Howard A. Stone, Chair

MECHANICAL AND AEROSPACE ENGINEERING

CONTENTS

MAE BY THE NUMBERS

Distinctive Characteristics of the Department of Mechanical & Aerospace Engineering (MAE):

71 Visiting & Professional Researchers

The department concentrates its research activities in five broadly defined areas with many faculty involved with two or more areas. The five areas are:

- Applied Physics
- Dynamics & Controls
- Fluid Mechanics
- Propulsion & Energy Sciences
- Materials Science

375 INDIVIDUALS

164 Undergraduate & Exchange Students

97 Graduate Students

15 Administrative & Technical Staff

4 Research & Active Emeritus Faculty

About the Department of Mechanical and Aerospace Engineering at Princeton University

Princeton's Department of Mechanical and Aerospace Engineering (MAE) has played a leading role in propulsion, combustion, aerospace dynamics, and fluid dynamics over the past half century, with expansion in recent decades into dynamics and control, applied physics, and materials science.

Our multi-disciplinary focus and attention to both engineering fundamentals and groundbreaking research helps us train graduate and undergraduate students for future leadership in areas of rapidly evolving technologies.

As a result, the people of MAE are providing engineering solutions to address the world's challenges in the areas of biotechnology, energy production and distribution, sustainability, transportation, communication, and health, safety and security.

Together, we take on future challenges, today.

MAE is:

Applied Physics • Dynamics and Controls • Fluid Mechanics • Materials Science
Propulsion & Energy Sciences

Challenges:

Space Exploration • Satellite Technology • Pollution and Alternative Fuels • Energy Usage • Battery Technology • Novel Optical Systems • Propulsion Systems • Mechanics of Fluids and Solids • Stability and Control of Vehicles • Aircraft Performance Instrumentation

Cross-disciplinary Collaboration:

Astronautics • Bio-Inspired Design • Bioengineering • Medical Applications Combustion and Energy Conversion • Computational Engineering • Environmental and Energy Technologies • Laser-Matter Interactions • Security • Vehicle Sciences and Applications

PRINCETON MAE 2018-19 YEAR IN REVIEW:

Capitalizing on Synergy

By Howard A. Stone, MAE Chair and Donald R. Dixon '69 and Elizabeth W. Dixon Professor

Welcome to the 2018-19 edition of the annual report of the Department of Mechanical and Aerospace Engineering (MAE). Each year, we celebrate the accomplishments of the people of MAE and share how we are meeting the challenges faced in our field to develop a better, safer, and more productive world.

Looking back at the 2018-19 accomplishments and milestones set out in these pages, one theme continues to be evident: our faculty and students are capitalizing on synergy to advance knowledge and discoveries not only in our own disciplines but also in other fields, at Princeton and around the world.

MAE operates under the auspices of Princeton University's School of Engineering and Applied Science (SEAS) and supports two of Princeton's five ABET-accredited undergraduate degree programs in SEAS. We are unique in that MAE represents a variety of disciplines recognized at most universities in separate departments.

The driving force of our department and its accomplishments is our faculty. We have 22 faculty members and one lecturer (19 FTEs total). Together, we build on a long history of academic success and societal impact. For example, five regular or emeriti faculty (Carter, Law, Miles, Smits, and myself) are members of the NAE and/or the NAS.

BEYOND BOUNDARIES

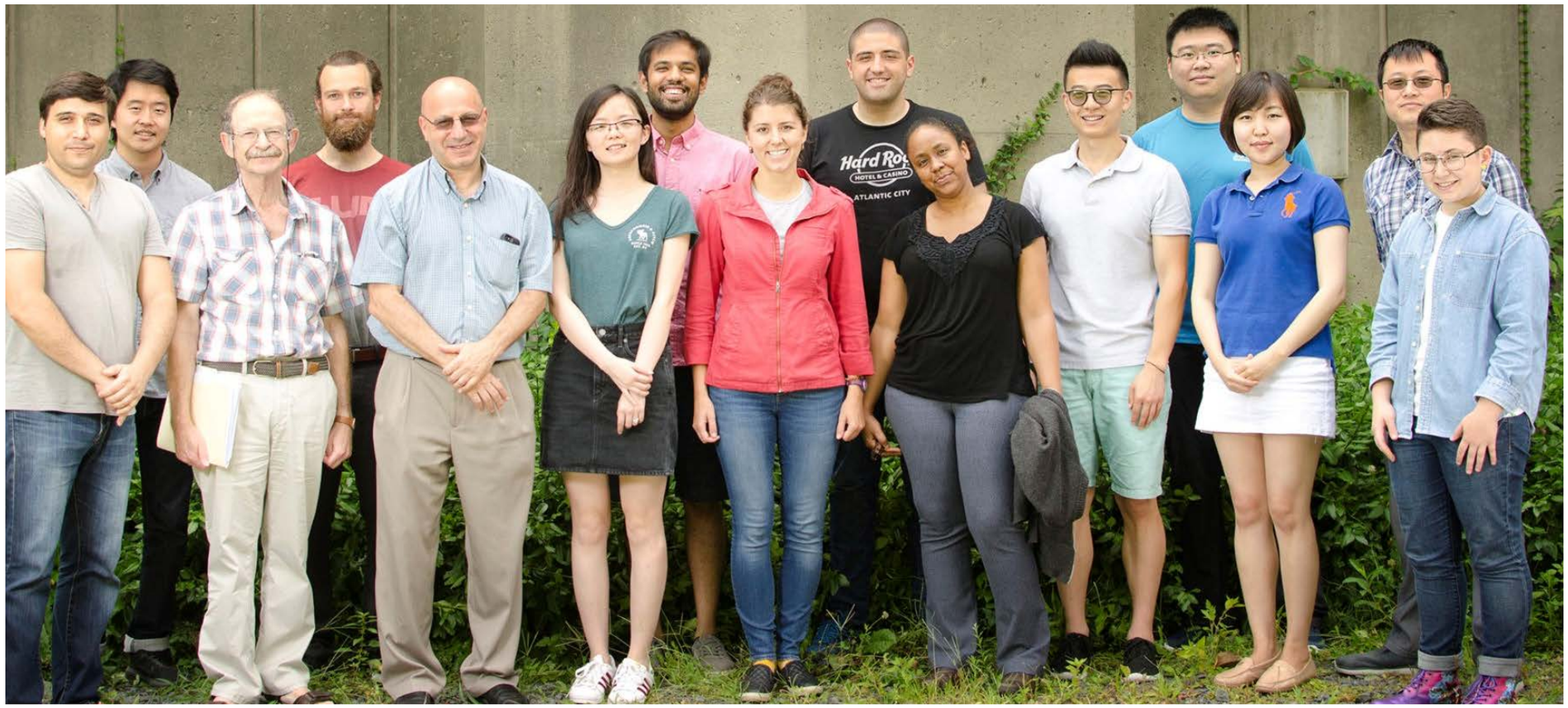
Our faculty conduct active, world-leading research programs in many areas, including some research topics that stretch the traditional boundaries of MAE. As such, collaboration is one of our greatest strengths. Our MAE faculty work with colleagues around the globe and in many departments at Princeton in areas as diverse as:

- Chemical and Biological Engineering
- Civil and Environmental Engineering
- Computer Science
- Ecology and Evolutionary Biology
- Mathematics
- Molecular Biology
- Neuroscience
- Operations Research and Financial Engineering
- Physics
- Woodrow Wilson School of Public and International Affairs

Our active, world-leading research programs range from uncovering basic principles to testing innovative theories in and beyond the traditional MAE realm of topics. For example, we are actively involved in:

- Robotics and dynamical systems, and its modern variants of cyberphysical systems
- Materials sciences—including problems from engineering materials to biomechanics
- Propulsion and combustion
- Fluid mechanics—including studies of turbulence, environmental flows, and complex fluids
- Several areas of applied physics—including fundamental studies of laser-material interactions, electric propulsion, and fusion energy

We hope you enjoy learning through this publication about our community of faculty, researchers and students who explore new ideas and challenge old ones every day, contributing to science and real-world applications from mechanical to aerospace engineering — and beyond. ♦



The Complex Fluids Group (with some visitors). ▶

YEAR IN REVIEW

Each year, many stories about student and faculty achievements grace the pages of the MAE website. Here is a summary of some highlights in one easy-to-read place. To read more details about the stories below, please visit the MAE news pages at https://mae.princeton.edu/about-mae/news.

July 2018

Foam offers greener option for petroleum drillers

Princeton researchers, led by Prof. Howard Stone, described in the July 2018 edition of the journal PNAS how a compressible foam can reduce the amount of fresh water and resulting wastewater typically involved in the hydraulic fracturing (fracking) process. Lead author Ching-Yao Lai, PhD '18, reported that foam fracking would use only about 10 percent of water by volume. Additional authors include Princeton researchers Bhargav Rallabandi, Antonio Perazzo, Zhong Zheng, and Samuel Smiddy (an undergraduate in Chemical and Biological Engineering). Stone is the Donald R. Dixon '69 and Elizabeth W. Dixon Professor of Mechanical and Aerospace Engineering, and Chair, Department of Mechanical and Aerospace Engineering.

Building fish-inspired robots

Former MAE graduate student Derek Paley '07 has long been fascinated by how fish flap their way efficiently through water and how they swim cohesively in a group by using a strip of sensors on their sides to detect water flow and obstacles. He is leading researchers at the University of Maryland in developing a fish-inspired submarine to explore fish-sensing and propulsion in the context of developing autonomous robots. He is UMD's Willis H. Young Jr. Professor of Aerospace Engineering Education and the Director, Collective Dynamics and Control Laboratory in Department of Aerospace Engineering. See a video of the fish-submarine here: https://youtu.be/TTxS19EofQ0

August 2018

Glassman receives the 2018 Daniel Guggenheim Medal

Irvin Glassman, the Robert H. Goddard Professor of Mechanical and Aerospace Engineering, Emeritus, was recognized for his work as a legendary combustion expert who has enhanced understanding of fundamental combustion processes. His contributions have enabled engineers and scientists to improve the performance of propulsion and power generation systems, while minimizing their adverse environmental effects.

August 2018

MAE alumni gathering in California

MAE alums, who are all engineers at Virgin Space Companies, gathered for dinner in Los Angeles: (from left) George Whitesides (WWS) and MAE's Josh Ellis '15, Brittany Ilardi '16, Daphne Rein-Weston '12, Isabel Cleff '18, Carter Green '20, and Scott Ostrem '89.

September 2018

Leonard presents 2018 Marsden Memorial Lecture

Naomi Ehrich Leonard, the Edwin S. Wilsey Professor of Mechanical and Aerospace Engineering, gave the annual award lecture at the Pacific Institute for the Mathematical Sciences in Vancouver, British Columbia. Her topic was nonlinear dynamics for distributed decision-making that derive from principles of symmetry and bifurcation. Her work is inspired by studying animal groups such as house-hunting honeybees and schooling fish to demonstrate how they can be both flexible and stable in response to a changing environment.

October 2018

Video shows a particle surfing in its own wave

Check out this video (at https://engineering.princeton.edu/news/2018/10/02/riding-wave) showing a marble-sized sphere falling through a tank of silicone oil, a viscous, honey-like liquid, alongside a thin rubber sheet. At the beginning, the sheet and marble are almost touching, but as the sphere falls, the two grow further apart. This behavior (a particle surfing its own wave) was identified by a team of researchers from Prof. Stone's MAE lab, along with their counterparts at the Flatiron Institute in New York and the Center for Soft Matter Research at New York University. The team hopes this research will help measure elastic properties of biological membranes or help learn how to separate particles.

Passing of Professor Emeritus Lam

Sau-Hai (Harvey) Lam, who developed influential theories in fluid mechanics, combustion and plasma dynamics and helped shape engineering education at Princeton, died Oct. 29 in Plainsboro, N.J., at age 87. He served on the University faculty for four decades and was the Edwin Wilsey '04 Professor Emeritus of Mechanical and Aerospace Engineering. He earned his PhD in aeronautical engineering from Princeton in 1958.

November 2018

Prof. Ju wins 2018 International Prize of the Combustion Society of Japan

Yiguang Ju, the Robert Porter Patterson Professor of Mechanical and Aerospace Engineering and Director, Program in Sustainable Energy, was honored for making distinguished contributions to the international and Japanese combustion research communities.

At the intersection of nonlinear dynamics and improvisational dance

Prof. Leonard and her team collaborated with Princeton dance and music colleagues to study how a collective, in-the-moment creative process such as improvisational dance is a valuable model for studying social decision-making. The rule-based improvisational work was entitled, "There Might Be Others." Her team uses mathematical model-based investigations of complex group dynamics to explain and explore collective behavior in nature and art and to inform the design of control systems for robot teams operating in challenging environments. The research was published in the Nov. 20, 2018 edition of the journal Interdisciplinary Science Reviews. It represents a new application of an evolutionary theory examining this tension in the context of different survival strategies within a population of individuals. Learn more here: https://doi.org/10.1080/03080188.2018.1544806

December 2018

Modeling how New Mexico harvester ants collectively weigh the cost of losing water while foraging for food

The research, published in the Dec. 4, 2018 edition of the journal PLOS Computational Biology, was written by lead author Renato Pagliara Vasquez, the MAE graduate student who spent two summers conducting research in the New Mexico desert. He worked with MAE Prof. Leonard in collaboration with a team from Stanford University that has been studying the ants for the past three decades. The model is a tool for investigating how ant colonies respond to a changing environment and how behavioral differences among colonies affect their long-term survival and reproductive success. The team published their results here: https://doi.org/10.1371/journal.pcbi.1006200

December 2018

Dying bacteria absorb antibiotic, allowing others to survive and grow

MAE Assistant Prof. Andrej Kosmrlj collaborated with a team from California State University-Northridge (CSUN) to develop a mathematical model to more fully explain the "self-sacrifice" phenomenon and aid further investigations. They created the model by observing what happens when a population of E. coli bacteria is treated with a particular antimicrobial molecule and discovered that some dying cells absorbed large amounts of the antibiotic, allowing their neighbors to survive and continue growing. The results were published in the Dec. 18, 2018 edition of eLife.

January 2019

From mechanics and materials to robots and rocks, MAE has an outsized "intellectual breadth and impact"

MAE Chair Stone gave an update about the department's innovative faculty and students, as well as research bridging many fields in science and engineering. (Read more here: https://engineering.princeton.edu/news/2019/01/04/mechanics-and-materials-robots-and-rockets-department-outsized-intellectual-breadth)

How making brooms is like robot engineering

Buse Aktas, who graduated with a Princeton BSE in 2014, was profiled by Harvard University's School of Engineering and Applied Sciences, where she is pursuing her PhD. As an engineer and artist, she noted the similarities between working on her engineering degree and the two years she spent as a broom-maker's apprentice in her native Turkey, which resulted in a sculpture project. While at Princeton, for her senior thesis she developed a device to help individuals with physical and mental disabilities build objects on an assembly line at an Easter Seals workshop. (Read more here: https://www.seas.harvard.edu/news/2019/01/grad-student-profile-buse-aktas)

Falcone '74, MAE's Advisory Council Chair, talks about women in science on Princeton's "She Roars" podcast

At the forefront of women in science since her undergraduate days on campus and as one of the first Princeton women to major in engineering, Patricia Falcone now oversees strategic development as deputy director of science and technology for Lawrence Livermore National Laboratory. On the podcast, she discussed the importance of college mathematics, early research experience, and clearer communications. (Listen to the interview here: https://sheroarspodcast.princeton.edu/) She is chair of the Advisory Committee for MAE.

Majumdar receives Amazon Research Award

Assistant Prof. Anirudha Majumdar's research focuses on the control of highly agile robotic systems such as unmanned aerial vehicles with formal guarantees on their safety and performance.

MAE alumnus honored as Distinguished Lecturer at AIAA Science and Technology Forum

Virginia Tech Prof. Joseph Schetz (Princeton MAE '62) gave the 2019 American Institute of Aeronautics and Astronautics (AIAA) Dryden Lecture in Research on "Truss-Braced Wing Designs for High-Speed Transport Aircraft." He currently is the Fred D. Durham Endowed Chair in the Kevin T. Crofton Department of Aerospace and Ocean Engineering at Virginia Tech.

February 2019

Prof. Stone gives inaugural lecture at the Leeds Institute for Fluid Dynamics

He spoke on fluid dynamics at the new cross-disciplinary institute in at University of Leeds in Leeds, West Yorkshire, England.

Former MAE student named 2019 Franklin Institute Laureate

Frances H. Arnold (MAE '79) won the Bower Award and Prize for Achievement in Science for pioneering the development of directed protein evolution. This discovery allowed chemists to engineer biological catalysts that mimic natural evolution in a laboratory setting, thus enabling greener, less energy-intensive and less polluting manufacturing processes. She received the 2018 Nobel Prize in Chemistry and is the Linus Pauling Professor of Chemical Engineering and Biochemistry at the California Institute of Technology.

Kokmanian receives Excellence in Teaching Award

Katherine Kokmanian (MAE 222) received an Excellence in Teaching Award presented by the Undergraduate and Graduate Engineering Councils.

MAE Jacobus Fellow's swimming research has propulsion system applications

Doctoral student Daniel Floryan was named a Princeton's Porter Ogden Jacobus Fellow at the annual Alumni Day. His work employs experimental and computational methods to better explain how fish swim most effectively, which could lead to applications in human-made propulsion systems.

March 2019

Prof. Deike receives NSF Career Award for modeling bubble fragmentation

The National Science Foundation (NSF) award cites Luc Deike's series of state-of-the-art numerical and experimental studies of the fragmentation of bubbles in turbulent flow. These can have applications for environmental and industrial situations such as oil spill mitigation, air entrained in bow waves of ships and submarines, and ocean-atmospheric interactions associated with breaking waves. His research represents an innovative and valuable tool for designing engineering solutions as well as ocean and climate modeling. The award will also support educational activities for elementary school students, undergraduates, and graduate students. Software developed through this work will be open source and available to the public and other researchers interested in modeling multiphase flows.

May 2019

Prof. Ju selected as plenary lecturer for the 38th International Symposium on Combustion in 2020

Yiguang Ju will present on "Cool Flames" at the biennial symposium to be held in Adelaide, Australia, in July 2020.

Zhao honored with the Karl H. Walther Award

Hao Zhao, graduate student in Prof. Yiguang Ju's group, was recognized for his article, entitled, "A Supercritical Jet-stirred Reactor," considered the best article published from May 2018 to February 2019 in the quarterly journal, Fusion, by The American Scientific Glassblowers Society.

continued on page 25

STUDENT PROFILES

Diego Fierros:
Bringing engineering to the world stage

DEGREE: BSE SPECIALTY: DYNAMICS AND CONTROLS

Diego Fierros knew he wanted to be an engineer early on.

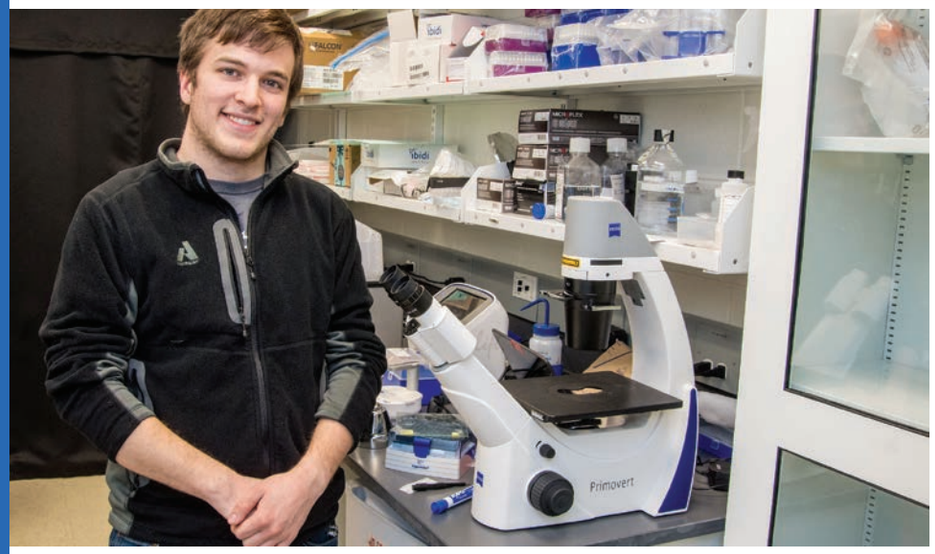
"As a kid, I loved television shows like 'MythBusters' and 'How It's Made,'" he says. "By watching the Discovery Channel, I learned what engineering was in an ideological sense—which is taking the world into your hands and changing it for the better. That really spoke to me."

Fierros pursued his interest in science in middle school and high school, even spending a summer as a high school researcher on Villanova University's Autonomous Surface Vehicle Team. His team competed in the AUVSI Roboboat competition and later in the international RobotX competition and he gained an appreciation for the work that goes into designing and building robotic systems, he says.

"Diego is very personable, well organized and willing to go the extra mile to help. His personality is multifaceted. And from our talks about CAD and robotics in particular, I find him to be technically knowledgeable and engaging."

—Prof. Luigi Martinelli

In high school, he also discovered another passion: technical theater.



"My specialty is sound design, setting up speakers in the performance space, programming the sound board, and making sure that every actor's microphone is working properly," he explains. "Plus, I mix in the music from our pit orchestra so that every sound is balanced in the theater. My goal is for the audience to hear every line and have the best possible time at our shows."

Fierros' love of theater carried over to Princeton, where he joined the Triangle Club in 2016. Founded in 1891, the Triangle Club is America's oldest touring college musical-comedy theater group, with productions written and performed by the students. Fierros uses advanced theater hardware to create and adjust a live theater soundscape. He has directed several teams of technicians in setting up and breaking down the theater sound system at tour venues and is mentoring incoming students about theater sound design.

When Fierros was considering universities to attend, he visited many institutions, including schools that were purely technical. "However, they seemed like competitive pressure cookers where people have learned to become addicted to the stressful environment," he notes. "Princeton is competitive as well, but by contrast, the atmosphere is more relaxed. Plus, it provides a good liberal arts education, which is important for STEM majors. A great engineer who can't properly express their ideas is doomed to failure."

In his freshman year, one of his courses involved authenticating and repairing two antique Triumph motorcycles. "I learned a lot about mechanical design and how to machine things," says Fierros.

Later, he participated in the Fluid Mechanics Transport Phenomena Group, where he used PTC Creo design software to develop laboratory equipment such as a sensor test bench and a wind tunnel pitot traverse. He developed procedures for injection molding low-cost sensor interfaces for medical fluid tubing.

His internship at the Siemens Corporate Technology Future of Automation Lab gave him experience learning practical robotic programming using the Robotic Operating System and Linux. He collaborated with a team of researchers to develop an autonomous robotic farming system. He is now pursuing certificates in Computer Science and Robotics and Intelligent Systems along with his degree.

In Prof. Daniel Cohen's bioengineering lab, he studied how the shape of wounds affects how fast they heal. He also started pondering how to create a device that maps asymmetric strain fields onto wounded tissue to determine how the cells act when subjected to these conditions.

Under the supervision of Prof. Luigi Martinelli, Fierros also volunteers as an Interactor, a resource for undergraduate engineers or those interested in the BSE program.

"I talk to them about my experiences, hoping it will help them as they are starting out," he says. "It can be daunting, especially during the first two years in engineering, to get all the classes under your belt while acclimating to what Princeton expects of you as a student. It's important to me, even in a minor way, to help alleviate some of that stress and let them know that someone cares."

Looking ahead, Fierros is weighing his options for the future, which could include a master's degree. "But I may want to get some industry experience first, just to get an idea of what that scene is like. I'm interested in learning more about automation and robotics, particularly as it relates to autonomous vehicles," he says. "I think robotics is an aspect of engineering that has the potential to do a lot for our society." ♦

Zirui Liu:

Blowing Stuff Up in Life and the Lab

DEGREE: PHD SPECIALTY: PROPULSION AND ENERGY SCIENCES

Zirui Liu has always been interested in rockets, space, travel and "blowing stuff up," he says with a laugh. In fact, the likable third-year PhD student initially became interested in the engineering and aerospace fields as a result of his voracious reading habit.

As a child, he loved science biographies: Isaac Newton inspired his love of mathematics and science, while Albert Einstein and Marie Curie deepened his interests in physics and chemistry, respectively. Somewhere along the way he read about combustion. He began conducting experiments while reading M.M. Pattison Muir's page-turner "The Story of the Chemical Elements," which mentioned using flame to heat up salt and bones. It was a great idea—until his parents found out, that is.

His interest in fire goes back to around age 8. "I would buy matches and light the grass on fire in the lot near my house," Lui explains. "My parents weren't very happy about that." But, he did it a few more times after that. How else is a budding scientist supposed to learn about combustion, right?

Liu comes from Fuxin, China, also called the "Agate City," since roughly 90 percent of the country's agate products are mined in the agricultural region. "Fuxin is a nice city with mountains, rivers, and one main street, similar to Princeton," he says.

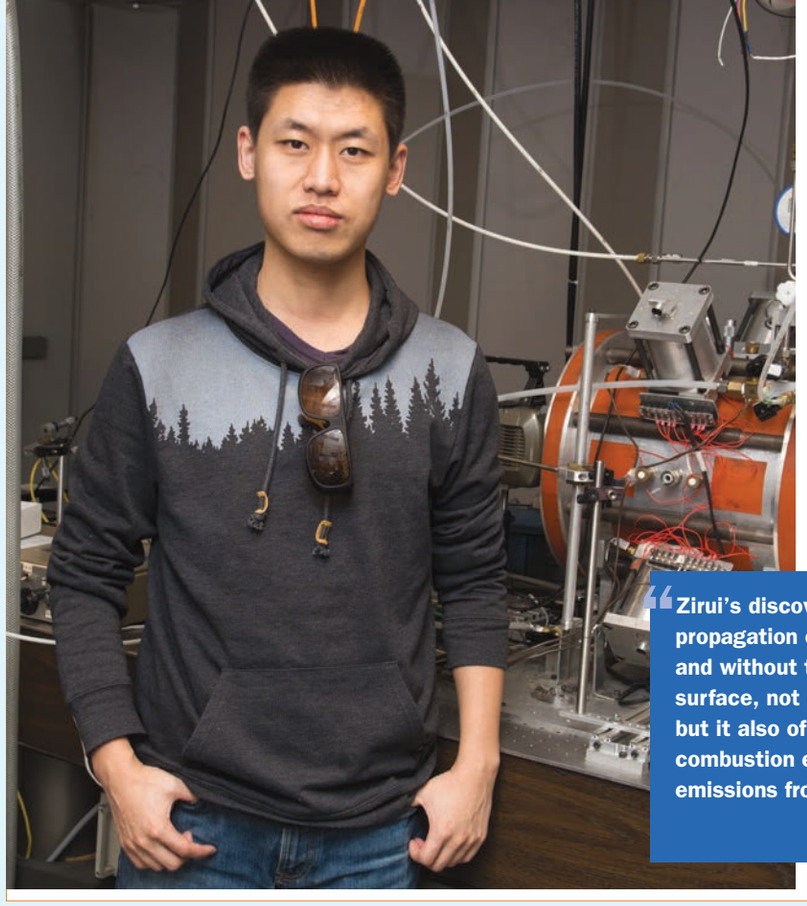
Liu traveled frequently in China with his parents and caught the sightseeing bug. He enjoyed the skyscrapers in the big city of Shanghai and the desert and mountains of western China.

He also inherited his parents' sense of honor and duty to country. His mother works in China's environmental protection department, which safeguards forests and wild animals. Her appreciation for nature seeped into family life and gave Liu his fondness for the outdoors.

While Liu and his classmates were hard at work studying for the very competitive college entrance exams, he eagerly followed the news about SpaceX launching the first flight of the reusable cargo spacecraft called the Dragon. This solidified his desire to combine his interests in math, science, combustion, and space into a major. His hard work paid off when he was accepted into the Aerospace Engineering program at Beijing's Tsinghua University.

He still found time to satisfy his wanderlust during his undergraduate years, traveling to Tibet, Beijing and Shanghai. "We saw many beautiful mountains, lakes, and went into the sacred mountains of Mount Nojin Kangsang. It was a life-changing experience to see new cultures and become immersed in them," he says.

So, how exactly does one from China hear about Princeton University in New Jersey? "It's the best school for combustion and the professors are the best," he says, noting that the university's reputation is world-renowned.



"Zirui's discovery and analysis on the structure and propagation of laminar and turbulent flames, with and without the occurrence of cells over the flame surface, not only is a major advance in flame theory, but it also offers strategies towards increasing the combustion efficiency and reducing the undesirable emissions from burning petroleum fuels."

— Prof. C.K. Law

"This is the leading research department with a long history of studies into combustion. Combustion is very important if you are interested in space."

At Tsinghua University, he took second place in the Aeronautic and Aerospace Design Competition and won the National Academic Scholarship, also in China.

At Princeton, Liu was awarded the MAE Second Year Fellowship in 2017. Humble by nature, he wanted to share his knowledge and spent the Fall 2018 semester as a Teaching Assistant helping students with Mathematical Methods of Engineering Analysis I (MAE-APC 501).

He has continued his passion for sightseeing since arriving in the Western Hemisphere. He's been to Iceland and Alaska, where he missed seeing the Aurora Borealis because it was snowing. "But the mountains were very beautiful," he adds. Since starting at Princeton, he's been to New York several times and also drove from LA to San Francisco.

As for his research, his project for Prof. C.K. Law's group is called "Laminar and Turbulent Flame Propagation Under the Effect of Flame Instability," which has application to automobile and airplane engines.

"I am trying to see the interaction between flame instability and turbulence," says Liu, who would like eventually to teach at a U.S. university to continue his combustion research or work at a national lab or in industry. "This could be applied to real engines because the flame instability appears when the pressure is high and in engines the flow is turbulent."

For now, this talented young man is sharing his curiosity and insights at Princeton…by blowing things up in a lab. ♦

Nikita Dutta:

From Childhood Inventor to Materials Scientist

DEGREE: PHD SPECIALTY: MATERIALS SCIENCE

When Nikita Dutta was a child, she invented a cutter that sliced through her EGGO waffle ridges faster, crafted a penny and nickel sorter from a cereal box to organize her loose change, and created a long straw that reached from her room to the sink, to avoid the walk downstairs for a drink of water.

"I always liked inventing and creating things," says Dutta. "It combines my enjoyment for making projects with my hands and my need to make life around the house more efficient."

During childhood, she took apart old toys and sifted through the recycling to find spare parts. Today, as a materials scientist, she finds ways to repurpose materials by changing their properties and structures to make them work in new or more efficient ways.

When she started her undergraduate studies at Yale University, her first preference was to be a biology major, which required an introductory physics class. She considered placing out of the class but changed her mind when she called her mom for advice.

"My parents always taught me never to take the short route to anything — that I should take everything slow and use it as an opportunity to learn more," she says.

Her parents were right, and, much to Dutta's surprise. she fell in love with physics. "I started to see how physics explains everything around you and how through math you could derive natural phenomena," she explains. "Physics creates order for the entire world. It gives you unifying laws that explain things seemingly disconnected. I really like when things can be packaged up neatly or follow some kind of pattern."

In a junior year particle physics project, she developed an algorithm to reconstruct muon events coincident between the Ice-Cube Neutrino Observatory and the DM-Ice 17 dark matter detector. Her goal was to reduce background noise for both experiments and it was the first time she saw herself pursuing a research career.

> **"We believe her methods and approaches can be adapted to other amorphous materials, which would be truly transformative for a major branch of materials science."**
> *— Prof. Craig Arnold*

"Repairing implies an endpoint," she explains. "When the job is done, the device works one way, and there is nowhere to go from there. Research, on the other hand, builds off existing science, but there is no fixed endpoint. Even after a successful study, there is somewhere new to go."

Also, projects that make people's daily lives better appealed to her, as did materials science, which seemed a nice combination of fundamental science and impactful, real-world applications.

"In any kind of engineering you need materials that behave efficiently and with the right kinds of properties. Materials science often fuels innovation in other areas. Some of my work can be used in solar energy, some in medicine for laser surgery, and some in information storage," she says.

Dutta is developing new ways to understand and control how processing materials in various solvents will generate desired properties for use in a device and make them work better. In particular, she works with chalcogenide glasses, which are very responsive to light and are used in fiber optic networks, chemical sensors, and other applications that transmit information or store energy using light.

Previous approaches have involved solution processing of materials, seeing what happens, and then going back to tweak the process. Instead, Dutta developed a process that creates a solution with parameters that lead to a certain structure with desired properties.

"This gives you more control than the reverse technique [where you] go backwards to tweak your result without really understanding how the properties arose," she says.

"Solution processing is useful because it is very simple — you do not need high temperatures or expensive equipment. You can simply add things to the solution that change the structure of the material. It is also very flexible, so it allows for a variety of deposition methods, like inkjet printing or filling a mold," she says.

Her research has developed new characterization methods, notes Prof. Craig Arnold, that have "revealed the first-ever experimental validation of the molecular structure of this material in solution. This is an initial stage to the formation of bulk material and a critical missing link in our current understanding of amorphous materials."

Even today, Dutta's mind is always conceiving new inventions, including a focus on how material science could be applied to women's health issues. "What I love most about science is that it is never stagnant," she says. "Science is constantly evolving and growing. It is a real privilege to be a part of this field and know that you can have a practical impact on the world around you."

Vivian Steyert:

A Love of Learning, Teaching, and Modeling

DEGREE: PHD SPECIALTY: DYNAMICS AND CONTROL, FLUID MECHANICS

Vivian Steyert's lifelong passion for learning — and imparting that knowledge to others — was evident from the start. From twirling pirouettes and viola scales to science fair experiments and algebra equations, she has long been enamored with both the arts and sciences. But, figuring out puzzles and finding ways to demonstrate concepts ultimately captivated her extensive curiosity.

"From very early on, I loved school and was interested in learning everything," she recalls. "Growing up I spent a lot of free time pursuing my interests in ballet and viola. I loved the artistry and teamwork involved in orchestra and ballet performances. I was also a voracious reader. Over the years, my interests gradually narrowed more towards math, physics, engineering, and computer science."

As a child, she "taught" her younger sister in pretend art or math school, later helping her sibling with homework. She was a teen SAT tutor for the National Honors Society and continued tutoring in college. As a fourth-year PhD student at Princeton, Steyert was an assistant instructor for the undergraduate automatic control systems lab course.

"Teaching has been a great way for me to help other students and, at the same time, deepen my understanding of the material," says Steyert. "My favorite part of teaching is watching a concept click into place for a student. It is an incredible process to witness."

Steyert's favorite part of the course is the culminating pendulum project, in which students piece together the concepts they have learned all semester and balance an upside-down pendulum using a control system they design.

The wonderment Steyert sees so often in her students' eyes reminds her of a defining personal moment. Her fluid mechanics professor asked the class to describe what would happen to an adiabatic subsonic flow in the presence of friction. They all assumed it would slow down. Even though Steyert understood every step, she didn't predict the result.

"Situations like this one, where the mechanical world is shown to be more complicated than I had previously imagined, are exciting. Understanding why and how the strange physical behavior occurs is thrilling to me," she explains.

Observing the physical world was a common topic of conversation in her Maryland home growing up. Both Steyert's mother and father have PhDs in chemistry and microbiology, respectively.

"My mother would always talk about work at home. It gave me insight into what it was like to conduct research," says Steyert. "They were very hands-on with my science fair projects and made me think more deeply about the subjects, while still giving me the space to make the experiment my own."

Steyert pursued a broader engineering degree at Harvey Mudd College and gained exposure to as many disciplines as possible through internships and research opportunities. She got a taste of civil engineering at the University of Washington's Structures Laboratory, constructing welded connections that could be used to build more sound structures. She presented this work at the Northridge 20 Earthquake Symposium. Steyert also investigated ways to reduce noise and drift in the self-contained breathing apparatus (SCBA) used by firefighters for Honeywell.

But it was an internship at NASA Goddard Space Flight Center that first exposed her to the working world of coding and software analysis. Today, at Princeton, she uses computational modeling to find ways to better understand and control fluid systems.

> **"It has been such a pleasure for me to work with Vivian. In addition to being a creative and meticulous researcher, she is also a terrific teacher, and she has been an invaluable help to me in teaching the undergraduate controls course."**
>
> *— Prof. Clarence W. Rowney*

The overarching idea of Steyert's research is to develop simplified models and algorithms that can explain and control natural processes and allow predictions to be made. For example, researchers obtain a copious amount of velocity data when studying the flow of fluids within a system. Her approach separates the data about structured behavior from the random, chaotic behavior, letting her develop a simple model and algorithm that can explain the flow, which can ultimately help control the fluid in a desired way.

"If we better understand the limits and capabilities of these algorithms, we can develop new, more efficient methods," says Steyert, whose approach could be applied not just in fluid mechanics but also in disease modeling or even finance.

While teaching has been a defining part of the researcher Steyert has become, she says she will likely pursue a career in industry first, where there will undoubtedly be countless opportunities to fuel her first love — learning — and perhaps even become a mentor and teacher again someday. ♦

FACULTY

Meet the People of MAE

Every day, the people of MAE harness their vast expertise and insatiable curiosity to improve how human beings interact with the world through the creative science of engineering. Our faculty cultivate the unique matrix of lessons and research through which both discoveries and student potential can thrive.

Professor
Craig Arnold
Emily Carter
Edgar Choueiri
Mikko Haataja
Yiguang Ju
N. Jeremy Kasdin
Chung (Ed) Law
Naomi Leonard
Michael Littman
Clarence Rowley
Robert Stengel
Howard Stone, *Chair*

Associate Professor
Alexander Glaser
Marcus Hultmark
Luigi Martinelli
Michael Mueller
Daniel Nosenchuck
Daniel Steingart

Assistant Professor
Daniel Cohen
Luc Deike
Egemen Kolemen
Andrej Kosmrlj
Anirudha Majumdar
Julia Mikhailova

Lecturer
Lamyaa El-Gabry
Ankur Gupta (part-time)
Glenn Northey (part-time)
Suin Shim (part-time)

Associated Faculty
Ilhan Aksay, *Chemical & Biological Engineering*
Amir Ali Ahmadi, *Operations Research & Financial Engineering*
Elie Bou-Zeid, *Civil & Environmental Engineering*
Nathaniel Fisch, *Astrophysical Sciences*
Bruce Koel, *Chemical & Biological Engineering*
David Spergel, *Astrophysical Sciences*
Salvatore Torquato, *Chemistry*
Robert Vanderbei, *Operations Research & Financial Engineering*
Claire White, *Civil & Environmental Engineering*

DEPARTMENTAL COMMITTEES

Graduate Committee:
Alex Glaser, *Chair*
Edgar Choueiri
Marcus Hultmark
Ani Majumdar
Michael Mueller

Director of Graduate Studies:
Alex Glaser, *Chair*

Undergraduate Committee:
Michael Littman, *Chair*
Craig Arnold
Marcus Hultmark
Yiguang Ju
Andrej Kosmrlj
Luigi Martinelli
Julia Mikhailova
Alex Glaser, *Ex-officio*

Seminar Committee:
Yiguang Ju, *Chair*
Marcus Hultmark
Mikko Haataja
Egemen Kolemen

Honors and Awards Committee:
Howard Stone, *Chair*
C.K. Law
Naomi Leonard

Teaching Schedule Coordinators:
Michael Littman
Alex Glaser
Jill Ray, *Ex-officio*
Jo Ann Love, *Ex-officio*

Climate & Inclusion Committee
Michael Mueller, *Co-chair*
Julia Mikhailova, *Co-chair*
Daniel Floryan
Courtney Kohut
Katherine Kokmanian
Leonid Pogorelyuk
Suin Shim
Deanna Spoth
Tyler Van Buren
Chuck Witt
Howard Stone, *Ex-officio*
Jenn Widdis, *Ex-officio*
Jill Ray, *Ex-officio*

EEO Officer:
Michael Mueller

Chemical Hygiene Officer
Michael Vocaturo

Department Safety Manager
Jonathan Prevost

SEAS Lab Safety Committee Representatives
Michael Littman
Jonathan Prevost
Michael Vocaturo

Student Organization Representatives:
AIAA: Michael Mueller
SAE: Yiguang Ju
MRS: Craig Arnold

Tau Beta Pi (SEAS-wide):
Michael Mueller, Howard Stone

Freshman Advisors:
Marcus Hultmark
Michael Mueller
Andrej Kosmrlj
Gigi Martinelli
Dan Nosenchuck

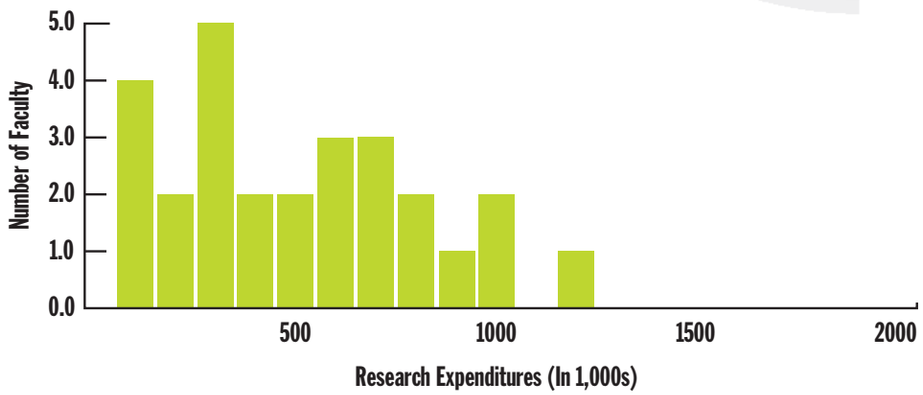
Class of 2019
Craig Arnold
Luc Deike
Yiguang Ju
Michael Littman
Dan Nosenchuck
Clancy Rowley
Daniel Steingart

Class of 2020
Daniel Cohen
Mikko Haataja
Marcus Hultmark
Yiguang Ju
Andrej Kosmrlj
Michael Littman
Ani Majumdar
Daniel Nosenchuck

Class of 2021
Craig Arnold
Michael Littman
Gigi Martinelli
Daniel Nosenchuck

Faculty Leaves
Fall 2018: Ed Law
Spring 2019: Naomi Leonard

Faculty Research Expenditures Distribution FY19



FACULTY AWARDS, HONORS AND RECOGNITION

Craig Arnold (Professor)
- 2019 named the Susan Dod Brown Professor of Mechanical and Aerospace Engineering

Emily Carter (Professor & Dean)
- 2018 CME Leadership Award for Interdisciplinary Innovation, New York Section of the American Chemical Society
- 2018 C. R. Mueller Distinguished Lecturer, Purdue University
- 2019 Dow Foundation Distinguished Lecturer, University of California, Santa Barbara
- 2019 Mildred Dresselhaus Memorial Lecturer, Ras Al Khaimah Centre for Advanced Materials, United Arab Emirates
- 2019 Eyring Lecturer in Molecular Sciences, Arizona State University
- 2019 Distinguished Alumni Award, California Institute of Technology
- 2019 Graduate Mentoring Award, McGraw Center for Teaching and Learning, Princeton University
- 2019 18th NCCR MARVEL Distinguished Lecturer, L'École Polytechnique Fédérale de Lausanne (EPFL), Switzerland

Luc Deike (Assistant Professor)
- 2019 NSF CAREER award

Yiguang Ju (Professor & Director of the Program in Sustainable Energy)
- 2018 International Prize, The Japanese Society of Combustion
- 2019 Fellow of School of Engineering, The University of Tokyo
- 2019 Karl H. Walther Award, from the American Scientific Glassblowers Society
- 2019 Plenary Lecturer (Selected) for the 38th International Symposium on Combustion, 2020, in Adelaide, Australia; The Combustion Institute (International)

Andrej Kosmrlj (Assistant Professor)
- 2019 Alfred Rheinstein Faculty Award, SEAS
- 2019 Paper in Emerging Investigators issue of Soft Matter

Naomi Leonard (Professor & Director of the Council on Science & Technology)
- 2018 Marsden Memorial Lecture Prize, Pacific Institute for Mathematical Sciences (PIMS)

Anirudha Majumdar (Assistant Professor)
- 2019 Amazon Research Awards

Richard Miles (Professor, Emeritus)
- 2019 Elected Senior Member of the National Academy of Inventors (NAI)

Michael Mueller (Associate Professor)
- 2018 Invited Lecture, 71st Annual Meeting of the APS Division of Fluid Dynamics
- 2019 Invited Lecture, AIAA SciTech Forum

Clarence Rowley (Professor)
- 2020 Selected as a Sectional Lecturer for the 25th International Congress of Theoretical and Applied Mechanics (Milan)

Alexander Smits (Professor, Emeritus)
- 2018 Plenary Lecture, 15th International Conference on Fluid Dynamics

Howard Stone (Professor & Chair)
- 2019 Elected APS Councilor, representative for the Division of Fluid Dynamics and the Topical Group on Climate
- 2019 Arthur Newell Talbot Distinguished Lecturer, Department of Mechanical Science and Engineering, University of Illinois
- 2019 Endowed Distinguished Lecturer in Fluid Mechanics, Department of Chemical Engineering, University of Florida
- 2019 Jan D. Achenbach Lecture, Civil and Environment Engineering and Mechanical Engineering, Northwestern University
- 2019 Berkeley Lectures in Chemical and Biomolecular Engineering, UC Berkeley

Claire White (Associated Faculty, Assistant Professor of Civil & Environmental Engineering)
- 2019 Gustavo Colonetti Medalist (RILEM)

Department Personnel (as of September 1)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Faculty						
Professor	15	16	15	13	12	11
Associate	3	2	2	3	4	6
Assistant	6	7	7	6	7	6
Other	2				1	1
Subtotal	**26**	**25**	**24**	**22**	**24**	**24**
Professional Researchers	44	45	50	52	43	50
Visiting Researchers	13	13	12	13	19	17
Technical Research	6.5	6.5	5.5	5.5	4	4
Technical Teaching	4	4	4	4	4	4
Administrative	12	12.5	11.5	12	11	11
TOTAL	**105.5**	**106**	**107**	**108.5**	**105**	**110**

The MAE Department Seminar Series

Beyond the classroom, student learning is enhanced through an expanding program of lectures, seminars, colloquia and conferences brought to the University. Leading scholars from outside the Princeton community give lectures about exciting, leading-edge research in fields related to mechanical and aerospace engineering.

Katharina Kohse-Höinghaus, University of Bielefeld
Crocco Colloquium—Burning Issues and Bright Concepts: Some Aspects in Combustion Chemistry Research

Molly Stevens, Imperial College London
Baetjer Colloquium—Bio-responsive hybrid materials for regenerative medicine and biosensing

Lydia Bourouiba, Massachusetts Institute of Technology, *Unsteady fluid fragmentation*

Pierre-Thomas Brun, Princeton University
Building with Fluids, Lazy Design of Functional Materials

YuFeng Chen, Harvard University, *Manipulating interfacial physics for novel multimodal and multiphase insect-scale robots*

David J Cleary, Aramco Services, Detroit
Global Energy Demand and Opportunities to Reduce the Carbon Footprint of Transportation

Laura Collins, Cornell University
The Role of Atmospheric Turbulence on Cloud Processes

Chiara Daraio, California Institute of Technology
Morphing materials in freeform objects, at the micro- and macro-scales

Derek Dunn-Rankin, University of California, Irvine
Electric Field Effects on Laminar Diffusion Flames

V. Reggie Edgerton, University of California, Los Angeles, *How can neuromodulation immediately transform the physiological state of the spinal cord from complete to incomplete paralysis?*

Patricia Falcone '79, Lawrence Livermore National Laboratory, *Engineering and National Security*

Daniel Goldman, Georgia Tech, *Robophysics: robotics meets physics*

Cheng Gong, University of California, Berkeley
2D Magnets: Discovery, Challenges, and Opportunities

Anya Jones, University of Maryland, *Fundamentals of vortex formation on high advance ratio rotors*

Eva Kanso, University of Southern California
Cilia-driven Flows: from Mechanics to Biological Function

Scott Kemp, Massachusetts Institute of Technology
How Do You Solve a Problem Like North Korea?

Chris Kliewer, Sandia National Laboratories
Ultrafast Nonlinear Optical Diagnostics: Cross-Cutting Innovations for the Study of Combustion, Fluid Dynamics, and Catalytic Materials

Amy LaViers, University of Illinois at Urbana-Champaign, *Dancing With Robots: Expressivity in Natural and Artificial Systems*

Tian Li, University of Maryland, *Wood for energy and high temperature emerging technology*

Vicky Nguyen, Johns-Hopkins University
The thermomechanical behavior of glassy polymers: applications to modeling shape memory behavior and 3D-printed polymers

Celia Reina, University of Pennsylvania
Multiscale Modeling and Simulation: Some Challenges and New Perspectives

Nicole Sharp, FYFD, *From Memes to Molasses Floods: Adventures in Science Communication*

Alexandra Techet, Massachusetts Institute of Technology, *Jumping Archer Fish Hydrodynamics in 3D*

Patricia Schuster, University of Michigan
New Strategies in Radiation Detection for Nuclear Arms Control and Nonproliferation

Feifei Shi, Stanford University, *Structural and interfacial challenges in energy storage systems*

Jie Zhao, Northwestern University
Interfacial materials for electrochemical and biomedical devices

UNDERGRADUATES

Class of 2019 Senior Projects

Senior Thesis Projects are the culminating experience for the undergraduate mechanical and aerospace engineering programs. They participate, in teams, groups or individually, in a research or engineering project that includes elements of engineering design.

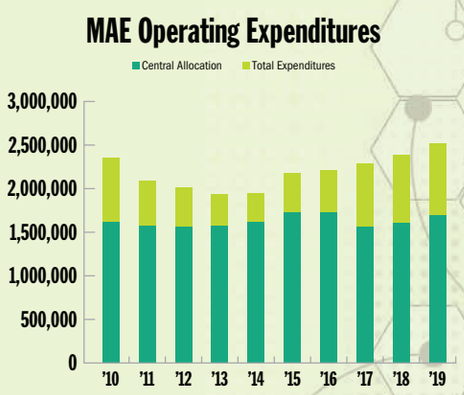
The Class of 2019 completed the following interesting and exciting year-long projects.

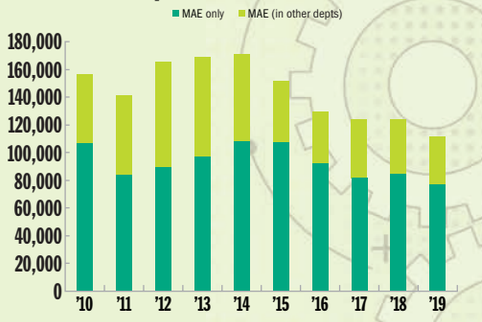
Individual Thesis Projects

Emily Achterkirch, *Analysis of Hockey Skate Blade Holders: An Investigation into Broken Skates by Reverse Engineering*
Billy Andrews, *Aerodynamic Analysis and Simulation of Drag Racing Motorcycle Bodywork*
Dylan Baroody, *Analysis of Soft Phononic Crystals: Using Machine Learning to Predict Compression using Transmission Data*
Mrudhula Baskaran, *A Study of Flow Separation in Micro and Milli-Channels*
Sami Belkadi, *AgriFlow: The Application of Elastic Filament Velocimetry to Water Flow Measurement and Control in Hydroponic Vertical Farms*
Nora Bradley, *Injection Molding: Process and Design Principles for 3D Printed Molds*
Daniel Chao, *Investigation into Computational Performance of a Multi-Modal Turbulent Combustion Model*
Katherine Denner, *Identification of Lithium Deposition and Characterization of State of Charge and State of Health in Extreme Fast Charge Cells using Ultrasonic Methods*
William England (Oxford), *Investigating the Effect of Separation of Row Aligned Wind Turbines on Power Production*
Diego Fierros, *A New Method for Inducing Strain in Living Tissue*
Teresa Irigoyen-Lopez, *Vertical Axis Wind Turbines: Analysis of Experimental Data at Full Dynamics Similarity*
Suren Jamiyanna, *Phosphor Crystal Materials: A Design of an Anti-Counterfeiting Feature*
Bartek Kaczmarski, *Mechanical Behavior of Pressurized Rods: 3D Shape Transformations of Rod Networks via Local Curvature Control*
Hemani Kalucha, *Detecting Life on Mars – Analysis of Deep UV Raman Spectrometer with Organics in Martian Soil Matrix*
William Kelly, *Gene Ark Design*
Lydon Kersting, *xPLOR: An Expandable Pack for Lightweight Outdoor Refuge*
Tanner Kliewer, *EMITD3D: A Laser Diode Array Approach to Metal Additive Manufacturing*
Jacob Lisner, *Development of an Economical Device to Perform Automated Venipuncture*
Larry Loprete, *Two Degree of Freedom Motion Simulator Design, Fabrication, and Analysis*
Jackie Macharashvili, *Measuring the Acoustics of the Interior of a Tesla 3 Automobile*
Coleman Merchant, *Princeton SpaceShot: Analysis, Design & Construction of a High Performance Two-Stage Sounding Rocket*
Nicholas Nelsonwood, *One-Axis Tracking for Roof-Mounted Residential Solar*
Caleb Owens, *Reconstructing the Past: Analysis, Design and Assembly of Arago's Disk*
Kendall Ratter, *TAG Lens Laser Experimentation*
Jorge Reyes, *An Affordable Navigation and Weed Detection System for Farming Robot*
Beni Snow, *Design, Simulation, and Testing of an ABS/GOX Hybrid Rocket Engine*
Nikita Turley, *ElectroMagnetic Intake Valve Actuation Using a Subwoofer*
Nicolas Viglucci, *Design and Construction of an Energy-Efficient Living Space*
Michael Whitmore, *Analysis and Closure of Dissipation Rates in a Physically Derived Reduced-Order Manifold for Turbulent Combustion*
David Wu, *Intelligent Audio Beam Locking for Source-Listener Isolation (one-semester)*

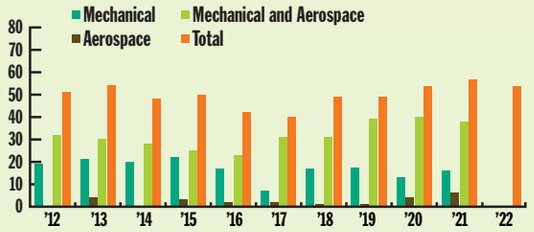
Team or Group Projects

Ashley Barnes, Adele Dimitui, & William Kittler, *Fixed-Wing UAV Autonomous Deployment for Search and Rescue Applications*
Tammy Benjapibal & Victoria Ou, *One Light Touch: A Simulation of the Sensory Cell Network in the Finger*
Robert Buline, Robbie Cohen, & Fred Zheng, *reOcean: An Active System for Removing Waste from the Oceans*
Will Hess &Alexander Hsia, *Parameter Identification and Adaptive Control of a Fixed-Wing UAV in the Longitudinal Mode*
Whitney Huang & Ramesh Gayatri/ELE, *Controlling Unmanned Aerial Vehicles in High Wind Speeds using Nano-Scale Thermal Anemometry Probes*
Spencer Kyrczka, Connor Roettig, Joshua Teves, & Max Veronneau, *Hybrid Performance Golf Cart: Examining the Feasibility of Low-Budget Hybrid Engines*
Mario Liu & Nadir Noordin, *Autonomous Quadcopter Navigation using Depth Camera and Real-Time Kinematic GPS*
Curtis Merrill, Joseph Puryear, & Serg Zhelezniak, *Dynamic Thrust and Vector Control of a Small Scale Turbojet Engine*
Jeremy Spiezio & Matias Supervielle, *The Sound of Silence: A Preliminary Investigation into the Effects of Blade Row Spacing in Counter-Rotating Propellers on the Sound Intensity in the Near-Field*





Mechanical & Aerospace Engineering
Undergraduate Actual Enrollment by Concentration by Class Year



MAE supports the education of 179 undergraduate students from the U.S. and around the world, preparing them for a career or further study. In addition to getting exposure to vast learning resources through our faculty and research staff, students also have the chance to apply their discipline to their own projects and/or collaborate with MAE classmates and students in other disciplines.

GRADUATE

Graduate Programs in MAE

The majority of outstanding technical problems in today's science and engineering fields require a multi-disciplinary research approach at the intersection of engineering, physics, chemistry, biological science, and applied mathematics. Our 101 graduate students, who can earn a PhD or MSE, stand at the center of these challenges. Through their research and study, they contribute new knowledge in mechanical and aerospace engineering to answer the challenges to important societal, scientific, and industrial problems.

2018-19 Graduate Students

Qiang Chen, PhD
Advisor: Szymon Suckewer
Thesis: Stimulated Raman Back-Scattering and Self-Guiding of Femtosecond Laser Pulses
William Coogan, PhD
Advisor: Edgar Choueiri
Thesis: Thrust Scaling in Applied-Field Magnetoplasmadynamic Thrusters
Position: Project Manager, Orbital Transfer Vehicle, Firefly Aerospace, Cedar Park, Texas
Elizabeth Davison, PhD
Advisor: Naomi Leonard
Thesis: Synchronization and Phase Locking in Networks of Heterogeneous Model Neurons
Position: Data Scientist, The Aerospace Corporation, El Segundo, California
Matthew Edwards, PhD
Advisor: Julia Mikhailova
Thesis: Ultrafast Sources of Intense Radiation
Position: Lawrence Fellow, Lawrence Livermore National Laboratory, Livermore, California
Daniel Floryan, PhD
Advisors: Clarence Rowley, Alexander Smits
Thesis: Hydromechanics and Optimization of Fast and Efficient Swimming
Position: Postdoctoral Research Associate, University of Wisconsin, Madison, Wisconsin
Matthew Fu, PhD
Advisor: Marcus Hultmark
Thesis: Measuring and Modifying the Near-wall Behavior of Wall-bounded Turbulence
Position: Postdoctoral Researcher, University of Melbourne, Melbourne, Australia (7/2019); Postdoctoral Research Associate, Mechanical and Aerospace Engineering, Princeton University
Remi Kahwaji, MEng
Advisor: Alexander Glaser
Position: Engineering Project Manager, Dassault Falcon Jet Corporation, Little Ferry, New Jersey
Ching-Yao Lai, PhD
Advisor: Howard Stone
Thesis: Fluid-Structure Interactions for Energy and the Environment
Position: Lamont Postdoctoral Fellow, Lamont-Doherty Earth Observatory, Columbia University, Earth Institute, Palisades, New York
Peter Landgren, PhD
Advisor: Naomi Leonard
Thesis: Distributed Multi-agent Multi-armed Bandits
Position: Software Development Engineer, Amazon.com, Inc., Seattle, Washington
Weiyu Li, MSE
Advisor: Yiguang Ju
Thesis: Flame Dynamics in Supercritical Conditions
Mark Miller, PhD
Advisor: Marcus Hultmark
Thesis: High Reynolds Number Horizontal and Vertical Axis Wind Turbine Experiments
Position Assistant Professor of Aerospace Engineering at the Pennsylvania State University, University Park, Pennsylvania (8/2019); Postdoctoral Research Associate, Mechanical and Aerospace Engineering, Princeton University
Cody Nunno, PhD
Advisor: Michael Mueller
Thesis: Reduced-Order Manifold Models for Non-Adiabatic Turbulent Combustion (5/14/2019)
Position: Postdoctoral Research Associate, Argonne National Laboratory, Lemont, Illinois
Bruce Perry, PhD
Advisor: Michael Mueller
Thesis: Computationally Efficient Large Eddy Simulation of Multi-Stream Partially Premixed Turbulent Combustion
Position: Postdoctoral Researcher, National Renewable Energy Laboratory, Golden, Colorado
Christopher Reuter, PhD
Advisor: Yiguang Ju (Michael Mueller will comment)
Thesis: Chemistry and Dynamics of Counterflow Cool Flames
Position: Postdoctoral Fellow, Air Force Research Lab, Wright-Patterson Air Force Base, Dayton, Ohio
Sandra Sowah, MSE
Advisor: Howard Stone, Michael Mueller
Thesis: Laminar and Turbulent Secondary Flow Profiles for Curved Pipes of Constant Radius of Curvature
Emre Turkoz, PhD MAEMS
Advisor: Craig Arnold
Thesis: High-Resolution Printing of Complex Fluids Using Blister-Actuated Laser-Induced Forward Transfer
Position: Research Physicist, Exxon Mobil Corporate Strategic Research, Clinton, New Jersey
Joseph Tylka, PhD
Advisor: Edgar Choueiri
Thesis: Virtual Navigation of Ambisonics-Encoded Sound Fields Containing Near-Field Sources

Graduate Student Fellowships and Awards

DEPARTMENTAL:
Anastasia Bizyaeva, *Phillips Second Year Fellowship*
Xiaohan Du, *Guggenheim Second Year Fellowship*
Kerry Klemmer, *Guggenheim Second Year Fellowship*
Katherine Kokmanian, *Harari Post Generals Fellowship*
Udari Madhushani, *Athena-Feron Award*
Udari Madhushani, *Summerfield Second Year Fellowship*
Alex Novoselov, *Crocco Award for Teaching Excellence*
He Sun, *Harari Post Generals Fellowship*
Nan Xue, *Harari Post Generals Fellowship*
Omar Yehia, *Harari Post Generals Fellowship*
Yingxian (Estella) Yu, *Larisse Rosentweig Klein Award*
Hongtao Zhong, *Sayre Award for Academic Excellence*
UNIVERSITY:
Daniel Floryan, *Porter Ogden Jacobus Graduate Honorific Fellowship*
Ying Liu, *Charlotte Elizabeth Procter Graduate Honorific Fellowship*
Tasman Powis, *PEI-STEP Fellowship*
Yingxian (Estella) Yu, *PEI Mary and Randall Hack Fellowship*
EXTERNAL:
Claudia Brunner, *National Defense Science and Engineering Graduate*
Danielle Chase, *National Science Foundation*
Elizabeth Davison, *National Science Foundation*
David Feng, *National Defense Science and Engineering Graduate*
Kelly Huang, *National Defense Science and Engineering Graduate*
Justice Mason, *GEM Fellowship*
Samuel Otto, *National Science Foundation*
Bruce Perry, *National Science Foundation*
Aric Rousso, *National Defense Science and Engineering Graduate*
Anthony Savas, *National Defense Science and Engineering Graduate*
Vivian Steyert, *National Science Foundation*

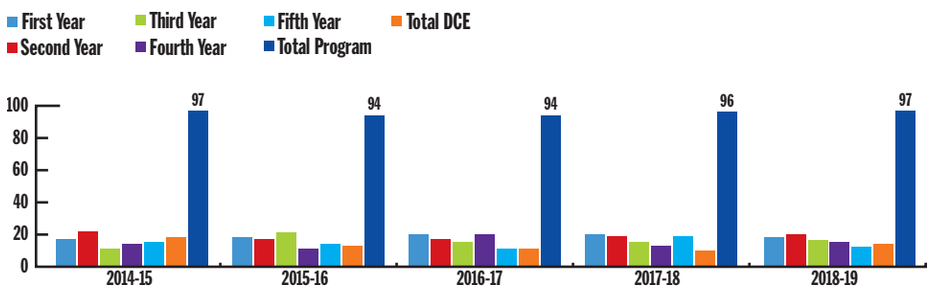
Graduate Program Professional Development

Complementing academic offerings, the department provides programming to promote student success in research, teaching, career development and professionalism. Students can participate in a number of workshops to develop skills in areas such as public speaking, writing, research and explore post-graduation possibilities.

Alumni Career Panel

Jing Du '12, *Assistant Professor of Mechanical Engineering, Penn State University;* **Sandeep Mulgund '94**, *Principal Scientist, The Mitre Corporation;* **Gunter S.Schemmann '00**, *Project Development Manager in the Battery Storage Group, Con Edison Clean Energy Businesses;* **Barry Zhang '94**, *CEO Princetel, Inc.;* **Anastasia Bizyaeva**, *Graduate Student, Flexible Task Allocation Dynamics for Multiple Agents;* **Claudia Brunner**, *Graduate Student, Dynamic Effects on Airfoil Performance Under Unsteady Inflow Conditions at High Reynolds Numbers;* **Christopher Burger**, *Graduate Student, Solid-gas Reactions of Copper-Oxide Particles with Hydrocarbons;* **Wesley Chang**, *Graduate Student, Understanding Structural Development of Electrodeposited Lithium Metal;* **Danielle Chase**, *Graduate Student, Fluid Driven Fracture in a Porous Medium;* **Xiaohan Du**, *Graduate Student, Modeling and Optimization of the TAG lens;* **Daniel Dudt**, *Graduate Student, Definition of Stellarator Equilibrium with Minimal Unknowns and its use for Numerical Applications;* **Nicholas Fasano**, *Graduate Student, Particle-in-cell Simulations of Electron Bunch Formation During Relativistic Laser Plasma Interactions;* **Alexander Glaser**, *Associate Professor, Trying to Save the World from the Nuclear Apocalypse: Research Opportunities in MAE's Laboratory for Science and Global Security;* **Susanne Killian, Ph.D.**, *Senior Associate Director of Graduate Student Career Development, Career Services, Virtual Career Panel; Mapping Your Skills to Careers and Job Descriptions;* **Brandt Belson, PhD**, *Tonal, Senior Data Scientist;* **William Coogan, PhD**, *Firefly Aerospace, Project Manager;* **Elena Krieger, PhD**, *Physicians, Scientists and Engineers for Healthy Energy, Director, Clean Energy Program;* **Kerry Klemmer**, *Graduate Student, Uncertainty Quantification of RANS Closure Models Using Model Error Transport;* **Courtney Kohut**, *Business Manager, MAE Business Center: Traveling and Getting Reimbursed;* **Andrej Kosmrlj**, *Assistant Professor, Mechanical Instabilities in Growing Biological Systems: Wrinkling and Branching;* **Jinyoung Lee**, *Graduate Student, Unified Manifold-Based Approach to Modeling Turbulent Combustion in LES;* **Jason Liu**, *Graduate Student, Confined Crystallization of Polymers;* **Udari Madhushani**, *Graduate Student, Multi-agent Dynamics in Multi-armed Bandit Problem with Heterogeneous Stochastic Interactions;* **Gigi Martinelli**, *Professor, CFD: Engineering at the Intersection of Numerical Mathematics, Scientific Computing and Fluid Dynamics;* **Julia Mikhailova**, *Assistant Professor, Waveforms of Light;* **Michael Mueller**, *Associate Professor, So You Want to be a Professor...;* **Alberto Padovan**, *Graduate Student, Understanding and Modelling Nonlinear Mechanisms in Flow Separation;* **Juliane Preimesberger**, *Graduate Student, Piezoelectrochemical Effect in Commercial Lithium Ion Batteries;* **Amy Pszczolkowski**, *Assistant Dean for Professional Development, Graduate School, PhD. Long-term Career Outcomes – Where do grad alumni go? How can I find them?;* **Daniel Ruth**, *Graduate Student, Bubble Dynamics in Turbulence;* **Robert Stengel**, *Professor, Project Apollo: Origins, Missions, and the Legacy;* **Nic Vog**, *Senior Associate Director, ULP, McGraw Center for Teaching and Learning, Productivity and Time Management;* **Madeline Vorenkamp**, *Graduate Student, Aerospike Rocket Nozzle;* **Jessica Wilson**, *Graduate Student, Electrolyte Diffusiophoresis in One-Dimensional Salt Gradients;* **Hongtao Zhong**, *Graduate Student, Plasma-Assisted Low-Temperature Combustion: Kinetics and Stability*

Mechanical & Aerospace Engineering
Graduate Actual Enrollment by Year (PhD)



Year in Review *continued from page 7*

June 2019

Princeton team participates in NASA's Micro-g NExT Competition
The annual NASA design competition challenges undergraduate students to design, build and test a tool or device to function in microgravity environments over the course of a year. The Princeton Rocketry Team, which is competing in the Mini-Arm End-Effector challenge, designed and built a device that uses a granule-filled bag that can go between malleable and rigid states to achieve grip. It is designed to interface with a robotic arm that has been designed by NASA Jet Propulsion Laboratory (JPL) scientists and engineers. The winning device will be used to handle samples underwater on missions to ocean worlds like Europa and Enceladus. The team is comprised of team leader Nina Arcot (MAE) and Alex Rogers (MAE), Whitney Huang (MAE), Kyle Johnson (ELE), Cindy Li and Hoang Le (Prospective ELE '22), Alexander Essig (Woodrow Wilson), Jacob Essig and Elizabeth Petrov (Prospective COS '22), Thomas McBride, Shaylee McBride, and Andrew Xu (Prospective MAE '22).

Witt wins the 2019-B MolSSI Seed Software Fellowship
Chuck Witt, PhD, was named one of the Molecular Sciences Software Institute's seven fellowship winners. Recipients receive six months of support and mentoring by the MolSSI's Software Scientist team.

Rousso receives first prize for the best oral presentation at the 24th International Symposium on Plasma Chemistry
MAE graduate student Aric Rousso, who is advised by Prof. Ju, spoke on "Kinetic Effect of Hydrocarbon Oxidation on Filamentary Instabilities in Nanosecond-pulsed Plasma Discharges" at the symposium held in Naples, Italy.

Brunner awarded 2019 PEI-Step Graduate Fellowship
Graduate student Claudia Brunner's topic is "Offshore Wind Energy in the United States — From Burgeoning

Technology to Competitive Market Force?" She will xamine the federal policies supporting the establishment and growth of this energy resource as well as the sector's potential for success.

Madhushani wins President's Award for Scientific Research
Doctoral student Udari Madhushani was given the award by the National Research Council of Sri Lanka, which recognizes Sri Lankan scientists whose research is published in top-ranked journals.

Smits receives 2019 Fluid Dynamics Prize
Alexander Smits, the Eugene Higgins Professor of Mechanical and Aerospace Engineering, Emeritus, was recognized by the American Physical Society for his "transformative contributions to the measuring and understanding of wall turbulence in extreme Reynolds and Mach number regimes, for pioneering research on bio-inspired propulsion, and in recognition of exemplary technical leadership, mentoring, and community service." He will give his award lecture in Seattle at the Annual Division of Fluid Dynamics Meeting, November 2019.

PRINCETON
UNIVERSITY

MECHANICAL AND
AEROSPACE ENGINEERING
PRINCETON, NJ 08544