Naomi E. Leonard, Chair

MECHANICAL AND AEROSPACE ENGINEERING

CONTENTS

Letter from the Chair

By Naomi Ehrich Leonard, Edwin S. Wilsey Professor and Chair of MAE

We are looking forward to an exciting year ahead in the Department of Mechanical and Aerospace Engineering.

This summer, I replaced Howard Stone as chair of the department. Howard has served three consecutive three year terms as chair, and we are grateful to him for his long service and the work he has done to grow and improve so much of what we do here.

I look forward to continuing Howard's work to further innovate and advance the department's mission of excellence in research, teaching and education. As an undergraduate alumna of the department and a member of the faculty since 1994, I am excited to take on this leadership role.

Serving alongside me as associate chair is Michael Mueller, professor of mechanical and aerospace engineering. Michael has been director of graduate studies since 2020 and a member of the faculty since 2012. Andrej Košmrlj, associate professor of mechanical and aerospace engineering, has taken on the role of director of graduate studies.

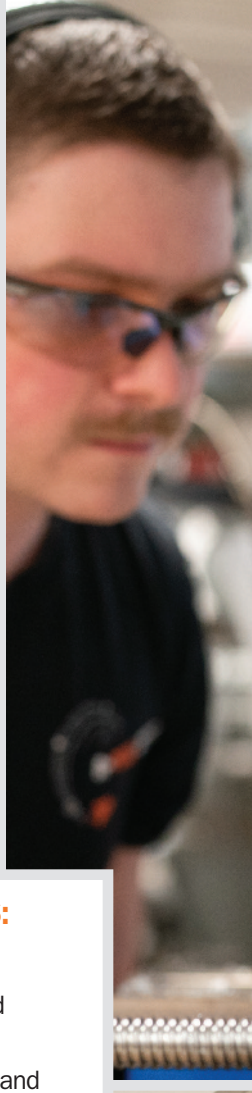
The 2022-2023 academic year brought many new students into MAE, including 28 graduate students and 75 undergraduates. The Class of 2026 will be one of our largest undergraduate classes ever. We look forward to welcoming the undergraduate Class of 2027 and incoming graduate students in September.

> "I look forward to continuing Howard's work to further innovate and advance the department's mission of excellence in research, teaching and education."

This past June we celebrated the graduating Class of 2023, several of whom won departmental awards and awards from the School of Engineering and Applied Sciences. We look forward to seeing all they accomplish in the coming years!

On our faculty, Aditya Sood joined this year as an assistant professor, after completing a doctorate and postdoctoral work at Stanford. Luc Deike was recently awarded tenure. Finally, Allison Ferris will join the faculty in June 2024 as an assistant professor, and we are looking forward to welcoming her! ♦

About MAE



The Department of Mechanical and Aerospace Engineering (MAE) is one of six departments within Princeton University's School of Engineering and Applied Science. As part of a world-class research university that emphasizes the liberal arts, MAE strives to innovate through cutting-edge research, as well as educate the next generation of leaders in engineering. The department is committed to Princeton's informal motto — in the nation's service and the service of humanity — addressing the world's challenges in areas like energy, sustainability, robotics, astronautics, transportation, biotechnology, and more.

Our distinctive undergraduate program supports two ABET-accredited degree programs, aerospace engineering and mechanical engineering. Students can choose their preferred track of study depending on their interests or even do both.

Our graduate program emphasizes the highest quality in graduate education and mentorship. Ph.D. candidates have access to a wealth of resources, including funding, advanced technology and facilities, and connections to leading researchers across the School of Engineering and Applied Science, Princeton University, and beyond. ♦

RESEARCH AREAS:

- Applied Physics
- Biomechanics and Biomaterials
- Control, Robotics and Dynamical Systems
- Fluid Mechanics
- Materials Science
- Propulsion and Energy Science

INTERDISCIPLINARY PROGRAMS AND CENTERS ACROSS CAMPUS:

- Andlinger Center for Energy and the Environment
- Princeton Materials Institute
- High Meadows Environmental Institute
- Center for Statistics and Machine Learning
- Omenn-Darling Bioengineering Institute
- Princeton Plasma Physics Laboratory
- Program in Applied & Computational Mathematics
- Program in Biophysics


KURT


First Aid

YEAR IN REVIEW

Here are some highlights of the many stories about MAE student, faculty, and staff achievements from the past academic year. For more details, please visit https://mae.princeton.edu/about-mae/news.

September 2022

NASA awards Hatzell a grant to improve batteries for space missions

NASA awarded an early career grant to Kelsey Hatzell to help develop new rechargeable batteries for solar powered orbital missions and missions to the surface of Mars.

Jesse Jenkins discusses decarbonization on the Ezra Klein Show

Jesse Jenkins, assistant professor of mechanical and aerospace engineering and the Andlinger Center for Energy and the Environment, was interviewed on the Ezra Klein Show.

September 2022

Nagpal and Wissa featured in Nature

A Nature article on bioinspired robots features research by Radhika Nagpal and Aimy Wissa, experts in robotics and bioinspired design.


Photo by David Kelly Crow

Radhika Nagpal


Aimy Wissa

Hatzell and Majumdar win early career award from the Office of Naval Research

Kelsey Hatzell and Anirudha Majumdar, both assistant professors, have received Young Investigator Program awards from the Office of Naval Research (ONR).

October 2022

Alec Farid and Jiarong Wu win SEAS Award for Excellence

Two doctoral students, Alec Farid and Jiarong Wu, have won awards for excellence from the School of Engineering and Applied Science.

Egemen Kolemen featured in Popular Mechanics

Egemen Kolemen, associate professor of mechanical and aerospace engineering, has been featured in an article in Popular

Mechanics on plasma spurts inside tokamaks — the doughnut-shaped devices that can contain nuclear fusion reactions.

Hultmark wins experimental physics award

The Gordon and Betty Moore Foundation has awarded Marcus Hultmark, professor of mechanical and aerospace engineering, an Experimental Physics Investigators Initiative award. The award will support Hultmark's research using a unique new facility that will be housed on Princeton's Forrestal Campus.

Photo by David Kelly Crow

NuEnergy, spinout of Ju and Koel labs, wins 2022 Tiger Entrepreneurship Award

Princeton Entrepreneurship Council has awarded a 2022 Tiger Entrepreneur Award to Princeton NuEnergy, which is developing green technologies to recycle and upcycle cathode materials of lithium ion batteries for electric vehicles and energy storage.

December 2022

Thomas Olson receives award from the Society of American Military Engineers

Thomas Olson, a senior studying mechanical and aerospace engineering, has received the J. Rich Steers Award from the New York City Post of the Society of American Military Engineers.

February 2023

Space industry fellowship awarded to three MAE students

Mechanical and aerospace engineering students *(left to right)* Faraz Awan, Candace Do and Sydney Hsu have been selected as 2023 Matthew Isakowitz Fellows. The Isakowitz Program is a highly selective national fellowship for aerospace engineering students with an interest in commercial spaceflight.

January 2023

Michael E. Mueller elected a Fellow of the American Society of Mechanical Engineers

Michael E. Mueller, an expert in computational modeling of multi-physics turbulent reacting flows, has been elected a Fellow of the American Society of Mechanical Engineers.

Photo by David Kelly Crow

Alexander J. Smits named an Officer of the Order of Australia

Alexander J. Smits, emeritus professor, has been named an Officer of the Order of Australia for his distinguished service to aerospace engineering and higher education. This is one of the highest civilian honors given by the Australian government for outstanding achievement.

February 2023

Anirudha Majumdar awarded 2023 Sloan Fellowship

The Sloan Foundation has announced that Anirudha Majumdar, an expert in robotics, has been awarded a 2023 Sloan Research Fellowship. The fellowship recognizes creative early-career researchers in the sciences and social sciences.

Photo by David Kelly Crow



March 2023

Teaching awards recognize MAE graduate students and faculty

The School of Engineering and Applied Science Excellent in Teaching Awards, overseen by the graduate and undergraduate engineering councils. MAE graduate students Niki Abbasi, Lena Sabidussi and Katie Wu were recognized for their excellence as teaching assistants. Professor Clarence Rowley was honored for his teaching in MAE 541: Applied Dynamical Systems.

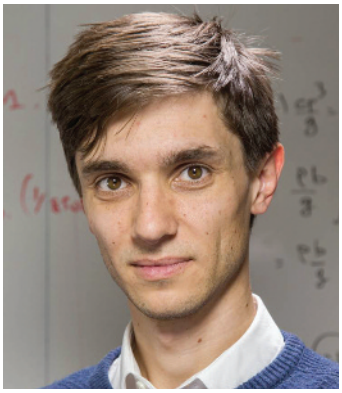
May 2023

Luc Deike awarded grant from NASA

Luc Deike, an expert in fluid dynamics, has been awarded a grant from the earth sciences division of NASA for work on the remote sensing of ocean currents and winds.

Luc Deike honored for work with graduate students

Luc Deike, assistant professor of mechanical and aerospace engineering and the High Meadows Institute, has been named one of four recipients of the Graduate Mentoring Awards given by Princeton University.



Daniel Cohen receives funding for research on electrical inputs and cellular behaviors

An MAE project co-led by Daniel Cohen, assistant professor, is one of three projects funded by the Eric and Wendy Schmidt Transformative Technology Fund.

Photo by Michael Franken

Hatzell wins SEAS junior faculty award

Kelsey Hatzell, an expert in batteries and energy storage, has won the Alfred Rheinstein Faculty Award from Princeton's School of Engineering and Applied Science, one of the school's annual honors for junior faculty.

Francisco Sáenz awarded Maeder Fellowship

The Maeder Graduate Fellowship in Energy and the Environment has been awarded to Francisco Sáenz, a graduate student in mechanical and aerospace engineering, for his work to study liquid metals and their applications to nuclear fusion.

Photo by Bumper DeJesus

May 2023

MAE graduates honored at Class Day

Princeton MAE honored its 46 graduating seniors in a Class Day ceremony on Monday, May 29, conferring honors and awards for outstanding academic achievement.

June 2023

SEAS innovation funds support research of four MAE faculty

The School of Engineering and Applied Science awarded more than $2.4 million in 2023 annual research grants for 15 projects. Four of these awards support research by faculty members in mechanical and aerospace engineering, including Christine Allen-Blanchette, Anirudha Majumdar, Michael Mueller, and Aimy Wissa.

August 2023

Luc Deike wins award from the American Physical Society

Luc Deike, an expert in fluid dynamics, has received the François Frenkiel Award from the American Physical Society's Division of Fluid Dynamics.

Julia Mikhailova wins experimental physics award

The Gordon and Betty Moore Foundation has awarded Julia Mikhailova an Experimental Physics Investigators Initiative award. The grant will support her work on laser-based sensing technologies.

* * *

For details on these and other stories, please visit https://mae.princeton.edu/about-mae/news.

July 2023

Naomi Leonard, a leader in control and dynamical systems, named chair of MAE

Naomi Ehrich Leonard, an expert in control and dynamical systems, has been named the chair of Princeton's Department of Mechanical and Aerospace Engineering, effective July 1.

Photo by David Kelly Crow

UNDERGRADUATE PROFILE

Gabby Graves-Wake: From the Marines to Princeton

By Julia Schwarz

Gabby Graves-Wake dreams of owning a Triumph Daytona 675 in black and white with red framing. The draw of the Daytona is not necessarily its mechanical properties, but its overall feel. "It's a beautiful bike," she said. While she isn't currently able to ride, she's working on a way to change that.

In the spring of 2022, she took a freshman seminar with Michael Littman, professor of mechanical and aerospace engineering, on the art and science of motorcycle design. In the class, students refurbished an old rusted 1954 Triumph Terrier, disassembling, restoring and reassembling it from top to bottom.

Learning about motorcycle design gave her an idea for how to retrofit a bike to her needs. Currently, the main impediment is that you can't ride without also being able to stop, and stopping requires a degree of leg strength that she can't guarantee moment to moment.

Her love of motorcycles started at age 13, when she first learned to ride. She didn't even bother getting a regular driver's license as a teenager, since her bike took her everywhere she wanted to go. At least, everywhere terrestrial. When she enlisted in the Marines at 17 years old, she had visions of the Naval Academy and NASA. She wanted to fly. She wanted to go to space. Then in 2014, while stopped at a red light on her street bike outside of Camp Lejeune, a minivan hit her from behind. The driver had been texting.

The accident left her with lasting injuries. While she can walk, most of the time she finds it safer and easier to use a manual wheelchair. She has also turned her lifelong competitive streak into a career in international para sports, including her current role as goalie for the Philadelphia Hammerheads and the USA women's sled hockey team.

"She's a leader," said Athan Blaine, coach of the Hammerheads. "She's always looking to improve her game for the good of the team."

A move to Princeton

Graves-Wake had been working at United Airlines and taking community college classes when she found out she was accepted to Princeton. She arrived in the fall of 2021, one of only 16 transfer students to matriculate that year. Initially, acclimating to Princeton posed challenges. For one, there were physical obstacles. She often felt as though she were expected to adapt to the quirks of campus, rather than the other way around.

McCosh Hall, for example, has one main accessible entrance that leads to an elevator. Getting to the other side of the building requires traveling through lecture halls, which meant that Graves-Wake sometimes found herself interrupting ongoing lectures while trying to get to class. Entire classes would need to pause and wait while she asked students to move their bags so she could get down narrow aisles. Moments like these made her feel like "an intruder and a burden," she said.

She also felt that she had no team at Princeton, a stark contrast to serving in the Marines, where the mantra was, "We get ahead together, and we leave no one behind." On top of that, she was a woman

in the Corps — one of the fewer and the prouder — which only strengthened her belief in teamwork. She feels strongly that no mission can be completed without collaboration, and a Princeton degree is no different.

It wasn't until Graves-Wake officially joined the MAE department, in the spring of her freshman year, that she felt as though she had found her team. And finding that team helped to ease some of the physical barriers. Faculty and staff in the department quickly understood the challenges she was facing, she said, and tried to anticipate what she needed. Group projects and collaboration are common in many MAE classes.

Case in point: Littman's motorcycle class, where the work was done in teams. Littman helped to make sure the route to the elevator was unblocked and arranged for the facilities department to grind down the sidewalk between E-Quad and the Friend Center to make it easier for her to get to class.

"Gabby is tenacious," said Littman. "Her determination to learn and participate despite obstacles is exemplary."

Making the tools work for her

Graves-Wake also found a team in the machine shop, where Glenn Northey, lecturer and machine shop manager, and Al Galliard, machine shop associate, teach the lab competent of "Engineering Design." This is a required class for all MAE students, and students work in groups to design and manufacture an airplane wing from start to finish using sophisticated engineering tools.

"Gabby is tenacious. Her determination to learn and participate despite obstacles is exemplary."

—Professor Michael Littman

Even before she entered the shop in the spring of 2023, Northey and Galliard started thinking about what Graves-Wake might need. "We met with Gabby and asked her what she wanted," Northey said. They added a hand railing, moved a workbench and built a stationary platform so she had the height to operate a milling machine and lathe. One machine, a variable speed mill, required a retrofit so Graves-Wake could change the drill bits.

She said it gets exhausting always having to solve her way into a problem before she can solve her way out. This time, she didn't have to find the workaround. "They adapted to me," she said.

Mike Barnes, Princeton's Director of Campus Access, said he was "blown away" by the ingenuity and thought Northey and Galliard put into their adaptations. He called it a model for shops across campus.

She is returning to the machine shop in the fall for the next course in the sequence, "Mechanical Design." As part of this course, students learn to weld. But the machine operates through a floor switch, which won't work for anyone using a wheelchair, so they installed a manual control. Shouldn't be any harder for Gabby, Northey said. She already knows how to weld. She learned in the Marines. ♦

GRADUATE PROFILE

Susan Redmond: Exploring the Origins of the Universe Through Engineering

By Julia Schwarz

The sun never sets in the Antarctic summer, which is quite convenient for solar powered science. Susan Redmond, who has spent the last three months helping to launch a solar powered balloon the size of a hockey arena into space, is one of those scientists relying on the endless sunshine of the southernmost continent.

"It's pretty wild," she said.

Redmond, a fifth-year year graduate student in mechanical and aerospace engineering, is part of an interdisciplinary team studying cosmic microwave background radiation, a key to understanding the evolution of the universe. The project, called SPIDER-II, involved sending a balloon 35 kilometers into space with an array of telescopes attached.

She has been at McMurdo Station in Antarctica since October 2022, which has about 600 scientists and support staff working on site during the Antarctic summer. "There's a ton of science happening down here," Redmond said. And despite the endless sunshine and cold, she finds that in some ways it feels similar to where she grew up, in the Canadian province of Newfoundland and Labrador. It's not just the weather that's similar, but also the "small community vibe."

The community is an essential part of keeping up morale in such an isolated place, Redmond said, with researchers and staff organizing trivia nights and hikes, and finding time to decompress at the station bar. There's even an observation window under the ice where you can sometimes see the seals swim by with their pups. (Penguins will arrive later in the season, Redmond said, once the sea ice breaks up.) "A lot of effort goes into keeping people sane down here," she said.

Once launched, the balloon remains airborne for weeks at a time, where it scans approximately 10% of the sky. It's solar powered, which makes the constant Antarctic sunlight helpful. The project is led by the University of Illinois with collaboration from Princeton University and the University of Toronto, along with support from the National Science Foundation and NASA.

Redmond is responsible for thermal design and control on the project as well as the structural subsystems. For thermal design, she models the predicted temperature of component parts during flight and creates controls to ensure they are kept heated and cooled as needed. She has also done a full redesign and rebuild of the structure — an overhaul of the previous flight, SPIDER-I, which launched in 2015 — including overseeing an entire rebuild of the balloon's gondola, which supports the telescopes.

Building balloon-borne telescopes involves "a great deal of physics and engineering expertise," said William C. Jones, professor of physics and one of Redmond's advisers. From proposal to design to launch, these projects take about five to seven years to complete, and grad students are involved in all phases of the project, including building all the specialized hardware. "Susan has done amazing work," Jones said. "Her interest and expertise in control systems and thermal and mechanical

design makes her a perfect fit for the research in our group."

Redmond has been involved in these projects for about seven years, beginning when she was working towards a master of science degree in aerospace engineering at the University of Toronto. As an undergraduate, her interests weren't necessarily space related — she started out studying mechanical engineering at the Memorial University of Newfoundland. "I always knew I wanted to do engineering," she said, "and I thought I wanted to do something along the lines of planes, trains and automobiles."

But an internship at the European Space Agency in the Netherlands piqued her interest in space telescopes. "I got hooked," she said. Unlike working on cars and airplanes, "every telescope is different, and each one has new problems you need to solve, problems that are unique to a particular scientific goal."

> **"Her interest and expertise in control systems and thermal and mechanical design makes her a perfect fit for the research in our group."**
>
> *—Professor William C. Jones*

Photo by Jared May

With SPIDER-II, for example, the detectors must be "really, really cold in order to measure the signal," of cosmic microwave background, down to 300 millikelvin, which is minus 450 degrees Fahrenheit. To achieve this, the detectors — 6 monochromatic telescopes — are slotted into a vacuum vessel that is filled with liquid helium. The vacuum vessel is then mounted to a carbon fiber frame that allows the telescopes to point at the desired patch of sky while in space. These kinds of engineering challenges, Redmond said, provide many avenues for innovation.

Space telescopes also gave her a way to combine her interdisciplinary interests in engineering and astronomy. Her work at Princeton reflects these interests as well, and she is co-advised by Egemen Kolemen and Jeremy Kasdin in mechanical and aerospace engineering and Jones in physics. "I've been very fortunate in graduate school," Redmond said, "to have worked on smaller team projects where everything is very interdisciplinary and you get to be a part of the full project, from start to finish."

After Antarctica, Redmond's next stop is Wānaka, New Zealand, where this spring she will help to build another balloon-borne space telescope, SuperBIT. The University of Toronto is leading that project, with collaboration from Princeton University and support from the NSF and NASA. This project is another cosmology experiment and will focus on studying dark matter, another key to understanding the evolution of the universe. This particular space telescope will provide a very wide field of view, according to Redmond — a field of view that is "about the size of the moon" and about 40 times greater than the Hubble telescope.

Considering the many years of hard work that it takes to design, build, and launch them, balloon-borne telescopes are in flight for only a short time. For Redmond, though, the years of work and the months spent in Antarctica begin to pay off when she sees that first star field or nebula on camera. ♦

NEW FACULTY PROFILE

Aditya Sood Joins MAE Faculty to Research Dynamic Energy Transport in Materials

By Julia Schwarz

Aditya Sood has joined the Department of Mechanical and Aerospace Engineering and the Princeton Materials Institute as an assistant professor, bringing expertise in the dynamic properties of materials.

In many everyday engineering applications, Sood said, materials are not static. "You think about your phones, with transistors switching. You think about your hard drive, which is storing and erasing information. You think about solar cells, where you shine light and get a current out of it. The materials in these applications are constantly evolving."

Fundamental processes in materials can take place extremely quickly. For example, atoms that vibrate trillions of times per second govern the generation and transmission of heat. These ultrafast phenomena are a primary area of interest for Sood and his lab group. In one project, his lab plans to make movies of heat moving through materials and navigating their microstructures, capturing what happens at the nanoscale during thermal transport. Another project plans to take snapshots of the pathways that atoms take when materials are electrically shocked, like in a memory device that is switching between two electronic states, or in a battery electrode that has ions moving into and out of it.

"Beyond visualizing dynamics, we want to understand if we can rationally engineer materials and create any sort of structure that we want, to get the type of thermal, electronic, and ionic conduction properties that we want," he said. The applications of this work are numerous. On the thermal side, his lab is exploring applications in microelectronics and semiconductor chips, which consume ever-increasing amounts of energy and produce a lot of heat.

"It's a really exciting physics problem," he said, "with immense real-world implications."

Sood's research extends across several disciplines, including mechanical engineering, applied physics, materials science and electrical engineering. His interdisciplinary interests are one reason he decided to join Princeton Engineering. Because the school is relatively small, he said, you get many opportunities to interact with colleagues in other departments. "To get to my office in MAE I often walk through electrical and computer engineering or chemical and biological engineering — that isn't something you can do everywhere," he said.

Sood, who is originally from Bangalore, India, became interested in materials science initially through conversations with his father, who is an experimental physicist. He stumbled upon his interest in heat transfer by attending a colloquium while a graduate student in the department of materials science at Stanford. For his postdoc, he changed directions to build new kinds of techniques to take ultrafast snapshots of atoms inside electronic devices at the SLAC National Accelerator Lab.

> **Beyond visualizing dynamics, we want to understand if we can rationally engineer materials and create any sort of structure that we want, to get the type of thermal, electronic, and ionic conduction properties that we want.**
>
> *—Assistant Professor Aditya Sood*

Fundamental curiosity, he said, and a drive to always be exploring and discovering something new, has turned out to be instrumental in his work as a researcher and engineer. Some of his best ideas and collaborations have come from purely chance interactions, something he hopes will continue at Princeton.

Before joining Princeton in January 2023, Sood was a postdoctoral fellow and research scientist at the Stanford Institute for Materials and Energy Sciences. He completed his doctoral work in materials science at Stanford, and a bachelor's degree from the Indian Institute of Technology in Kanpur, India. ♦

RESEARCH SPOTLIGHT

Researchers Cook Up a New Way to Remove Microplastics From Water

By Julia Schwarz

Researchers at Princeton Engineering have found a way to turn your breakfast food into a new material that can cheaply remove salt and microplastics from seawater.

The researchers used egg whites to create an aerogel, a lightweight and porous material that can be used in many types of applications, including water filtration, energy storage, and sound and thermal insulation. Craig Arnold, the Susan Dod Brown Professor of Mechanical and Aerospace Engineering and vice dean for innovation at Princeton, works with his lab to create new materials, including aerogels, for engineering applications.

One day, sitting in a faculty meeting, he had an idea.

"I was sitting there, staring at the bread in my sandwich," said Arnold. "And I thought to myself, this is exactly the kind of structure that we need." So he asked his lab group to make different bread recipes mixed with carbon to see if they could recreate the aerogel structure he was looking for. None of them worked quite right initially, so the team kept eliminating ingredients as they tested, until eventually only egg whites remained.

"We started with a more complex system," Arnold said, "and we just kept reducing, reducing, reducing, until we got down to the core of what it was. It was the proteins in the egg whites that were leading to the structures that we needed."

Egg whites are a complex system of almost pure protein that — when freeze-dried and heated to 900 degrees Celsius in an environment without oxygen — create a structure of interconnected strands of carbon fibers and sheets of graphene. In a paper published Aug. 24 in Materials Today, Arnold and his coauthors showed that the resulting material can remove salt and microplastics from seawater with 98% and 99% efficiency, respectively.

"The egg whites even worked if they were fried on the stove first, or whipped," said Sehmus Ozden, first author on the paper. Ozden is a former postdoctoral research associate at the Princeton Center for Complex Materials and now a scientist at Aramco Research Center. While regular store-bought egg whites were used in initial tests, Ozden said, other similar commercially available proteins produced the same results.

"Eggs are cool because we can all connect to them and they are easy to get, but you want to be careful about competing against the food cycle," said Arnold. Because other proteins also worked, the material can potentially be produced in large quantities relatively cheaply and without impacting the food supply. One next step for the researchers, Ozden noted, is refining the fabrication process so it can be used in water purification on a larger scale.

If this challenge can be solved, the material has significant benefits because it is inexpensive to produce, energy-efficient to use and highly effective. "Activated carbon

is one of the cheapest materials used for water purification. We compared our results with activated carbon, and it's much better," said Ozden. Compared with reverse osmosis, which requires significant energy input and excess water for operation, this filtration process requires only gravity to operate and wastes no water.

While Arnold sees water purity as a "major grand challenge," that is not the only potential application for this material. He is also exploring other uses related to energy storage and insulation.

Photo by Nathan Dumlao

The research included contributions from the departments of chemical and biological engineering and geosciences at Princeton and elsewhere. "It's one thing to make something in the lab," said Arnold, "and it's another thing to understand why and how." Collaborators who helped answer the why and how questions included professors Rodney Priestley and A. James Link from chemical and biological engineering, who helped identify the transformation mechanism of the egg white proteins at the molecular level. Princeton colleagues in geosciences assisted with measurements of water filtration.

Susanna Monti of the Institute for Chemistry of Organometallic Compounds and Valentina Tozzi from Instituto Nanoscienze and NEST-Scuola Normale Superiore created the theoretical simulations that revealed the transformation of egg white proteins into the aerogel.

The article, "Egg protein derived ultralightweight hybrid monolithic aerogel for water purification," was published in the journal Materials Today. Besides Arnold, Monti, Ozden, Priestley, Link and Tozzi, authors include Nikita Dutta, a former graduate student in mechanical and aerospace engineering who is now at the National Renewable Energy Laboratory; Stefania Gill, John Higgins and Nick Caggiano of Princeton University; and Nicola Pugno of the University of Trento and Queen Mary University of London. Support was provided in part by the Princeton Center for Complex Materials and the U.S. National Science Foundation. ♦

> **"It's one thing to make something in the lab," said Arnold, "and it's another thing to understand why and how."**
>
> *—Professor Craig Arnold*

FACULTY

As of August 1, 2023, MAE has 28 faculty members and one part-time lecturer. Faculty have joint appointments with various departments and interdisciplinary centers, including Andlinger Center for Energy and the Environment, the Department of Computer Science, Princeton Materials Institute, and more.

Professor
Craig Arnold
Emily Carter
Edgar Choueiri
Mikko Haataja
Marcus Hultmark
Yiguang Ju
Chung (Ed) Law
Naomi Leonard, *Chair*
Michael Littman, *Undergraduate Representative*
Luigi Martinelli, *Independent Work Advisor*
Michael Mueller, Associate Chair
Radhika Nagpal
Clarence Rowley
Howard Stone

Associate Professor
Luc Deike
Alexander Glaser
Egemen Koleman
Andrej Košmrlj, *Director of Graduate Studies*
Julia Mikhailova
Daniel Nosenchuck

Assistant Professor
Christine Allen-Blanchette
Ryne Beeson
Daniel Cohen
Kelsey Hatzell
Jesse Jenkins
Anirudha Majumdar
Aditya Sood
Aimy Wissa

Lecturer
Glenn Northey

Visiting Professor
Francesco Grasso

Senior Scholar
N. Jeremy Kasdin
Richard Miles
Alexander Smits
Szymon Suckewer

Associated Faculty
Amir Ali Ahmadi, *Operations Research & Financial Engineering*
Elie Bou-Zeid, *Civil & Environmental Engineering*
Pierre-Thomas Brun, *Chemical and Biological Engineering*
Nathaniel Fisch, *Astrophysical Sciences*
Robert Goldston, *Astrophysical Sciences*
Bruce Koel, *Chemical & Biological Engineering*
David McComas, *Astrophysical Sciences*
Glaucio Paulino, *Civil & Environmental Engineering*
Salvatore Torquato, *Chemistry*
Robert Vanderbei, *Operations Research & Financial Engineering*
Claire White, *Civil & Environmental Engineering*

Faculty Honors and Awards

During the 2022-2023 academic year, MAE faculty received the following major awards and honors:

Luc Deike: Graduate Mentoring Award from the McGraw Center for Teaching and Learning and the Graduate School; François Frenkiel Award, American Physical Society

Clarence Rowley: SEAS Excellence in Teaching Award

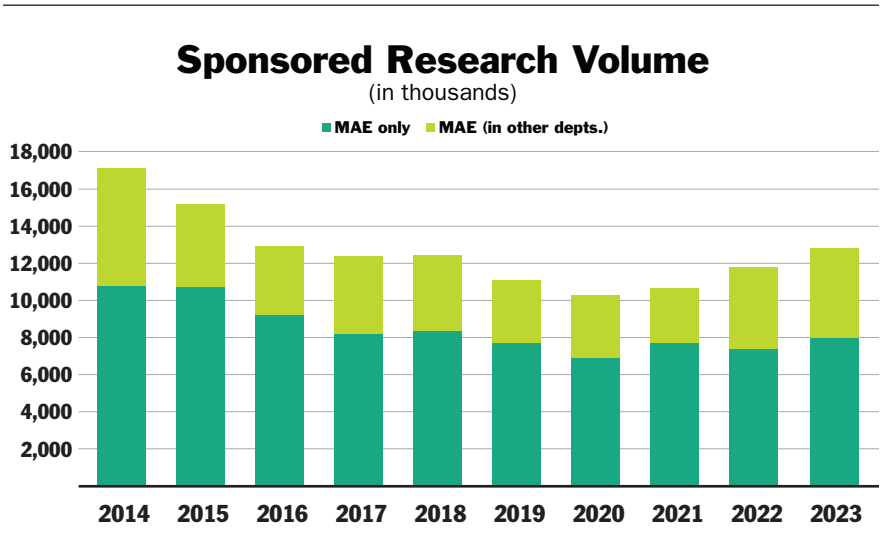
Anirudha Majumdar: Sloan Fellowship; Early Career Award, Office of Naval Research

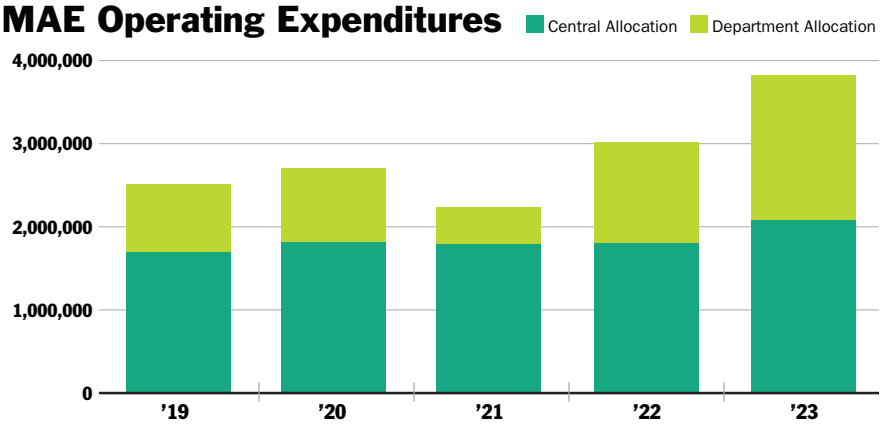
Kelsey Hatzell: SEAS Alfred Rheinstein Faculty Award; Early Career Award, Office of Naval Research

Marcus Hultmark: Betty and Gordon Moore Experimental Physics Award (2022)

Julia Mikhailova: Betty and Gordon Moore Experimental Physics Award (2023)

Michael Muller: Elected a Fellow of the American Society of Mechanical Engineers





UNDERGRADUATE

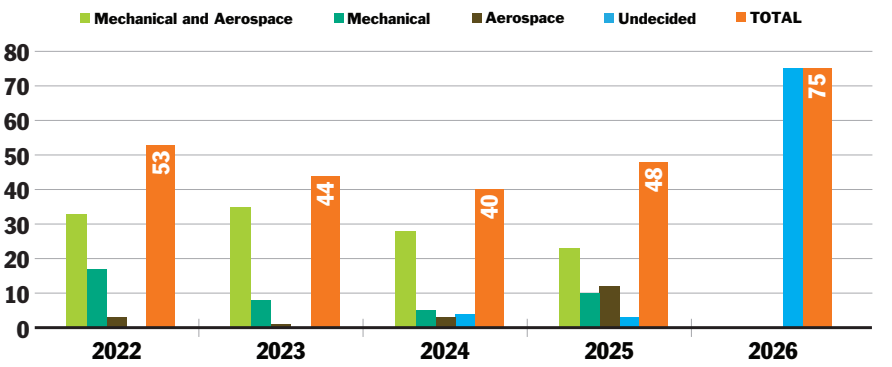
The undergraduate program supports two ABET-accredited degree programs, aerospace engineering and mechanical engineering. Students can choose their preferred track of study depending on their interests. Most choose to study a combined program of mechanical and aerospace engineering.

Enrollment Trends

Current undergraduate enrollment is strong. After slightly falling enrollment numbers for a couple years, the Class of 2026 poised to be one of the largest ever, with 75 students. Most students continue to take the Mechanical & Aerospace track for their course of study, but there are still a handful each year who focus on either Mechanical or Aerospace.

Here is the breakdown of recent class sizes. These numbers have been updated as of June 2023.

Recent Class Sizes



Awards for the Class of 2023

Department awards recognizing academic and scholarly achievement, service, and leadership were conferred on MAE undergraduates on Class Day, May 23, 2023.

The Morgan W. McKinzie '93 Senior Thesis Prize
Sau-Hai Lam*58 Prize in Mechanical and Aerospace Engineering
Abhinav Agarwal

The Morgan W. McKinzie '93 Senior Thesis Prize
Kristen Ahner

The John Marshall II Memorial (first place)
Sophie Amiton

The John Marshall II Memorial (second place)
Jeb Carter

The John Marshall II Memorial (third place)
Gavin Cotter

The Mechanical and Aerospace Engineering Undergraduate Academic Support Award
Rodrigo Fernandez

The Donald Janssen Dike Awards for Excellence in Undergraduate Research
Kyle Ikuma

Sigma Xi Book Award
Kathryn-Alexa Kennedy

The Enoch J. Durbin Prize for Engineering Innovation
Eric James Love

The George Bienkowski Memorial Award
Ken Nakamura

The Enoch J. Durbin Prize for Engineering Innovation
J. Rich Steers Award
Thomas Olson

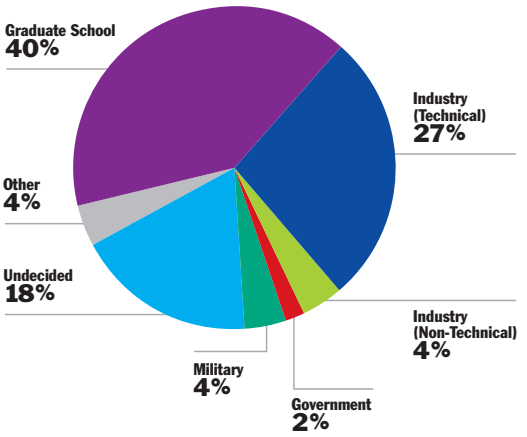
The Donald Janssen Dike Awards for Excellence in Undergraduate Research
Shannen Prindle

The George Bienkowski Memorial Award
Lauren Rawson

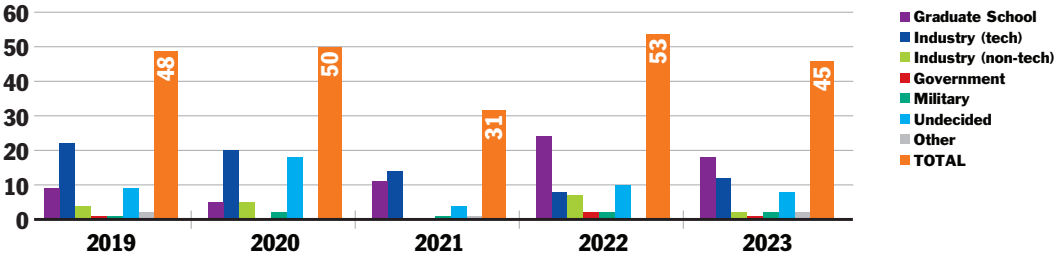
The Enoch J. Durbin Prize for Engineering Innovation
Bradley Rindos

The George Bienkowski Memorial Award
Richard Zhu

Career Plans for the Class of 2023



Enrollment by Concentration by Class Year



GRADUATE

The graduate program emphasizes the highest quality in graduate education and mentorship. Doctoral and master's degree students have access to a wealth of resources, including funding, advanced technology and facilities, and connections to leading researchers across the university.

Enrollment Trends, Master's Degree Program

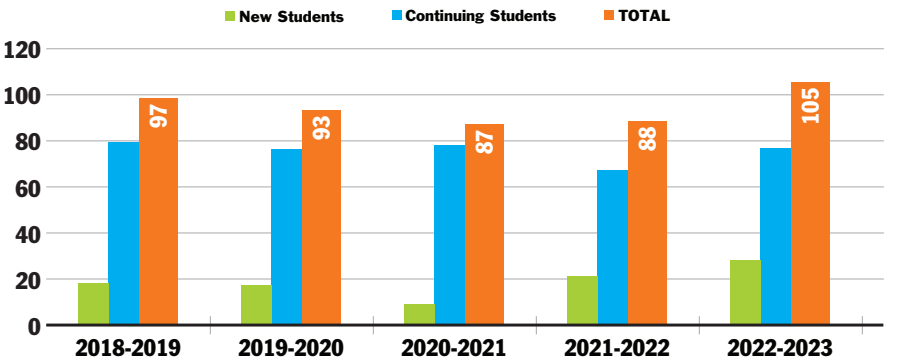
The MAE department, along with a few other departments in the School of Engineering and Applied Science, began a new Master's in Engineering (M.Eng.) degree beginning in 2021.

In 2021-22 the department had 22 M.Eng. students enrolled, in 2022-2023 the department enrolled 18 M.Eng. students.

Enrollment Trends, Ph.D. Program

The doctoral program has remained steady over the last 5 years, with total numbers of new and continuing students around 90 per year.

New and Continuing Students



15 doctoral students and 1 MSE student graduated in AY 2022-2023 and completed theses:

Anastasia Bizyeava
Advisor: Naomi Leonard
Thesis: Nonlinear dynamics of multi-agent multi-option belief and opinion formation
Position: Distinguished Postdoctoral Fellow, University of Washington

Danielle Chase
Advisor: Howard Stone
Thesis: Fluid-structure interactions in low-Reynolds-number flows: patterned surfaces and elastic boundaries
Position: Postdoctoral Researcher at BioFrontiers Institute, University of Colorado-Boulder

Xiaohan Amanda Du
Advisor: Craig Arnold
Thesis: Ultrafast focus control in laser processing using liquid acoustic lenses: modeling, methods, and applications
Position: Assistant Professor at the City University of Hong Kong

Mohamed El Hedi Bahri
Advisor: Andrej Košmrlj
Thesis: Thermal fluctuations of active and anisotropic elastic membranes

Alec Farid
Advisor: Anirudha Majumdar
Thesis: Provably safe learning-based robot control via anomaly detection and generalization theory
Position: Software Engineer, Zoox

Nick Fasano
Advisor: Julia Mikhailova
Thesis: Harmonic Generation in reflection from plasma mirrors
Position: Postdoctoral Researcher, Princeton University

Cristian Lacey
Advisor: Michael Mueller
Thesis: Computationally efficient data-enhanced manifold modeling of multi-modal turbulent combustion
Position: Senior member of the technical staff, Sandia National Laboratories

Jason Liu
Advisor: Craig Arnold and Rodney Priestley
Thesis: Structure formation via phase transformations in soft materials
Position: Postdoctoral Researcher, Princeton University

Udari Madushani
Advisor: Naomi Leonard
Thesis: Learning through social interactions and learning to socially interact in multi-agent learning

Vincent Pacelli
Advisor: Anirudha Majumdar
Thesis: Information-theoretic necessary and sufficient conditions for the task-driven control of robots
Position: Postdoctoral Researcher at Georgia Institute of Technology

Alberto Padovan
Advisor: Clancy Rowley
Thesis: Frequency-domain analysis, model reduction and control of time-periodic fluid flows
Position: Postdoctoral Researcher, University of Illinois at Urbana-Champaign

Alex Piqué
Advisor: Marcus Hultmark
Thesis: High Reynolds number wind tunnel studies of a wind turbine's wake
Position: Fluids Machinery Engineer, Pennsylvania State University, Applied Research Laboratory

Sheetal Ramsurrun
Advisor: Luc Deike
MSE Thesis: Analysis of a spectral wave kodel for air-sea carbon dioxide fluxes
Position: Engineer, Applied Intuition

Gawoon Shim
Advisor: Daniel Cohen
Thesis: External control of cellular collectives with direct current electrical stimulation
Position: Postdoctoral Fellow, Hubrecht Institute, Netherlands

Madeline Vorenkamp
Advisor: Yiguang Ju
Thesis: Plasma-assisted deflagration to detonation transition

Josiah Wai
Advisor: Egemen Kolemen
Thesis: Shape and divertor control in tokamaks

Awards and Fellowships

Several graduate students also received fellowships and awards this year from the department, the School of Engineering and Applied Science, Princeton's Graduate School, and external organizations.

EXTERNAL:

Niki Abbasi, *Natural Sciences and Engineering Research Council of Canada Graduate Fellowship*

Ian Gunady, *Department of Defense National Defense Science and Engineering Graduate Fellowship*

Eric Lepowsky, *National Science Foundation Graduate Research Fellowship Program*

Justin Lidard, *National Science Foundation Graduate Research Fellowship Program*

Megan Mazzatenta, *National Science Foundation Graduate Research Fellowship Program*

Daniel Pardo, *National Science Foundation Graduate Research Fellowship Program*

Valeria Saro-Cortes, *National Science Foundation Graduate Research Fellowship Program*

Daniel Shaw, *National Science Foundation Graduate Research Fellowship Program*

Nathaniel Simon, *National Science Foundation Graduate Research Fellowship Program*

David Snyder, *National Science Foundation Graduate Research Fellowship Program*

Katie Wu, *National Science Foundation Graduate Research Fellowship Program*

UNIVERSITY:

James Roggeveen, *Schmidt Science Fellowship*

Francisco Saenz Castro, *Maeder Graduate Fellowship in Energy and the Environment*

Mohd Shaharyar Wani, *Mary and Randall Hack '69 Graduate Award for Water and the Environment*

MAE DEPARTMENT FELLOWSHIPS AND AWARDS:

Giovanna Amorim, *Martin Summerfield Second Year Fellowship*

Francisco Saenz Castro, *Britt and Eli Harari Fellowship*

Nick Conlin, *Phillips Second Year Fellowship*

Eric Lepowsky, *Crocco Award*

Greg Macchio, *MAE Department Fellowship*

Allen Ren, *Britt and Eli Harari Fellowship, Crocco Award*

Zhiyu Shi, *Guggenheim Second Year Fellowship*

David Snyder, *Crocco Award*

Hannah Williams, *MAE Department Fellowship*

Mohd Shaharyar Wani, *Guggenheim Second Year Fellowship*

SEAS AWARDS:

Niki Abbasi, *Excellence in Teaching Award, Undergraduate and Graduate Engineering Council*

Alec Farid, *School of Engineering and Applied Science Award for Excellence*

Lena Sabidussi, *Excellence in Teaching Award, Undergraduate and Graduate Engineering Council*

Jiarong Wu, *School of Engineering and Applied Science Award for Excellence*

Katie Wu, *Excellence in Teaching Award, Undergraduate and Graduate Engineering Council*

PRINCETON
UNIVERSITY

MECHANICAL AND
AEROSPACE ENGINEERING
PRINCETON, NJ 08544