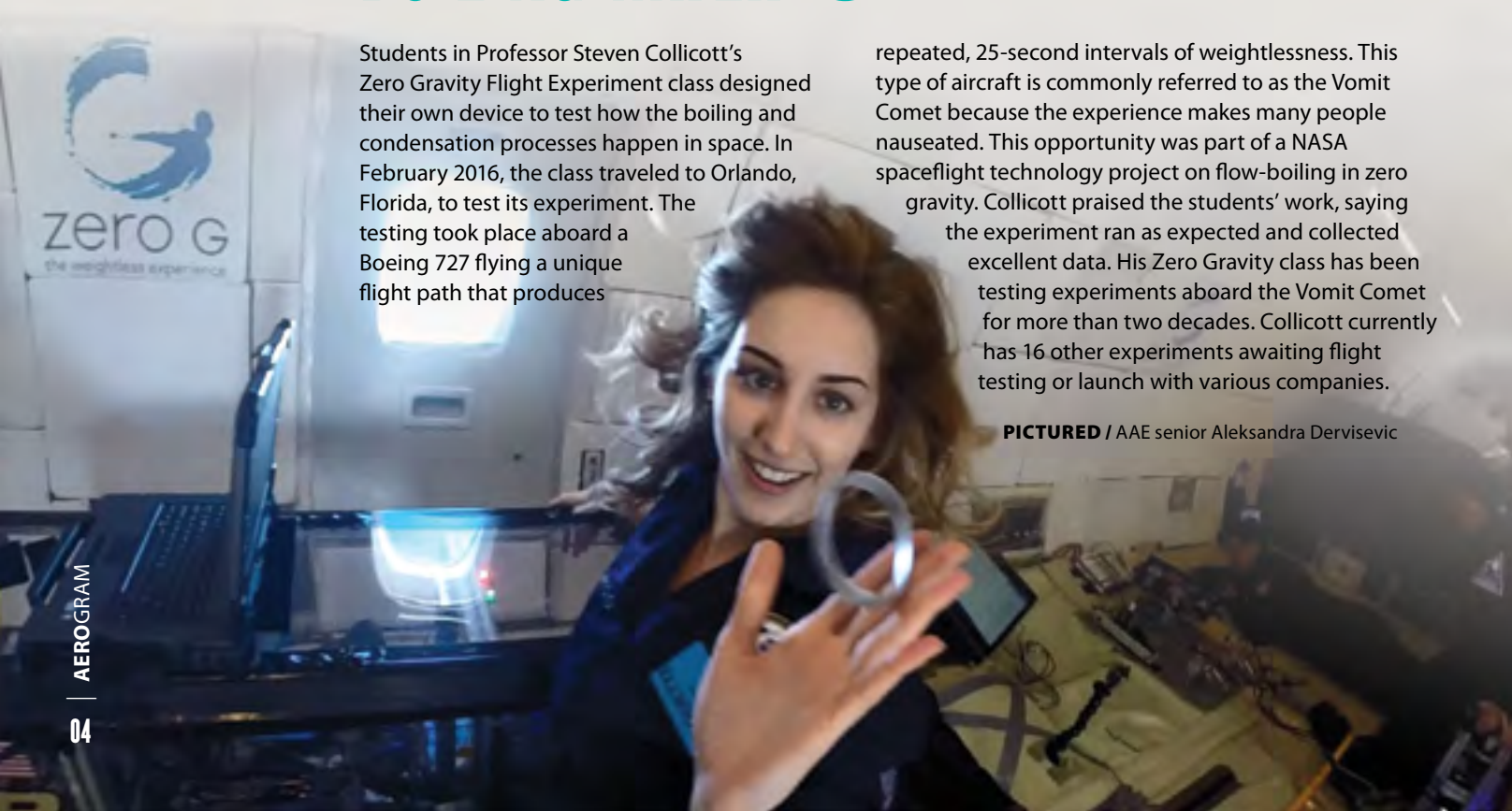


# BOILING WATER @ ZERO GRAVITY

Students in Professor Steven Collicott's Zero Gravity Flight Experiment class designed their own device to test how the boiling and condensation processes happen in space. In February 2016, the class traveled to Orlando, Florida, to test its experiment. The testing took place aboard a Boeing 727 flying a unique flight path that produces

repeated, 25-second intervals of weightlessness. This type of aircraft is commonly referred to as the Vomit Comet because the experience makes many people nauseated. This opportunity was part of a NASA spaceflight technology project on flow-boiling in zero gravity. Collicott praised the students' work, saying the experiment ran as expected and collected excellent data. His Zero Gravity class has been testing experiments aboard the Vomit Comet for more than two decades. Collicott currently has 16 other experiments awaiting flight testing or launch with various companies.

PICTURED / AAE senior Aleksandra Dervisevic



# MISSION: URANUS AND THE OUTER PLANETS

## Student design team presents spacecraft concept to NASA, JPL

A team of 19 AAE students recently completed a conceptual spacecraft design for a next-generation mission to the outer planets. Results were presented to experts from NASA and the Jet Propulsion Laboratory. The study was part of an intensive two-week engineering exercise led by Visiting Assistant Professor Sarag Saikia as part of his Maymester AAE 590 class.

Students investigated different ways of exploring the planet Uranus using a spacecraft launched sometime during the late 2020s or early 2030s. The analysis covered many aspects of space vehicle design including trajectories, atmospheric entry, onboard subsystems and cost. The students settled on a single design that could reach Uranus in a little more than 11 years and achieve a variety of science objectives, while satisfying a cost limit of \$2 billion. The team named the design "Oceanus" in honor of the eldest son of Gaia (Earth) and Ouranos, or Uranus (Sky) in Greek mythology.



Design team for Oceanus spacecraft

### WHY URANUS

"Uranus is a real 'oddball' in the Solar System," says Justin Mansell, the team's principal investigator and AAE master's student. "There are a lot of mysteries about the planet, but it hasn't been explored by spacecraft in over 30 years."

Uranus isn't the only stop for Oceanus. The concept spacecraft also passes Saturn along the way and deploys an entry probe to study the planet's atmosphere, something that has so far proved difficult to measure from orbit.

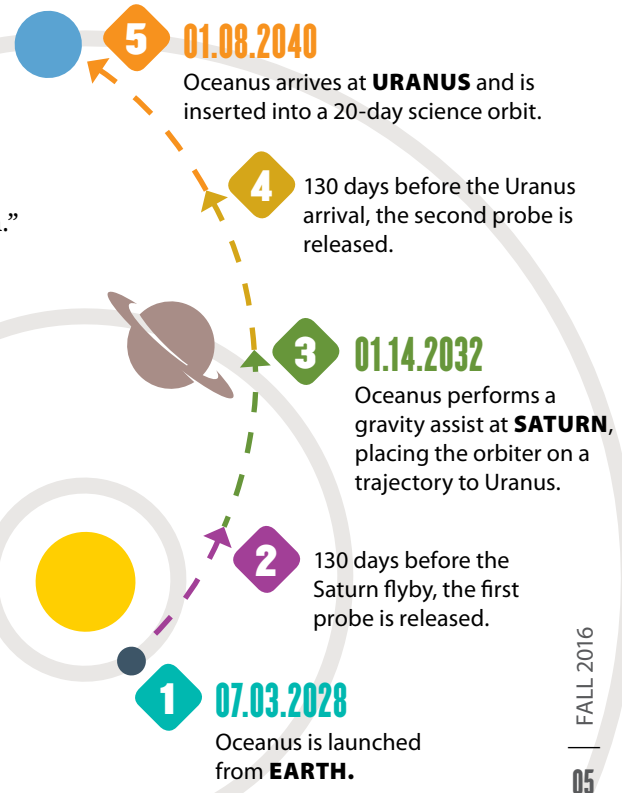
Members from the team also presented their work at the 13th International Planetary Probe Workshop in Baltimore on June 15.

"You won't find many other schools that have the capability to do a concept study like this," Mansell says. "The whole class has been an incredible learning opportunity and everyone on the team was a privilege to work with."

### OCEANUS SPACECRAFT



### MISSION TRAJECTORY





## ROCKET-FUEL STARTUP BRINGS HOME \$65,000

### Adranos Energetics LLC wins three national awards

A Purdue-related startup, which is developing a new rocket fuel formulation that could make rockets used in military and space applications travel farther, carry greater payloads and be safer for the environment, won three business competitions in early 2016, accumulating \$65,000 in prize money.

Adranos Energetics LLC claimed top prize in the Gold Division of Purdue's Burton D. Morgan Business Plan Competition, first in the University of Oregon's 25th New Venture Championship and first in the graduate division of the University of Nebraska-Lincoln's Global New Venture Competition.

Brandon Terry (PhD AAE '15), a postdoctoral research associate in Purdue's College of Engineering, and Chris Stoker, an Indiana University alumnus, co-founded the company. Shane McGuire, MBA student from the Krannert School of Management, and AAE undergraduate Luciano Mozzone are also members of the team.

Adranos's competition-winning innovation aims to provide a more efficient and environmentally friendly rocket fuel than the traditional fuel formulation that has been used for the last 60 years. The fuel formulation uses micro-explosive tendencies to produce much higher combustion efficiency and decreased flow losses, causing rockets to go farther while carrying more weight, something that has not yet been used in a propellant formulation.

The company is in the lab-scale testing stage and has shown increased performance and elimination of hydrochloric acid in small-scale propellant combustion.

Stoker said the prize money will be used to cover technology development and fundraising costs, to help the company move closer to its next stage.

Technology used by Adranos Energetics LLC has been licensed through the Purdue Research Foundation Office of Technology Commercialization. The company uses lab space in Purdue's Maurice J. Zucrow Laboratories, which is affiliated with the School of Aeronautics and Astronautics and the School of Mechanical Engineering. The company also receives assistance from Purdue Foundry.

Terry said winning these competitions has really strengthened their belief in their technology.

"Prior to competing in these competitions, I thought we had a great technology and decent pitch, but I was not sure how we would be viewed by outsiders," he said. "After winning against startups from some of the best universities in the world, it has become clear that we have a great shot at raising the capital we need to build a lasting company."

For information on other Purdue intellectual property, visit [prf.org/otc](http://prf.org/otc). For more information about available leadership positions, investing in a Purdue startup or licensing a Purdue innovation, visit [purduefoundry.com](http://purduefoundry.com).



Shane McGuire (left), an MBA student in the Krannert School of Management, and Brandon Terry, a Purdue AAE alumnus and postdoctoral research associate in Purdue's College of Engineering. PHOTO: JACK LIU



## 2016 BOEING LECTURE



## AIR FORCE GENERAL ELLEN M. PAWLIKOWSKI

### Wright-Patterson Air Force commander discusses the future of air power

Air Force Gen. Ellen M. Pawlikowski presented the William E. Boeing Distinguished Lecture at Purdue University on April 12. Her talk was entitled "The Third Offset Strategy: The Future of Airpower." The William E. Boeing Distinguished Lecture Series, named in honor of the Boeing Co.'s founder, is administered by the College of Engineering's School of Aeronautics and Astronautics. Started in 1999, the series features an internationally known speaker from the aerospace or air transportation industries.

Pawlikowski serves as commander, Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio. The command employs some 80,000 people and manages \$60 billion annually, executing the critical mission of warfighter support through leading-edge science and technology, cradle-to-grave life cycle weapon systems management, world-class developmental test and evaluation, and world-class depot maintenance and supply chain management.

During her visit to Purdue, Pawlikowski toured the Maurice J. Zucrow Laboratories, attended a luncheon for female faculty and students from the School of Aeronautics and Astronautics, and met with cadets in the Purdue Air Force ROTC Det. 220.

The Boeing Co. Senior Vice President John Tracy accompanied the general for most of the day, as did AAE alumnus and Air Force Research Laboratory Executive Director C. Douglas Ebersole (BSAAE '82).

Pawlikowski's career has spanned a wide variety of technical management, leadership and staff positions including command at the wing and center levels. She has served as director of the Acquisition Management Office for the assistant to the secretary of defense for atomic energy and as deputy assistant to the secretary of defense for counterproliferation, Office of the Secretary of Defense.



ELLEN M. PAWLIKOWSKI

Her leadership assignments included program director of the Airborne Laser Program; commander of the Military Satellite Communications Systems Wing; deputy director of the National Reconnaissance Office; commander of the Air Force Research Laboratory; and most recently commander of the Space and Missile Systems Center.

Prior to her current assignment, Pawlikowski was the military deputy, Office of the Assistant Secretary of the Air Force for Acquisition, the Pentagon, Washington, D.C.

## 3 FACULTY RISE TO FULL PROFESSOR

Congratulations to three faculty members in the School of Aeronautics and Astronautics who have been promoted to full professor. On April 8, the Purdue University Board of Trustees approved the faculty promotions, which became effective with the 2016-17 academic year.



ALINA A. ALEXEENKO



INSEOK HWANG



VIKAS TOMAR





## 20 Indiana composite materials companies join Purdue to dedicate the \$50 million INDIANA MANUFACTURING INSTITUTE

More than 300 people and about 20 Indiana composite materials companies celebrated the opening of the \$50 million Indiana Manufacturing Institute (IMI), based in the Purdue Research Park of West Lafayette. The ribbon-cutting event took place on July 26, 2016.

The 62,000-square-foot institute will house the Center for Composites Manufacturing and Simulation, where Purdue researchers and graduate students from the Purdue College of Engineering and Purdue Polytechnic Institute will conduct research and development on composite materials to increase energy efficiency for the vehicle production, wind, aerospace and other industries. Purdue's Product Lifecycle Management Center and the Indiana Next Generation Manufacturing Competitiveness Center, or IN-MaC, also will be located in the institute.

The Center for Composites Manufacturing and Simulation is part of a \$250 million U.S. Department of Energy initiative to support President Barack Obama's National Network for Manufacturing Innovation. The DOE project, called the Institute for Advanced Composites Manufacturing Innovation, or IACMI-The Composites Institute, is a five-year public-private collaboration that includes a federal



**LEFT** / The Indiana Manufacturing Institute in the Purdue Research Park of West Lafayette. **RENDERING:** CHRIS JOHNSON, PURDUE RESEARCH FOUNDATION

**ABOVE** / A ribbon-cutting for the IMI during a dedication at the Purdue Research Park. From left are Dan Hasler, president, Purdue Research Foundation; Ian Steff, executive vice president and chief innovation officer, Indiana Economic Development Corporation; Craig Blue, CEO, Institute for Advanced Composites Manufacturing Innovation; Leah Jamieson, the John A. Edwardson Dean of Engineering; Suresh Garimella, executive vice president for research and partnerships at Purdue; John Dennis, mayor of West Lafayette; and Kelly Visconti, technology manager for the U.S. Department of Energy Advanced Manufacturing Office. In back is R. Byron Pipes, the John Leighton Bray Distinguished Professor of Engineering, who emceed the event. **PHOTO:** PURDUE RESEARCH FOUNDATION

commitment of \$70 million and over \$180 million pledged by industry, state economic development agencies and universities. The University of Tennessee at Knoxville is the lead institution in the collaboration that includes public and private agencies in Indiana, Kentucky, Michigan, Ohio, Tennessee and Colorado.

### DEVELOPING technology and engineers

About 10 faculty researchers and 20 graduate students will conduct research in the Center for Composites Manufacturing and Simulation.

"Our students will have even greater education, internship and career prospects through their involvement in the institute," says Leah Jamieson, the John A. Edwardson Dean of Engineering. "The research conducted in the institute will create new opportunities for translating research to practice."

### ADVANCING next generation manufacturing

R. Byron Pipes, the John Leighton Bray Distinguished Professor of Engineering, is the director of the institute. Pipes has joint appointments with the schools of Aeronautics and Astronautics, Chemical Engineering, and Materials Engineering. AAE Associate Professor Wenbin Yu serves as co-director of the institute.

"The Indiana Manufacturing Institute will provide an innovative venue for academic and industrial stakeholders to join together for rapid transfer of technology to societal prosperity," said Pipes. "As a national manufacturing institute, IACMI links the Indiana composites manufacturing efforts with our five state partners in Tennessee, Michigan, Colorado and Ohio to build the next generation manufacturing technology for the vehicle, wind and compressed gas application areas."

### BOOST to the Indiana economy

Advanced manufacturing represents 25 percent of the Indiana economy, according to the Indiana Economic Development Corporation.

"The state of Indiana has about 50 companies contributing to this sector," says Victor Smith, Indiana secretary of commerce. "There is little doubt that our state's economic leadership in composite materials has a direct impact on the fact that Indiana continues to grow its national reputation in advanced manufacturing job growth."

Purdue Research Foundation invested \$11 million in the construction of the building on property that was, in part, donated by the City of West Lafayette Redevelopment Commission. The foundation already owns the remainder of the land for the development.





# ROLLS-ROYCE/PURDUE PARTNERSHIP TAKES OFF

Rolls-Royce and Purdue University are combining resources to form a \$33 million jet engine research and development program to create next-generation aircraft propulsion systems. This collaboration will be part of the University's new Aerospace District, where the School of Aeronautics and Astronautics will play a major role.

"It is a badge of pride for Purdue University to be selected by one of the world's truly great research and manufacturing companies for a partnership," says Purdue President Mitch Daniels. "There is no more fitting or prestigious first step for the University's Aerospace District, which we imagine is a big piece of Purdue's future."

Rolls-Royce, already a strong recruiter of Purdue graduates, employs nearly 600 Purdue alumni.

"Research and development in jet engines is an important objective for Rolls-Royce as we strive to create jet engines that are more energy-efficient and can perform even more effectively," says Phil Burkholder, president of Rolls-Royce Defense Aerospace, North America. "Purdue has always been a great partner with Rolls-Royce and I am confident that our collaborative research will result in strong long-term advances in jet engine development."

Lisa Teague, head of Rolls-Royce Research & Technology in Indianapolis, says, "We're very happy to have such a world-class university just up the road from us, and we're very pleased to see this increased recognition of the strong relationship."

As part of the increased engagement, Rolls-Royce will designate Purdue as a university technology partner. The Purdue UTP will initially encompass two research centers in the areas of advanced thermal management systems and advanced compressor systems, expanding beyond the current university technology center designation. The first Rolls-Royce UTC established outside of Europe was launched at Purdue in 2003 to study high-Mach propulsion, and that program is transitioning into a focus on systems for advanced thermal management, says Dan Hirleman, Purdue's chief corporate and global partnerships officer. Now Purdue receives the second UTP designation in the U.S.

"The investment by Rolls-Royce will further support Purdue's Maurice J. Zucrow Laboratories, the nation's largest university-based propulsion laboratory, which has a storied history of performing research for NASA, the U.S. Department of Defense and other federal agencies," Hirleman says.

In early 2015 Purdue announced that Lilly Endowment Inc. had provided \$5 million to expand the Zucrow Laboratories as part of a \$40 million grant to the University to support five transformational projects in the colleges of engineering and technology, as well as Purdue Libraries. The grant was the largest cash donation given in Purdue's history.

The new partnership with Rolls-Royce reflects Purdue's commitment to leveraging the Lilly Endowment grant to bolster research and education in engineering and technology and to strengthen Purdue's contribution to Indiana's economy.

"When the Endowment provided this grant we hoped it would generate collaborations like this one between Rolls-Royce and Purdue," says Sara B. Cobb,

the Endowment's vice president for education. "We are eager to see this promising partnership evolve."

"This work will have an important impact on the industry," says Nicole Key, associate professor of mechanical engineering. "We have a good team in place. We know we are impacting future engine designs and yet we are able to simultaneously investigate many fundamental questions into the science and engineering of propulsion."

The Maurice J. Zucrow Laboratories, Purdue University Airport and Purdue Aviation LLC are situated within the 980-acre Purdue Research Park Aerospace District, which is located on the west side of the Purdue University campus. The site has been named an Indiana certified technology park by the Indiana Economic Development Corporation.



Rolls-Royce and Purdue University representatives signed a new research agreement. From left: Dan Hasler, president of Purdue Research Foundation; Dennis Warner, president, Rolls-Royce Controls and Data Services; Phil Burkholder, president of Rolls-Royce Defense Aerospace, North America; and Suresh Garimella, Purdue executive vice president for research and partnerships. PHOTO: JOEL REUTER, ROLLS-ROYCE



# COOL TECH

Freeze-drying technology improves food and drug manufacturing

Under the co-leadership of AAE Professor Alina Alexeenko, Purdue University has created a new lyophilization consortium, LyoHUB, to improve freeze-drying technology to make food, pharmaceuticals, and biotech products safer and more affordable.

The center is funded by the National Institute of Standards and Technology through a \$453,623 planning grant from its Advanced Manufacturing Technology Consortia, or AMTech, program.

## Lyophilization

Lyophilization, the process by which water is gently removed from materials to make them more stable and lengthen their shelf life, is



Alina Alexeenko (left), professor of aeronautics and astronautics, and Elizabeth Topp, head of Purdue's Department of Industrial and Physical Pharmacy, co-lead the LyoHUB consortium to improve freeze-drying technology.

a high-priority technology challenge, says Elizabeth Topp, head of Purdue's Department of Industrial and Physical Pharmacy, who co-leads the center.

The conditions required for lyophilization are similar to those in outer space, and the Purdue team plans to apply aerospace engineering principles to the project, Alexeenko says.

"We need to approach the equipment design the same way we approach a new spacecraft design, by first understanding in detail all of the forces and mechanics involved and using some of the special physical effects of the rarefied environment to our advantage," she says.

## A \$30 billion industry

"Lyophilization is a \$30 billion piece of the U.S. food and pharmaceutical manufacturing industry," Topp says. "Without this freeze-drying process, important drugs would not be available to those who need them. However, the current lyophilization process hasn't changed in 50 years, and it is very expensive.

"It is similar to the semiconductor industry a few years ago. We want to revolutionize the lyophilization process in the same way."

The leadership team, in addition to Topp and Alexeenko, includes Michael Pikal of the University of Connecticut and Steve Nail of Baxter International Inc.

# ZUCROW LABS

## expansion makes progress

In February 2016, Purdue University held a celebration to mark the expansion of its Maurice J. Zucrow Laboratories, the nation's largest university propulsion laboratory.

The simulated groundbreaking event took place in the Kurz Atrium of Neil Armstrong Hall of Engineering and included remarks by President Mitch Daniels and Leah Jamieson, the John A. Edwardson Dean of Engineering.

Purdue officials wielded gilded shovels in a simulated groundbreaking, including the original spade used by Maurice Zucrow in 1965 to break ground on the current high-pressure lab.

## Aviation research powerhouse

Located in the 980-acre Purdue Research Park Aerospace District, the labs specialize in rockets and gas-turbine engines, with AAE and

ME faculty and students performing a wide range of propulsion-related research. More than 90 graduate students are working in the labs, which have annual research expenditures exceeding \$9 million.

Propulsion research at Zucrow is led by AAE's Stephen D. Heister, Zucrow director and the Raisbeck Engineering Distinguished Professor for Engineering and Technology Integration; Robert Lucht, the Ralph and Bettye Bailey Professor of Combustion in Mechanical Engineering; William Anderson, professor of aeronautics and astronautics; Nicole Key, associate professor of mechanical engineering, and aeronautics and astronautics; Steven Son, professor of mechanical engineering, and aeronautics and astronautics; and Timothée Pourpoint, associate professor of aeronautics and astronautics.

## FACILITY UPGRADES



New, one-floor, 9,600-SQUARE-FOOT FACILITY costing \$8.2 MILLION

\$5 million comes from a \$40 million grant from Lilly Endowment Inc. Additional funding comes from contributions of Purdue alumni and friends. Construction is slated to be complete by spring 2017.



Five new TEST CELLS that will support LASER-BASED MEASUREMENTS

in a building to be constructed adjacent to Zucrow's high-pressure lab. The current high-pressure lab will be renovated and 5,000 square feet added for offices and a control room.



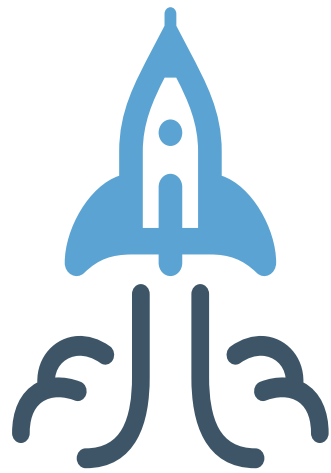
NEW AIR HEATER that heats air to as high as 1,500 DEGREES FAHRENHEIT

at a pressure of up to 850 pounds per square inch — critical factors for developing better jet engines.

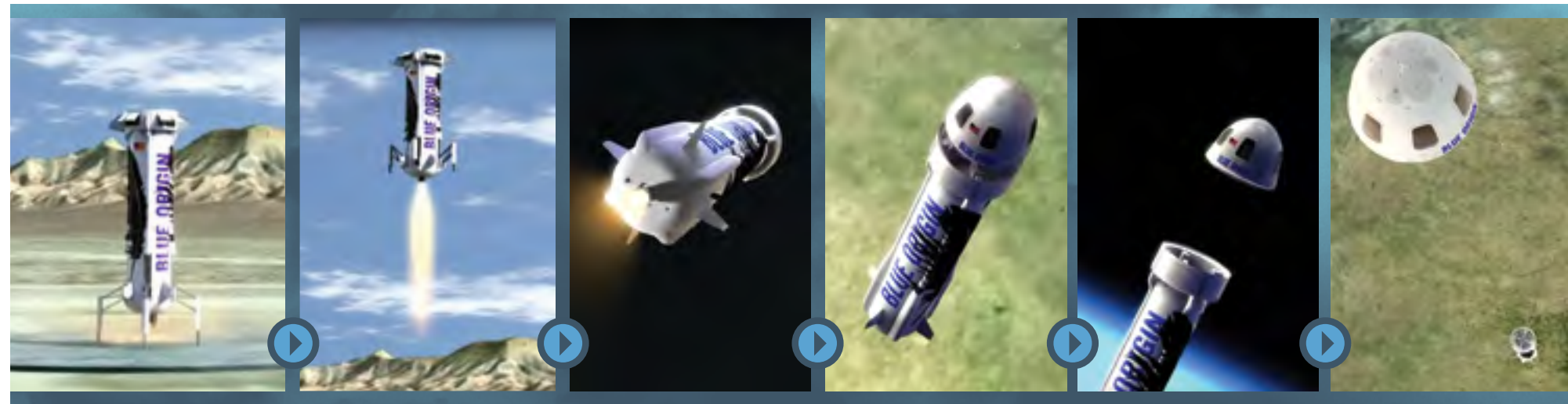


Purdue University officials celebrated a simulated groundbreaking for the expansion of facilities at the University's Maurice J. Zucrow Laboratories. From left: Anil Bajaj, head of Purdue's School of Mechanical Engineering; Zucrow Director Stephen D. Heister; Purdue President Mitch Daniels; Leah Jamieson, the John A. Edwardson Dean of Engineering; and Tom Shih, head of the School of Aeronautics and Astronautics.





# PAYLOAD EXPERIMENT ABOARD BLUE ORIGIN SUBORBITAL ROCKET A SUCCESS



A payload experiment by Professor of Aeronautics and Astronautics Steven Collicott ended with success aboard the first suborbital rocket research flight by private company Blue Origin.

Collicott is one of three scientists asked by Blue Origin to work with the private company as it tested and perfected its suborbital rocket design.

On June 19, Collicott's experiment testing the physics of liquid movement in zero-gravity situations was carried in the payload of the rocket, which took off from a private location in Texas. Collicott was there to see the launch.

"I was excited to see the fluid physics happening in real spaceflight," Collicott says.

## The SUBORBITAL VEHICLE

This payload flew on board Blue Origin's New Shepard space vehicle. The suborbital rocket flew through the middle atmosphere, an altitude of 31 miles to 62 miles known as the mesosphere and lower thermosphere. The New Shepard vertical takeoff and vertical landing vehicle is capable

of carrying hundreds of pounds of payloads per flight and will ultimately carry six astronauts to altitudes beyond 100 kilometers, the internationally recognized boundary of space.

## Wicking in ZERO GRAVITY

The experiment successfully tested details of the physics of zero-gravity wicking — the movement of liquid from one location to another inside a container. Wicking is relevant only in small lengths on Earth. Understanding wicking in zero gravity is important in designing systems such as life support that involve water and air.

"You either want to keep the liquid somewhere or move it somewhere," Collicott says. "You don't want your design to be indecisive, so to speak.

"It's a different world in zero gravity where a satellite fuel tank might be 10 feet tall and 3 feet across. Wicking is the dominant force on the liquid fuel," Collicott says. "So how do you control it or how do you know where it's going to sit? How do you move it from one place to another?"

"These are topics that still require additional research even 50 years into the Space Age to aid in designing better, cheaper and more dependable space vehicles."

For the experiment, diode panels illuminated a sphere inside a bolted-down box in the rocket. Mirrors and cameras were used to record liquid moving along a plastic vane, determining how big a gap between the vane and the wall of the sphere

keeps the liquid in place and how small a gap causes the liquid to move along.

The experiment initially was built with National Science Foundation funding and help from the College of Engineering. Since then, undergraduate students in Collicott's Zero-Gravity Flight Experiment class at Purdue have worked on the experiment hardware.

This payload was part of Blue Origin's Pathfinder Payloads program, demonstrating the integration and operation of scientific experiments during untended test flights of the New Shepard system to high altitudes.

## Future of suborbital RESEARCH

"Companies like Blue Origin who are developing this suborbital research capability in fully reusable rockets are bringing down the cost of spaceflight experimentation so much that all kinds of things can use space as a laboratory," Collicott says. "It's a small fraction of the cost of old-fashioned NASA and European Space Agency sounding rockets."

The experiment's results are just as important on Earth as they are in space. Collicott said the ever-increasing miniaturization of analytical systems for health care and the optimization of one type of automotive fuel cell are among the possible uses for his work.

"It's nice to know you can impact a lot of things on Earth, too," he says.

Professor Steven Collicott (center) with AAE PhD student George Georgalis (left) and alumnus Brian O'Neill at the Blue Origin launch. PHOTO: BLUE ORIGIN





# MODEL MOLECULES

## Carbon nanostructure models reduce costs for industry and research

A Purdue University research team has developed a simulation technique to help reduce the cost of carbon nanostructures for research and potential commercial technologies, including advanced sensors and batteries. The modeling effort is being led by Alina Alexeenko, a professor in the School of Aeronautics and Astronautics.

Carbon nanostructures such as nanotubes, “nanopetals” and ultrathin sheets of graphite called graphene may find a wide variety of applications in engineering and biosciences. Due to the rapid increase in their use over the past decade, researchers are working to develop a mass-production system to reduce their cost.

The nanostructures are manufactured with a method called plasma-enhanced chemical vapor deposition (CVD).



AAE Professor Alina Alexeenko and graduate student Andrew Strongrich work in the vacuum chamber in her lab at the Aerospace Sciences Lab building.

In new findings, researchers have developed a model to simulate what happens inside the CVD reactor chamber to optimize conditions for fast and environmentally friendly conversion of raw materials, such as methane and hydrogen, into carbon nanopetals and other structures.

“The modeling could enable us to do less trial and error in searching for conditions that are just right to create nanostructures,” Alexeenko says.

The research is part of a Purdue project funded by the National Science Foundation focusing on creating a nanomanufacturing method capable of mass production at low cost.

“Now that we can simulate the process, we will be able to look first on the computer for the set of conditions that improves the process in order to guide the next experiments in the lab,” says Timothy Fisher, the James G. Dwyer Professor of Mechanical Engineering.

Findings are detailed in a paper authored by graduate students Gayathri Shivkumar, Siva Sashank Tholeti and Majed Alrefae; Fisher; and Alexeenko. It was published online in the *Journal of Applied Physics* and was the featured article of the journal’s March 21, 2016, print edition.

“The next and ongoing step in this research is applying the modeling to roll-to-roll for large-scale manufacturing of nanopetals,” Alexeenko says. “Also, optimizing the reactor conditions for energy efficiency and environmental effects to minimize production of toxic chemicals.”



## PROFESSOR SKIP GRANDT RETIRES

On March 31, the School of Aeronautics and Astronautics held a retirement reception to honor Distinguished Professor Alten “Skip” Grandt Jr. for his 36 years of service. Family, friends and many current and former colleagues and students attended the ceremony, which was held in the Herman & Heddy Kurz Atrium in the Neil Armstrong Hall of Engineering.

Grandt joined the school in 1979 as an associate professor, was promoted to full professor in 1983, served as head from 1985 to 1993, and was appointed the Raisbeck Engineering Distinguished Professor of Engineering and Technology Integration by the Purdue University Board of Trustees in December 2000.

Throughout his career, Grandt received numerous awards and appointments, including AIAA Fellow, Purdue University Department of Engineering Professional Education Distance Faculty Award, United States Air Force J.W. Lincoln Medal, and the E.F. Bruhn Best Teacher Award from Purdue’s School of Aeronautics and Astronautics.

Grandt also is co-author of a 500-page book detailing the history of the Purdue School of Aeronautics and Astronautics, titled “One Small Step: The History of Aerospace Engineering at Purdue University.”

# MUST READ



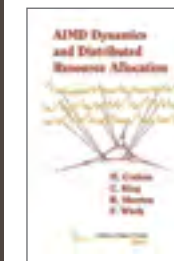
## Multiscale Characterization of Biological Systems

BY VIKAS TOMAR

Professor Vikas Tomar has had a book published by Springer. “Multiscale Characterization of Biological Systems” is based on work Tomar has done with his students over the past decade in the field of interface mechanics of biomaterials.

The book covers the latest research in the area of interface mechanics of collagen and chitin-based biomaterials, along with various techniques for understanding the mechanics of biological systems and materials. The use of nanomechanics to investigate interface thermomechanics of collagen and chitin-based biomaterials is also covered in detail.

The book’s co-authors also are from Purdue’s School of Aeronautics and Astronautics. Devendra K. Dubey and Tao Qu earned their PhDs from the school, and Devendra Verma and Yang Zhang are in the final stages of their PhD programs.



## AIMD Dynamics and Distributed Resource Allocation

CO-AUTHORED BY MARTIN CORLESS

Professor Martin Corless has co-authored

the book “AIMD Dynamics and Distributed Resource Allocation.” Published by the Society for Industrial and Applied Mathematics, it is the first comprehensive book on the AIMD algorithm, the most widely used method for allocating a limited resource among competing agents without centralized control. The book describes the basic and fundamental properties of the

algorithm, offers examples to illustrate the richness of the resulting dynamical systems, and provides applications to illustrate ways the algorithm can be used in the context of smart cities, intelligent transportation systems, and the smart grid.

Corless’s research focuses on obtaining tools that are useful in the analysis and control of systems containing significant uncertainty, with the major application of this research being in the analysis and control of aerospace and mechanical systems.





**AIAA Energy Systems Award**

★ ★ ★

**TOM SHIH**

PROFESSOR AND HEAD,  
SCHOOL OF AERONAUTICS  
AND ASTRONAUTICS

Tom Shih, professor and head of the School of Aeronautics and Astronautics, was recently awarded the 2015 Energy Systems Award by the American Institute of Aeronautics and Astronautics (AIAA). The award recognizes Shih's "outstanding contributions to computational tool development and improvement for use in design, analysis and examination of complex engineering problems involving aerodynamics, propulsion and energy."

Established in 1981, the Energy Systems Award is presented for significant contributions in the field of energy systems, specifically as they relate to the application of engineering sciences and systems engineering to the production, storage, distribution and conservation of energy. The award was presented to Shih at the AIAA Propulsion and Energy Forum in July 2015.



**FACULTY**

**AWARDS**

**AND**

**HONORS**

U.S. research institutions who received a PhD or equivalent degree in the last five years and show exceptional ability and promise for conducting basic research. The award fosters research in science and engineering and early-career development of outstanding young investigators, while increasing opportunities for these investigators to recognize the challenges in science and engineering related to the mission of the Air Force.

AAE Assistant Professor Sally Bane is among 56 scientists and engineers to share in \$20.6 million in grants awarded by the Air Force Office of Scientific Research (AFOSR). Bane received a Young Investigator Research Program (YIP) grant for her project titled "Plasma-Enhanced Flames at Elevated Pressure." The research focuses on combustion and plasma science for a range of applications, including propulsion system design, plasma-assisted combustion, and aerodynamic flow control.

"I am extremely excited to receive this award because it will allow me to design new state-of-the-art experiments to study plasma-assisted combustion," says Bane. "Through this grant, I hope to obtain critical data and scientific understanding that can be used in new propulsion applications."

The Young Investigator Research Program is open to scientists and engineers at



**YIP Grant**

★ ★ ★

**SALLY BANE**

ASSISTANT PROFESSOR,  
SCHOOL OF AERONAUTICS  
AND ASTRONAUTICS



**DURIP Award**

★ ★ ★

**CARSON SLABAUGH**

ASSISTANT PROFESSOR, SCHOOL OF  
AERONAUTICS AND ASTRONAUTICS

AAE Assistant Professor Carson Slabaugh has been chosen by the U.S. Department of Defense to receive a research instrumentation award. The award is being made under the Defense University Research Instrumentation Program (DURIP), which supports the purchase of state-of-the-art equipment necessary to conduct cutting-edge research. Slabaugh's DURIP funds will be used to purchase a high-speed imaging system.

"What we're doing is looking at this new detonation engine type cycle," Slabaugh says. "The combustion wave is actually moving at supersonic speed, so in order to capture that and image the way the combustion process takes place, we need a really fast camera."

Slabaugh says this new camera has one of the fastest sensors, shooting 20,000 frames/second. He says this high-speed camera will produce the clear images needed for the research being done at Zucrow Laboratories.

DURIP awards are the result of a merit competition conducted by three DoD research offices: the Army Research Office, the Office of Naval Research and the Air Force Office of Scientific Research. The program is highly competitive. Of the 622 proposals received, just 176 were selected.



**ION Award**

★ ★ ★

**JAMES L. GARRISON**

ASSOCIATE PROFESSOR,  
SCHOOL OF AERONAUTICS  
AND ASTRONAUTICS

AAE Associate Professor James L. Garrison has been honored with the Institute of Navigation (ION) Tycho Brahe Award. The award recognizes an individual who has

made outstanding contributions to the science of space navigation, guidance and control. Garrison was acknowledged for his contributions to developing and applying global navigation satellite system (GNSS) and other signals-of-opportunity and reflectometry methods for space-based and remote sensing — in oceanography, agriculture and hydrology. The award was presented during ION's winter meeting, the International Technical Meeting (ITM), which was held Jan. 25-28 in Monterey, California.

Garrison was previously honored by ION with an Early Achievement Award (2001) for his contributions to the development of algorithms for satellite navigation in highly elliptical orbits, and the use of GPS reflections for remote sensing.



**ASME Fellow**

★ ★ ★

**VIKAS TOMAR**

PROFESSOR, SCHOOL OF  
AERONAUTICS AND ASTRONAUTICS

Vikas Tomar, professor in the School of Aeronautics and Astronautics, has been named a fellow of the American Society of Mechanical Engineers (ASME). The fellow grade is the highest elected level of membership in ASME.

In order to be selected as an ASME Fellow, one must be an active member for more than 10 years and have at least 10 years of experience in the field. A prospective fellow must be nominated by a current fellow, receive three additional sponsor letters and submit a professional record to account for their accomplishments. Tomar was nominated by R. Byron Pipes, the John Leighton Bray Distinguished Professor of Engineering at Purdue. Pipes was named an ASME Fellow in 1991.

Of the more than 140,000 members of the American Society of Mechanical Engineers, fewer than 4,000 have attained the rank of fellow.

CONTINUED ON NEXT PAGE





### Teaching for Tomorrow Fellowship

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#### KAREN MARAIS

ASSOCIATE PROFESSOR,  
SCHOOL OF AERONAUTICS  
AND ASTRONAUTICS

AAE Associate Professor Karen Marais was selected for a Teaching for Tomorrow Fellowship. The program was established by the Purdue classes of 1944 and 1945 to foster continued excellence of teaching and learning, and to facilitate the development of the teaching potential of the faculty. Teaching for Tomorrow recognizes tenure-track or clinical junior faculty members who are committed to improving their teaching at Purdue and senior faculty members for their long-term contributions to teaching and mentoring.

Marais was chosen as one of three Senior Fellows for the

2016-17 academic year. In that role she will serve as a mentor to junior faculty. This includes helping them craft a plan that will enable them to grow as educators, observing them in the classroom or lab setting and providing feedback, and participating in panel discussions.

The Teaching for Tomorrow program is administered by Purdue's Center for Instructional Excellence (CIE). Recipients are nominated by their college and selected by a CIE committee.



### CoE Leadership Excellence Award

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#### WILLIAM CROSSLEY

PROFESSOR, SCHOOL OF  
AERONAUTICS AND ASTRONAUTICS

AAE Professor William Crossley is the 2016 recipient of the College of Engineering's Leadership Excellence Award. The honor recognizes leadership that improves the climate and environment for other CoE faculty, staff, and students and that values and promotes diversity and inclusiveness.

The Leadership Excellence Award is one of seven faculty awards given annually by the College of Engineering since 2002. Crossley and the other award winners were recognized at the 14th annual recognition banquet in April.



### Faculty Scholar

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#### VIKAS TOMAR

PROFESSOR, SCHOOL OF AERONAUTICS  
AND ASTRONAUTICS

AAE Professor Vikas Tomar has been named a University Faculty Scholar. Created in 1998, the University Faculty Scholar program honors tenured associate professors and full professors who have been in that rank for no more than five years and are named in recognition of their scholarship.

University Faculty Scholars in AAE are nominated by the school and reviewed by a committee of named and distinguished professors in the College of Engineering, which makes a recommendation to the dean. Finalists then are approved by the provost.

Honorees receive funding to support their research. The newly named University Faculty Scholars will begin their five-year terms in the fall of 2016.



### Elmer F. Bruhn Best Teacher Award

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#### TYLER TALLMAN

ASSISTANT PROFESSOR,  
SCHOOL OF AERONAUTICS  
AND ASTRONAUTICS

AAE Assistant Professor Tyler Tallman was selected to receive the School of Aeronautics and Astronautics Elmer F. Bruhn Award for 2016. The annual Bruhn teaching award is presented to an outstanding teacher. The honoree is selected through a vote by AAE's sophomores, juniors and seniors. The award is made possible by the generosity of friends and alumni of the school.

"Providing our students with the best possible education is the goal of every faculty member in our school," says Tom Shih, professor and head of the School of Aeronautics and Astronautics. "Since we have so many outstanding faculty members who excel at teaching, winning this award speaks wonderfully of Professor Tallman."

The faculty members who received the next highest votes for the Bruhn Award are Professor Dan Dumbacher and Professor Kathleen Howell.

The winner of the Bruhn Award becomes the school's nominee for the College of Engineering's annual A.A. Potter Best Teacher Award.



### Outstanding Faculty Mentor Award

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#### DANIEL DELAURENTIS

PROFESSOR, SCHOOL OF  
AERONAUTICS AND ASTRONAUTICS



AAE Professor Daniel DeLaurentis received the 2016 Outstanding Faculty Mentor Award by graduate students in the School of Aeronautics and Astronautics. This is the first award in which graduate students have nominated and selected the winner. The selection committee consisted of two representatives from Purdue Aero Assist and one from the Graduate Women's Gatherings.

The nomination for DeLaurentis read in part, "Dr. DeLaurentis excels at bringing out the best in his students with extraordinary accommodation of their personal research interests, expertise and career goals, creating tailored development plans unique to each student. Dr. DeLaurentis has created and fosters an atmosphere where students are encouraged to make, admit, and learn from their mistakes."

Six AAE professors were nominated for the 2016 Outstanding Faculty Mentor Award.



### AIAA Associate Fellow

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#### DANIEL DUMBACHER

PROFESSOR, SCHOOL OF  
AERONAUTICS AND ASTRONAUTICS

Daniel Dumbacher, AAE professor of practice, was named Associate Fellow in the American Institute of Aeronautics and Astronautics. AIAA Associate Fellows are individuals of distinction who have made notable and valuable contributions to the

arts, sciences, or technology of aeronautics or astronautics. Each year, only one of every 150 voting members is selected and approved. Dumbacher was honored at the AIAA Associate Fellow recognition ceremony and dinner in January 2016, in conjunction with the AIAA SciTech Forum held in San Diego.

Also this year, Dumbacher received the Alumni of Achievement Award from the University of Alabama in Huntsville (UAH) Alumni Association, the association's highest honor. The award recognizes graduates who have distinguished themselves professionally and personally and who exemplify the high standards of UAH. Winners are selected by a committee from nominations made by alumni, faculty and friends of UAH.



## FACULTY AWARDS AND HONORS

CONTINUED





## INCITE Program Grant

★ ★ ★

### JONATHAN POGGIE

ASSOCIATE PROFESSOR, SCHOOL OF AERONAUTICS AND ASTRONAUTICS

AAE Associate Professor Jonathan Poggie won a grant of 150 million CPU-hours per year for two years on Argonne National Laboratory's supercomputer Mira, the fifth-largest in the world. The grant of supercomputer time comes under the INCITE Program (Innovative and Novel Computational Impact on Theory and Experiment) administered

by the U.S. Department of Energy's Office of Science.

With his collaborators at the Air Force Research Laboratory, Poggie will investigate unsteady separation in compressible, turbulent flow. Unsteady separation is characterized by the presence of long time-scale (1–100 ms), low-frequency (10–1000 Hz) pressure fluctuations. These fluctuations lie in a region near the typical resonant frequency of aircraft panels and thus lead to severe structural fatigue loading. A key scientific question remains as to why such low-frequency oscillations exist.

The disparity of length and time scales between fine-grain turbulence and large-scale flow unsteadiness makes computational simulation of these flows inherently challenging. With the extraordinary computational power of the DoE's supercomputers, Poggie's project will attack the problem through massively-parallel, direct numerical simulations.



## FACULTY AWARDS AND HONORS

CONTINUED



## W.A. Gustafson Award for Outstanding Teaching

★ ★ ★

### DANIEL DUMBACHER

PROFESSOR, SCHOOL OF AERONAUTICS AND ASTRONAUTICS

AAE Professor of Practice Dan Dumbacher is the winner of the prestigious 2015 W.A. Gustafson Award for Outstanding Teaching. The award is presented annually to an outstanding teacher in the Purdue School of Aeronautics and Astronautics. The winner is selected by the juniors and seniors of the student body. The award is made possible by the interest and generosity of friends and alumni of the school.



## NATO Science and Technology Scientific Achievement Award

★ ★ ★

### TERRENCE WEISSHAAR

PROFESSOR EMERITUS, SCHOOL OF AERONAUTICS AND ASTRONAUTICS

AAE Professor Emeritus Terrence Weisshaar received the 2014 NATO Science and Technology Scientific Achievement Award for his contribution to AVT-174

on Qualification and Structural Design Guidelines for Military Unmanned Aerial Vehicles (UAVs).

In the period from 2010 to 2012, Weisshaar and the other members of the technical group made an outstanding contribution to the mission of the NATO Science and Technology Organization (STO), conducting extensive cooperative research in the field of military UAVs, also known as "drones." Further, the results generated by AVT-174 were directly and immediately exploited within NATO and NATO nations as they were specifically requested by various industry and research institutions.

Encompassing a network of over 3,000 scientists and engineers from across the alliance and its partners, the STO promotes and conducts cooperative research and information exchange across the full spectrum of defense research, develops and maintains a long-term NATO research and technology strategy, and provides advice to all elements of NATO on research and technology issues. As well, it is the largest such research group in the world.



## Violet Haas Award

★ ★ ★

### KATHLEEN C. HOWELL

HSU LO DISTINGUISHED PROFESSOR OF AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

Kathleen C. Howell, the Hsu Lo Distinguished Professor of Aeronautical and Astronautical Engineering, was the winner of the 2015 Violet Haas Award.

The Susan Bulkeley Butler Center for Leadership Excellence administers the award, which "recognizes individuals, programs or departments at Purdue who have effectively facilitated the advancement of women in hiring, promotion, education, and salary, or have generally enhanced a positive professional climate for women at Purdue."

At a December 2015 reception, Patrice Buzzanell, director of the Butler Center and the Susan Bulkeley Butler Chair for Leadership Excellence, said Howell's "lists of accomplishments in discovery, learning, and engagement — and tireless work on behalf of women at Purdue, in engineering, and in the local and global community — are inspiring."

In nomination materials, Tom Shih, head of the School of Aeronautics and Astronautics, said Howell has been "nurturing a generation of future female faculty members who could lead the nation."



Professor James Garrison (left) with AAE Head Tom Shih.

## C.T. Sun Award

★ ★ ★

### JAMES L. GARRISON

ASSOCIATE PROFESSOR, SCHOOL OF AERONAUTICS AND ASTRONAUTICS

Professor James Garrison was the recipient of the 2016 C.T. Sun School of Aeronautics and Astronautics Excellence in Research Award. Presented annually, this prestigious award recognizes an individual or a team of faculty members in the School of Aeronautics and Astronautics who have made high-quality contributions to research in science and engineering.



## Early Career Award

★ ★ ★

### MICHAEL D. SANGID

ASSISTANT PROFESSOR, SCHOOL OF AERONAUTICS AND ASTRONAUTICS

Michael D. Sangid, assistant professor in the School of Aeronautics and Astronautics, has received the Minerals, Metals and Materials Society's Early Career Faculty Fellow Award. Sangid, who has a courtesy appointment in the School of Materials Engineering, is one of two recipients of the 2016 award.

His research focuses on integrated computational materials engineering, which allows industry to save money and time by using sophisticated models to more efficiently design and manufacture products. The models can simulate material behavior at the crystal level, reducing the need for trial and error, an approach that could make it possible to produce aerospace parts twice as fast at half the cost.

Sangid leads the Advanced Computational Materials and Experimental Evaluation Laboratory. The ACME group combines computational modeling and in situ experiments to solve complex applied problems in aerospace materials.

He has received other honors, including the 2015 Orr Award for Fatigue and Fracture from the American Society of Mechanical Engineers; the International Journal of Fatigue's most-downloaded journal paper in 2013, 2014 and 2015; and early career distinctions from the U.S. Air Force, U.S. Navy and the Defense Advanced Research Projects Agency.





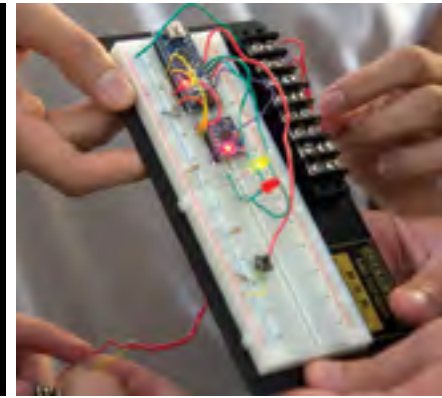
# PURDUE LIGHTS (AND LEADS) THE WAY

## AAE student design team creates high-tech torch for Indiana bicentennial

An interdisciplinary team of students and faculty at Purdue University has designed and built the torch that is central to Indiana's bicentennial relay. Timothée Pourpoint, associate professor in the School of Aeronautics and Astronautics, led the project, which was more than a year in the making. A workhorse "flagship" torch will dominate the relay, while a high-speed torch capable of staying lit amid high winds will be used in special circumstances.

AAE students designed the body of the torch and the burner. The Department of Agricultural and Biological Engineering researched the E85 torch fuel and additive to be used, and the School of Materials Engineering worked on manufacturing and anodizing the torch's prototype body. Electronics and software — including technology never before used in a torch relay — were handled by the School of Electrical and Computer Engineering.

The design of the torch aesthetically matches the original Hadley torch on the Indiana state flag, adopted in 1917. The



**LEFT** / Electronics board for the bicentennial torch. **MIDDLE** / Front row, from left: AAE Associate Professor Timothée Pourpoint, Kylee Davison (ECE), Brock Macknick (AAE), Gabby Feldman (AAE). Back row, from left: Todd Wild (ECE industrial designs project manager), Noah Chesnut (ECE), Matt Elliott (AAE), Phil Baldwin (AAE design-build-test engineer). **RIGHT** / The two rings on each torch are made completely from aluminum lithium alloy.

torch contains 19 stars — five stars on the bottom ring, 13 stars on the top ring and one star on the top of the torch. The stars on the top ring have a practical function: they serve as air inlets for the flame. One star on the bottom ring serves as a viewport for the camera and the star on the top of the torch represents the 19th state in the union: Indiana.

The torch rings are made from aluminum lithium alloy from Alcoa's Lafayette plant. Overall, the company donated close to \$100,000 in materials and labor to the project.

"We're also using their latest and greatest alloy, which saved us about 10 percent in weight," Pourpoint says. The final version of the torch weighs a little less than 5 pounds and stands around 2 feet tall."

The torch burns an ethanol fuel blend known as E85, which is produced with agricultural products grown in Indiana. An additive was needed to make the flame brighter and more yellow.

The torch will be handled by about 1,800 people during the course of the relay.

"The torchbearer will be able to click a button to take a picture, or hold the button to shoot video, which will be uploaded to the internet via Wi-Fi," Pourpoint says.

The camera can record high-definition video and photographs. Data will be relayed via wireless signals to a nearby van. A GPS system tracks the relay's

progress, and a USB port in the bottom of the handle allows for battery recharging.

The torch is also equipped with a sensor that detects when it tilts farther than 45 degrees, representing a potential burn hazard. Excessive tilt activates a mechanism that deploys a "snuff plate" to extinguish the flame while at the same time closing air inlets.

AAE senior Gabby Feldman came up with the idea for the snuff plate, along with working on other aspects of the torch design and assembly.

"We play pretend design in our classes all the time, but it's rarely a real thing that people are going to use," Feldman says. "This was super cool because it actually had to work, and it actually does work, and so that's really rewarding."

She says the project has been a valuable experience, in part because of the need to work with other teams.

"Going through the process has really helped me as an engineer because you realize how many iterations something goes through between design, prototype and final design," Feldman says.

Patterned after the Olympic torch relay, Indiana's bicentennial torch relay will pass through all 92 of the state's counties and cover 3,200 miles over a five-week period. The relay culminates on Oct. 16 on the Statehouse grounds in Indianapolis with a special welcome ceremony and celebration.

**"THE TORCHBEARER WILL BE ABLE TO CLICK A BUTTON TO TAKE A PICTURE, OR HOLD THE BUTTON TO SHOOT VIDEO, WHICH WILL BE UPLOADED TO THE INTERNET VIA WI-FI."**

TIMOTHÉE POURPOINT, AAE associate professor, torch project leader



# NEED FOR (HYPER) SPEED

## HYPERLOOP POD

Purdue students create a passenger capsule for a transportation system that could travel at nearly the speed of sound in a vacuum tube.

## Purdue students advance in SPACE X HYPERLOOP COMPETITION

Students on the Purdue University Hyperloop team won the chance to bring their ultra-modern transportation designs to life. Sponsored by SpaceX, the 2015-17 Hyperloop pod competition is an incentive prize competition in which student and non-student teams design — and for some, build — a subscale prototype transport vehicle to demonstrate technical feasibility of various aspects of the Hyperloop concept. SpaceX released the concept in 2013; it involves a passenger capsule that might travel at nearly the speed of sound in a vacuum tube.

Purdue's 18-member team was among 30 teams selected (from among 115) to advance during the SpaceX Hyperloop pod competition, Jan. 29-30, at Texas A&M University, College Station, Texas.

With their design selected, the team now has the opportunity to construct and test their design at the first Hyperloop Test Track in California.

Purdue team members participated in a multidisciplinary Hyperloop class taught by faculty members such as Alina Alexeenko, professor in the School of Aeronautics and Astronautics. She says the project was a unique learning experience.

"This has taken the team to a different level beyond just engineering," Alexeenko says.

Students in the College of Engineering's schools of Aeronautics and Astronautics, Mechanical Engineering, Electrical and Computer Engineering, and Industrial Engineering, as well the departments of Computer Science and Physics and Astronomy in the College of Science, all contributed to the project. Students from Purdue's Brian Lamb School of Communication assisted with stewardship of sponsors and publicity. AAE Professor John Sullivan advised students during the design process.

More than 100 student engineering teams representing 27 states and 20 countries participated in the competition. Teams were judged on categories ranging from design detail and innovation to feasibility for test track competition.



Purdue President Mitch Daniels (center) with Purdue's Hyperloop team

## Witsberger wins 2016 Herbert F. Rogers Award

Paul Witsberger is the recipient of the 2016 Herbert F. Rogers Award, which is given annually to a senior who is "deemed the most worthy and deserving as determined by her/his contributions to the growth of the School of Aeronautics and Astronautics in fostering engineering as an academic discipline." The winner is selected by the school's awards committee along with two student members.



"Most of my friends and classmates that I work with on a daily basis are outstanding, so it's humbling to be the one chosen to receive this award," Witsberger says. "It's

also a great feeling to be acknowledged for all the hard work I've put in the last four years."

During his time as an undergraduate, Witsberger was active with the Purdue Chapter of AIAA, serving as outreach chairman and president, and co-founded the Purdue Lunabotics team. He also took part in the AAE 450 senior design project, known as Project Legacy, that designed a lunar base to serve as a steppingstone for a human mission to Mars and presented those plans to Buzz Aldrin.

As project manager for the Purdue Hyperloop team, Witsberger is coordinating efforts of more than 60 students from across the College of Engineering to compete in the SpaceX Hyperloop Pod Competition. The team is one of 30 selected to build a pod and test it at the Hyperloop Test Track in California in early 2017.

Witsberger earned his BSAAE in May 2016 and is now continuing his graduate studies at Purdue as part of Professor James Longuski's Advanced Astrodynamic Concepts (AAC) research group. Witsberger says he would love to return to the NASA Jet Propulsion Laboratory, where he interned in summer 2015, and work on a human mission to Mars or planetary exploration to the outer planets.



## Atyam named one of Aviation Week's

# 20 TWENTIES



**DEEPAK ATYAM**  
AAE GRADUATE STUDENT

AAE graduate student Deepak Atyam was recognized as one of "Tomorrow's Engineering Leaders: The 20 Twenties." The honor is part of Penton's Aviation Week Network, in partnership with the American Institute of Aeronautics and Astronautics. The award recognizes top engineering, math, science and technology students based on their academic excellence, research and projects undertaken, and the contributions they are making to the broader community.

A student of AAE Associate Professor Timothée Pourpoint, Atyam is pursuing an MS in aerospace engineering with a

focus in propulsion and a minor in industrial engineering. Atyam says he is happy his work is being recognized by professionals in the aerospace community.

"It helps validate the direction I chose to go in my career path and gives me confidence to push further while aiming for ambitious goals," Atyam says.

The 20 Twenties winners for 2016 were honored during Aviation Week's 59th Annual Laureate Awards on March 3 at the National Building Museum in Washington, D.C. They also were featured in the Feb. 29 digital and print publication of Aviation Week & Space Technology.



**ANTHONY COFER**  
AAE PhD CANDIDATE

## PhD candidate and faculty team to develop SMALL SPACECRAFT TECHNOLOGY

AAE PhD candidate Anthony Cofer, along with professors Alina Alexeenko and Stephen Heister as co-principal investigators, was selected to collaborate with NASA's Small Spacecraft Technology Program within the Space Technology Mission Directorate.

The Small Spacecraft Technology Program selected only eight university teams to collaborate on development and demonstration of new technologies and capabilities for small spacecraft. Each of the

university teams will work with engineers and scientists from NASA on two-year projects beginning in the fall of 2016. These projects target the development of technologies for small spacecraft, some of which weigh only a few kilograms, dramatically enhancing their ability to serve as powerful but affordable platforms for science, exploration and commercial space missions.

## FAA names Rao a 2016 PEGASAS OUTSTANDING RESEARCHER

AAE PhD student Arjun Rao was recognized by the Federal Aviation Administration with a 2016 PEGASAS Outstanding Student Researcher Award. He was honored at the PEGASAS Annual Meeting on June 8 at Iowa State University.

Rao is a PhD candidate in the systems engineering major under AAE Associate Professor Karen Marais. He specializes in general aviation safety, including fixed-wing and rotorcraft. His research focuses on identifying high-risk precursors to aviation accidents through the integration of historical accident analysis, identifying abnormal conditions from flight data and subject matter expert opinion. This research is carried out as part of the Rotorcraft ASIAs project, which is supported and led by the FAA.

Purdue is a lead institution for Partnership to Enhance General Aviation Safety, Accessibility and Sustainability (PEGASAS). The PEGASAS Center of Excellence, directed by AAE Professor William Crossley, focuses on research and testing efforts on safety, accessibility and sustainability to enhance the future of general aviation. Marais supports the efforts of PEGASAS by working on effective communication among the center's researchers.



**PICTURED FROM LEFT** / Eric Neiderman, FAA Manager of Aviation Research Division; AAE Professor Bill Crossley; Arjun Rao and Peter Sparacino, FAA Program Manager for PEGASAS





## Orbital ATK awards AAE 251 DESIGN TEAM

Congratulations to the winners of the fall 2015 S.P.A.C.E. Awards. One team of students from each section of the Introduction to Aerospace Design (AAE 251) course was recognized for its work. The course was taught by AAE Assistant Professor Michael Grant.

The teams were tasked with designing an orbital recovery system (ORS) consisting of three parts: 1) a rocket that will launch a space-based recovery system (SRS) into low Earth orbit (LEO); 2) an SRS capable of rendezvousing with the orbital asset from LEO and deorbiting the asset in a controlled manner; and 3) an aircraft that will catch the deorbited asset as it descends in the atmosphere on a parachute and return the asset to the launch site of the rocket.

The winning teams were chosen by Orbital ATK. Certificates were presented to the students during the Spring 2016 meeting of AAE's Industrial Advisory Council by Dave McGrath, Orbital ATK's director of systems engineering and IAC member. Orbital ATK Inc. is an American aerospace and defense industry firm.

**PICTURED FROM LEFT** / AAE Assistant Professor Michael Grant, Christopher Johnson, Sean McCrohan, Will Stanczykiewicz, Ricardo Gomez, Tyler Halterman, Will McNulty, Maaninee Gupta, Chris Polivick, Dave McGrath

## Guariniello earns CERIAS DIAMOND AWARD

AAE PhD student Cesare Guariniello received the 2016 Diamond Award from Purdue's Center for Education and Research in Information Assurance and Security (CERIAS). The annual award recognizes a graduating student who, like coal, is put under a lot of pressure to emerge a "diamond."

CERIAS Executive Director Gene Spafford says Diamond Award recipients have faced various difficulties on their road to success. He says Guariniello's main obstacle was that he is not a U.S. citizen. Guariniello has faced a set of restrictions that make it difficult to gain access to some necessary data and software. But Spafford says Cesare has had great success despite that obstacle, including being an integral part of the System-of-Systems research group and being first author on a number of peer-reviewed papers.

"Cesare in general is just an outstanding scholar," Spafford says. "He is one of the kinds of people that we are so proud to have here."

Guariniello, a student of AAE Professor Daniel DeLaurentis, received the award at CERIAS 2016, the 17th annual Information and Security Symposium, which was held April 19-20 at Purdue.

**FROM LEFT** / Cesare Guariniello and Gene Spafford



## Kravchenko, Kwon win prestigious BILSLAND DISSERTATION FELLOWSHIPS

PhD candidates Sergii Kravchenko and Cheolhyeon Kwon received the 2016 Bilsland Dissertation Fellowship Award. This award honors outstanding PhD candidates in their final year of doctoral degree completion. The Bilsland Dissertation Fellowship is highly competitive and recognizes students' superior academic abilities and scholarly achievements.

Kravchenko is a student of R. Byron Pipes, the John Leighton Bray Distinguished Professor of Engineering. The title of Kravchenko's dissertation is "Progressive Failure Analysis of a Platelet-stacked Material System."

Cheolhyeon Kwon is a student of Inseok Hwang, professor of aeronautics and astronautics. The title of Kwon's dissertation is "Secure and High Assurance Control of Networked Cyber-Physical Systems with Application to Unmanned Aircraft Systems." His research seeks to mitigate the threat of cyberattacks on cyber-physical systems, especially in unmanned aircraft system applications.

Sergii Kravchenko (left) and Cheolhyeon Kwon



## AAE graduate students win ACCOLADES

AAE graduate students won honors at Purdue University's annual Celebration of Graduate Teaching Excellence, hosted by Purdue's Office of the Provost, the Teaching Academy, the Graduate School and the Center for Instructional Excellence. Gayathri Shivkumar and Waterloo Tsutsui received the Teaching Academy Graduate Teaching Award. Hao Wang earned the Graduate Instructional Development Certificate.

Six students received the 2016 Magoon Excellence in Teaching Award from the College of Engineering for exemplary work as teaching assistants:

- Sayan Biswas (Advisor Professor Li Qiao)
- Nitin S. Dhamankar (Advisor Professor Gregory Blaisdell)
- Jooyoung Lee (Advisor Professor Inseok Hwang)
- William O'Neill (Advisor Professor Daniel DeLaurentis)
- Bhavani Singh (Advisor Professor Sally Bane)
- Waterloo Tsutsui (Advisor Professor Wayne Chen)

Natasha Bosanac received the 2016 Award for Outstanding Research, for excellence and leadership in research. Natasha's advisor is Professor Kathleen Howell.

Heather Wiest was one of 10 CoE graduate students who received the 2016 Outstanding Service Scholarship, for outstanding service to the graduate student community, their school, the college, and/or the University. Wiest's advisor is Professor Steve Heister.

**PICTURED FROM LEFT** / Bhavini Singh, Professor Gregory Blaisdell, Nitin S. Dhamankar, Sayan Biswas, William O'Neill, Jooyoung Lee, Natasha Bosanac, Heather Wiest, Professor Steve Heister, Professor Kathleen Howell



## EBERSOLE LEADS THE U.S. AIR FORCE RESEARCH LABORATORY

The Pentagon has named C. Douglas Ebersole (BSAAE '82) as the new civilian leader of the Air Force Research Laboratory (AFRL). He assumed his new role in September 2015.

Ebersole, previously director of the Aerospace Systems Directorate at the AFRL, has been a fixture of Wright-Patterson Air Force Base since starting his career there in 1982 as a performance engineer. Over the years he has worked in numerous critical engineering positions, mostly in what is now called the Air Force Life Cycle Management Center.

One notable assignment outside of the AFRL, from 2010 to 2013, was serving as director of engineering for the F-35 Joint Program Office, responsible for the development, production and sustainment of the next generation strike aircraft for the Air Force, Marine Corps and Navy.



C. DOUGLAS EBERSOLE

AFRL, with four directorates and its headquarters at Wright-Patterson, oversees billions of dollars in annual research that shapes the technology used by the Air Force and other military services. Ebersole's leadership

is critical to national defense and the regional economy.

In his former role at the Aerospace Systems Directorate, Ebersole led the Air Force's program in propulsion, power and air vehicles for advanced next-generation space, missile and aircraft applications.

The directorate consists of \$4 billion in research facilities spread over 65 square miles at Wright-Patterson and Edwards Air Force Base in California. It has more than 1,800 employees — military, civilians and contractors — and sustains a nearly \$700 million annual budget.

Ebersole entered civil service after graduating from Purdue University and was assigned to the what was known then as Aeronautical Systems Division at Wright-Patterson. Along the way he earned a master's degree in aerospace engineering from the University of Dayton, as well as an MBA from the Massachusetts Institute of Technology. He also was a senior executive fellow at Harvard University.

Ebersole was named to the Dayton Business Journal's Who's Who in Aerospace and Defense list for the last two years.



## GEYER NAMED DEPUTY DIRECTOR OF THE JOHNSON SPACE CENTER

Ellen Ochoa, director of Johnson Space Center, named Mark S. Geyer (BSAAE '82, MSAAE '83) as deputy director of the center. Geyer assumed the position in September 2016.

Geyer served as Orion Program Manager since 2007 and succeeds Kirk A. Shireman as deputy director. Shireman recently was named the International Space Station program manager.



MARK S. GEYER

"Mark has been an outstanding asset to the Johnson Space Center and the agency as Orion Program manager," Ochoa said.

"With the success of Orion's first flight last December and hardware being manufactured for Orion's next mission, this is a great time to have Mark apply his talents in a new center role that touches all human spaceflight efforts."

Geyer earned bachelor's and master's degrees in aeronautics and

aeronautics from Purdue. He began his career with NASA in 1990 as a systems engineer in the Lunar and Mars Exploration Office and was quickly recognized for his leadership capabilities. Over the next 25 years, Geyer moved into progressively more responsible leadership roles, including manager of the International Space Station Integration Office, chair of the ISS Mission Management Team and deputy program manager of the Constellation Program.

Under Geyer's leadership, Orion, NASA's next-generation spacecraft that will send astronauts to deep space destinations, was successfully flown in space for the first time. The 2014 flight sent the spacecraft 3,600 miles in altitude to test many of Orion's elements most critical to safety. Geyer positioned the program to be poised for future missions atop the agency's Space Launch System rocket with crew.

## AAE ALUMS SWEEP AIAA LIQUID PROPULSION AWARDS

Zucrow Laboratories alumni swept the American Institute of Aeronautics and Astronautics Liquid Propulsion Technical Committee Awards at the 51st AIAA/SAE/ASEE Joint Propulsion Conference.

Alumni Jacob Dennis (PhD '14) and Brian Pomeroy (MSAAE '09, PhD '12) won the Young Professional Award. Eric Meier (BSAAE '13, MSAAE '15) won the Student Award.

The Joint Propulsion Conference focuses on identifying and highlighting how innovative aerospace propulsion technologies powering both new and evolving systems are designed, tested and flown.



FROM LEFT / Jacob Dennis, Eric Meier and Brian Pomeroy



# FINISHING FIRST

## AAE grad plays crucial role in 2016 INDY 500

Andretti Autosport engineer and 2011 Purdue University graduate Nick Heinz played a crucial role in helping rookie Alexander Rossi win the 100th running of the Indianapolis 500 on May 29.

His role? He provided team co-owner Bryan Herta with the fuel number Rossi would need to cross the finish line. "We knew that there wasn't enough fuel and that we would probably run out on the last lap," Heinz said. "I remember Rossi going through turn 3 and then turn 4 and it hit me, we were going to win the 500."

Rossi won the race and coasted to a stop in turn 4 during his victory lap after running out of fuel. Herta's team can boast that it won both centennial era events at the Indianapolis Motor Speedway, first with the late Dan Wheldon in the 100th year of the Indianapolis Motor Speedway in 2011, and again, with Rossi in the 100th running of the 500-mile race. There was a pause in the race during World War II.

Heinz was born in Indianapolis but grew up in Freeport, Maine. He graduated from Purdue with a master's degree in aerospace engineering. With the help of Danny White, director of motorsports, and the Motorsports at Purdue program, Heinz landed at Bryan Herta Autosport in 2012.

This year, the team merged with Andretti Autosport to field Rossi's entry in the Verizon IndyCar Series.

Heinz said working in motorsports was always a dream, but not something he thought would ever become a reality.

"I didn't really know until I came to Purdue that I could have the chance to work in motorsports," he said. "It was definitely helpful having people like Danny White who knows people in the industry and was able to help me network."

## 2016 OUTSTANDING AEROSPACE ENGINEER AWARDS



The Purdue University Outstanding Aerospace Engineer Award recognizes the professional contributions of graduates from the School of Aeronautics and Astronautics and thanks them for the recognition that their success brings to Purdue and the school.

In 2016, the school was pleased to honor nine graduates of AAE with the designation "Outstanding Aerospace Engineer." The award banquet took place April 1.

Criteria for the award state that recipients must have demonstrated excellence in industry, academia, governmental service or other endeavors that reflect the value of an aerospace engineering degree. The 180 OAEs represent just over two percent of the more than 8,500 alumni of Purdue's School of Aeronautics and Astronautics.

**Congratulations to our 2016 Outstanding Aerospace Engineers.**



**MARK W. ANDERSON**  
Test Pilot  
DER Consulting



**MARK S. GEYER**  
Deputy Director  
NASA Johnson Space Center



**DAVID N. LOFFING**  
Chief Engineer  
737 MAX Engineering Integration  
Boeing Commercial Airplanes



**CHARLES C. BOCK JR.**  
Test Pilot, Retired  
U.S. Air Force & Rockwell Collins Inc.



**ROLF E. HAMKE**  
Engineering Director for Defense Programs  
Aerojet Rocketdyne Inc.



**KEVIN J. MILLER**  
Director of Liquid Engine Development  
SpaceX



**ERNEST U. GAMBARO**  
Senior VP & General Counsel, Retired  
Infonet Services Corp.



**BENJAMIN C. LINDER**  
Director of Flight Sciences  
Boeing Commercial Airplanes



**J. DAVID SCHWEIKLE**  
Vice President, Retired  
Boeing Delta Government Launch Services

## 2016 PURDUE COLLEGE OF ENGINEERING DISTINGUISHED ENGINEERING ALUMNI



**C. DOUGLAS EBERSOLE**  
Executive Director  
Air Force Research Laboratory  
Wright-Patterson Air Force Base  
BSAAE '82



**WAYNE S. TYGERT**  
787-10 Chief Project Engineer  
Boeing Commercial Airplanes  
BSAAE '85

The College of Engineering Distinguished Engineering Alumni/Alumnae Award is presented to men and women who have distinguished themselves, in any field, in ways that reflect favorably on Purdue University, the engineering profession or society in general.

For honorees who have been engaged in engineering work, their record of accomplishments indicates a high potential for future growth into positions of increasing responsibility.

In 2016, two of the six awardees are graduates from the School of Aeronautics and Astronautics.



## In Memoriam

### 1940s

- Arthur E. Brown**  
(BSAE '48), June 8, 2015
- Thomas Gary DeMuesy**  
(BSAE '48), May 30, 2016
- Thomas A. Fenton**  
(BSAE '48), January 7, 2016
- William L. Garlic**  
(BSAE '47), June 10, 2016
- Dr. Charles A. Gillespie**  
(BSAE '45), October 19, 2015
- Richard S. Johnson** (BSAE '46,  
MSAE '50), February 16, 2016
- U. Oscar Lappe**  
(BSAE '43), June 19, 2015
- John I. Nestel**  
(BSAE '47), December 26, 2015
- Jerry G. Tomlinson**  
(BSAE '49), August 5, 2015
- Henry R. VanGoesy**  
(BSAE '49), March 10, 2016

### 1950s

- Kenneth E. Beyer**  
(BSAE '57), May 29, 2016
- William A. Clingenpeel**  
(BSAE '52), May 30, 2016
- Charles R. Coates Jr.**  
(BSAE '54), March 10, 2016

- W. James Dillingham**  
(BSAE '52), June 6, 2016
- Leslie Leon Dunning**  
(BSAE '50), September 13, 2015
- L. Jackson Hepler**  
(BSAE '59), June 9, 2016
- George J. Komechak**  
(BSAE '58), August 8, 2015
- James F. Kucaba**  
(BSAE '52), September 1, 2015
- Robert K. MacNicol**  
(BSAE '55), September 29, 2015
- Glen E. Marunde**  
(BSAE '56), August 26, 2015
- Jack S. Meade**  
(BSAE '53), November 1, 2015
- Victor O. Peck** (BSAE '56,  
MSAE '69), March 14, 2016
- Ernest Ravinet**  
(BSAE '51), July 9, 2015
- Gerald F. Southland**  
(BSAE '50), April 13, 2016
- Richard F. Swenson**  
(BSAE '50), October 31, 2015
- Lynn R. Whisman**  
(BSAE '50), April 2, 2016

### 1960s

- Raymond A. MacKay**  
(BSAE '63), July 31, 2015

- Thomas W. Parkinson**  
(BSAE '64), August 10, 2015
- James M. Ricks II**  
(BSAE '64), March 8, 2016
- Burghard H. Ruterbories**  
(BSAE '62), June 4, 2015
- David W. Underwood**  
(BSAE '69), June 27, 2015

### 1970s

- Darryl E. Hannah** (BSAE '70,  
MSAE '71), December 27, 2015
- Charles B. Travelbee**  
(BSAE '72), May 28, 2016

### 1980s

- Daniel R. Aldrich**  
(BSAAE '84), January 13, 2016
- Mark Avery Farrell**  
(BSAAE '84), February 8, 2016
- Bud W. Runner**  
(BSAAE '86), June 23, 2016
- David A. Wright**  
(BSAAE '87), September 25, 2015

### 2000s

- Nicholas Ros Gohn**  
(BSAAE '07), November 9, 2015



#### **Richard W. Taylor, October 4, 2015**

Richard "Dick" Taylor (BSME '42) was a veteran of WWII who saw combat during the Battle of the Bulge as a spotter pilot for the U.S. Army. His career with The Boeing Company spanned 50 years, during which time he served as an airplane designer, test pilot, executive and consultant. As director of engineering during the development of the 737, Taylor earned the title "Father of the 737." He retired as Boeing vice president. Taylor received a Distinguished Engineering Alumni award from Purdue's College of Engineering in 1968, an honorary doctorate from the School of Aeronautics and Astronautics in 1973 and was among the inaugural class of Outstanding Aerospace Engineer award recipients in 1999.



#### **Bruce A. Reese, June 30, 2016**

In 1948, Dr. Bruce Reese (MSME '48, PhD '53) joined what was then known as the Purdue School of Aeronautical Engineering as an instructor. He was promoted to full professor in 1958. In 1966, he was appointed director of the Thermal Sciences and Propulsion Center, now known as the Maurice J. Zucrow Laboratories, during a stint as a professor in the School of Mechanical Engineering. Reese rejoined the School of Aeronautics and Astronautics in 1973 and served as head until his retirement in 1979. Reese received a Distinguished Engineering Alumni award from Purdue's College of Engineering in 1982 and was in the School of Aeronautics and Astronautics inaugural class of Outstanding Aerospace Engineer award recipients in 1999.



## PURDUE SPACE DAY

Purdue Space Day is a student-run event that receives support from the School of Aeronautics and Astronautics and the Indiana Space Grant Consortium.

The 20th annual Purdue Space Day took place on October 25, 2015, with VIP guest Buzz Aldrin, more than 550 children in grades 3-8, and 250 student volunteers from a variety of majors. Purdue Space Day also debuted a giant map of Mars, purchased from Buzz Aldrin's ShareSpace Foundation, which will be a fixture of the event for years to come.

Purdue Space Day 2016 is set for October 22 with VIP guest Jerry Ross.

PHOTO PROVIDED BY PURDUE SPACE DAY



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## THANK YOU

With the support of 1,400 generous donors during the 2015-16 academic year, the School of Aeronautics and Astronautics is well on its way to meeting our Ever True campaign goal. With your help, we can continue to place students first, build on our strengths, and champion research and innovation. Together, we are granting opportunities to achieve the dreams of a lifetime!



For more information on ways to give, contact AAE Senior Director of Development Rita Baines at [rlbaines@prf.org](mailto:rlbaines@prf.org).

