MAE news

School of Engineering and Applied Science
PRINCETON

MECHANICAL AND AEROSPACE ENGINEERING

Spring 2020 Volume 2

Dear friends of MAE –

I hope that this note finds you all healthy and well, though I am aware that many have been affected by Covid-19. As you now know, Princeton University shutdown all on-campus activities as Spring break arrived. The University implemented social distancing and work from home well before the State of New Jersey. The last six weeks of the semester were fully remote, faculty, staff, and students all made adjustments in real time (as was true almost all across the US and in most countries). This was especially challenging for seniors completing their thesis, as well as other students pursuing independent work, design courses and projects, etc.. The ingenuity, exceptional ability and hard work of our students helped to make the most of a difficult situation. Soon our class of 2020 will be graduating and the seniors will take the next steps in their career, though they enter a world and work place very different than even the beginning of 2020. We plan to welcome them back in person to campus next Spring 2021 for a proper graduation. In response to the health emergency, several MAE projects and contributions sprung up, as was true in several departments on campus, and in many universities and departments across the country. We will need this ingenuity (the origin of the word engineering) as we tackle the next phases of work, classes, and campus life, etc.. We are now anticipating the next steps in returning to work, re-opening labs, libraries, etc. and beginning plans for what education next fall might look like. Stay in touch and best wishes to you and yours as we tackle together the challenges ahead.

Best regards, Howard Stone

In this issue...

student spotlight

Maya Naphade

Helping Others, Space Travel, and Laser Diagnostics

It is hard to miss Maya Naphade. She is one of the brightest stars in the lab, and bravest faces in the crowd. Every year around St. Patrick's Day, the Princeton senior shaves her head to raise money for pediatric cancer research and show solidarity with children affected by cancer. She was inspired to start the tradition in high school by a teammate on the swim team. Says Maya: "I have always had this strong desire to help other people."

Her passion for giving back has defined Maya both personally and professionally. Fascinated with the human body as a child, she thought being a doctor was the best way to aid those less fortunate for a long time. However, during her junior year of high school, Maya was invited by the Society of Women Engineers

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grad program info

IN OUR PhD PROGRAM

All PhD students are fully supported with tuition and a living expense stipend during the entire program. A First Year Fellowship covers tuition and stipend in year one. The remaining years of the program are fully funded through a combination of teaching and research support provided by the student's adviser. As a candidate for the doctoral program, the student, in consultation with a faculty adviser, develops an integrated program of study which culminates with a dissertation showing technical mastery of their chosen field and contribution to the advancement of knowledge, followed by a public presentation of the material. Princeton's Department of Mechanical and Aerospace Engineering has played a leading role in propulsion, combustion, aerospace dynamics, and fluid dynamics over the past half century. In recent decades the Department has extended its reach as a leading presence in dynamics and control, robotics, biomechanics, applied physics, and materials science. By exploiting its multi-disciplinary character and stressing science and engineering fundamentals, the Department seeks to educate the very best students – undergraduate and graduate - for future positions of leadership in areas of rapidly evolving technology.

GET MORE INFO

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mae.princeton.edu

faculty spotlight

Jesse Jenkins, PhD
Transforming Energy Systems

For newly appointed faculty member Jesse Jenkins, PhD, producing relevant, high-impact research about how to transform our energy systems requires an unexpected tool: Twitter. With nearly 24,000 followers on the platform, Jenkins engages daily with leading thinkers and practitioners in the field.

"I became an academic to learn, create, and apply energy modeling tools to answer questions from decision-makers," said Jenkins, assistant professor of mechanical and aerospace engineering at the Andlinger Center for Energy and the Environment. "My best research questions have come out of conversations with policy makers, utility strategists, venture capitalists, and non-profit organizations working on public policy, the answers to which could dramatically impact the changing energy landscape."

Jenkins' work focuses primarily on energy systems engineering. "I think about how different energy technologies fit together and interact with one another on a regional or national scale, with a particular focus on the electricity sector and the role of electricity in decarbonizing the overall economy," he explains.

Most strategies for addressing climate change and limiting global warming, Jenkins says, rely on transitioning fully to carbon-free electricity sources and then expanding the role electricity plays in society. What sets Jenkins apart from other researchers is that he is not focusing on solving fundamental chemistry or material science challenges. Instead Jenkins is developing models that explore how this transformation could actually occur within the electricity sector, in areas like transportation, for example.

"I try to find the lowest-cost way to build out the electricity system, given different assumptions about the price and performance of technologies, while taking into account the engineering constraints that we need to meet to keep the grid reliable," he explains.

In addition to his high profile on social media, Jenkins has been featured in several major media outlets about his work in energy transitions and pathways to decarbonization. He started his first blog as a junior in college and encourages students to communicate with the public about research topics. Says Jenkins: "If you share something you learn, it can have a greater impact and you can get much more rapid feedback on what you have learned." ¤

student spotlight *continued*

to attend an event at Princeton. The keynote address was on epidemiology and the students made a model that showed how inoculations can spread through a population to eradicate disease.

"Until then, medicine and math had always been two separate disciplines in my head. But soon I realized engineering could be used to further medicine on a larger scale. As a doctor I could treat individual people, where as an engineer I could institute more widespread change," she says.

Throughout her undergraduate career, Maya has worked extensively in advanced laser diagnostics. As a research assistant in the Princeton University Applied Physics Group, Maya updated a pulse-burst laser system used to conduct gas flow diagnostics. During her internship with the Laboratoire de Physique des Plasmas at École Polytechnique in France, she commissioned a device to reliably shorten laser pulses. Maya is also a member of the Princeton Rocketry Club, Society for Women Engineers, and Special Olympics Rowing Program.

While she enjoyed working in laser diagnostics, Maya missed the idea of research being used to better humanity in a more tangible way. Along with medicine, she had long been fascinated by space exploration. Some of her fondest childhood memories involve poring over atlases with her parents and studying photos of the storms on Jupiter.Searching for inspiration, Maya applied to the Matthew Isakowitz Fellowship Program, which pairs students who are passionate about the exploration of the universe with positions in the commercial space industry. Maya was placed at her dream company, Virgin Galactic, and was involved in the maintenance and operation of Spaceship Unity and Mothership Eve.

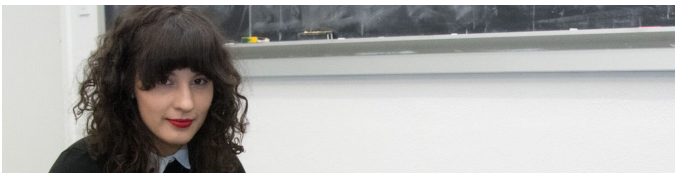
Someday, Maya, who will start a job at Virgin Galactic after graduation, hopes to see the world from the outside firsthand. During her internship, there was a raffle for a spot on one of the flights. Keep your fingers crossed and maybe one day they will pull her lucky number. ¤

a word from the lab

APPLIED PHYSICS ▫ DYNAMICS & CONTROLS ▫ FLUID MECHANICS ▫ MATERIALS SCIENCE ▫ PROPULSION & ENERGY SCIENCES

Anastasia Bizyaeva

My Favorite Language is Math



When Anastasia Bizyaeva moved from Siberia to Southern California in middle school, she was the only Russian-speaking student. It was difficult for her to communicate at first, but Anastasia quickly discovered a universal language that transcended all borders: math.

Everyday socialization and group interactions, concepts Anastasia would study later as a researcher, helped her best learn the language. As a third-year PhD student working in the Dynamical Control Systems Lab, the goal of Anastasia's research is to help create a new approach to coordinate collective decision-making in intelligent systems. This process, she explains, can be very difficult to replicate in an engineered collective.

"What I am really exploring is how can we design a way for artificial systems, such as networks of self-driving cars, to make collective decisions that are very sensitive, robust, and flexible at the same time," says Anastasia. "Systems in nature have a remarkable ability to be very flexible and reactive to relevant changes in the environment, but also very robust in the sense that they can filter out irrelevant information and ignore it as a group." ¤

Alex Novoselov

Wins First Place Research Day Prize for Cool Flame

Taking home an unexpected first-place prize at the annual Mechanical & Aerospace Engineering (MAE) Research Day was the perfect way for Alex Novoselov to culminate nearly five years of graduate work at Princeton. His research involving cool flames, which exist alongside hot flames in real-world combustion devices like diesel engines, is unique because it is being studied in the context of a real, turbulent system. Using computational models, Alex is evaluating how relevant cool flames may be to actual systems in cars, airplane engines, or gas turbines.

Direct Numerical Simulation (DNS) is too expensive to simulate an entire system. Instead, Alex uses the DNS results to develop models for Large Eddy Simulations (LES), which he refers to as "the little brother of DNS". In LES, the governing equations are filtered so they become less expensive to solve. With LES, engineers are able to simulate the most critical aspects of a real engine model.

"The biggest takeaway so far is our conventional models work for both hot and cold flames. This tells us that engineers who want to study this phenomenon in a real system can use the tools they have knowing they are not missing any sort of physics," explains Alex. ¤

Mohamed El Hedi Bahri

For the Love of Math

Having grown up with two mathematician parents, Mohamed El Hedi Bahri was raised to question everything and gain understanding of details through math and physics. The fourth-year PhD student in Statistical Mechanics is exploring how mechanical properties like graphene are influenced by temperature. "The effective bending rigidity of these graphene sheets grows larger and larger," describes Mohamed of the two-dimensional structure. "This behavior is quite anomalous in the world of mechanics." His theory-based research has important applications for nanomaterials. ¤

awards and honors

Michael Mueller –
receives the Research Excellence Award from the Combustion Institute

Anirudha Majumdar –
receives the Google Faculty Award

Mikhail N. Shneider –
receives the 2020 American Institute of Aeronautics and Astronautics Plasmadynamics and Lasers Award

For full stories, visit: http://mae.princeton.edu/about-mae/spotlight

PRINCETON UNIVERSITY

Mechanical & Aerospace Engineering
Engineering Quad - D Wing
Princeton University 08544

events: spring 2020

May 29, 2020
VIRTUAL HOODING
May 31, 2020
VIRTUAL COMMENCEMENT

Visit **mae.princeton.edu/about-mae/events** for event updates and location information. Events are free and open to the public.

Newsletter Editor: Carolyn Sayre

Announcements

Three MAE Undergrads Selected for Matthew Isakowitz Fellowship Program

The Matthew Isakowitz Fellowship Program, a summer internship and executive mentorship program inspiring the next generation of commercial spaceflight leaders, announced three MAE Undergraduates as recipients:

DOUGLAS CHIN
MEREDITH HOOPER
MICHAEL HAUGE

Five Undergraduate Students Selected for Brooke Owens Fellowship

We are excited to announce that out of 566 applicants from 290 Universities in 15 countries, five undergraduate students from MAE were among the 40 selected to receive a Brooke Owens Fellowship. The MAE recipients are:

SOPHIE AMITON
SHANNEN PRINDLE
SAMARIE WILSON
NINA ARCOT
BEIMNET SHITAYE

MAE responds to COVID-19: The Covid-19 crisis has affected communities across our country and indeed throughout the world. The situation has changed very quickly and, as you have likely read, New York City and New Jersey have been impacted greatly. Many members of the MAE community have been engaged in helping our community, and I am sure that I do not even know everyone involved in these efforts. Daniel Cohen and his research group rapidly started to prepare PPE for local hospitals, and also launched a design for a new ventilator, informed by Daniel's strong connections to the local medical community. Also, our talented technicians, Al Gaillard, Glenn Northey and Jon Prevost contributed their skills to various projects including PPE and the design of backup ventilators based on ambubags. Finally, some of our students and postdocs are joining an effort based in the Princeton Neuroscience Institute to 3D print swabs to help meet the need at local hospitals and several in our community are contributing to a Physics-led rapid-build effort to design part of a mechanical ventilator for the Princeton-Penn Medical community. We are all looking forward to the day when these difficult times are behind us. Stay well.