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

events: fall 2017

October 6 – 4:00pm
"Stretching Battery Utilization using Novel Stress/Strain Models and Measurements."
ANNA G. STEFANOPOULOU, University of Michigan, Ann Arbor

October 13 – 4:00pm
"Turbulent Combustion Modeling: A Combustion Perspective and a Turbulence Perspective"
MICHAEL MUELLER, Princeton University

October 20 – 4:00pm
"Investigations of Turbulence: a Journey from Nanometer to Kilometer"
MARCUS HULTMARK, Princeton University

October 27 – 4:00pm
"Microsystems-inspired Robotics"
SARAH BERGBREITER, University of Maryland

November 10 – 4:00pm
"Numerical Models of Surface Tension"
STEPHANE POPINET, Institut d'Alembert, Universite Paris Sorbonne

November 17 – 4:00pm
"Picking the Right Tools for the Job: Experimental Diagnostics for Reacting Flows and Thermoacoustics"
SIMONE HOCHGREB, University of Cambrige

December 1 – 4:00pm
"Hairy Hydrodynamics"
Crocco Colloquium Speaker, PEKO HOSOI, MIT

December 8 – 4:00pm
"Passive Dynamics is a Good Basis for Robot Design and Control, Not!"
ANDY RUINA, Cornell University

events: spring 2018

Friday, February 5
CHRIS KLIEWER
Sandia National Laboratories

Friday, February 16
DAVID LENTINK
Department of Mechanical Engineering, Stanford University

Friday, February 23
ELLEN KUHL
Department of Mechanical Engineering, Stanford University

Friday, March 30
CAMBELL CARTER
Air Force Research Laboratory

Friday, April 6
Baetjer Colloquium
SUNNEY XIE
Department of Chemistry and Chemical Biology, Harvard University

Friday,April 20
DENNICE GAYME
Department of Mechanical Engineering, Johns Hopkins University

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

MAE news

School of Engineering and Applied Science
PRINCETON

MECHANICAL AND AEROSPACE ENGINEERING
Fall 2017

Welcome to the 2017 Fall edition of MAE News. Classes kicked off in September and within a few days the halls, labs and classrooms were buzzing with lectures, projects and seminars. MAE welcomed 20 new graduate students, Ani Majumdar joined us as a new Assistant Professor in the robotics area, Lamyaa El-Gabry joined us as a new lecturer (this semester she is teaching undergraduate thermodynamics) and Louis Gonzalez (Embry-Riddle Aeronautical University) is visiting Assistant Professor for Distinguished Teaching for academic year 2017-18. A few of the talented members of our community are highlighted in this newsletter. We look forward to staying in touch with you.

—Howard Stone, MAE Chair

student spotlight

Mattie Baron
Displaying Intuition in the Lab and on the Track

Mattie Baron's dual-identity as a junior MAE major and a sprinter on the Track and Field team seems to be rooted in a passion for empirical problem solving.

"I think of track as a lot like engineering because each training cycle you try something and say, 'okay, what was I missing here?' Then you have the next cycle to tinker with something to see if it makes you better or faster."

It is this thoughtful scrutiny of situations to assess how to solve a problem that makes Mattie tick. Her penchant for engineering—and sprinting—started in Colorado Springs where Mattie's parents are in the aerospace field. Her father is a satellite engineer and her mother is a professor. Her high school cross-country coach also happened to teach AP physics. And it didn't hurt that Mattie was the fastest kid on the playground.

Mattie, however, brings something else to the table. Daniel Nosenchuck, PhD, Associate Professor in MAE, calls it an engineer's intuition.

"Intuition is not something one is born with, as the word might suggest, but rather something that is instilled in an engineer over time through experience. Mattie seems to have that maturity now. It's quite unusual," he says.

...continued p. 2

In this issue...

grad program info

JOIN 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 in preparation for a comprehensive general exam, which is normally taken in January of the second year. Subsequent to passing the exam, the student prepares 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, 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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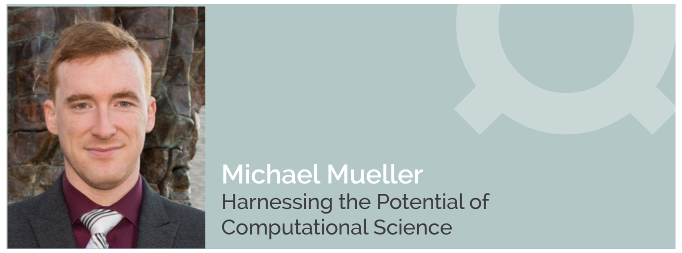
Alex Glaser, Associate Professor & Director of Graduate Studies, aglaser@princeton.edu

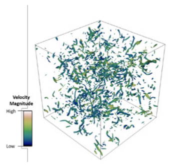
Jill Ray, Graduate Administrator, jfray@princeton.edu

mae.princeton.edu

faculty spotlight



It is hard for Michael Mueller, PhD, to remember a time before he "talked shop." As a combustion engineer, Professor Mueller says he is undoubtedly a product of his environment—his father was a mechanical engineer and his mother was a chemist.

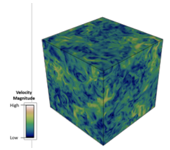

Vorticity

Ever since he interned in NASA's Jet Propulsion Laboratory, Professor Mueller has been fascinated with computational engineering. For him, the raw potential of developing models and performing simulations on high-speed super computers that could solve complex engineering problems was truly a way to transform the field.

"For me, the unstructured and creative aspects of this type of research were not only fascinating, but critical to the betterment of science. Today, every area of engineering—not just fluid mechanics and combustion—is beginning to lean heavily on computational science," he says.

In his laboratory, Professor Mueller develops better computational models for combustion systems such as automobile engines, jet engines, and gas turbines. His aim is to develop predictive models that could be used to design practical combustion systems computationally— similar to what is done for external aerodynamics of aircrafts.

"Compared to experimental prototyping, computational design is potentially faster, less expensive, and can lead to more optimized systems with higher efficiency and lower emissions," explains Professor Mueller.


Velocity field

His goals are threefold. First, develop generalized—yet computationally efficient—models to describe "turbulent combustion." Current models are either computationally expensive and general, or computationally efficient and very restrictive. Second, create models for turbulence in the presence of combustion. Lastly, generate models for pollutant formation—particularly soot and nitrogen oxides—in turbulent combustion.

Research aimed at reducing pollutants is particularly inspiring for Professor Mueller. As an engineer—and a bit of an outdoorsman—he has always felt a strong responsibility to help preserve the environment for future generations.

The opportunity to shape young engineering minds to think about sustainable solutions for our society is what drew him to Princeton. Computational science, he believes, will be a major driver in these endeavors. Says Professor Mueller: "We are just beginning to understand the potential of what computers can do." ¤

student spotlight *continued*

"When you talk to Mattie, she's looking at you and listening, but she's almost looking beyond you to a picture she's attempting to form in her mind until she has the epiphany that allows her to move forward."

While intuition is hard to put your finger on, there is some consensus about how Mattie draws on her knowledge and makes inferences—whether she is in a heat transfer class or on the track. Both Professor Nosenchuck and her track coach, Reuben Jones, describe Mattie the same way: extremely tenacious in her desire to understand.


India students

But Mattie's desire to problem solve is not for herself. She's only satisfied if that understanding can help others.

"When I was little, I wanted to be a doctor," she says. "I guess that's carried over into what excites me now—helping people through some combination of medicine and engineering."


Surgery shadow

Last summer, Mattie worked in the engineering division of the Mayo Clinic, designing surgical tools, working with their laser cutter to experiment on different types of materials, or running jobs for their 3-D printer. Mattie has also recently joined Professor Alexander Smits' Fluids Mechanics lab, conducting research on a hemolysis meter—a device that could more efficiently measure damage to the blood by measuring blood's conductivity. Last summer, she taught English in India through Princeton's International Internship Program.


India teaching

"Teaching is still on my radar. Maybe coaching, too," she says. That's good news for curious young tinkerers outrunning their friends on the playground. ¤

a word from the lab

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

Bec Gray
Observing Natural Systems

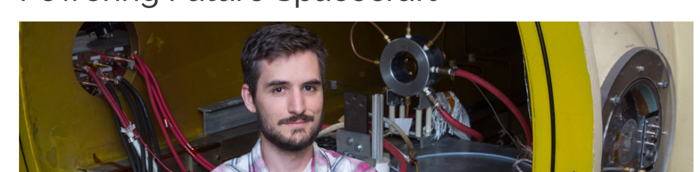
It is Wednesday morning and Bec Gray is ready for her latest presentation. Only this time her audience isn't the usual group of scientists studying multi-agent systems—it is a fourth-grade class. As part of an elective course, the third-year PhD student is teaching young students how engineering can be used to help others.

Bec's research also approaches biological problems from an engineering perspective. Her work focuses on developing mathematical models for collective decision-making inspired by observing natural systems, such as house-hunting honeybees. Many natural systems, like honeybees, can be studied by considering the evolution of their equilibria with respect to the various system parameters.

"My role is to think about this natural process from a control engineering perspective—what is coming into the system, what is going out of the system, and what happens in the middle to make the process work," she says.

Bec's insights have important applications for robotic systems. For example, search and rescue robots sent out to find survivors or collect information after a natural disaster have to make decisions about where to search based on the information they observe directly. ¤

Pierre-Yves Taunay
Powering Future Spacecraft



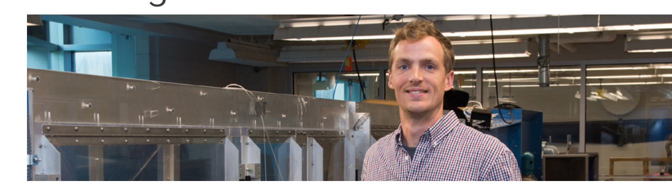
When Pierre-Yves Taunay looks up at the sky, he thinks about how we can get there faster and stay there longer. As a third-year PhD student, he is conducting basic research that is needed to develop the next generation of electric propulsion technology.

Pierre-Yves works with hollow cathodes, which provide electrons to ionize the propellant used by the thrusters; and in the case of ion thrusters, neutralize the exhaust ion beam. "Without them," he says, "most plasma thrusters would not work."

His goal is to figure out how to extend the life of these hollow cathodes by working with some of the largest experimental designs in the field. The first hurdle has been the durability of the materials—the exterior heater of the cathode operates at 2,500 degrees Fahrenheit.

Pierre-Yves's team is using a heat-resistant type of stainless steel called RA 253 MA for the electrical connection to the heater. "We have been able to draw 400 A of current for the cathode, which is in line with the requirements for the next generation of electric thrusters," he says. "We affectionately call it crazy steel." ¤

Mark Miller
Modeling Wind Turbines



As a boy, Mark Miller was always fixing things in the house. As a PhD student, he tinkers around on a larger scale—studying wind turbines in unprecedented detail.

Since wind turbines can be as big as two football fields, they can be difficult to study. To solve that problem, Mark's team developed a scaled-down model that matches the aerodynamics of full-size wind turbines. So far, Mark's experiments have produced useful information about the flow structure around the turbines. ¤

awards

Emily Carter is the recipient of the Irving Langmuir Prize in Chemical Physics, American Physical Society

Marcus Hultmark and **Claire White** received NSF Career Awards

Naomi Leonard is the recipient of the Hendrik W. Bode Lecture Prize, IEEE Control System Society

Howard Stone is the recipient of the Fluid Dynamics Prize of the American Physical Society

Michael Mueller is the recipient of the Army Research Office Young Investigator Program Award

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