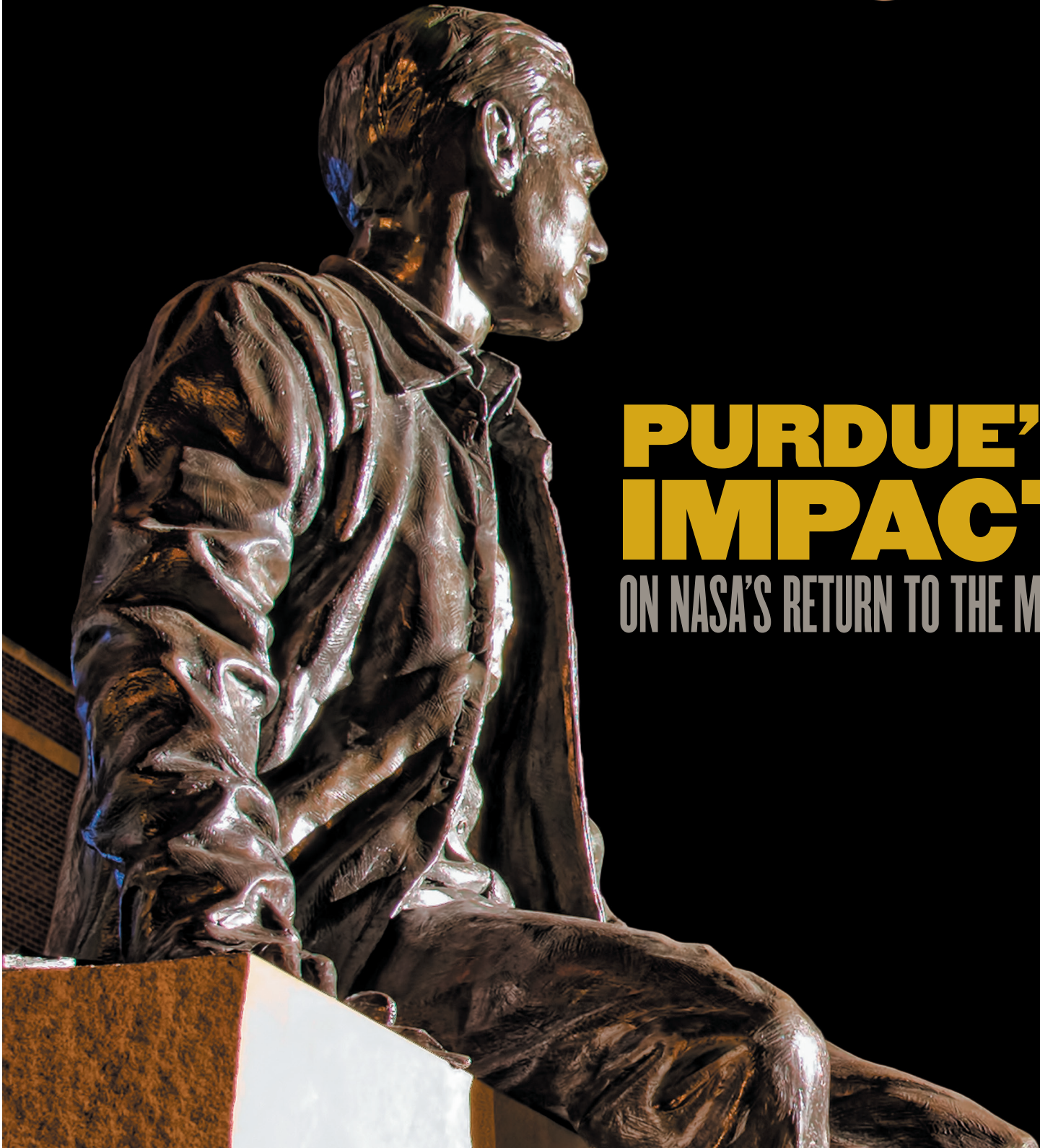


AEROGRAM

PURDUE UNIVERSITY SCHOOL OF AERONAUTICS AND ASTRONAUTICS // FALL 2018



**PURDUE'S
IMPACT**
ON NASA'S RETURN TO THE MOON

EXPANDING ZUCROW

The nation's largest university propulsion lab got an upgrade, and that expansion of the Maurice J. Zucrow Laboratories was celebrated in September 2017.

The Sept. 22 dedication highlighted the facility's largest expansion in nearly 40 years with the completion of the High Pressure Combustion Lab (ZL8), which included five new test cells, a 2,000-square-foot climate-controlled laser diagnostics lab, three control rooms, offices, and a fabrication shop.

ZL8 features four 500-square-foot test cells to house airbreathing combustion and spray experiments and a 1,000-square-foot test cell with a state-of-the-art turbine lab for studying aerodynamics and heat transfer in advanced turbine systems. The test cells are 20 feet high to include necessary instrumentation and data acquisition.

The Stanley G. Tebbe TDI Laser Lab has windows that directly connect to the five test cells to allow optimal inclusion of laser diagnostic measurements. The laser lab also includes two control rooms, an instrumentation room, mechanical room, and fabrication shop.

"Zucrow is a unique facility in academia. By design, it allows for high pressure and high temperature combustion devices to be evaluated safely but also because of the people and the philosophy of running that facility," says Timothée Pourpoint, an associate professor in AAE.

"We work with students at Zucrow to develop the next generation of rocket engines, gas turbine engines, spray systems, etc. We are very careful to teach them how to conduct such research safely and effectively. The students design most of our research infrastructure from the ground up, learning along the way what it takes to operate real, industry-scale aerospace systems."

On Purdue Day of Giving 2018, an anonymous donor created an endowment to support the Zucrow Lab research facilities. The fund will cover lab equipment and expenses unaccounted for in faculty research grants, such as materials or necessities that allow for the facility to grow. The donor, who worked at Zucrow as a Purdue graduate student, wanted to ensure future graduate students would be given the same or better opportunities. With that, the donor encourages donations from anyone who would like to invest in the future of Zucrow Labs.

TO DONATE, PLEASE VISIT PURDUE.EDU/AAE





THANK YOU!

TO ALL THE DONORS WHO MADE THE MAURICE J. ZUCROW LABORATORIES RENOVATION PROJECT POSSIBLE

- ▶ *Stephen Heister (left), Raisbeck Engineering Distinguished Professor for Engineering and Technology Integration and former director of Maurice J. Zucrow Laboratories, provided updates for distinguished alumni at the dedication.*
- ▶ *(From left) Tom Shih, J. William Uhrig and Anastasia Vournas Head and Professor of Aeronautics and Astronautics; Mung Chiang, John A. Edwardson Dean of the College of Engineering; Mitch Daniels, Purdue president; Robert Lucht, Ralph and Bettye Bailey Distinguished Professor of Mechanical Engineering and director of Zucrow Labs; Anil Bajaj, William E. and Florence E. Perry Head of Mechanical Engineering & Alpha P. Jamison Professor of Mechanical Engineering.*



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'PINNACLE OF
EXCELLENCE AT SCALE'**

AEROGRAM is an annual publication for the alumni and friends of Purdue University's School of Aeronautics and Astronautics. Unless otherwise noted, articles in *AEROGRAM* may be reprinted without permission. Appropriate credit is appreciated.

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PURDUE SPACE DAY REVISITED



THE COVER

The Neil Armstrong statue in front of Neil Armstrong Hall of Engineering has become one of the most iconic landmarks on Purdue University's campus.

(Photo credit: Purdue University /Mark Simons)



Greetings from the School of Aeronautics and Astronautics at Purdue University! In this **AEROGRAM**, we are excited to share news and stories from the 2017-18 academic year. Also, we want to set the stage for an exciting year that will celebrate Purdue University's sesquicentennial and the 50th anniversary of the Apollo 11 mission in which AAE alumnus Neil Armstrong became the first human to step foot on the Moon.

Our stellar faculty, who are among the world's best in their fields of expertise and who care deeply about excellence in teaching, continue to be recognized. Byron Pipes received an honorary doctorate from the University of Edinburgh; Kathleen Howell was inducted into the International Academy of Astronautics; Dan Dumbacher was appointed executive director of the American Institute of Aeronautics and Astronautics (AIAA); Steve Schneider was elected AIAA Fellow; Li Qiao was elected AIAA Associate Fellow; and Jim Garrison was elected fellow of the Institute of Navigation. In addition, Dave Wolf was appointed a member of the newly formed National Space Council. Also, I am honored to have been appointed as a member of the Aeronautics Committee of the NASA Advisory Council, joining Kathleen Howell, who continued in her role on the Technology, Innovation and Engineering Committee. All of us want to do our very best in serving our aerospace community and sector.

Our faculty also continues to do exciting and innovative things in education and research. Some that will be highlighted in this issue include accomplishments from space-situational awareness, signal of opportunity for Earth observation, and lava tubes on the Moon to rotating detonation engines, green propellants for rockets, and in-space propulsion for CubeSats.

Our priority is educating and nurturing our students. We are excited that our students are so passionate about learning, envisioning yet undreamed technologies in aerospace, and wanting to make this world a better place. Our enrollment continues to grow, topping more than 700 undergraduate and over 500 graduate students in 2017-18. Some of our students' accomplishments also are highlighted in this issue.

Our amazing alumni continue to make huge impacts in the aerospace sector from engineering to policy to leadership, which is the ultimate testament of our success as one of the world's leading programs in aerospace engineering. Also, we are extremely grateful for the generosity of our alumni in supporting our school with their time, energy, and money. In 2017-18, a rising-star professorship was endowed to enable our school to recruit and retain our very best junior faculty. On the 2018 Purdue Day of Giving, gifts to AAE totaled approximately \$2.2 million. Our school is deeply grateful.

Purdue is privileged to have a visionary and exciting dean in Mung Chiang, who joined us in August 2017. Mung has provided AAE with exceptional support to help us move to an even higher level of excellence. We were given nearly 7,000 square feet of prime real estate on the second floor of the Neil Armstrong Hall of Engineering to allow AAE to accommodate our ever-growing student enrollment and to provide our students with more collaborative space for design-build-test, design-build-fly, and other team projects.

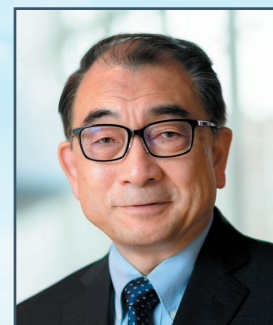
Thus, this has been an exciting year, and we thank you for your support that made everything possible. As always, please keep us informed of developments in your lives so we can share in future issues, as well as on AAE's website and social media.

Hail Purdue!

Tom Shih

30,000 FOOT VIEW

MESSAGE FROM THE HEAD



TOM I-SHIH

*J. William Uhrig and
Anastasia Vournas
Head and Professor
of Aeronautics and
Astronautics*

AAE BY THE NUMBERS

THE RANKINGS

NO.



Ranked undergraduate
aerospace/aeronautical/
astronautical engineering
2018 U.S. News and World Report

NO.



Ranked graduate aerospace/
aeronautical/astronautical
engineering
2018 U.S. News and World Report

NO.



Rated by aerospace
and defense employers
Aviation Week & Space Technology

THE FACULTY

37 


TENURED/TENURE-TRACK FACULTY MEMBERS
23 FULL PROFESSORS | 7 ASSOCIATES | 7 ASSISTANTS

42 

FELLOWS OF PROFESSIONAL SOCIETIES

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NAE, NAS AND OTHER ACADEMICS

22 

NSF, OTHER YI AWARDS

109 

MEMBERSHIPS ON TECHNICAL COMMITTEES, BOARDS
AT INTERNATIONAL AND NATIONAL LEVELS

THE STUDENTS

712 504

UNDERGRADUATE STUDENTS

12.5% | **6.7%** | **14.5%**
 FEMALE | URM | INTERNATIONAL

GRADUATE STUDENTS

16.3% | **6.5%** | **41.7%**
 FEMALE | URM | INTERNATIONAL

CENTERS OF EXCELLENCE

DEVELOPED BY FACULTY SINCE 2009

AFOSR:

Center of Excellence on Combustion Dynamics (Bill Anderson)

ASCENT:

FAA Center of Excellence for Alternative Jet and Environment (Dan DeLaurentis)

CITMAV:

Center for Integrated Thermal Management of Aerospace Vehicles (Tim Fisher/Tom Shih)

IACMI:

Institute for Advanced Composites Manufacturing Innovation (Byron Pipes)

ISA:

Center for Integrated Systems in Aerospace (Dan DeLaurentis)

i-GSDI:

Institute of Global Security and Defense Innovation (Dan DeLaurentis)

LIFT:

Lightweight Innovations for Tomorrow Institute (Michael Sangid)

LyoHUB:

Consortium on Lyophilization/Freeze-Drying (Alina Alexeenko)

Nextor II:

FAA Consortium on Aviation Operations Research (Dengfeng Sun)

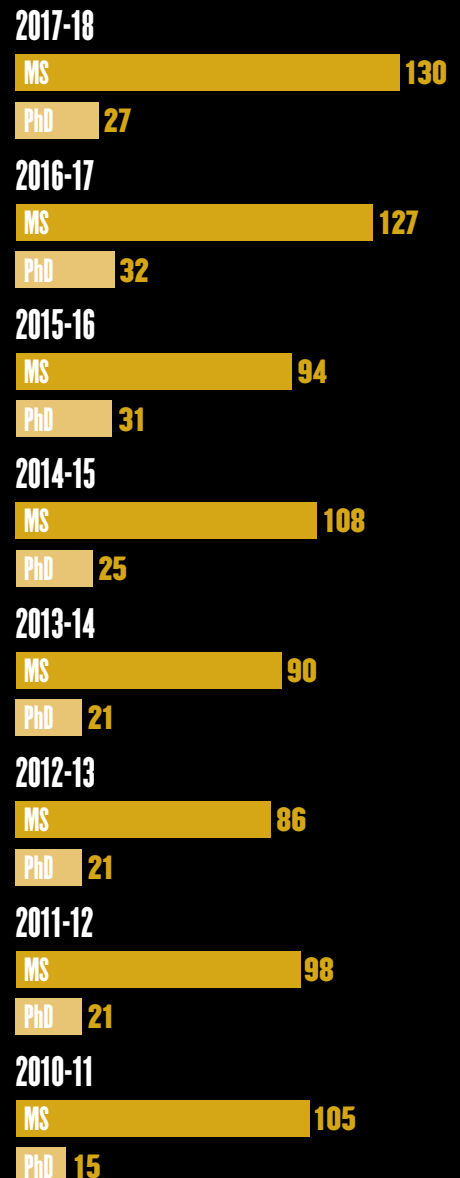
PEGASAS:

FAA Center of Excellence for General Aviation (Bill Crossley/Karen Marais)

PTCA:

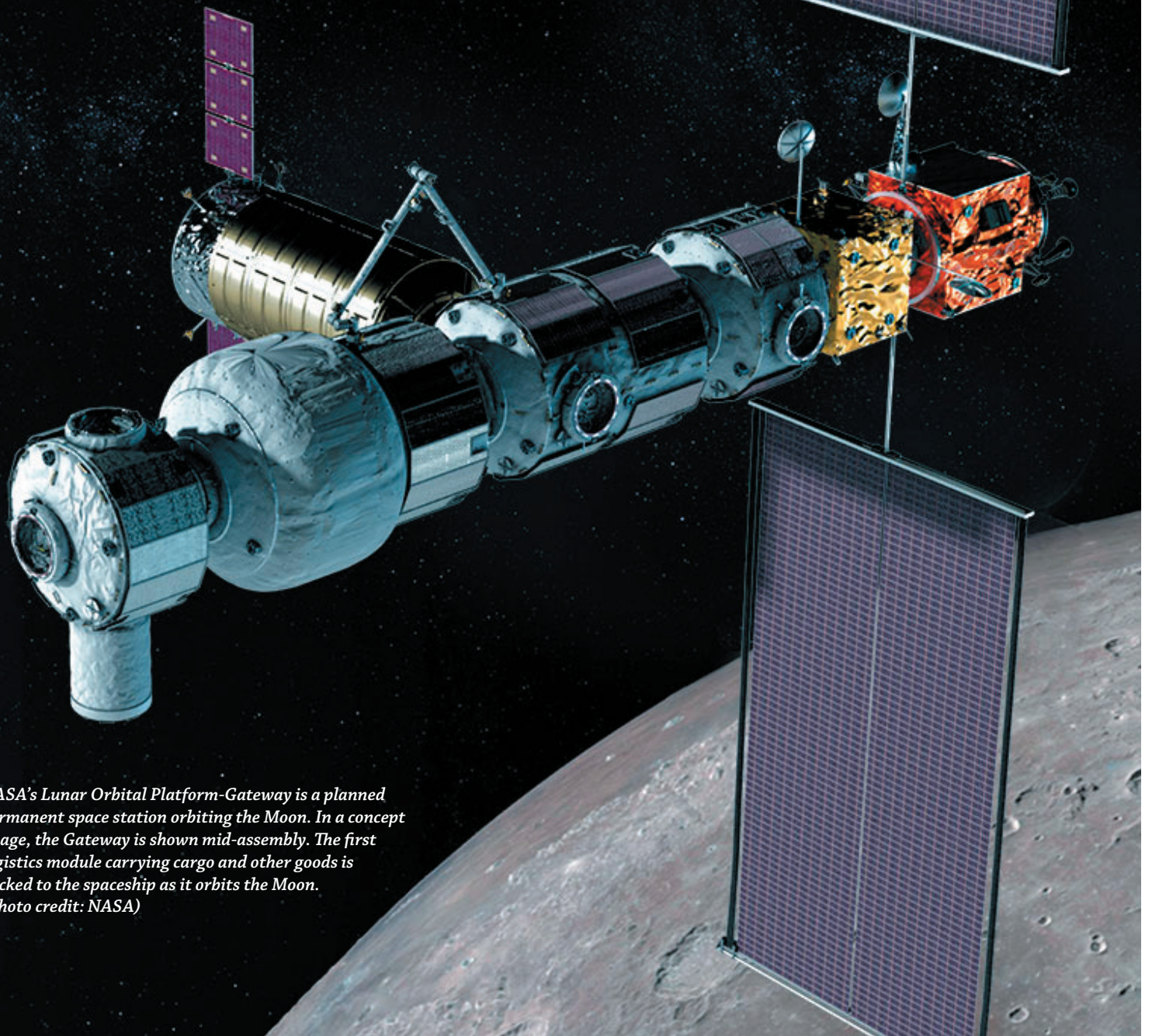
Rolls-Royce Research Center for Advanced Thermal Management (Stephen Heister)

THE GRADUATES



STEPS TOWARD GIANT LEAPS

**AAE FACULTY, STUDENTS FACTOR
INTO RETURN TO MOON**



NASA's Lunar Orbital Platform-Gateway is a planned permanent space station orbiting the Moon. In a concept image, the Gateway is shown mid-assembly. The first logistics module carrying cargo and other goods is docked to the spaceship as it orbits the Moon. (Photo credit: NASA)

Vice President Mike Pence was in front of a microphone in mid-August, after touring NASA's Johnson Space Center in Texas, reiterating a sentiment he'd shared before but nonetheless still was powerful.

"While our sights are once again set on our lunar neighbor," Pence told NASA employees in a speech that was shown live on NASA's website, "this time, we're not content to leave behind only footprints — or even leave at all.

"The time has come, we really believe, for the United States of America to take what we have learned over these many decades, put (NASA's) ingenuity and creativity to work and establish a permanent presence around and on the Moon."

A return to the Moon isn't just about who will be next to step onto the lunar surface. To address the complex issues that a return entails, it requires problem-solving and innovative thinking.

And that's happening at Purdue's School of Aeronautics and Astronautics.

The constant in human space exploration has seemed to be change, emphasis varying on the administration. George Bush initiated the cancellation of the space shuttle program but outlined a plan to develop a return to the Moon, replacing it with a return-to-the-Moon program run out of Houston. But in 2010, Barack Obama canceled that Constellation program to build the Orion spacecraft and Ares rocket and effectively shut down the effort to return to the Moon. Now, President Donald Trump and his VP, former Indiana governor Pence, have shifted focus back to the Moon.

A place in which Purdue is pretty familiar, and not just in the obvious ways.

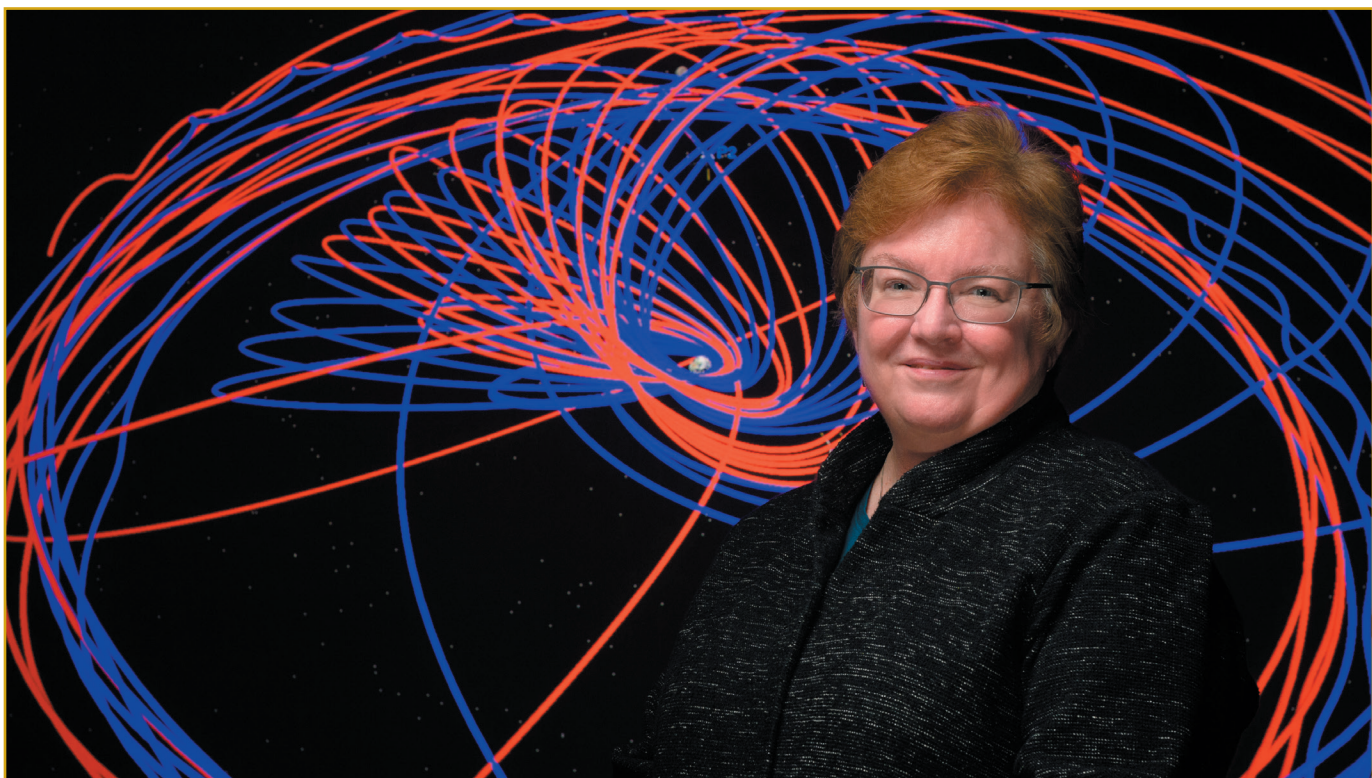
Purdue alumni were the first and most recent to step foot on the surface nearly 50 and 46 years ago, and alumni have played key behind-the-scenes roles, too. Whether it be firmly entrenched in pivotal positions within NASA — from Bill Gerstenmaier to Julie Kramer White to Mark Geyer — or in other influential space exploration roles, like Dan Dumbacher as the AIAA's executive director.

Or entrenched on the West Lafayette campus, many in the building named after that "first man."

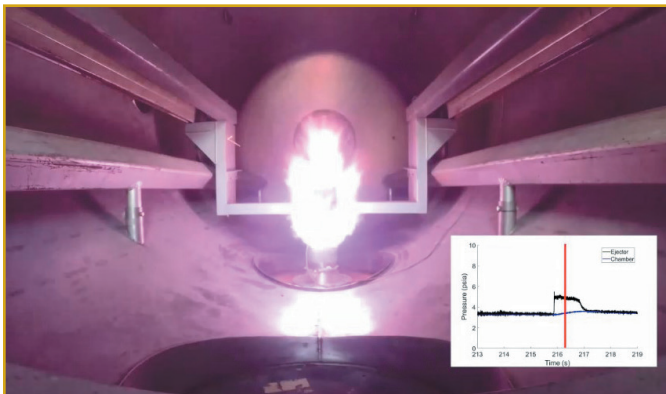
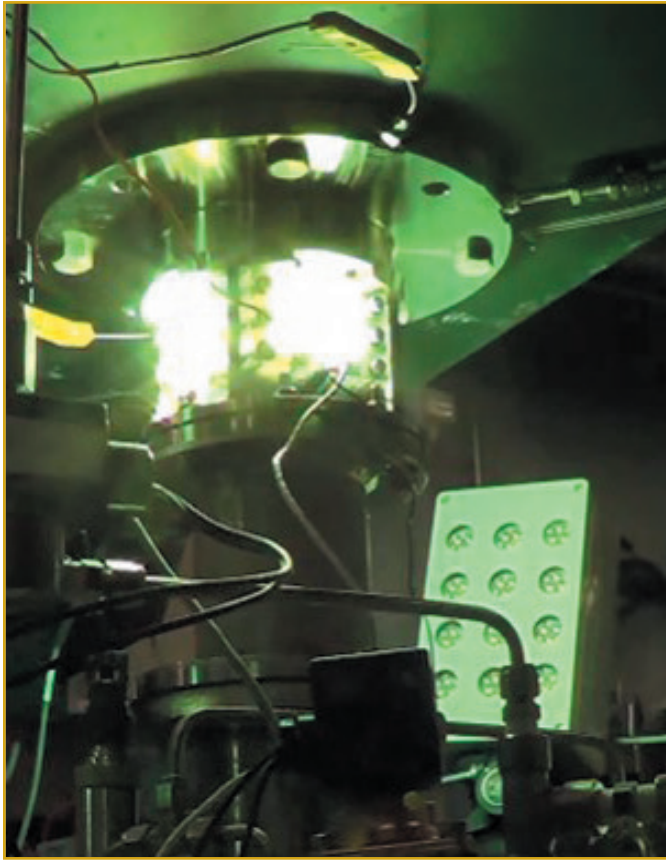
Neil Armstrong Hall of Engineering houses offices, classrooms, and some labs for researchers who are shaping the way the world looks at human spaceflight, whether by influence in prestigious international and national academies or with ground-breaking studies. Armstrong is littered with accomplished faculty and innovative graduate students.

Kathleen Howell, the Hsu Lo Distinguished Professor of Aeronautics and Astronautics, and her team have been instrumental in identifying pathways for a proposed Lunar Orbital Platform-Gateway facility by using non-traditional orbits, called near-rectilinear halo orbits (NRHO). Howell also was part of a team that identified lava tubes on the Moon, which could allow habitation for more extended stays. No one has been able to last longer than three days on the Moon because of its harsh conditions, varying from extreme heat to extreme cold.

Stephen Heister, the Raisbeck Engineering Distinguished Professor for Engineering and Technology Integration, and



Kathleen Howell, Hsu Lo Distinguished Professor of Aeronautics and Astronautics (Photo credit: Purdue University/John Underwood)



Timothée Pourpoint and his team are using Maurice J. Zucrow Laboratories to develop new chemical propellants with reduced toxicity for a variety of space missions.

his team have made strides on developing the next-generation rocket engine with rotating detonation engine combustor development research.

Timothée Pourpoint, an associate professor in AAE, and his team are developing new chemical propellants with reduced toxicity for a variety of space missions. This research at the Maurice J. Zucrow Laboratories directly benefits the idea of more frequent and consistent travel to the Moon and beyond.

Professor Alina Alexeenko's lyophilization research is helping a private company develop a system that would preserve and propagate bacteria that clean water to support a space colony.

Every potential challenge to a return — and a sustained stay, either on the Gateway or the Moon itself — is being evaluated and explored.

"I've always been motivated by an assessment that says, 'It can't be done,'" Howell says. "I typically tell my graduate students, 'You don't ever say you can't do something. It only depends upon how it can be accomplished.' And maybe it takes a new propulsion system or something like that. It's not that it can't be done. But it's how to accomplish it is maybe what drives the research, not only in our field but in the neighboring directions as well. And it's complementary. The guys at Zucrow, Tim Pourpoint will say to me, 'If I gave you this, what could you do with it?' Then we see what we can do with it and we go to the scientists and say, 'You could do this cool stuff.' It goes two ways."

Howell and her team certainly are doing their part.

Bloomberg Businessweek featured the longtime Purdue professor in the summer, highlighting her expertise on NRHOs, which aren't traditional orbit ellipses around the Earth or the Moon. They're "exotic," in part, because they're leveraging multiple gravity fields. NASA wants to use those orbits in the Lagrange Point 2 region for the Gateway because, once positioned, the orbit can be maintained and serve as a hub for various activities. NASA is planning to build The Gateway in the 2020s, and Pence said in 2018 he expects to have an American crew aboard the Gateway before the end of 2024.

But NASA has to be able to calculate the orbits. That's where Howell and her team come in.

Howell started studying NRHOs as a graduate student, and she's shared her knowledge with her students at Purdue. The paper that spurred Bloomberg's interest, Howell says, was written by Howell, one of her current graduate students and a then-Ph.D. student, who now works at JSC.

One of the reasons NASA prefers the NRHOs, Howell says, is because they can keep a spacecraft out of shadows. That's important because spacecraft may need the sun as an energy source via solar panels, and there's a maximum amount of time that a spacecraft could be in shadow and still be able to recover.

Batteries only last so long, Howell says.

“So part of my job, when I look at trajectories, is to figure out what trajectories might meet that power requirement,” she says. “That’s another reason why it may not be quite as straight forward, and propellant is not effective without the capability to fire the thrusters; also without power, communications may be restricted. Thus, this particular type of orbit can be leveraged to avoid Earth and Moon shadows.”

Two Lagrange points already have been leveraged, in a Genesis mission in 2001 and Artemis in 2010. The first was Sun-Earth system and the latter the Earth-Moon, which a lot of critics said could never be done, Howell says.

“But here we are,” she says. “With the success of Artemis, the Earth-Moon region is now available, and non-Keplerian orbits can be successfully used in this region.

“Folks hear that orbits are chaotic, an unfortunate choice of word. Some folks may interpret ‘chaotic’ as unpredictable. But that is not necessarily true. We can also consider flipping the concept. As an orbit designer, it can also be useful. If one small disturbance can cause the vehicle to shift away, it also means

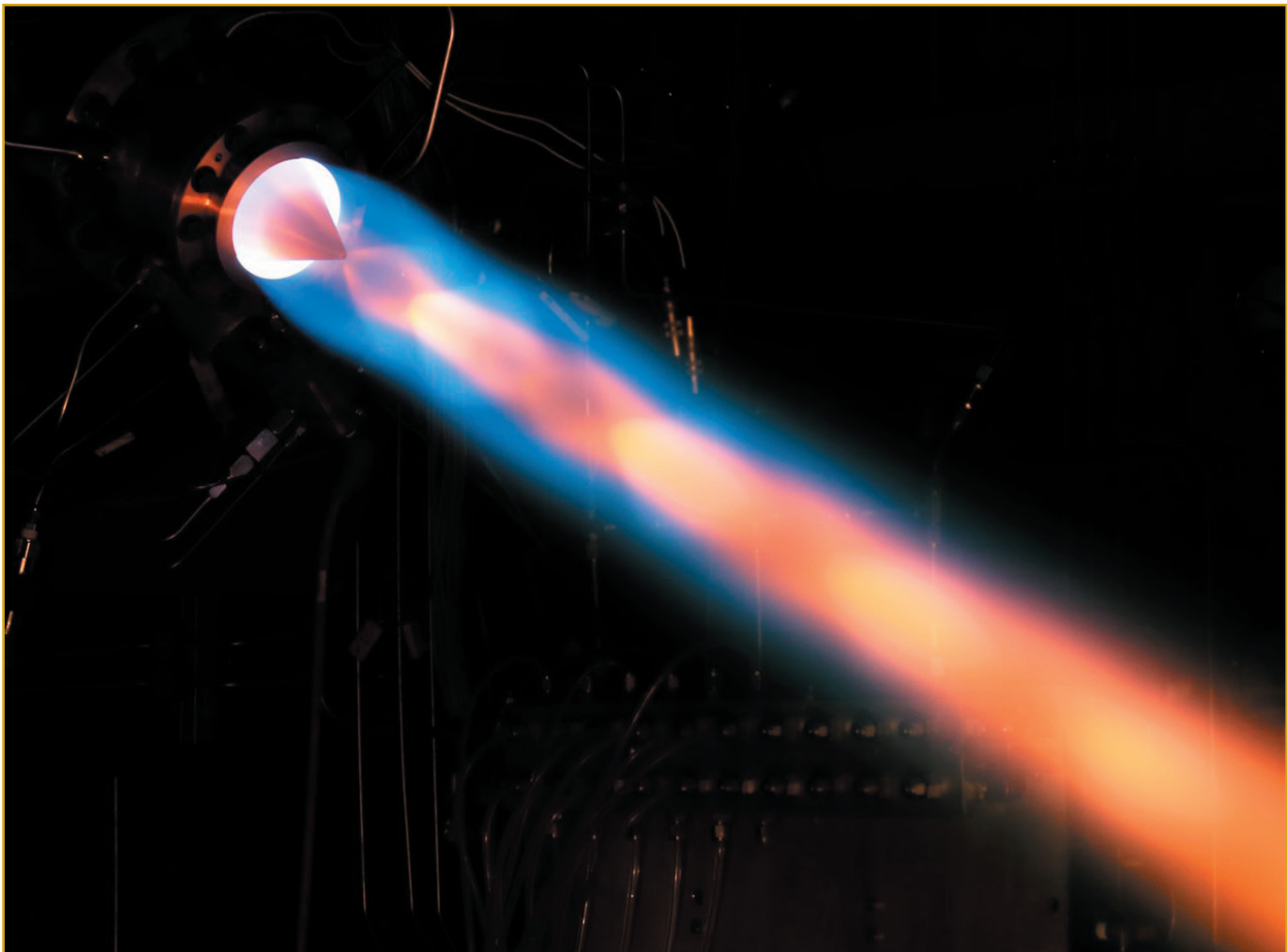
that a very small amount of propellant can maintain the vehicle on orbit. So, deterministic chaos reflects an environment that is complex. It means that if we understand it, we can work with it. There are advantage and disadvantage to both ways of thinking. But when we have a human vehicle that we can control, it’s something that we can actually work it.”

In October 2017, Howell teamed with a group on a published study that confirmed the existence of a large open lava tube on the Moon that could be used to protect astronauts from hazardous conditions on the surface.

That’s not only important for understanding the Moon’s internal structure, but if that is studied close to home, that could also be something that exists on Mars, which is a considerably longer journey.

There continue to be revelations about Earth’s Moon, seemingly validating why it’s so important to return.

“I personally have always been an advocate of not bypassing the Moon. Because although Mars is great, asteroids are great, I don’t think of these just as destinations we visit,” Howell says. “I see less long-term value in simply passing by, say the Moon



Stephen Heister, the Raisbeck Engineering Distinguished Professor for Engineering and Technology Integration, and his team are leading rotating detonation engine combustion development research.

or Mars, and returning to Earth. I would like to see a more complete expansion into space. Part of a natural expansion is an extension throughout your own neighborhood first. So the current thinking is, let's expand in our own, what's now called the Earth-Moon neighborhood, and build up our infrastructure, build up our capabilities and use the Moon to help us plan to go to these other destinations as part of a natural evolution of exploration and expansion."

A major force related to the discussion of a return to the Moon is in-space chemical propulsion. Chemical propellants include liquids and solids, and they are, right now, the "workhorse of everything we have available to go to space," says Pourpoint, "from taking off from the Earth, to moving satellites in orbit, to positioning the Space Station where it is, to going back to the Moon."

That involves working with propellants that can be very toxic and hard to handle.

That's one of the research areas for Pourpoint's group. They work with hypergolic — which means "ignite on contact" — materials in a green propellants lab that Pourpoint designed in Zucrow. Pourpoint's specific focus is designing fuels in particular that could replace the very toxic monomethylhydrazine (MMH) fuel. In fact, to land and take off from the Moon, Neil Armstrong and others after him actuated MMH-fed thrusters. Though it's a high-performing fuel, it's also one that "would kill us through exposure to a few parts-per-million over a few hours."

But Zucrow, a unique, state-of-the-art facility, allows Pourpoint's team to work with those toxic chemicals in a controlled environment.

Zucrow also offers a recently operational vacuum rocket testing chamber that has shaped Pourpoint's research. The 6-by-10-foot chamber allows testing chemical rocket engines at conditions approaching the vacuum of space. For example, the group can verify the predicted performance of a thruster with newly developed propellants or can test where the thrusters' combustion products travel in that environment, which could keep astronauts on space walks safer because even a drop of the current fuels is dangerous.

"The way the exhaust gases of rocket engines develop on Earth versus the way they expand in space is very different," Pourpoint says. "When those thrusters are firing in the vacuum of space, there's nothing there, but if a droplet attaches to you, you have a problem. Satellites have sensors and mirrors. Those droplets or residues go on everything you don't want them to be on. So understanding where they go and what's where is very important. That's part of what we are doing now."

Pourpoint also has been exploring another propellant option with other Purdue professors. The idea: Use water as the propellant, combined with nanoscale aluminum powder. Ice is on the Moon, and there's also aluminum on the surface of the

Moon because the Moon is related to the Earth.

"You could also mine aluminum on the Moon," Pourpoint says. "So you could make your propellant in-situ, on the Moon itself, to go around the Moon or to come back to Earth. Not the best propellant in the world in the sense of performance, but it is an interesting concept."

"Say we use even just the ice and make hydrogen and oxygen for the rocket to come back to Earth. What SpaceX is suggesting we do on Mars is the exact same thing except with methane, using CO₂ in the atmosphere. So learning how to do these things on the Moon before we go to Mars has a lot of scientific value, on top of the curiosity, on top of the exploration part of it."

Alexeenko's research factors in water, too. She's working with NASA and Pancopia Inc. to develop a system that would preserve and propagate bacteria that clean water to support a space colony. Per Pancopia's website, it is "developing methods to freeze dry and rapidly reactivate organisms, while developing a novel, low-cost biological treatment process to further recycle water by reverse osmosis."

The second phase of a three-phase contract was completed in May. Alexeenko is providing oversight of the lyophilization task and reviews other portions of the project as needed. Elizabeth Topp, professor of industrial and physical pharmacy, is working closely with Alexeenko on the optimization of the procedure for freeze-drying the proposed mix of organisms.

"Water is one of the most vital resources for human exploration of space and we need to figure out how to recycle it in deep space. Most of wastewater on Earth is cleaned by bacteria, but like all living creatures, they are sensitive to all kinds of stresses, and space is a stressful place," Alexeenko says. "By freeze-drying with the right nutrient mixes, we can keep them preserved over long periods of time. Our collaborators at Pancopia showed that they can reactivate those freeze-dried microorganisms and make them do the work of breaking down waste in the water."

"Now that we know how to get to space, we also need to figure out how to live there. Freeze-drying is one of the technologies useful for space exploration. It's not just to make astronaut food, but can be used to preserve all kinds of resources for a space colony, including live bacteria to clean water, help grow food and maybe even make personalized medicine for space explorers."

Heister and his graduate students' work on rotating detonation engines (RDEs) has produced encouraging data that indicate we may be able to increase thrust beyond theoretical limits of today's devices.

"It gives us hope we might be able to build more efficient rocket engines in the future," Heister says.

Rotating detonation engines employ an annular combustion chamber to promote azimuthal instabilities that grow to full



AAE Ph.D. student Drew Strongrich conducts freeze-drying experiments as a member of Professor Alina Alexeenko's research team on the Pancopia Inc. project.

detonations under the right circumstances. Peak pressures behind the detonation wave greatly exceed those in today's engines and permit greater thermal efficiency from combustion at these conditions. Though RDE technology was proposed in the 1960s, it has generated more interest in the last decade as computational capability and high-speed instrumentation permits researchers to capture events that are happening incredibly fast. (Waves can move at speeds up to 5,000 mph.)

While most groups are studying RDE combustion with gaseous propellants, Heister's team was the first in the U.S. to explore liquid propellants that are more readily stored for space missions. Fortunately, the facilities at Zucrow Labs provide infrastructure to study liquids — a factor that distinguishes Purdue from other academic researchers in the rocket propulsion field. In addition, it provides an opportunity to look at something that has been totally unstudied — an RDE based on hypergolic propellants. As with Pourpoint's work in this area, hypergols permit ignition without the use of a separate system, thereby simplifying operations. However, it was not known how this feature might affect the rotating detonation wave.

After the propellants are ignited and a detonation wave is formed, can the propellants be ignited by the wave and burn at high pressure, rather than self-igniting at lower pressure? It turns out they can — and this is an important first for the community. Because the detonation wave revisits a combustion site in less than a millisecond and hypergolic reactions typically take several milliseconds to occur, the high speed of the wave permits successful ignition once the wave is established.

Increasing thrust output for a given amount of fuel is the prime measure of propulsion efficiency and this "gas mileage" is measured by a term called specific impulse. While much work

remains, RDE technology has potential to increase specific impulse up to 10 percent. Since large rockets are more than 90 percent propellant by mass, this small change in efficiency has a huge change on payload.

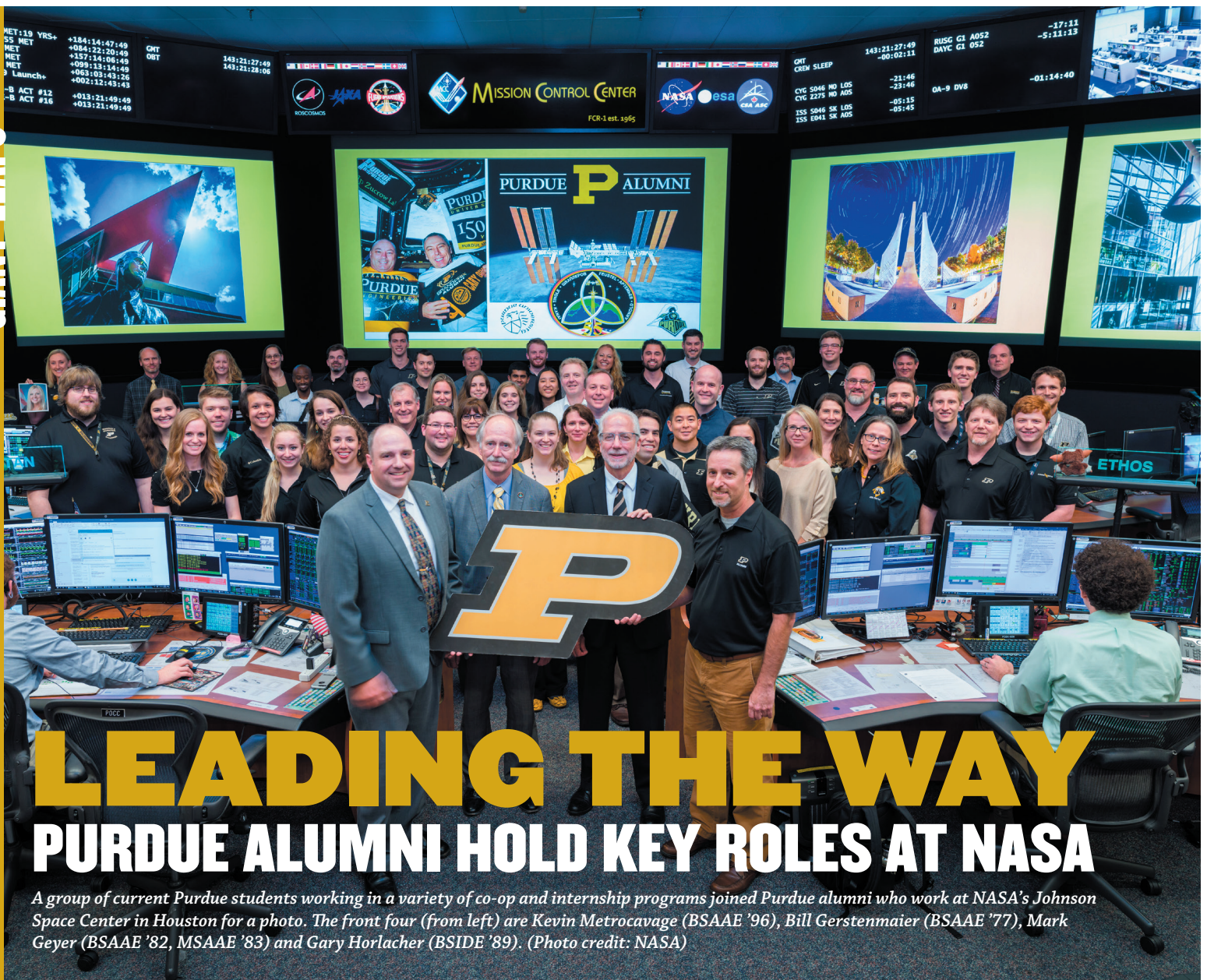
"You could have a 50 percent increase in payload. That's a big deal for us and could drastically reduce the cost of space travel as a result," Heister says. "Having said that, we have a long way to go to truly understand and optimize the combustion, then to build engines that can house the intense heating that goes with the detonation process.

"It is gratifying that our research group has become a focal point due to our successes in recent years, and it is a testament to the brilliant efforts of our grad students."

New insights and research are happening daily, with more grants and partnerships for AAE with NASA, among others, to continue to move us closer to the Moon.

And Purdue's faculty appreciates the opportunity to be part of not only a team of professors and students inside Armstrong but beyond in reaching the administration — and NASA's — goal.

"I think that's one of the things that attracts the students," Howell says. "I think that's one of the things unique about our program. We are not disconnected. Talk about being part of the real world. A lot of my graduate students are out there, at those research centers, doing real work in support of actual mission requirements. They're not all off doing a study on the side. They're doing real work that's needed today for real mission information. So that's what really cool."



LEADING THE WAY

PURDUE ALUMNI HOLD KEY ROLES AT NASA

A group of current Purdue students working in a variety of co-op and internship programs joined Purdue alumni who work at NASA's Johnson Space Center in Houston for a photo. The front four (from left) are Kevin Metrocavage (BSAAE '96), Bill Gerstenmaier (BSAAE '77), Mark Geyer (BSAAE '82, MSAAE '83) and Gary Horlacher (BSIDE '89). (Photo credit: NASA)

Many answered the callout.

This spring, when a group email was sent inviting all Purdue alumni to mission control at NASA's Johnson Space Center, nearly 60 people showed up.

The big monitors in the room had a distinct flavor. There was Neil Armstrong's face peeking under the dramatic overhang at the Hall of Engineering bearing Armstrong's name; the capsule hanging from inside Neil Armstrong Hall; Purdue's Engineering Fountain; and two gentlemen holding posters emblazoned with "Purdue," a glimpse of Earth in the background. Those men were alumni Scott Tingle and Drew Feustel, who were on board the International Space Station (ISS) at the time.

Inside mission control, others scrunched together, some shoulder-to-shoulder, gathering for an epic photo.

Mark Geyer was front and center, clutching a 2-foot motion P logo.

He was flanked by Bill Gerstenmaier, the agency's associate administrator for the Human Exploration and Operations Mission Directorate; Kevin Metrocavage, the International Space Station operations manager; and Gary Horlacher, flight director for Tingle's expedition.

Sprinkled in the group was Allison Bolinger, who was named flight director at JSC months after the picture was snapped, as well as current Purdue students who were working at NASA in a variety of co-op and internship programs.

In a sense, the image captured Purdue's presence at the agency. In another, it couldn't quite. Not when so many more weren't able to get in the photo. Hundreds of Purdue alumni hold positions at Johnson Space Center, and there are hundreds more at NASA's other nine field centers.

It's clear: Purdue is having an impact in the country's next step in returning humans to the Moon and beyond, especially considering even more graduates are scattered across private industries that focus on spaceflight.

“You think of all the people who have gone to Purdue. What a lot of people don’t know is that it’s not just astronauts but flight directors and programmers and engineers, it’s just full,” Geyer says. “The photo had, maybe, half the people I know of that work here who are Purdue graduates.”

When NASA announced its latest astronaut class in June 2017, Geyer bumped into Vice President and former Indiana Governor Mike Pence in the green room for the event, and Geyer made sure to mention he was a fellow Hoosier. Pence asked where Geyer was from, and Geyer said Indianapolis — but also added he attended Purdue.

Pence’s response, per Geyer: “Imagine that? A NASA guy who went to Purdue.”

“That was pretty funny,” Geyer says. “It’s a great school. I was blessed to go there. I learned a bunch about how to do hard things and really the vision of wanting to work in space. You go to Purdue, and they just have a heritage. They know what that’s about. It was great.”

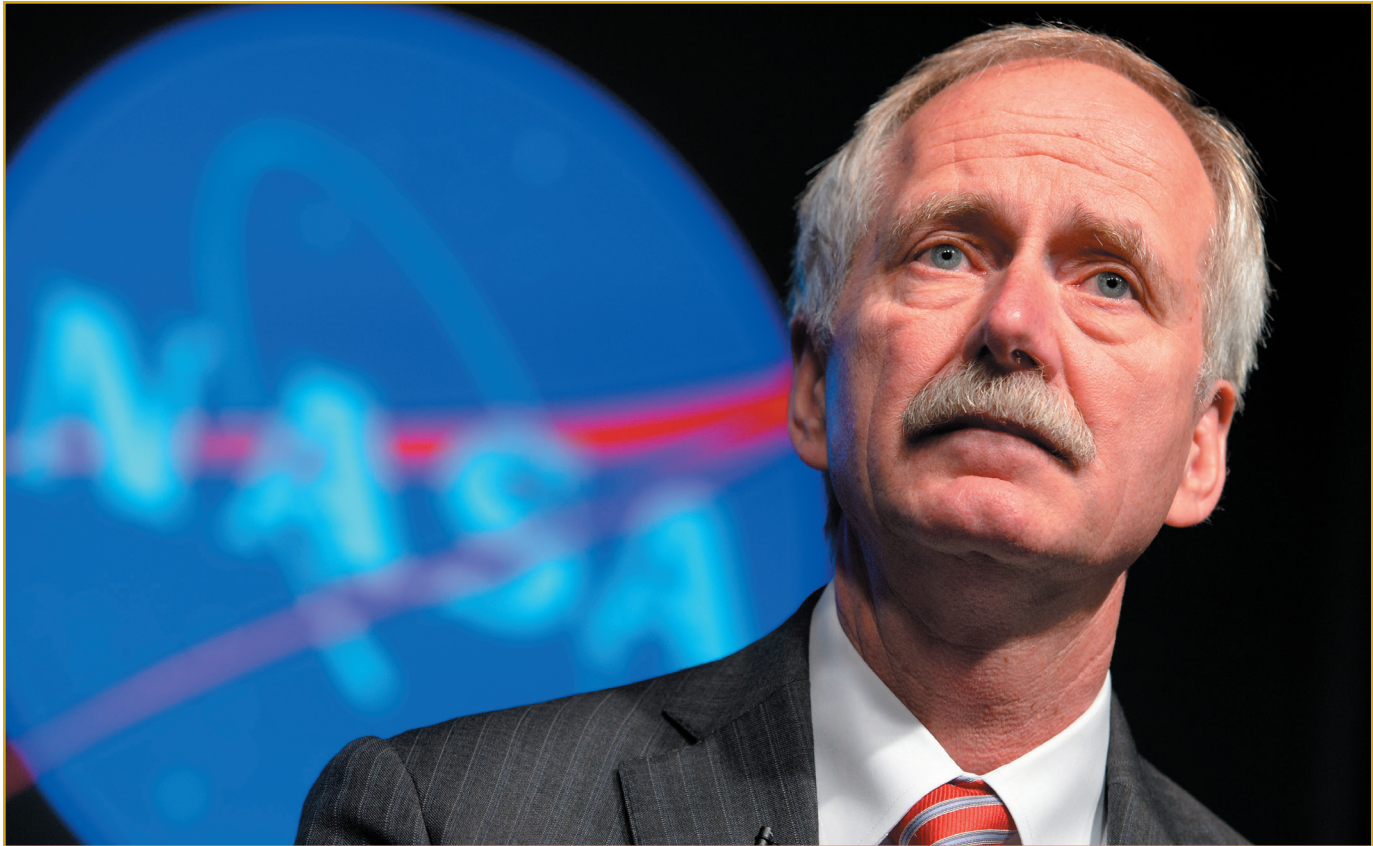
In July, NASA announced four crews of astronauts it said will begin a new era in human American spaceflight by flying the first commercial spaceships, built by Boeing and SpaceX. The companies developed Crew Dragon (SpaceX) and CST-100 Starliner (Boeing) as part of NASA’s Commercial Crew Program to allow the U.S. to send its own astronauts to ISS. Currently, the U.S. relies on Russia’s Soyuz spaceships to fly there. During a speech at JSC in August 2018, Pence said it costs the U.S. about \$82 million per seat on Soyuz for trips to ISS.

The U.S. hasn’t had a launch from American soil since the space shuttle retired in 2011. But NASA is eager to see that change soon.

Gerstenmaier, NASA Deputy Director of Engineering Julie Kramer White (BSAAE ’90) and Geyer are heavily involved in Orion, the spacecraft that will crew a return to the Moon. It’ll launch on the Space Launch System (SLS) rocket. Gerstenmaier told Time in July the SLS is “almost ready.” Kramer White said on a podcast over the summer that Orion



Mark Geyer was appointed as the director for NASA’s Johnson Space Center in May. (Photo credit: NASA/Bill Ingalls)



Gerstenmaier is NASA's associate administrator for the Human Exploration and Operations Mission Directorate. (Photo credit: NASA/Bill Ingalls)

is scheduled to undergo its next test flight, which will test the abort system, in April 2019, and Boeing and SpaceX will begin demo flights after that.

Those developments will catapult the U.S. back into the space race. NASA astronauts haven't gone beyond low Earth orbit since 1972, the final Apollo moon mission that included Purdue alumnus Gene Cernan. Gerstenmaier said NASA is working to have astronauts on the Moon by the mid-2020s, probably in the 2025-2026 timeframe.

For Geyer, that makes it an "incredibly exciting" time to be the director at Johnson.

"No. 1, because of the near-term things like the crew launches and Orion getting ready to launch, which is tough and exciting, but also to frame the future," Geyer says. "How are we going to move forward in the future to maximize the capabilities the United States has to leading human exploration? Some of that is thinking about new ways of partnering with people, whether it's international or commercial partners to get the most out of the budget we have. And, also, to keep America as a leader in human exploration. It sounds simple. But there's a lot to it."



Julie Kramer White, NASA's deputy director of engineering, earned her bachelor's in aeronautics and astronautics from Purdue in 1990.

DEAN ESTABLISHES ‘PINNACLE OF EXCELLENCE AT SCALE’

In just over one year as the John A. Edwardson Dean of the College of Engineering, Mung Chiang has strengthened Purdue’s presence not only as one of the top 10 engineering colleges in the nation but also by tackling challenges and seizing opportunities enabled by scale.

Under Chiang’s guidance, the College set new records in research grants awarded and in philanthropic support over the past year. The faculty launched an NSF Engineering Research Center in energy innovation and an SRC-DARPA center in artificial intelligence. The student body included Marshall and Truman Scholarships.

“From new spaces to new interdisciplinary teams, from new degree programs to new industry partnerships, many exciting accomplishments by the amazing Boilermaker Engineers continue to propel Purdue Engineering to the Pinnacle of Excellence at Scale,” Chiang says.

That overarching goal for the College focuses on never allowing complacency. With the field of engineering changing rapidly, Chiang has stressed an emphasis on what to teach, how to teach and where to teach as questions with opportunities and urgency, especially at a large, land-grant university. What should be the intellectual identity, differentiating strength and unique culture of Purdue Engineering?

The Pinnacle of Excellence at Scale also charges the College to be “more eager, more agile, more visible” by leveraging long-standing strength in “what-we-touch” engineering and growing “what-we-code” engineering; developing a large pool of premier engineering talent, including via online learning; and engaging with industry in curriculum innovation, workforce development, research impact and entrepreneurship.

Chiang also has been determined about rapidly growing the College’s graduate education programs by publicizing offerings to applicants across the nation and throughout the world.

“Attaining the Pinnacle of Excellence at Scale depends heavily on our graduate students, who are central to both the discovery and dissemination of knowledge,” Chiang says.

(Photo credit: Purdue University/John Underwood)



SATELLITE TECHNOLOGY COULD HELP AGRICULTURAL PRODUCERS MORE ACCURATELY MEASURE SUBSURFACE MOISTURE

Agricultural producers could, in the future, make use of better forecasts to more efficiently irrigate their fields using a Purdue-developed technology that could more accurately sense soil moisture below the surface through measuring the reflections of communication satellite signals.

“The reflectivity of the surface is a function of the soil moisture, and that allows us to quantify the amount of moisture in the soil so, if necessary, growers can take corrective actions to protect their crops,” says James Garrison, a professor in Purdue’s School of Aeronautics and Astronautics. “The technology we’re developing can be cost effective.

“Water is becoming more and more scarce. So, managing the water that is available is becoming increasingly important. To manage it, you need to be able to accurately determine the amount being used. The key is to measure how much of it is in the soil where most of it is absorbed by the plants’ roots.”

The technology makes use of a specialized receiver to capture reflections of communication satellite signals with wavelengths of about one meter (39 inches), which scientists refer to as “P-band.”

Conventional satellite technology used for measuring soil moisture cannot operate at these longer wavelengths due to the required antenna size and the substantial interference from communications links. Current observations of soil moisture from a satellite uses wavelengths of about 20 centimeters (8 inches) and can only penetrate the soil about 5 centimeters (2 inches). Predictions of sub-surface soil moisture, currently require the application of models to extend the surface measurements deeper.

The new technique is known as “signals of opportunity,” or SoOp, and essentially uses the same transmissions that are the source of interference that prevents measurements from other methods. P-band SoOp is expected to be sensitive to soil moisture down to 15 to 20 centimeters, or about 6 to 8 inches, below the surface. Reflections of the signals from the surface are compared to the original satellite signals.



James Garrison

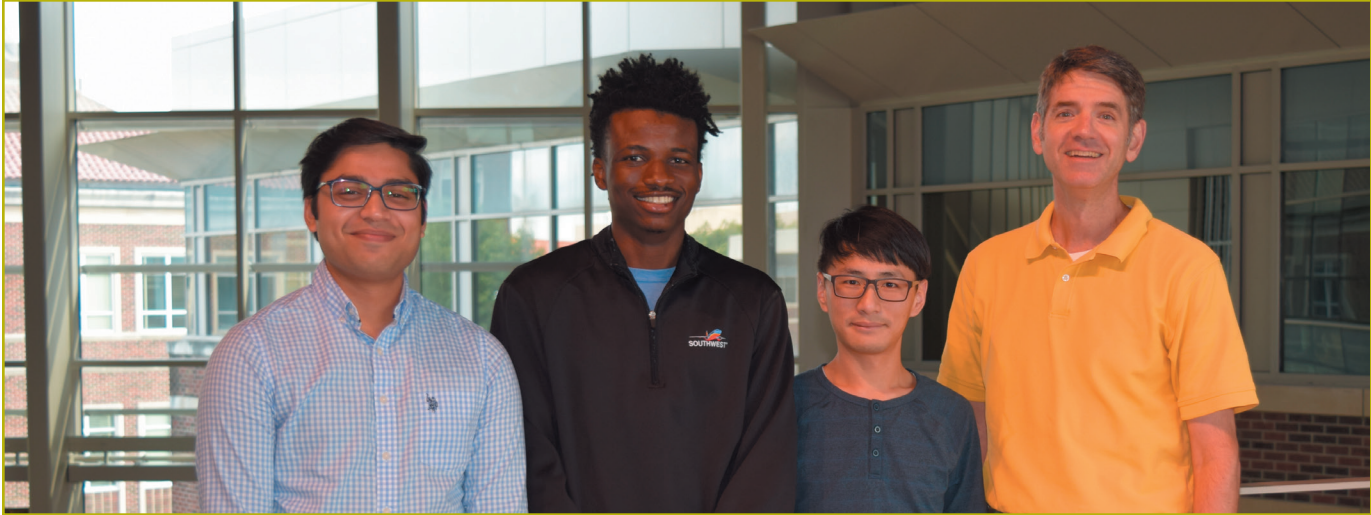
“By using these existing satellite signals, we bypass the requirements for licensing a P-band transmitter, which is extremely difficult,” Garrison says. “It also reduces the size of the antenna required.”

Researchers have tested a prototype of the instrument on a small plane during an experiment in the Little Washita watershed in Oklahoma. They now plan to collect data from a fixed tower location to observe the changes in a single agricultural field over at least one growing season.

If successful, this technology can be mounted on drones for planning the irrigation schedule of crops.

The technology has been patented through the Purdue Office of Technology Commercialization and is available for licensing. Funding for Garrison’s research came, in part, from the NASA Earth Science Technology Office under the Instrument Incubator Program.





(From left) Samarth Jain, Kolawole Ogunsina and Hsun Chao, three AAE graduate students currently using FLEET in support of the ASCENT project for the FAA, and AAE Professor William Crossley

INNOVATIVE AAE RESEARCH FOCUSES ON THE FUTURE FOR COMMERCIAL AIRLINES

How obtainable are new emission reduction goals for commercial aviation? That's the question two Purdue AAE professors and their colleagues are trying to answer with an innovative research model.

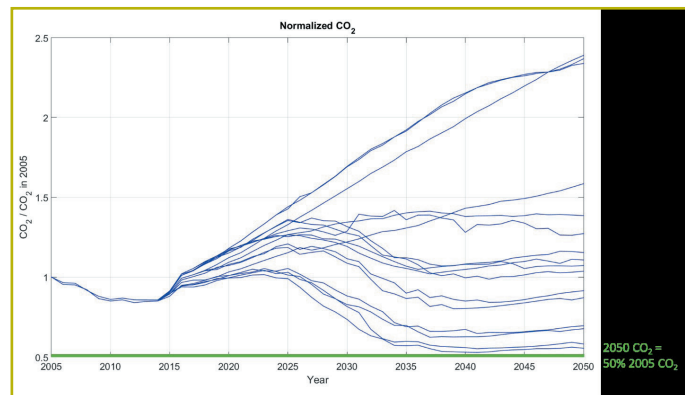
Professors William Crossley and Dan DeLaurentis are performing simulations of future scenarios for commercial aviation using the Fleet-Level Environmental Evaluation Tool (FLEET). FLEET can assess the environmental impact of commercial aviation in the U.S., particularly fleet-level CO₂ emissions with considerations of advanced aircraft concepts, airline operations, and eco-friendly policies for the U.S. commercial aviation industries.

Their work comes as the International Air Transport Association (IATA) set carbon emission reduction goals and called for a greater urgency in the partnership between airlines and governments to ensure aviation remains on the leading front of industries in sustainably managing the effect of climate change. The current IATA reduction goals include carbon neutral growth from 2020 and cutting net CO₂ emission to half of their 2005 values by 2050.

"An important innovation in FLEET is its unique model of how an airline would decide to retire old aircraft and acquire new aircraft," Crossley says. "FLEET's predictions emphasize the challenge in having an airline quickly change over its fleet to newer aircraft, and that has an impact on how quickly CO₂ emissions might be reduced by new technology aircraft."

FLEET also provides model-based predictions to compare to the emission goals.

Crossley presented recent results at the CESUN 2018 Engineering Systems Symposium in Tokyo, Japan.



This shows FLEET predictions of commercial aviation CO₂ emissions for 16 different scenarios of aircraft technology development levels and economic growth conditions. Some scenarios have a peak "carbon neutral" point, although these are after 2020. None of the scenarios reach the goal for 2050 aviation CO₂ to equal 50 percent of the 2005 CO₂.

"The goals stated for future aviation CO₂ emissions from agencies like NASA or IATA are admirable and challenging, but we did not really have a good sense of how likely it might be to meet these targets," Crossley says. "These goals do look like they will be difficult to meet."

FLEET started in support of NASA's Subsonic Fixed Wing and Environmentally Responsible Aviation programs. Recent developments and studies have supported the FAA via ASCENT, the FAA's Center of Excellence for Alternative Jet Fuels and the Environment.

Although the FAA has sponsored this project, it neither endorses nor rejects the findings of this research. The presentation of this information is in the interest of invoking technical community comment on the results and conclusions of the research.

NEW CUBESAT PROPULSION SYSTEM USES WATER AS PROPELLANT

A new type of micropropulsion system for miniature satellites called CubeSats uses an innovative design of tiny nozzles that release precise bursts of water vapor to maneuver the spacecraft.

Low-cost “microsatellites” and “nanosatellites,” far smaller than conventional spacecraft, have become increasingly prevalent. Thousands of the miniature satellites might be launched to perform a variety of tasks, from high-resolution imaging and internet services, to disaster response, environmental monitoring, and military surveillance.

However, to achieve their full potential, CubeSats will require micropropulsion devices to deliver precise low-thrust “impulse bits” for scientific, commercial, and military space applications. AAE Professor Alina Alexeenko has led research to develop a new micropropulsion system that uses ultra-purified water.

“Water is thought to be abundant on the Martian moon Phobos, making it potentially a huge gas station in space,” she says. “Water is also a very clean propellant, reducing risk of contamination of sensitive instruments by the backflow from thruster plumes.”

The new system, called a Film-Evaporation MEMS Tunable Array, or FEMTA thruster, uses capillaries small enough to harness the microscopic properties of water. Because the capillaries are only about 10 micrometers in diameter, the surface tension of the fluid keeps it from flowing out, even in the vacuum of space. Activating small heaters located near the ends of the capillaries creates water vapor and provides thrust. In this way, the capillaries become valves that can be turned on and off by activating the heaters. The technology is similar to an inkjet printer, which uses heaters to push out droplets of ink.

The research paper was authored by graduate student Katherine Fowee; undergraduate students Steven Pugia, Ryan Clay, Matthew Fuehne and



Purdue University graduate student Katherine Fowee and postdoctoral research associate Anthony Cofer work on a new micropropulsion system for miniature satellites called CubeSats. (Photo credit: Purdue University/Erin Easterling)

Margaret Linker; postdoctoral research associate Anthony Cofer; and Alexeenko.

“It’s very unusual for undergraduate students to have such a prominent role in advanced research like this,” Alexeenko says.

The students performed the research as part of a propulsion design course.

Typical satellites are about the size of a school bus, weigh thousands of pounds, and sometimes cost hundreds of millions of dollars. And while conventional satellites require specialized electronics that can withstand the harsh conditions of space, CubeSats can be built with low-cost, off-the-shelf components. Constellations of many inexpensive, disposable satellites might be launched, minimizing the impact of losing individual satellites. However, improvements are needed in micropropulsion systems to mobilize and precisely control the satellites.

“There have been substantial improvements made in micropropulsion technologies, but further reductions in mass, volume, and power are necessary for integration with small spacecraft,” Alexeenko says.

The FEMTA technology is a micro-electromechanical system (MEMS), which are tiny machines that contain components measured on the scale of microns, or millionths of a meter. The thruster demonstrated a thrust-to-power ratio of 230 micronewtons per watt for impulses lasting 80 seconds.

The FEMTA thrusters are microscale nozzles manufactured on silicon wafers using nanofabrication techniques common in industry. The model was tested in Purdue’s High Vacuum Facility’s large vacuum chamber.

Although the researchers used four thrusters, which allow the satellite to rotate on a single axis, a fully functional satellite would require 12 thrusters for three-axis rotation.

The inertial measurement unit handles 10 different types of measurements needed to maneuver and control the satellite. An onboard computer wirelessly receives signals to fire the thruster and transmits motion data using this IMU chip.

“What we really want to do next is integrate our system into a satellite for an actual space mission,” she says.

The research involved a collaboration with NASA’s Goddard Space Flight Center through the space agency’s SmallSat Technology Partnership program, which provided critical funding since the concept inception in 2013.

A patent application for the concept has been filed through the Purdue Research Foundation’s Office of Technology Commercialization. The nozzles for the system were fabricated in the Scifres Nanofabrication Laboratory in the Birck Nanotechnology Center in Purdue’s Discovery Park.

TELESCOPE TRACKS NEAR-EARTH SPACE OBJECTS

AAE Professor Carolin Frueh is leading research on Space Situational Awareness and Satellite Navigation. The Purdue Optical Ground Station (POGS) telescope of Frueh's Space Information Dynamics (SID) Group is now operational. The telescope is in New Mexico, a location that provides superior observation conditions.

The fully remotely controlled telescope is used for detection, tracking and characterization of near-Earth space objects, in particular human-made objects, such as satellites and space debris. It collects astrometric position data for detection and tracking, and color data and so-called light curves for object characterization.

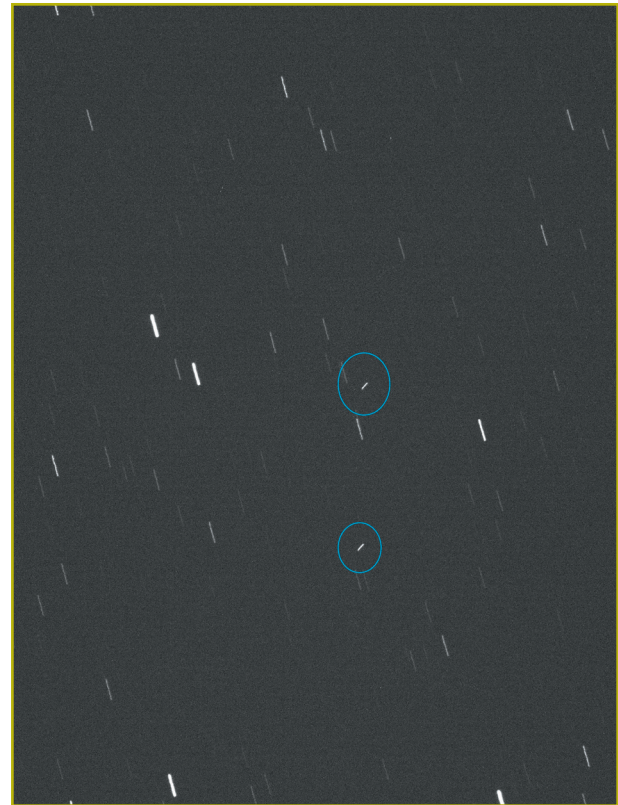
It is also a testbed to showcase the performance of image processing, orbit determination, sensor tasking, information fusing and light curve inversion algorithms developed by the SID Group.

"Space in the near-Earth realm has become increasingly populated," Frueh says. "And the space business is rapidly changing. New commercial satellite owner-operators are launching more and more small, CubeSat-sized satellites and have plans for mega constellations. Small satellites are often less agile, in addition to making space a lot more dense. This creates the urge for new techniques."

The SID Group explores questions about how to observe to gain the most knowledge, how to best determine an orbit with the least amount of observations, and how to characterize objects beyond their orbit, such as shape and attitude. Built on those are questions that leave the single-object realm but take into account the whole object population. How can sensor resources be distributed best to detect new unknown objects but also keep custody of the objects that are already known at least by their orbit? Or how can one have efficient image processing to allow for automated sensor tasking with a closed feedback loop in a decentralized manner? Or how can one associate the non-resolved object images to the objects — knowing which object is which — and the whole realm of computation of probability of collision in an efficient way for a large number of objects without sacrificing reliability?

"In order to automatically detect threats — object dynamics that are unusual or not well-modeled — an object taxonomy is still an open research question, to fully automatically group objects into relevant classes," Frueh says.

The Group is in the process of having the observation station operate fully autonomously without human interaction in both the observation collection (already automated) and also automated processing and feedback about successful observations within the same night. This allows for feedback informed sensor tasking.



Images of objects that were tracked (above) by the Purdue Optical Ground Station telescope (below).

APPOINTMENTS MADE TO NASA ADVISORY COUNCIL

Tom Shih, the J. William Uhrig and Anastasia Vournas Head and Professor of Aeronautics and Astronautics, was appointed as a member of the Aeronautics Committee of the NASA Advisory Council.

Shih began a two-year term in late June. The council is the senior external advisory body that assists NASA in addressing program and policy matters related to the U.S. civil space program.

Shih joined Kathleen Howell, the Hsu Lo Distinguished Professor of Aeronautics and Astronautics, on the Advisory Council. Howell is continuing in her role on the Technology, Innovation and Engineering Committee.

NASA astronaut and Purdue alumnus David Wolf, a visiting professor, was appointed as a member of the new Users Advisory Group for the National Space Council in February. He was among 29 individuals selected to serve on the advisory group from non-federal organizations, such as private industry. The group is sponsored by NASA and reports to the National Space Council on a range of issues.

“It is such an honor to represent Purdue as we plot the course to our next ‘giant leaps’ in human achievement, demonstrating we are truly without limits,” says Wolf, an Indianapolis native who logged 168 days in space over four space shuttle missions. “There is no question that it is Purdue that provided my opportunities to contribute to our Space Program. Our country demands to lead the world in space. Our fine students and faculty are sustaining the Purdue tradition of providing the very best to NASA as well as other endeavors.”



Tom Shih

DUMBACHER APPOINTED EXECUTIVE DIRECTOR

Daniel Dumbacher, an adjunct professor in AAE, was appointed executive director of the American Institute of Aeronautics and Astronautics.

As executive director, Dumbacher will lead the world’s largest aerospace technical society.

“At AIAA, an opportunity exists to connect aerospace professionals — as peers, mentors, and potential employers,” Dumbacher says. “My hope is to be an effective advocate for the aerospace community, while inspiring the next generation. My goal is to give back what Purdue has given me.”

Dumbacher became a faculty member at Purdue after retiring from NASA, where he spent more than three decades. At NASA, Dumbacher most recently served as deputy associate administrator in the Exploration Systems Development Division for the Human Exploration and Operations Mission Directorate.

“Undoubtedly, I will miss the day-to-day interaction with Purdue’s inspiring students — the leaders of tomorrow,” Dumbacher says. “I’ll also miss the guidance, expertise, and friendship offered by the AAE Purdue faculty. I am proud of my Purdue roots, and will always stay in touch — ever grateful, ever true.”



Daniel Dumbacher

HOWELL ELECTED TO INTERNATIONAL ACADEMY OF ASTRONAUTICS

Kathleen Howell, the Hsu Lo Distinguished Professor of Aeronautics and Astronautics, was elected to the prestigious International Academy of Astronautics.

She joins the IAA as a Corresponding Member in Engineering Sciences. The newly elected Corresponding Members and Members are from 25 countries. The IAA, founded in 1960, is a non-governmental organization of experts committed to expanding the frontiers of space.

Howell will be inducted Sept. 30 on IAA Academy Day in Bremen, Germany. The induction coincides with the IAA Commission, Study Group, and Committee meetings Sept. 29-30.



Kathleen Howell

GARRISON NAMED FELLOW IN THE INSTITUTE OF NAVIGATION

AAE Professor James Garrison was elected a Fellow in the Institute of Navigation (ION), one of three awarded in 2018. He was recognized for his contributions in developing Global Navigation Satellite System (GNSS) reflectometry methods for space-based and airborne remote sensing, with applications in oceanography, agriculture, and hydrology, and his recent work in expanding these methods to other signals-of-opportunity.



James Garrison

ION noted Garrison has made groundbreaking contributions demonstrating that reflections of GNSS signals contain valuable information on surface scattering. His seminal research sparked the subsequent development of an entirely new technique for Earth remote sensing. His subsequent research in this area contributed to the competitive selection of the CYGNSS mission in the 2011 NASA Earth Ventures solicitation. CYGNSS is a constellation of eight micro-satellites to measure ocean wind fields at a high revisit rate to improve forecasting of tropical storm intensification.

Expanding upon this work, Garrison pioneered the techniques of reflectometry methods beyond GNSS to the general class of "Signals of Opportunity (SoOp)," to enable new remote sensing capabilities making use of nearly any microwave frequency penetrating the Earth's atmosphere. He partnered with the Jet Propulsion Laboratory to develop a wideband ocean altimetry concept using reflectometry with K and Ku-band direct broadcast communication satellites, demonstrating centimeter-level precision in sea surface height retrievals. SoOp instruments built by Garrison's students have flown on the NOAA Hurricane Hunter aircraft.

The Institute of Navigation (ION) is a not-for-profit professional organization dedicated to advancing Positioning, Navigation and Timing (PNT). ION's international membership is drawn from many sources including professional navigators, engineers, physicists, mathematicians, astronomers, cartographers, photogrametrists, meteorologists, educators, geodesists, surveyors, general aviation and airline pilots, mariners, and anyone interested in position-determining systems.

AIAA FELLOWS INCLUDE AAE FACULTY, ALUMNUS

Three members of the AAE faculty and an AAE alumnus were named Class of 2018 Fellows and Associate Fellows by the American Institute of Aeronautics and Astronautics (AIAA).

Professor Steven Schneider and alumnus Stephen Rizzi were among only 22 individuals selected as Fellows. Professors Li Qiao and Steven Son were named Associate Fellows.

Schneider, an internationally recognized authority on the subject of laminar-turbulent transition in hypersonic boundary-layer flows, has guided and contributed to numerous government programs and international technological collaborations in hypersonics. He was one of only seven selections from academia.

"I am thankful for this honor that recognizes a career that has only been possible due to the help of many people, including senior colleagues such as Eli Reshotko, Jim Kendall and many others; graduate students; staff; and colleagues across the nation and the world," Schneider says. "There are too many to name, but I thank them all."

Rizzi (MSAAE '85, PhDAAE '89), who works at NASA's Langley Research Center, says this honor "would not have been possible without my AAE graduate education from Purdue University." Rizzi was awarded Purdue's OAE in 2005.

Qiao, an associate professor, and Son, a professor of mechanical engineering with a courtesy faculty appointment in AAE, were chosen for their accomplishments and leadership in the global aerospace community.

To be selected as an Associate Fellow, an individual must be an AIAA Senior Member in good standing, with at least 12 years professional experience, and be recommended by a minimum of three current Associate Fellows.

AIAA is the world's largest aerospace technical society with nearly 30,000 individual members from 85 countries.



Steven Schneider



Li Qiao

"I am thankful for this honor that recognizes a career that has only been possible due to the help of many people, including senior colleagues such as Eli Reshotko, Jim Kendall and many others; graduate students; staff; and colleagues across the nation and the world. There are too many to name, but I thank them all." - Steven Schneider

PIPES HONORED BY UNIVERSITY OF EDINBURGH

R. Byron Pipes, John L. Bray Distinguished Professor of Engineering at Purdue, received the honorary degree of Doctor Honoris Causa from the University of Edinburgh in July.

Pipes received the degree during the School of Engineering graduation ceremony in McEwan Hall on the Edinburgh campus. It was conferred by Acting Vice Chancellor Charlie Jeffery, who touched Pipes' head with the graduation cap thought to be made with material from John Knox's breeches.

The honor was bestowed in recognition of Pipes' international leadership of engineering research in lightweight composite materials. Pipes, who was elected to the National Academy of Engineering in 1987, has a joint appointment in chemical engineering, materials engineering, and aerospace engineering at Purdue.

During his speech at the ceremony, Pipes thanked University of Edinburgh faculty, current and past Vice Chancellors, and Professors Charlie Jeffery, Sir Timothy O'Shea and Conchúr M. Ó Brádaigh.

The moment carried particular significance for Pipes, whose family roots trace back to Scotland. His ancestors moved to Northern Ireland and spent over a century there before immigrating to the United States in the 1730s.

"It is in the Pipes family honor that I gratefully accept this award," Pipes said during his speech. "I take great pride in my Scottish ancestral heritage."



R. Byron Pipes

Pipes was joined at the ceremony by former and current doctoral students: Brádaigh, the head of Edinburgh's School of Engineering, was Pipes' student at Delaware in 1991, and Eduardo Barocio currently is pursuing a Ph.D. in materials engineering under Pipes' guidance at Purdue.

MARAI AWARDED

AAE Professor Karen Marais received an Incubator Award from the Systems Engineering Research Center (SERC).

From more than 30 proposals submitted, seven were selected for Incubator Projects. Her proposal, which focused on data science approaches to prevent failures in systems engineering, was one of four chosen for full research awards.



Karen Marais

HOWELL RECOGNIZED

Kathleen Howell, the Hsu Lo Distinguished Professor of Aeronautics and Astronautics, received the 2018 C.T. Sun School of Aeronautics and Astronautics Excellence in Research Award.

Howell has made pioneering contributions in celestial mechanics and astrodynamics. She has also contributed to the nation's space program, where her research has had a major impact on a number of NASA and international space flight missions.



Kathleen Howell and Tom Shih

The award is presented annually to an individual or a team of faculty members in AAE to recognize high-quality contributions in science and engineering.

POGGIE WINS GUSTAFSON AWARD

AAE Professor Jonathan Poggie won the prestigious 2017 W. A. Gustafson Award for Outstanding Teaching, selected by AAE juniors and seniors.

Poggie's research interests have encompassed the experimental, computational, and theoretical aspects of fluid dynamics and plasma physics. Current work in his research group focuses on turbulence in compressible flow, large-scale separation unsteadiness, and electrical discharges for flow control.

"I am grateful to be honored by the AAE juniors and seniors with the W. A. Gustafson Teaching Award, especially since my course, AAE 334 Aerodynamics, is required and rigorous," Poggie says.

"I am strongly committed to excellence in teaching and to the future success of Purdue students. Based on my own career experience as a research engineer, my classes emphasize fundamental understanding, practical techniques, and a broad context for our work. Our graduates should begin their careers feeling well prepared for the technical challenges ahead."

The award is made possible by the interest and generosity of friends and alumni of the school. Three additional faculty members were also nominated for the W. A. Gustafson Award for Outstanding Teaching: Professors James Longuski, Tyler Tallman and Karen Marais.

HWANG HONORED

AAE Professor Inseok Hwang received the 2018 Outstanding Faculty Mentor Award.

The award is presented annually to an individual AAE faculty member to recognize outstanding work in mentoring MS and Ph.D. students.

Hwang's research has been strongly motivated by difficult and interesting practical problems, such as controlling multiple-vehicle systems. Controlling multiple-vehicle systems is one of the most important and challenging aspects of modern system theory and practice.



Jonathan Poggie



Inseok Hwang

SANGID EARNS NAMED PROFESSORSHIP, PROMOTION

In the last academic year, Michael Sangid earned both a named professorship and a promotion.

In June 2017, Sangid was named the Elmer F. Bruhn Assistant Professor of Aeronautics and Astronautics. The named professorship intended for junior faculty is appointed by a committee of named and distinguished professors and the college's committee on named professors.

"The Elmer F. Bruhn Endowed Professorship has aided my research group in developing computational materials models for failure of structural materials with the aim of reducing certification time and cost, tailoring the performance of components, reducing overall weight, and increasing energy efficiency," Sangid says.

"Further, it has enabled us to explore the development of experimental validation efforts focused at characterization of the stress/strain evolution at the microstructural scale during in situ loading. I would like to thank my students and collaborators for their excitement and dedication to producing impactful research, which enabled this distinguished honor."

In April 2018, Purdue University's Board of Trustees approved Sangid's promotion to an Associate Professor, thus being named the Elmer F. Bruhn Associate Professor of Aeronautics and Astronautics effective starting at the 2018-19 academic year.

Sangid started at Purdue in Fall 2011. He received his bachelor's, master's and doctorate degrees from the University of Illinois. Additionally, he worked as a materials lifting engineer at Rolls-Royce Corporation and as a postdoctoral research associate at Illinois.

Sangid's research activities combine knowledge of materials science, solid mechanics, and advanced manufacturing to solve complex problems in materials behavior and processing.

"I would like to thank my students and collaborators for their excitement and dedication to producing impactful research, which enabled this distinguished honor." - Michael Sangid



Michael Sangid



Leo Aerospace LLC was started by five Purdue University students as a club and then turned into a business. The founders are, from left, Mike Hepfer, head of product development; Drew Sherman, head of vehicle development; Abishek Murali, head of mission engineering; Dane Rudy, chief executive officer; and Bryce Prior, head of operations and strategy. (Image provided)

‘ROCKOONS’

MAY SOON MAKE LAUNCHING SATELLITES
INTO SPACE MORE ACCESSIBLE

A Purdue University-affiliated startup plans to open access to space for microsatellite companies.

Leo Aerospace LLC will use “rockoons,” or high-altitude balloons, that launch rockets into suborbital and orbital flights. The company won third place and \$1,500 in a Midwest business competition in July at the 1871-Chicago Center for Technology and Entrepreneurship and \$15,000 in March through the Burton D. Morgan Business Model Competition.

Officials of Leo Aerospace, which was started by five Purdue students as a club before it became a business, say the company will revolutionize the space industry by giving priority service to microsatellite developers that now are secondary payloads for large rocket companies. Currently, developers have to wait to see if there is room left on large rockets carrying government payloads and often have to wait six months or more to find space on a rocket, a delay that can be quite costly. Those microsatellite developers also have limited options on which orbit their satellites are delivered to and when they are launched.

“We’re targeting the microsatellites by saying, ‘You don’t have to ride-share with anyone. We can guarantee you will be our only payload and we will be focused on you,’” says Leo Aerospace’s Head of Vehicle Development Drew Sherman, who has bachelor’s and master’s degrees from Purdue’s School of Aeronautics and Astronautics. “We will work with you exclusively to get you into orbit. You won’t have to worry about other payloads or getting dropped off in the wrong spot.”

Abishek Murali (BSAAE ’17), head of mission engineering, says a selling point for Leo Aerospace will be its flexibility and ability to meet customers’ needs. The company can tailor its launch vehicles and its operational capabilities to the exact needs of its clients.

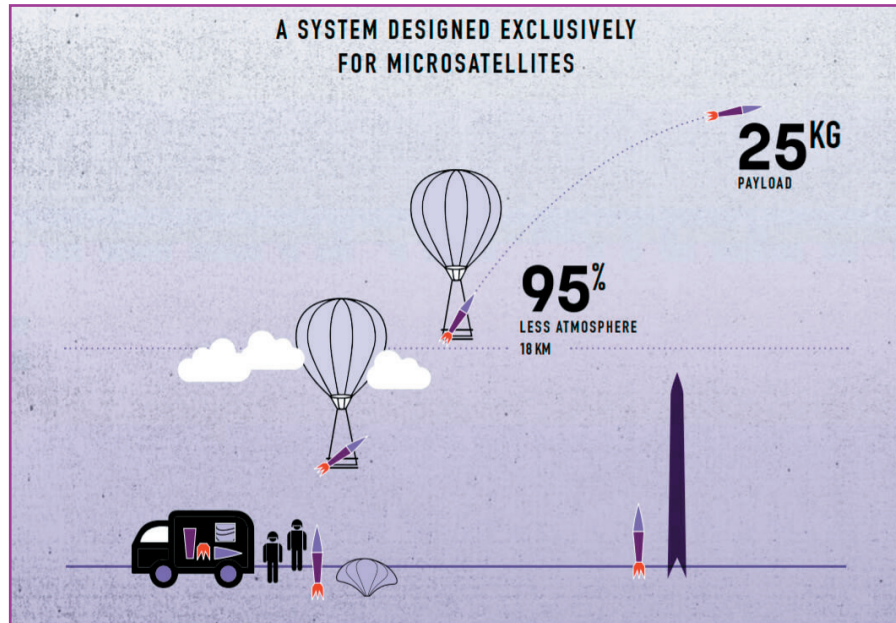
“Our goal is to give people access to space. The only way to do that right now is to help people get their satellite into orbit. That’s where we want to leave our mark,” Murali says.

Leo Aerospace, which took its name from low Earth orbit, plans to harness physics to cut costs and expand mission capabilities.

The cost of sending a satellite into space can be up to \$60,000 a kilogram. Leo Aerospace is confident it can lower that cost to launch microsatellites, which can weigh 1 to 50 kilograms. The rockoon, a hybrid of a rocket and high-altitude balloon, is less expensive to deploy than a traditional rocket since there is less drag because the rocket isn’t launched until the balloon is 11 miles above Earth, where there is 95 percent less atmosphere to cause drag.

“By doing that you can scale your rocket down much more efficiently,” Sherman says.

Leo Aerospace conducted a customer discovery and market validation study through the National Science Foundation I-Corps program and found a large demand to deploy microsatellites.



The rockoon was first used by the U.S. Air Force in the 1950s. Leo Aerospace can precisely launch the rocket by controlling the pitch and angle using core integration technology, for which it has filed patents.

The company’s goal is to launch its first suborbital flight by 2020 and use funds combined with a Series B funding round, to launch its first satellite into orbit in 2022. Its long-term goal is to increase launch frequency as operations develop. The company has done some preliminary analysis work and some hardware testing.

Leo Aerospace plans to initially launch the rockoons from existing spaceports licensed by the Federal Aviation Administration. The spaceports stretch from the Kennedy Space Center in Florida to Kodiak Island in Alaska.

Leo Aerospace plans to reuse the balloons for future launches, but the rockets will be used only once, says Murali.

“We want to be part of the space market,” says Murali, who is pursuing a graduate degree at Purdue in engineering management with an emphasis on dynamics and control systems. “People are interested in space and creating technologies that not only can operate in space but also help people back on Earth. What we’re trying to do is help them get there.”

AAE EXPERIMENT TAKES FLIGHT ON BLUE ORIGIN ROCKET

An AAE class successfully tested a zero-gravity flight experiment on Blue Origin's suborbital rocket, New Shepard. Professor Steven Collicott and his Zero-Gravity Flight Experiment class designed their payload on a July flight from a private location in Texas, to test predictions for how liquid forms droplets or plugs in small tubes in weightlessness, such as in the condenser of a heat transfer loop in a spacecraft.

Applications on Earth include the presence of water droplets in lung passages and the control of condensed liquid in fuel cell gas passages.

The Condensed Droplet Experiment for NASA in Suborbital Spaceflight (ConDENSS) was designed and built over the last two years by undergraduate students and a master's student in AAE.

NASA's Flight Opportunities program chose Collicott's ConDENSS experiment proposal for flight testing. The Flight Opportunities program uses new flight opportunities to research diverse problems identified in NASA's technology needs for future human and robotic space missions. "Flying experiments like this spaceflight technology payload for NASA on a commercial re-usable rocket will soon be common," Collicott says. "With a launch cost that is only a few percent of older, single-use rockets, this new space industry is opening up more options for space-based experimentation than most of us ever dared to hope for a decade ago."



Steven Collicott and Shih-Pin Cheng

During the flight, the experiment controlled a series of injections and withdrawals of small liquid amounts into eight specially designed tube-like test sections. Unique computer models created by the team predict whether the various liquid volumes form droplets, sleeves or plugs in the different test sections.

Video data from the experiment are used to test the predictive ability of the models. It takes about six months for data analysis and a comparison to modeling.

AAE TEAM HAS SUCCESSFUL TEST AT NASA'S NBL

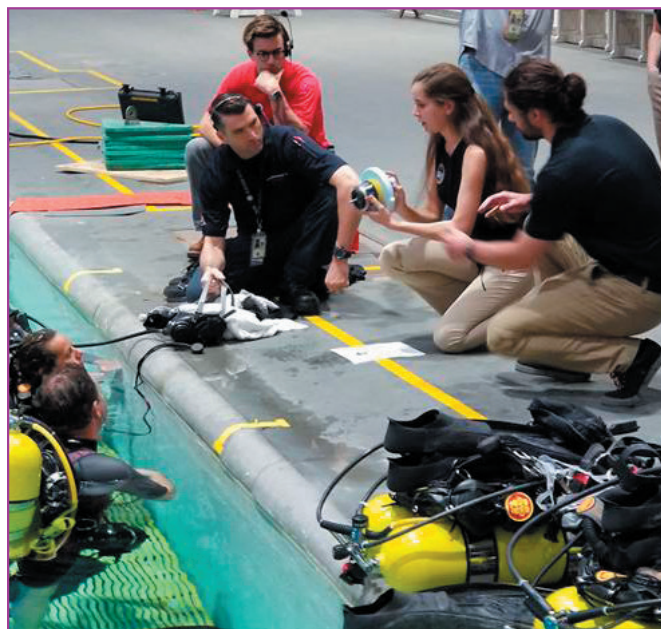
Purdue's NASA Neutral Buoyancy Experiment Design Team (NExT) successfully tested a space station hole-repair tool in NASA's Neutral Buoyancy Lab in May.

The team was led by visiting professor and former NASA astronaut David Wolf and AAE Professor Steven Collicott.

The team tested its device to patch micro-meteorite holes in the International Space Station at the Lab at NASA's Johnson Space Center in Houston.

The team, comprised of AAE undergraduate students in Collicott's Zero-Gravity Flight Experiment class, was able to test its tool after being selected by NASA for the 2018 Micro-g NExT challenge. Collicott's class has produced winning proposals for all three years of the NASA NExT program.

Professional Neutral Buoyancy Lab divers tested the tools, and the students offered direction from the Test Conductor Room of the NBL facility.



Purdue students Pau Pineda Bosque and Sam Albert were part of Purdue's NASA Neutral Buoyancy Experiment Design Team.

FOWEE AND RINK HONORED

AAE graduate students Kate Fowee and Kim Rink were among the 2018 winners of Aviation Week's "Tomorrow's Technology Leaders: The 20 Twenties."

The award recognizes students who are nominated by their universities on the basis of their academic performance, civic contribution, and research or design project. More broadly, the program is part of an over-arching effort to bring together technology hiring managers, students and faculty to recognize the full circle of what is required for business and academic success.

The winners were honored during Aviation Week's 61st Annual Laureates Awards March 1 at the National Building Museum, Washington, DC.

Fowee, a master's student of Professor Alina Alexeenko who graduated in the spring, had a concentration in propulsion. Her research focus was micropropulsion for small satellites, like CubeSats.

"I have known previous recipients of the 20 Twenties recognition and they were some of the most brilliant people I have met while at Purdue," she says. "I feel privileged to be recognized with this award as well."



Kate Fowee and Kim Rink

A master's student under Professor Karen Marais, Rink's concentration area is aerospace systems, and her research is a joint effort with the NASA Jet Propulsion Lab, where they are determining how deviations in the design process affect the success of robotic missions.

"I am very honored to receive this recognition," Rink says. "I am very appreciative of my research group and AAE for helping me get there!"

STUDENT ORGANIZATION RECEIVES 'CHAPTER OF THE YEAR' TITLE

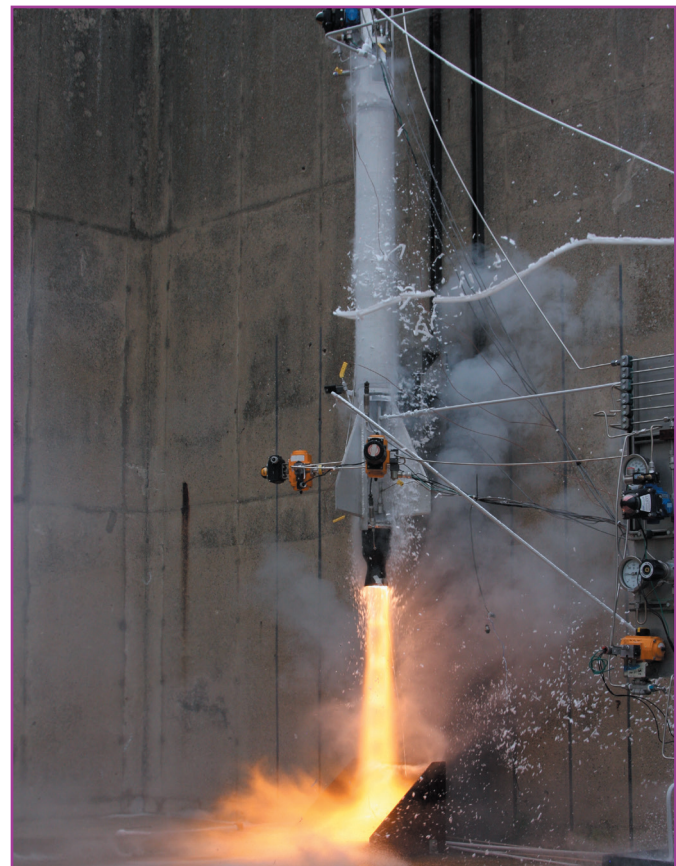
Purdue Students for the Exploration and Development of Space (SEDS) received the Chapter of the Year award from the national SEDS organization.

The Purdue group received the award in November during SpaceVision, the annual national conference for SEDS. Purdue SEDS was recognized for its excellence and outstanding performance as a chapter. The highlight of the year for the organization, says president Christopher Nilsen, was building a liquid oxygen-liquid methane rocket. When the host at the award ceremony revealed that detail about the winning group, that's when Nilsen knew Purdue was the winner.

"We were genuinely shocked," Nilsen says. "I wasn't happy that we had the title of Chapter of the Year, I was overjoyed to know that what we started was going in the right direction and people noticed it."

In only two years, Purdue SEDS grew from five people to more than 100 members who paid dues in 2017, Nilsen says. Entering the 2018 academic year, that number doubled with 90 percent of members participating in hands-on technical projects, Nilsen says.

Purdue SEDS is a student organization for anyone who is passionate about space exploration and the space exploration industry.



The biggest highlight of the year for Purdue Students for the Exploration and Development of Space was the Liquid Oxygen-Liquid Methane Rocket Static Fire 2. (Photo credit: Christopher Nilsen)



From left: Morgan Pietruch, Cathy Troyer and Nicoletta Fala (Photo credit: Purdue Pilots, Inc.)

ANOTHER AIR RACE CLASSIC FOR FALA, PURDUE PILOTS, INC.

The 42nd annual Air Race Classic included a pair of teams with Purdue students, including AAE Ph.D. student Nicoletta Fala and AAE undergrad Morgan Pietruch.

Fala is the president of Purdue Pilots, Inc., and flew with co-pilot Cathy Troyer, who is pursuing a master's in aviation management. Pietruch was the team's third member. The team representing Purdue University in the race included Alyssa Harvey and Tiffany Imhoff, seniors in Purdue's Professional Flight program. Harvey was the pilot, and Imhoff the co-pilot.

Despite the bad weather, the Purdue Pilots, Inc. team managed to complete the race and finished 22nd. The team also got the second prize for the last leg of the race — from Penn Yan, N.Y., to Fryeburg, Minn.

Fala also participated with Purdue Pilots, Inc., funded by Rockwell Collins, in the previous year's race.

"The race is a wonderful experience each year, and it's never the same, which makes all the pilots want to go back



Nicoletta Fala (Photo credit: Purdue Pilots, Inc.)

for more," says Fala, a commercial pilot who currently is completing training to become a flight instructor. "The best part about our participation was how many women we inspired to pursue their aviation dreams and reach higher milestones."

Purdue University has been represented by a team in the Air Race Classic for more than 20 years. The recent field consisted of 55 teams with 119 racers from 34 states and five foreign countries.

NEW STUDENT ORGANIZATION, WOMEN IN AEROSPACE, OFF TO STRONG START

A Graduate Women's Gathering luncheon in the fall generated such a discussion, it spawned a new organization for women in Purdue's School of Aeronautics and Astronautics.

GWG invited undergraduates for a chat and suggested the possibility of having a similar sort of organization for undergrads. Katherine Bolek, Sydney Dolan and Maisie Linker thought it was a great idea, so they founded "Women in Aerospace" in the spring of 2018.

"Aside from Maisie, I knew very few women in the major, and we both felt awkward singling out other girls in our classes," Dolan says. "Katherine is even our age, and we never had a chance to talk before that lunch. We wanted to form an organization that would help connect women in the major and provide them support to succeed."

The goal of the organization is to provide women interested in aerospace engineering with additional educational, professional, and networking opportunities. The organization still is growing, and the School now has an endowed scholarship to support women in AAE that was initiated by James Gregory (MSAAE '02, PHDAAE '05).

"Being a minority definitely has its challenges, but I never really noticed major issues until I was considering joining a technical project team and was the only woman in the room. That was a pretty insightful moment because for the first time, I questioned if I belonged here," Linker says. "I think the idea of 'strength in numbers' is pretty relevant, because if there had been just one other woman there, maybe I wouldn't have felt so out of place. Our organization has definitely eliminated that disheartening feeling for me, just by knowing there are other women out there doing what you

FRIEDMAN SELECTED AS SMART SCHOLAR

AAE Ph.D. student Alex Friedman was selected by an Air Force research lab (AFRL) facility as a SMART scholar.

The Science, Mathematics and Research for Transformation (SMART) Scholarship for Service Program is an opportunity for students pursuing an undergraduate or graduate degree in STEM disciplines to receive a full scholarship and be gainfully employed by the Department of Defense (DoD) upon degree completion.

Friedman will work at the AFRL facility during the remaining summers of his Ph.D. and then after he completes his program under AAE assistant professor Carolin Frueh.

Friedman's research focuses on space situational awareness (SSA) and his dissertation specifically looks at applying



AAE collaborated with ECE students to conduct a skills workshop, which AAE students Sydney Dolan and Veronica Yapriadi (pictured) attended.

are doing and trying to accomplish the same things as you is extremely encouraging."

In the first semester, the group had study nights, a skills workshop, hosted an event with First-Year Engineering students, and had talks with AAE Professor Alina Alexeenko, the group's advisor, and Gregory, a professor in the Department of Mechanical and Aerospace Engineering and Director of Aerospace Research Center at Ohio State University.

Entering the 2018-19 academic year, Dolan says there are about 100 women on the group's email list, which includes graduated women and interested freshmen.

"It's been extremely rewarding to start this organization," Dolan says, "and seeing the response thus far, I am hopeful we can build something really special."

Purdue was the first U.S. university to have a Women in Engineering Program in 1969.

observability analysis to near-Earth artificial space objects.

"I am grateful that I have been awarded the SMART Scholarship," Friedman says. "Not only does the program provide funding for my PhD, but it also results in a job following graduation. I am looking forward to applying the expertise gained during my Ph.D. to work for the DoD and AFRL."



Alex Friedman

AAE STUDENTS AWARDED FELLOWSHIPS

Ph.D. students **Andrea Nicolas**, **Gayathri Shivkumar** and **Pei Zhang** each received a Bilsland Dissertation Fellowship, which is awarded by the Purdue Graduate School.

The Fellowship provides support to outstanding Ph.D. candidates in their final year of doctoral degree completion. The students are nominated and selected by members of the graduate faculty.

Nicolas, a Ph.D. student of Professor Michael Sangid, wrote a dissertation titled "Relationships Between Galvanic Driving Force and Strain Energy Density Accumulation." In her research, Nicolas looks at the integrated evolution of corrosion from both a mechanical and chemical point of view, which is innovative because usually corrosion is separately evaluated from either perspective but never simultaneously from both.

"I am really happy and grateful to be awarded this fellowship because I can continue working in something I really love surrounded by amazing people," Nicolas says. "I am extremely thankful toward AAE, my adviser, and my awesome labmates/classmates for being so supportive and welcoming throughout my studies here at Purdue."

Shivkumar's dissertation is titled "Coupled Plasma, Fluid and Thermal Modeling of Low-Pressure and Microscale Gas Discharges." Part of her research focuses on the modeling of hydrogen microwave plasma for the chemical vapor deposition (CVD) of graphitic nanopetals, graphene and carbon nanotubes and introduction of a pillar for growth enhancement.

"I feel very honored and humbled to be chosen as a fellowship recipient from a department with many excellent Ph.D. candidates," Shivkumar says. "I also feel motivated to keep up my performance and work hard to improve it. I am extremely grateful to my adviser,

"I am really happy and grateful to be awarded this fellowship because I can continue working in something I really love surrounded by amazing people. I am extremely thankful toward AAE, my adviser, and my awesome labmates/classmates for being so supportive and welcoming throughout my studies here at Purdue."



Andrea Nicolas

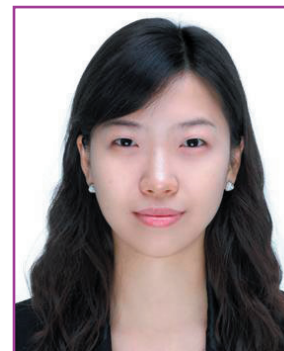
- Andrea Nicolas



Gayathri Shivkumar



Pei Zhang



Jooyung Lee



Sydney Dolan and Sam Albert

Professor Alina Alexeenko, for all her support and guidance.”

Zhang’s research focuses on extending the traditional single regime combustion models to predict multi-regime combustion, which will ultimately help the design and optimization of combustors. Her dissertation is titled “Modeling of Multi-regime Turbulent Combustion: Challenges and Advances.”

“I am deeply honored to receive the fellowship and very grateful to the department and graduate school for providing the fellowship,” Zhang says. “I would like to thank my adviser, Professor Haifeng Wang, for his patient guidance and constant support over the past four years.”

Sydney Dolan and **Sam Albert** were selected for the inaugural class of the Matthew Isakowitz Fellowship Program, a summer internship and executive mentorship program inspiring the next generation of commercial spaceflight leaders.

The highly selective program paired exceptional college juniors, seniors, and graduate students pursuing aerospace careers with paid internships at 20 cutting-edge commercial space companies across the nation. Fellows also received one-on-one mentorship from aerospace industry executives

for a full year. The program culminated in a two-day summit during which the fellows networked with leaders in industry, visited space start-ups, and developed entrepreneurial skills.

Ph.D. student **Jooyoung Lee** was selected as an Amelia Earhart Fellowship recipient for the 2017-18 academic year by Zonta International, which seeks to empower women through service and advocacy.

Lee’s research focuses on stochastic hybrid system modeling and state estimation for safe and efficient operations of aerospace systems in the National Airspace System (NAS). Lee’s adviser is Professor Inseok Hwang, and she’s part of the Dynamics and Control research area.

“I am sincerely grateful to be selected as a recipient of the Amelia Earhart Fellowship,” Lee says. “This generous support will allow me to concentrate on what is more important in my research and help me to grow as an independent researcher.”

Zonta International established the Amelia Earhart Fellowship in 1938 in honor of the legendary female pilot to assist the future of women in the fields of aerospace-related sciences or aerospace-related engineering.

OTHERS AWARDED FELLOWSHIPS

Purdue Forever Fellowship

Andrew Strongrich

National Science Foundation’s Graduate Research Fellowship Program

Adarsh Patra, Juan Ojeda Romero

NASA Space Technology Research Fellowship

Michael Baier, Alexis Harroun, Jenna Humble, Monique McClain, Eric Westphal

National Defense Science and Engineering Graduate Fellowship

Elizabeth Benitez

Hsu Lo Fellowship

Chao Han

Hugh W. and Edna M. Donnan Fellowship

Jayaprakash Suraj Nandiganahalli

David M. Knox Fellowship

Kimberly Rink

Rolls-Royce Fellowship

Blair Francis, Jakob Hartl, Jordan Fisher

C.L. Amba-Rao Fellowship

Rachana Agrawal

POUPLIN EXPERIENCES MARS SIMULATION

Imagine working and living inside a simulated Mars colony for two weeks. That was AAE Ph.D. student Jennifer Pouplin's dream come true, as she participated in the Poland Mars Analogue Simulation.

Pouplin, who received her master's in 2016, was one of six volunteer astronauts who worked through a realistic schedule of space exploration while living inside the simulated Mars colony in Poland.

The experiment was designed to support real missions to Mars.

"This was a tremendous opportunity for me to experience what life is like for astronauts and produce data to help future missions to Mars," says Pouplin, whose trip was made possible through the generosity of AAE donors.



Jennifer Pouplin (third from left) with the Poland Mars Analogue Simulation crew

AAE HOSTS AIAA CONFERENCE

Seven schools were represented with attendees at the American Institute of Aeronautics and Astronautics (AIAA) Region 3 Student Conference April 13-14 at Purdue.

The event included a tour of the Maurice J. Zucrow Laboratories; a networking session; and presentations from undergraduate and graduate students; and keynotes delivered by Dan Dumbacher, the executive director of the AIAA, Tom Shih, the J. William Uhrig and Anastasia Vournas Head and Professor of Aeronautics and Astronautics, and Dan Jensen, the Region 3 director of the AIAA.

"It was an absolute honor hosting the AIAA Region 3 Student Conference at Purdue," says Astha Tiwari, Purdue's AIAA president. "This conference was a great way for students to present their research and learn from each other while helping advance the aerospace industry. Also, the conference provided a great opportunity for students, faculty, and industry professionals to interact and discuss current aerospace topics while participating in local social activities.

"This conference was a great success."

Paul Stockett (Purdue) won in the graduate presentation category with "Investigation of Nanosecond-Scale Plasma Discharges at Atmospheric Pressure Using Time-Resolved Imaging." Mitchell Lozier and Cameron Sickbert (Rose-Hulman) were selected as winners in the undergraduate category, and the Purdue team of Ryan Clay, Benjamin Davis, Kate Fowee, Matthew Fuehne, Maisie Linker, and Steven Puglia won the team category for "Liquid Water-Fueled Micro-Propulsion System for Small Satellites."

Lockheed Martin, Rolls-Royce, Purdue's College of Engineering, and the School of Aeronautics and Astronautics sponsored the event.



Daniel Dumbacher, AIAA executive director, delivered one of the keynote addresses. (Photo credit: Astha Tiwari)



Geoffrey Andrews

ANDREWS WINS ZAREM AWARD

AAE Ph.D. student Geoffrey Andrews was the 2018 recipient of the AIAA Foundation's Abe M. Zarem Award for Distinguished Achievement in Aeronautics.

Andrews received the honor for his paper, "A Hybrid Length Scale Similarity Solution for Swirling Turbulent Jets." Andrews, who earned his master's in aerospace engineering from Purdue in 2017, is pursuing a doctorate degree in hypersonic computational fluid dynamics.

The award annually recognizes students in aeronautics or astronautics who have demonstrated outstanding scholarship in their field.

"It amazes me that something that began life as a simple class project here at Purdue has earned this level of recognition," Andrews says. "I'm truly grateful to be part of a department with such high academic standards and chuffed to bits to be pursuing my doctorate alongside some of the best students and faculty in the world."

Among that faculty is Greg Blaisdell, a professor of aeronautics and astronautics. Blaisdell will receive a certificate of recognition for his work with Andrews, whose award-winning paper was an extended version of a report for a class project in AAE 626, Turbulence and Turbulence Modeling.

"It amazes me that something that began life as a simple class project here at Purdue has earned this level of recognition."

- Geoffrey Andrews

PHD STUDENTS RECEIVE AWARDS IN PAPER COMPETITIONS

AAE Ph.D. student Harish Saranathan won the 2018 AIAA SciTech Atmospheric Flight Mechanics Student Paper Competition for his paper titled "The Relaxed Autonomously Switched Hybrid System (RASHS) Approach to Indirect Multi-Phase Trajectory Optimization for Aerospace Vehicles."

The winning paper focused on simplifying the design of optimal trajectories for hypersonic missions involving multiple phases of flight, which include multi-stage launch to orbit and reentry missions. The topic is part of Harish's overall research into conceptual mission design of hypersonic systems. His research looks at increasing the fidelity of conceptual hypersonic mission design.

Saranathan is advised by Professor Michael Grant and is part of the Rapid Design of Systems Laboratory (RDSL). Saranathan hopes to be a part of future planetary exploration missions.

"I have always been mystified by space since my mom introduced me to it when I was 3 years old," he says. "I was gifted a book titled, *Apollo Expeditions to the Moon*. Although I was too young to actually read it, the pictures it contained of space, Earth and the Moon blew my mind. From that moment, I knew I wanted to be in AAE because it provides us the means to explore space."

Jooyoung Lee, a Ph.D. student in Professor Inseok Hwang's research group, received a "Best Student Paper" award from the 2018 SciTech Forum Intelligent Systems conference.

Her paper was titled "UAS Surveillance in Low-altitude Airspace with Geofencing: Constrained Stochastic Linear Hybrid Systems Approach."

The goal of this research is to develop a UAS (Unmanned Aircraft Systems) tracking algorithm. It would effectively account for the complex behavior of UAS and its trajectory restricted to be within geofences assigned by the UTM (UAS traffic management) system so that it can produce more accurate UAS tracks than existing tracking algorithms, and thus support the safe and efficient operation of a UTM system. To achieve this goal, a constrained stochastic hybrid systems approach is proposed, and the constrained Kalman filtering technique is used in hybrid state estimation framework.

"I am sincerely honored to receive the Best Student Paper Award," Lee says. "It gave us a great opportunity to increase the exposure of our research and to receive invaluable feedback. It makes me feel like I am on the right track toward my goal of being an independent researcher."



(Photo credit: NASA)

GEYER BRINGS DARING, BUT REASONED, APPROACH TO NASA'S JOHNSON SPACE CENTER

When Mark Geyer started as a systems engineer at NASA in 1990, seven years removed from Purdue, he certainly had aspirations of reaching the agency's great heights.

Right?

"Yeah ... no," says Geyer, laughing.

Back then, there were no thoughts of making a progressive ascent toward NASA's most-influential positions.

But as he transitioned to other jobs — "really cool jobs," he notes — with the International Space Station and the Orion spacecraft, he recognized the weight and importance the director position held at each NASA site. He especially had a sense of that when he was selected in 2015 as deputy

director of NASA's Johnson Space Center in Houston.

So when Geyer (BSAAE '82, MSAAE '83) was appointed as the director at JSC in May, replacing retired Ellen Ochoa, he was able to fully grasp the significance.

"Johnson plays such a key role in NASA, both in the past and in the future. We have so many exciting capabilities here that it was really an honor to be picked and also kind of daunting, the responsibility for this place," he says. "I was thrilled that they asked me and excited to take the job."

The timing seems ideal.

With the current administration's emphasis on human exploration to the Moon and beyond, backed by a substantial



Outgoing NASA Johnson Space Center Director Ellen Ochoa introduced incoming director Mark Geyer at a meeting on May 14 in Houston. (Photo credit: NASA)

funding increase to about \$20 billion for NASA in 2019, Geyer is armed with resources and expectations to maximize the United States' capabilities of leading human exploration.

In the next two years, commercial crew providers will launch Americans from Florida to the International Space Station, and Orion will be launched past the Moon, Geyer says. Geyer, the 12th director of Houston's center that is the hub of human spaceflight activity, is charged with getting JSC ready for those launches, while still continuing to fly ISS. The next phase will be accessing the Moon.

"There's going to be a bunch happening that I think will wake up the country and the world to say, 'NASA is back in that business of launching people and doing exciting things,'" Geyer says. "Given the amount of work and the capabilities that only Johnson has, it's important to help the team focus and prioritize so we get the right stuff done on the right timeline."

Geyer's appointment was praised by former director Michael Coats, who told the *Houston Chronicle* that Geyer was the perfect choice, specifically mentioning Geyer's intelligence and calmness in deliberations.

Ochoa tweeted after the appointment about Geyer's "excellent" and "thoughtful" leadership, as well as his technical expertise and commitment to innovation and inclusion.

Certainly Geyer's character is crucial to success in the role, but his professional experience may be just as valuable.

He has served in a variety of roles in his nearly 30-year career with NASA, including as manager of ISS Integration Office, ISS Mission Management Team chair, and Orion program manager. He's familiar with the challenges of working with partners on a common goal — he was heavily involved in the early years of ISS, when it transitioned to adding the Russians in the early 1990s — and he also was part of the management team that tried a variety of approaches with commercial partnerships and succeeded.

All that lines up with NASA administrator Jim Bridenstine calling the Indianapolis native "eminently qualified."

"I think what helps is that people feel like we're on the same team and that we're aimed to the same goal. I think that's something I can bring because they know me. I've been here for a while," Geyer says. "The other part is having kind of a daring, but also reasoned, approach on how to move forward. We want to be aggressive but also have an approach that the team can follow. A lot of that is a management philosophy, strategy, and, then, communication because there will be conflicts and difficult decisions, so we need to make sure the team knows how to work them and how to bring issues up quickly so we can talk about them and get them resolved."

Being surrounded by fellow Boilermakers in Houston certainly can't hurt productive communication.

Bill Gerstenmaier (BSAAE '77) is NASA's associate administrator for human exploration and operations, Julie Kramer White (BSAAE '90) is the deputy director of engineering, Loral O'Hara (MSAAE '09) is an astronaut candidate in training, and Allison Bolinger (BSAAE '04) and Marcos Flores (MSAAE '15) recently were named flight directors.

And those are only a handful of Purdue alumni at JSC.

Geyer reflects fondly on his days in West Lafayette, saying he was "blessed to get to go there," following in the footsteps of his father Larry. His siblings, Ronald Geyer, Mary Hand and Sue Sieker, also graduated from Purdue, as did wife Jackie.

Geyer doesn't get back to campus often. Honored as a 2016 Outstanding Aerospace Engineer by Purdue's School of Aeronautics and Astronautics, he was forced to miss the ceremony when his daughter fell ill. Ultimately, Ochoa presented him the award — one he called "one of the coolest ones I've seen" — in Houston.

"To be recognized by that school, it's a great honor," he says. "I know it because I know the other people who have gone through it. It means a lot."



(Photo credit: NASA)

TWO AAE GRADUATES PART OF NASA'S LATEST FLIGHT DIRECTOR CLASS

NASA selected two AAE graduates to join an “elite corps” of flight directors who will lead mission control for a variety of new operations at the agency’s Johnson Space Center in Houston.

Allison Bolinger (BSAAE '04) and Jose Marcos Flores (MSAAE '15) were among six people chosen for the prestigious group. Once their class is trained, they’ll be among only 97 flight directors since the first in 1958. Bolinger has been at NASA since 2004, and Flores started full-time in 2010.

They’ll need to complete extensive training — from flight control and vehicle systems to operational leadership and risk management — before they can sit behind the flight director console in mission control supporting NASA’s astronauts.

Once they do, they’ll join the 26 active flight directors guiding mission control. Bolinger and Flores will oversee a variety of human spaceflight missions involving the International Space Station, including integrating American-made commercial crew spacecraft into the fleet of vehicles servicing the orbiting laboratory, as well as Orion spacecraft missions to the Moon.

ALLISON BOLINGER

As deputy chief for NASA’s Neutral Buoyancy Laboratory,

Bolinger enjoyed directing the day-to-day operations of its 6.2-million-gallon pool used to train astronauts for spacewalks by imitating zero gravity of space.

So when the opportunity arose to apply for the new class of NASA flight directors, Bolinger hesitated. Because she loved where she was. And because she remembered what happened the last time she applied.

In 2015, Bolinger thought she was ready to make the leap. She felt her experience as a flight controller and instructor in the Extravehicular Activities (EVA) group, essentially training astronauts for spacewalks, had sharpened the leadership and decision-making skills, among other things, required to become a flight director.

But she wasn’t selected. And she was “devastated.”

“I felt like, ‘I’m great. I’ve got really good things to bring to the office. I’ve got a good head on my shoulders. I’m ready for this challenge.’ When they said, ‘Thanks, but no thanks,’ I was depressed,” Bolinger says.

Since then, she’d moved from working as the lead spacewalk flight controller to running the NBL, a job she described as a



(Photo credit: NASA)

great change of pace and a more relaxed work lifestyle that made her “really, really happy.” So why would she leave that? For a more stressful situation with longer hours? Especially when that meant revisiting the disappointment from the last time?

Simple, really: Because though Bolinger’s initial childhood aspirations may have changed — shifting from becoming an astronaut to training them to operating the lab that offers training — she’d never really given up on the ultimate goal at NASA she identified as a 19-year-old.

Then, during one of her co-op rotations at NASA while a Purdue student, Bolinger heard Gene Kranz speak. Kranz was “*the guy*,” one of NASA’s first flight directors who led the Apollo 13 mission. And she knew perhaps the most rewarding piece of being involved in EVAs was being on the console, having to make real-time decisions and directing astronauts who were outside their spacecraft.

So it was time to try again.

“When I really took stock of, ‘What do I want to do? Where do I think I can make the biggest contributions to NASA overall?’ It’s definitely the flight director office,” she says. “While we’re doing great things at the NBL, I think I can make a bigger difference in the flight director office. So that’s what kind of pushed me over the edge.”

So she hastily updated her résumé — she’d waited to decide until only three days before the application deadline — and then went through what she called a nerve-racking interview process before heading on vacation. She didn’t get a phone call while on vacation. But after returning, she was asked into her “boss’s boss’s boss’s” office and told the news: She’d been selected as one of six members in the latest class who will lead mission control at Johnson Space Center in Houston.

“When I finally got the show-up-to-the-big-boss’s-office call, I’m like, ‘Oh my gosh, is this real? Is this actually happening?’”

she says. “I was pretty stoked when I finally got the handshake saying, ‘Welcome to the office.’”

For Bolinger, it’s just another step in a considerable journey at NASA that started when she was just a kid.

In January 1986, Bolinger’s family gathered at her great-grandmother’s home in Ohio, after the death of her great-grandfather. Bolinger, then not even 5, was plopped in front of the TV. The news showed replays of the main event of the day: The space shuttle Challenger’s explosion.

After that, whenever anyone asked Bolinger what she wanted to be when she grew up, she said an astronaut.

She was “obsessed” with NASA. She attended space camps as a sixth-grader and as a senior in high school. By the latter visit, her natural abilities toward engineering had surfaced, as she’d excelled in math and science. She’d also realized by then a tendency to get carsick and a fear of heights probably meant she wouldn’t be an astronaut.

But NASA still was a goal.

When it came to choosing a college, the Ohio native initially looked at schools in her home state. But she realized several operated on a quarter system, so that quickly eliminated them from the list because she knew NASA’s Cooperative Education Program wouldn’t line up with a quarter system.

She says Purdue had the largest presence in the astronaut corps aside from the military at the time, so she checked out the campus.

“I just fell in love,” she says.

The School of Aeronautics and Astronautics offered the ideal opportunity for Bolinger, allowing her to focus on astrodynamics as a discipline but also get off campus to apply what she was learning in courses in a real-world environment



through NASA's co-op program. She did five co-op rotations while at Purdue and learned from each one, realizing which disciplines fit. The first three rotations — flight control, engineering and advance exploration — did not. But the last two? They were with the EVA training group.

"That was the perfect mix," she says. "You had to understand how the entire space station was assembled and built, how every mechanism outside worked, how all the tools worked. So you had to use the engineering side of your brain. But it was a lot of those soft skills, people interaction, because you were teaching the astronauts, too. So, to me, that was the perfect mix of engineering as well as hands-on and interacting with the astronauts."

Bolinger realizes her education played a key role in identifying that passion within NASA.

"The worst thing would be to put all this time and effort into getting a degree and finally you go out and put it to use and then realize you don't like what you're doing. Being able to participate in internships was a great way to really test the degree while you were still earning it," she says. "It was easy for me to go on internships while I was at Purdue."

"And my classes just really helped lay the foundation of being a good engineer and thinking through problems. The baseline of what you need to work at NASA is how do you problem solve?"

MARCOS FLORES

Pablo Flores and Daisy Rodriguez were getting annoyed.

Seemingly every time they handed a new toy to son Marcos, he'd dismantle it, desperate to determine the function of each one. That curiosity was an early indication of a burgeoning engineer. Funny, though: All the space-related toys they bought Marcos as a kid? Those didn't get broken down.

So to foster Marcos's interest in all things space, Pablo and Daisy always made sure to put space shuttle launches on TV for him to watch.

They kept providing those space toys, even LEGOs, which were the ideal solution because they invited assembly ... and disassembly.

They incorporated a special experience into the family's first trip to the Continental United States from Puerto Rico. Disney World may have been the ultimate destination, but a stop at NASA's Kennedy Space Center was the real highlight for a then-9-year-old Marcos.

"That was my first time at a NASA center," Flores says, "and that definitely sealed the deal for me for sure."

From that point, NASA was the career destination. But just where he would best fit wasn't quite clear — until he actually started working there.

Flores began full-time at NASA in 2010, and he quickly realized flight director was a position that could deliver significant impact. So when applications for the most recent class were being accepted in March, he submitted a resume. Didn't really expect much, considering he'd heard there was a small chance of being selected when applying for the first time.

But then he got the call in mid-July: He was in.

"It was one of those things that I had to go talk to someone and figure out, 'Hey, is this really happening?' I just couldn't believe it," he says. "It was very shocking for me, and I'm still shocked in a way. Even though I know I've got the experience, and I know I've done a lot of work to get to a place where I can potentially have this position, it was still a surprise. Just being part of a very small group of people who have been leading human spaceflight in the last 60 years, it's an honor.

"Coming from Puerto Rico and having the aspirations I've had, this is something that's going to mean a lot, not just to myself but to everybody around me, my family, my friends, and the people back home. It's been a roller coaster of emotions, not just because I got selected, but because of the meaning of the selection for me and the people around me.

"It's very humbling."

COLLEGE OF ENGINEERING SELECTS DISTINGUISHED ENGINEERING ALUMNI

Two AAE graduates were honored as Distinguished Engineering Alumni, an honor 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.

Thomas Beutner (BSAAE '87) and Mike Moses (MSAAE '95) were honored at an awards dinner in February.

Beutner was selected for major impacts in Air Force and Naval Research, specifically in advanced technology demonstrations and engineering simulation development that has improved performance, affordability and reliability of aircraft and weapons systems. He joined the Defense Advanced Research Projects Agency (DARPA) as the deputy director of the Tactical Technology Office in January.

"Purdue taught me how to think about problems and how to decompose them," Beutner says. "Through many different projects and research efforts, those fundamentals have been a bedrock that anchors all other knowledge."

Beutner's early research included new diagnostic techniques for wind tunnel testing that allowed detailed velocimetry measurements of vortex burst phenomena. Now as a manager, he has led efforts to explore oblique wing designs, use flow control for alleviation of aero-optic distortions, demonstrate autonomous formation flight with transport aircraft, develop railgun technologies, conduct sea-based demonstrations of high energy lasers and demonstrate novel concepts for sea-based aviation.

"I don't think it's possible to plan for a career, but it is possible to prepare for one," he says. "A good education is the best preparation. There is a great deal of uncertainty and a bit of randomness in the opportunities that present themselves. But some of the ideas I became interested in at Purdue later became career opportunities. Getting the fundamentals right and valuing the knowledge you gain are essential in preparing for a career."

Moses was honored for monumental efforts in aiding safe and successful space shuttle missions, and for helping move human spaceflight into the era of tourism and commercial services for research and educational experiments.

As president of Virgin Galactic, Moses plays a major role in the advent of civilian space flight by leading his team in all aspects of the commercial human spaceflight program, including vehicle processing, flight planning, astronaut training, and flight-crew operations. He joined the company in 2011 as vice president of operations. Prior to Virgin Galactic, Moses spent 16 years working at NASA.

"I use the words 'fun' and 'cool' a whole lot in this job," Moses says in a YouTube video published by Virgin Galactic. "One of the best things I did, I think, in my old job was to put those folks into space to accomplish big things, and I will always carry that on my resume. But I think it will be replaced by the chance to be part of the team that gets to fly more people into space than ever before."

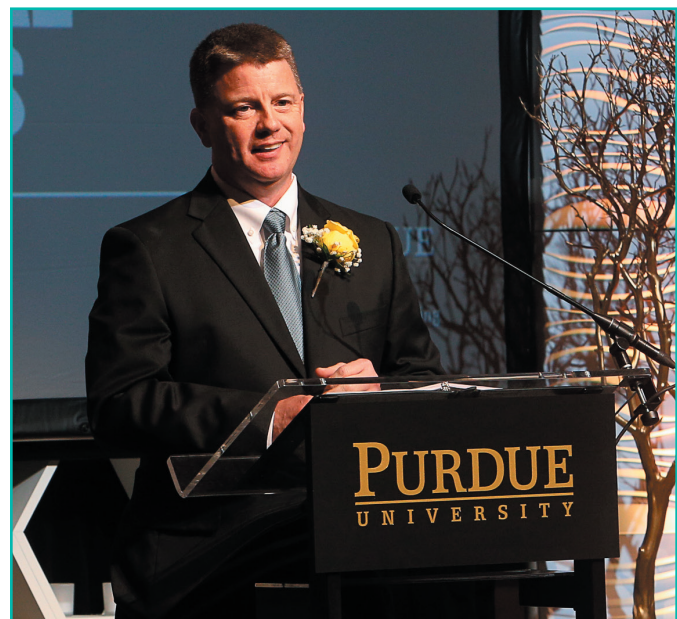


Thomas Beutner

At NASA, Moses oversaw 12 space shuttle missions from launch through landing as the shuttle program's launch integration manager. He is a two-time recipient of the NASA Outstanding Leadership Medal, one of the space agency's most prestigious medals.

Moses started at the agency as a flight controller in 1995, after receiving his master's from Purdue.

"Purdue taught me how to solve problems that didn't have answers in the back of the book," Moses says. "This critical thinking, and being able to decide what exactly needed to be answered first, has really helped me in my career."



Mike Moses



From left: Rafael de Jesús, James Gregory, Richard Raiford, John Murphy, and Tanya Skeen. Beth Moses not pictured.

CLASS OF 2018 OUTSTANDING AEROSPACE ENGINEERS

AAE honored six graduates in the 2018 class of Outstanding Aerospace Engineers.

James W. Gregory, Rafael O. de Jesús, Beth Moses, John R. Murphy, Richard R. Raiford, and Tanya M. Skeen joined the select group.

The designation “Outstanding Aerospace Engineer” recognizes the professional contributions of graduates from the School of Aeronautics and Astronautics and thanks them for the recognition their success brings to Purdue and AAE. The banquet was in April.

Recipients must have demonstrated excellence in industry, academia, governmental service, or other endeavors that reflect the value of an aerospace engineering degree. The 195 OAEs represent about 2 percent of the more than 8,800 alumni of AAE.

James Gregory
Professor, Dept. of
Mechanical and Aerospace
Engineering
Director, Aerospace Research
Center
Ohio State University
MSAAE 2002, PhDAAE 2005

Rafael O. de Jesús
Group Vice President
Global Account Executive
ABB
BSAAE 1994

Beth Moses
Chief Astronaut Instructor
and Interiors Program
Manager
Virgin Galactic
BSAAE 1992, MSAAE 1994

John Murphy
Vice President
Customer Support for
Europe
Boeing Commercial Airplanes
BSAAE 1989

Richard Raiford
Director
Global Strategy and
Relations
Global Logistics and
Modernization Division
Northrop Grumman
Technology Services
BSAAE 1980

Tanya M. Skeen
Deputy Director of Test and
Evaluation
Headquarters of the U.S. Air
Force
BSAAE 1990

GERSTENMAIER ELECTED TO NAE

William Gerstenmaier, NASA's associate administrator for human exploration and operations, was elected a member of the National Academy of Engineering (NAE).

Gerstenmaier (BSAAE '77) was recognized for his distinguished technical contributions in human spaceflight and for his leadership of national and international human spaceflight programs.

Gerstenmaier serves on the College of Engineering's Steering Advisory Council.



William Gerstenmaier

AAE ALUMNUS EARNS GUGGENHEIM MEDAL FROM AIAA

Paul Bevilaqua (MSAE '68, PhDAE '73) received the Daniel Guggenheim Medal from the American Institute of Aeronautics and Astronautics (AIAA) for his notable achievements in the advancement of aeronautics.

Bevilaqua, who retired in 2011 as manager of the Advanced Development Programs at Lockheed Martin Corporation, won "for the conception and demonstration of the multi-cycle propulsion system and other technologies enabling the production of the F-35 supersonic V/STOL Strike Fighters."

The AIAA is the world's largest aerospace technical society.

Bevilaqua is an AIAA Fellow and a member of the National Academy of Engineering. He has received numerous Purdue awards, as well, including the Distinguished Engineering Alumnus Award from the College of Engineering and the Outstanding Engineering Award from AAE. He also served on AAE's Industrial Advisory Council.



Paul Bevilaqua

AAE GRAD RECEIVES COLLEGE OF ENGINEERING YOUNG ALUMNUS AWARD

David Helderma (BSAAE '06, MSAAE '09) received the Purdue College of Engineering's 2017 Young Alumnus Award.

The Alumni Board selected Helderma for the award based on his achievements and career growth while working for Blue Origin, where he serves as a manager for test facility engineering.

During his time in AAE, Helderma's areas of study included systems engineering and rocket propulsion. He was also active at Zucrow Labs and with Purdue Solar Racing. Helderma credits the AAE 53500 Design, Build, Test course, taught by AAE Professor Bill Anderson, as the class that "set off my whole career." That course allowed him to work at Zucrow, a facility he says helped him get the job at Blue Origin.

"I really knew nothing about rocket engine testing other than course work," Helderma says, "so for almost three years between undergrad and grad school, I worked at Zucrow and learned everything I could. If it had to be done, I had to do it. So that was just an amazing opportunity. Hands down, the best experience, the best three years of hands-on learning that I've had, ever. A perfect segue into my career at Blue Origin. It really helped me be successful, that dedicated three years of hard work."

The Young Alumnus Award is presented to a Purdue graduate from the College of Engineering, who must be under 35 and demonstrate a rapid advancement in their chosen field.



David Helderma

IN MEMORIAM

1940s

Pablo Andrade (BSAE '46)
 George Buecheler (BSAE '49)
 A. David Boyum (BSAE '48)
 Oliver Brown (BSAE '48)
 James Brown Jr. (BSAE '49)
 Everett Bosworth (BSAE '48)
 G. Donald Canning (BSAE '48)
 Robert Donovan (BSAE '49)
 John Grayson (BSAE '46)
 John Haher (BSAE '48)
 Dale Jenkins (BSAE '46)
 Elwood Jerome (BSAE '48)
 Forrest Lewis Jr. (BSAE '49)
 Eugene Merkel (BSAE '47)
 Donald Roberts (BSAE '48)
 Robert Rupkey (BSAE '49)
 Bruce Shewmaker (BSAE '48)
 Ernest Stoops (BSAE '49)
 Clarence Steen (BSAE '48)
 Richard Thomas Jr. (BSAE '47)

1950s

Jacqueline Bassett (BSAE '50)
 Kemit Baumgardner (BSAE '51)
 Frank Beaven Jr. (BSAE '55)
 Joseph Bloom (BSAE '59)
 Stanley Boehmer (BSAE '54)
 Walter Brauer (BSAE '55)
 Dr. David Byrne (MSAE '59)
 Benjamin Chun (BSAE '56)
 Richard Dudley (BSAE '55)
 Robert Duhnke Jr. (BSAE '57)
 T. Richard Eiler Jr. (BSAE '52)
 Dennis Elliott (BSAE '51)
 John Georgas (BSAE '50)
 Carroll Gibson Jr. (BSAE '50)
 G. Donald Grassan (BSAE '55)
 John Gyorgyi (BSAE '53)
 William Hayden (BSAE '56)
 Wayne Hawk (BSAE '51)
 Dale Hesterman (BSAE '57)
 Edward Higgins (BSAE '55)
 William Hill Jr. (BSAE '58)
 Tracey Homburg (BSAE '59)
 Clarence Irion Jr. (BSAE '55)
 Charles Johnson Jr. (BSAE '53)
 Dr. C. Paul Kentzer (PHDAE '58, MSAE '54)
 F. Stevens Kirkham (BSAE '59)
 Robert Larsh (BSAE '54)
 William Leach (BSAE '57)
 James Long (BSAE '59)
 Frank Matthews (MSAE '57)
 Col. William Moses Jr. (BSAE '52)
 Daniel O'Brien (BSAE '55)
 Donald Pelton (BSAE '59)

James Plemel (BSAE '51)
 Arthur Richter (BSAE '51)
 Ray Rodman (BSAE '55)
 Edwin Silverman (BSAE '59)
 Robert Stroud (BSAE '57)
 James Tillotson Jr. (BSAE '55)
 James Toomey (MSAE '50, BSAE '48)
 Ronald Van Putte (BSAE '57)
 John Vinson (BSAE '57)
 Robert Wheasler (MSAE '54, BSAE '53)
 Arthur Wiggins (BSAE '53)
 Dr. Ralph Williams (BSAE '58)
 Brian Wilson (BSAE '59)
 Bernard Wontorek (BSAE '59)

1960s

Ronald Bradley (MSAE '68)
 Joe Cork (MSAE '61, BSAE '60)
 Dr. Duane Davis (PHDAE '67, BSAE '55)
 Frank Deis Jr. (BSAE '64)
 Stanley Dominiak Jr. (MSAE '67)
 Gerald Friedman (BSAE '61)
 Dr. Donald Gray (MSAE '69)
 Dr. Ronald Kelly (BSAE '64)
 Dr. Margaret Lewin (BSAE '63)
 Alan Miller (MSAE '68)
 A. Frederick Niemann Jr. (BSAE '61)
 David Ransburg (BSAE '61)
 Dr. Richard Rivir (BSAE '60)
 Franklin Roberts (BSAE '62)
 Angelo Stambolos (BSAE '69)
 Paul Ullrey (BSAE '60)

1970s

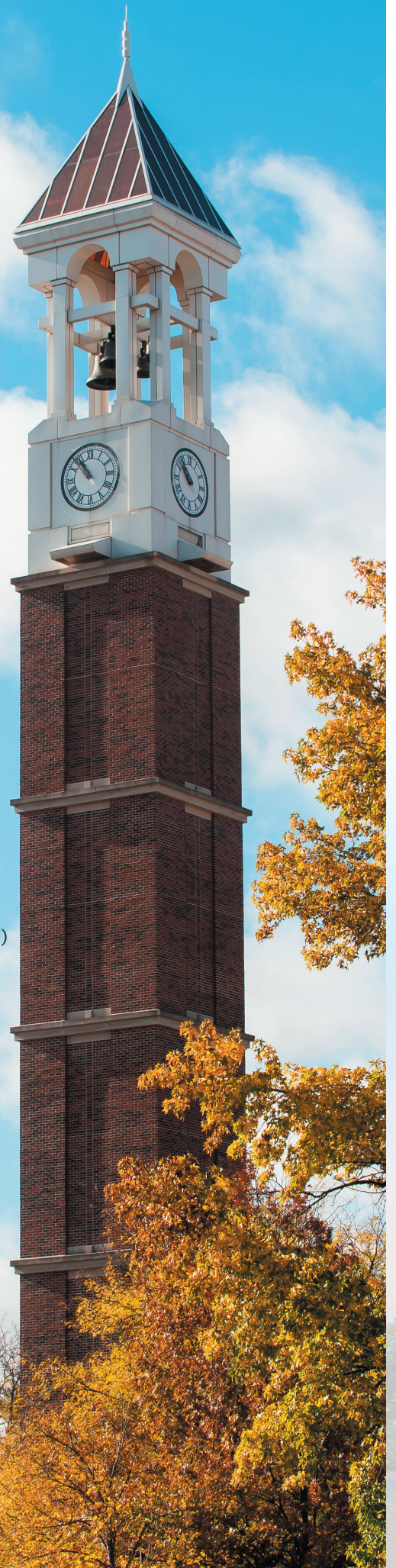
C. Larry Abernathy (MSAAE '76, BSAAE '75)
 Dr. Wen-Sheng Chan (PHDAAE '79)
 John Cors (BSAE '71)
 Ronald Gilsinger (BSAE '70)
 Andrew Hinsdale (MSAAE '76, BSAAE '75)
 Dr. John Kelley (PHDAAE '75, MSAAE '73)
 Clifton Larison (MSAAE '76)
 Vlado Lench (BSAAE '75)
 Christopher Rodgers (BSAAE '73)
 Carl Soderland (BSAAE '77)
 Frank Vondersaar (BSAE '72)

1980s

Dr. Li Ko Chang (PHDAAE '80)
 Mark Flora (BSAAE '84)
 Brent Marriott (BSAAE '81)
 Brian Polasek (BSAAE '85)
 Capt. Pamela Wolosz (BSAAE '86)

1990s

Nolan Bagadiong (BSAAE '90)



WELCOME



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NEW STAFF MEMBERS

AAE started the 2018-19 academic year with five new staff members.



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CHELL NYQUIST

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PURDUE SPACE DAY

A record-high number of participants attended the 22nd annual Purdue Space Day that featured former astronaut Mark Polansky (BSAAE/MsAAE '78), who flew three NASA shuttle missions.

Purdue student volunteers guided 700-plus children from third through eighth grades in hands-on STEM activities (pictured) with a space theme.

“One of the things that surprises me every Space Day is how excited and smart the kids are,” says Sam Evani, an AAE senior who was the director of activities for the event that included more than 300 Purdue student volunteers. “A few participants asked me some questions about things I haven’t even thought about in the realm of space exploration. It’s good to know the future of STEM is in good hands.”

Children experienced what life is like on the International Space Station, built and launched satellites, explored the concepts behind rockets, and created an air filter for the crippled Apollo 13 spacecraft. Polansky spoke to the children about his experience in space and how Purdue Space Day provides a unique opportunity to understand what life is like for an astronaut.

With support from AAE, the Indiana Space Grant Consortium, as well as corporate sponsors Boeing and Raytheon, Purdue Space Day seeks to inspire the next generation of space explorers through STEM outreach in the local community.

“My favorite part of Space Day was seeing all the kids take their group photos alongside former astronaut Mark Polansky and the Neil Armstrong statue,” Evani says. “It’s a perfect moment where the astronauts of the past and present are joined by the pioneers of the future.”

(Photo credit: Purdue Space Day)





“My favorite part of Space Day was seeing all the kids take their group photos alongside former astronaut Mark Polansky and the Neil Armstrong statue.” - Sam Evani



PURDUE

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EVER GRATEFUL

Our community of Purdue alumni and friends makes many of the stories you have read in the Aerogram possible. As we celebrate our 150th anniversary as a premier land-grant university, we want to acknowledge and celebrate the role that you play in building a community of strong and loyal philanthropic support!

We are inspired by the generosity of two unique gifts this year. The Women in Aerospace Scholarship Endowment is the first scholarship created that will specifically support women seeking a Purdue Aeronautics and Astronautics degree. The second is an endowment created to provide lab equipment and expenses for the Maurice J. Zucrow Laboratories. (For more details, please see inside cover story.) The donors who created these endowments would be honored to have your support.

If you would like to give to the School of Aeronautics and Astronautics, please visit: purdue.edu/AAE/giving or contact:



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THANK YOU CLASS OF 2017

ALUMNI CLASS WITH THE MOST DONOR PARTICIPATION ON PURDUE DAY OF GIVING 2018