



Students take flight in new private pilot course

In fall 2014, the Department of Engineering Physics began offering a new course to expand the hands-on educational opportunities for engineering mechanics and astronautics students.

Duane H. and Dorothy M. Bluemke Professor and Engineering Physics Chair Jake Blanchard says the course, EMA 601: *Introduction to Private Pilot*, is of interest to students pursuing astronautics because some of those students go on to work at employers like Boeing or UTC Aerospace Systems.

Instructor Chris Johnson says he believes courses like this help engineering students stand out when applying for jobs. "This course is valuable for engineering students, because it gives them hands-on experience with applied physics," Johnson says. "Learning how to fly involves learning about applied physics, mechanics, automated systems, and engineering-design limitations as well as standard operating procedures, FAA regulations and cognitive behavior, and having that experience can differentiate students."

The course teaches students all of the ground-school subjects necessary to become a private pilot. During the course, each student gets two and a half hours in the university's FAA-approved flight simulator, which is located in the Mechanical Engineering Building. As a certified flight instructor, Johnson can endorse the students' pilot logbooks, allowing that time to count toward their minimum of 40 flight hours to become a private pilot. The course prepares students to take the FAA's private-pilot written exam as well as the oral portion of the FAA practical exam—both of which are required to become a private pilot. Flight time is optional, but students who take flight lessons in preparation for the flight portion of the FAA practical exam

are allowed to use that flight time in place of homework assignments.

The class is structured in a "flipped" format, meaning that students are assigned online learning modules to complete outside of class. Then, when the class meets, Johnson demonstrates flight principles using PC-based simulation on his laptop, and students ask and answer questions about the material and engage in a discussion.

Johnson says he teaches the course similar to how the military teaches cadets how to fly. That means that during class, he sometimes calls on students at random to answer questions about the online training material. If a student says "I don't know," he

or she receives a zero. Students who at least try to answer receive some credit, and those who answer correctly receive full points. Then, participation points are tallied up over the semester and graded on a curve.

"It makes them memorize

the information, and it puts them on the spot," says Johnson, who is an Air Force veteran. "To be a pilot, you can't be shy. You have to be able to talk on the radio and ask for help when you need help from air traffic control."

There's so much technical, applied information that students need to memorize to become a pilot—and Johnson says this teaching style helps ensure that students don't slip through the cracks. "You can't be a D student and be a safe pilot," he says.

Johnson says his students have been very enthusiastic about the course. "They really enjoy the hands-on experience with the flight simulator," he says.



Chris Johnson, who is involved in student outreach efforts, demonstrates a PC-based flight simulation to a high school student.

Matt Molecha

MESSAGE FROM THE CHAIR

As usual, much has happened since I last wrote. Most importantly, we've hired a new assistant professor. Raluca Scarlat comes to us from UC Berkeley. She has expertise in thermal fluids and nuclear safety. Raluca has just begun to settle in, setting up her research labs, hiring a few graduate students, and teaching NE 411, our course in fuel element heat transfer and core thermal design. We are very pleased to have Raluca aboard and we look forward to her growth into a leader in the fission community.

The College of Engineering has also been very active. Dean Ian Robertson has been aboard for a year and a half and his impact has already been evident throughout the college. Dean Robertson and Associate Dean for Advancement Cathleen Walters have secured a generous \$25 million gift from The Grainger Foundation to create the Grainger Institute of Engineering. This will be a multidisciplinary research institute focusing, initially, on advanced manufacturing and materials discovery and sustainability. These are key research areas nationally and the institute will help us build a strong national presence in each area.

We also have made some changes to convocation and graduation. UW-Madison held graduation in Camp Randall in spring. This was the first outdoor graduation ceremony in many years and it was a great success. We even "jumped around" as part of the ceremony. That was quite a sight. The College of Engineering followed this commencement event with its own very successful ceremony in the Kohl Center, which gave us an opportunity to recognize all of our engineering graduates. More recently, Chancellor Rebecca Blank held a convocation for our new freshman, again in the Kohl Center, and our engineering students, wearing red engineering T-shirts, had a noticeable presence. Afterward, our students returned to the engineering campus for lunch and activities. Both events were a great success and I hope we are able to continue both going forward.

The biggest change in the college is in our undergraduate population. We have, for the first time in our history, reached an undergraduate population of 5,000 students. Just eight years ago, we had approximately 3,200 undergraduates. This growth is fantastic for the state of Wisconsin, as our students help support our technical industries and grow the economy, but it is a challenge to handle this rapid growth. Many of our early, core courses are reaching the limits of available classroom size, and our junior and senior lab courses are also at capacity. Our campus budget model is not equipped to handle this rapid growth, so the chancellor and her staff are seeking ways to provide the resources we need to continue to provide a world-class education to our students. As an example of our growth, we now enroll more than 800 students per year in our statics course (EMA 201), and we are offering summer versions of such core courses using distance education techniques.



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Another recent change is what we are calling "direct admission," which enables incoming freshman to enter our majors immediately,

rather than spending their first year as a "pre-engineering" student. This permits us to provide better advising to students from their first day on campus and to connect freshman with our older students. This will help retain students in engineering, as these freshman can participate in professional development activities from the beginning.

On a more exciting note, the highlight of my year was a ride with the Blue Angels. Our Navy recruiter put me on a list and I was offered a ride down in Gary, Indiana, just prior to the Chicago Air Show. We spent about 40 minutes in the air, hitting a top speed of about 700 mph and peaking at 7.3 g's. It was a once-in-a-lifetime experience and I'm grateful to the Navy for the opportunity.

Please feel free to drop me a note if you plan to be in Madison this fall. And thank you all for your continued support of our department, its initiatives, our faculty, and our students!

— Jake Blanchard

Thank you for your continued support of the UW-Madison
Department of Engineering Physics.

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Wisconsin nuclear researchers receive \$4 million in DOE grants

The Department of Energy recently announced a \$67 million investment in advanced nuclear technology, including a total of about \$4 million in grants for research and infrastructure at UW-Madison.

In the largest of the grants, Wisconsin Distinguished Professor and Wisconsin Energy Institute Director **Michael Corradini** received \$3 million for his proposal, "Advanced instrumental for transient reactor testing."

Distinguished Research Professor and an affiliate of materials science and engineering **Kumar Sridharan** garnered \$798,621 in DOE support for the proposal, "Development of self-healing zirconium-silicide coatings for improved performance of zirconium-alloy fuel cladding."

Additionally, a \$200,600 grant to Professor and Chair **Jake Blanchard** and Research Professor **Mark Anderson** will go toward general scientific infrastructure support at UW-Madison.



Corradini



Sridharan



Blanchard



Anderson

Hershkowitz receives IEEE Nuclear and Plasma Sciences Society's highest award

Irving Langmuir Professor Emeritus **Noah Hershkowitz** will receive the 2015 IEEE Marie Skłodowska-Curie Award, the highest award of the IEEE Nuclear and Plasma Sciences Society.

This will be the fifth time the IEEE has awarded the Marie Skłodowska-Curie Award, which includes a certificate, medal and an honorarium. In granting the award, the 3,000-member society recognized Hershkowitz for innovative research and inspiring education in basic and applied plasma science.

For nearly a century, the IEEE awards program has paid tribute to technical professionals whose exceptional achievements and outstanding contributions have made a lasting impact on technology, society, and the engineering profession. Each year the IEEE Awards Board recommends a select group of recipients to receive IEEE's most prestigious honors.



Hershkowitz

STUDENT NEWS

During Aaron Olson's freshman year at UW-Madison, his EPD 155 class, *Basic Communication*, required students to do a project on an engineering topic they were interested in. Olson chose NASA's space station. And little did Olson know that in the coming years, a prototype he created would be tested by NASA, he would fly in micro-gravity, he would work with NASA on acquiring fuel from the moon to use on earth, and have countless other opportunities that aspiring astronauts could only dream of.

Ever since EPD 155, Olson's mind has never strayed far from space and the ways astronautics can improve life on earth.

In 2012, Olson graduated with a bachelor of science in mechanical engineering and that same year he began pursuing a PhD in engineering mechanics and astronautics.

Although raised in Madison, Olson was born in the Congo, where his father met his mother while working in the Peace Corps. His accomplishments as both an undergraduate and graduate student in the College of Engineering are remarkable.

Olson credits programs at the university for helping him achieve his goal of becoming a UW-Madison engineering student. In sixth grade, Olson was accepted to UW-Madison's Pre-College Enrichment Opportunity Program for Learning Excellence (PEOPLE), which targets underrepresented students. The program provides these students with opportunities to start thinking about college and to explore career options. Students who complete the program and are accepted to UW-Madison receive a full-tuition scholarship.

The summer before his senior year, Olson participated in the Engineering Summer Program (ESP), which immerses rising high school juniors and seniors in college-level math and science classes, while exposing them to potential career paths through industry tours and lectures. After ESP, Olson knew he wanted to pursue engineering. That coming year he was accepted to UW-Madison and received the full-tuition scholarship from the PEOPLE program. "That was big for me and my family," Olson says.

Ever since Olson stepped foot on campus as a College of Engineering student, he has not stopped pursuing innovative ideas and looking to space for answers. The summer after his sophomore year, he went to Greenbelt, Maryland, where he worked on the James Webb Space Telescope at NASA's Goddard Space Flight Center. "It was an eye-opening experience. I hadn't done any real engineering at that point," Olson says. "It was a great opportunity to see what happens at NASA, what engineers do on a day-to-day basis and how I might fit into that."

A year later Olson interned at NASA's Langley Research Center in Hampton, Virginia. He focused on expandable structures, which can launch an object of a smaller volume that then expands in space. These structures not only can be used for space stations, but also on the moon, mars and other planets.

His work at Langley inspired a project he and fellow students created for NASA's eXploration Habitat Academic Innovation Competition, which challenges teams of university students to build an expandable habitat for space to be tested using NASA's systems. The UW-Madison team built what it named the Badger X-Loft, which expands



from a foot-long package into an entire room. The students won the competition and had the opportunity to travel to Flagstaff, Arizona, where they tested their prototype as part of NASA's Desert Research & Technology Studies field test.

Olson continued to get a feel for what life in space would be like as his undergraduate studies progressed. He participated in the Mars Desert Research Station, where selected students and faculty from around the country traveled to Hanksville, Utah, and lived as if they were living on Mars. "It gave me a perspective of what it

would be like to be an astronaut eventually," Olson says. "I would love to go into space."

Although Olson has yet to go into space, he has come close to it. His senior year he and fellow students were selected by NASA to fly in NASA's zero gravity plane. The plane does parabolas in the sky, which simulates weightlessness and microgravity in orbit.

As Olson now works on his PhD research, his desire to go into space could become a reality. Olson is looking at fuels that could be used in a fusion reactor to generate energy. In particular, he is interested in helium-3. "It turns out that there are actually some fuels that are very rare here on earth," he says. "This allows me to bring in my aerospace background to help with that problem. One particular fuel called helium-3, which we have roughly 100 kilograms of available here on earth—there is actually tons of it on the lunar surface."

He is researching ways to bring the helium-3 from the lunar surface back to earth. Helium-3 can be used as fuel in a fusion reactor to generate energy. "While deuterium and tritium, which are typically used as fuels in these reactors, produce extensive nuclear waste, helium-3 would produce a lot less and possibly zero nuclear waste," Olson says. "We can eliminate nuclear waste completely and still get the benefits of using nuclear power."

Research on using helium-3 as a fuel source has occurred since the 1950s and Olson believes one day helium-3 will be the answer to some of the world's greatest energy problems. "I am confident that helium-3 will be something that people will want to use eventually," he says.

He recently received a space technology research fellowship from NASA, which will allow him to work with NASA on his research of helium-3. While a future in space may seem inevitable for Olson, he is still considering all of his options and says he also would love to be involved in some sort of start-up company. And maybe one day his research will lead him to the moon to gather helium-3. "Being a contributor to moving forward in space and knowing what is out there would be a great thing," Olson says.

Traveler, musician, Goldwater scholar and engineer: Senior Geoff McConohy does it all. McConohy, 20, studies engineering physics and hopes ultimately to earn a PhD in materials science.

In fall 2013, McConohy traveled to Hong Kong through the college International Engineering Studies and Programs office for four months to study abroad. McConohy, who doesn't speak a second language, considered that his experience in Hong Kong would be more desirable to employers than simply studying abroad in a European country.

"I wanted to immerse myself in a different culture," he says.

Studying at the University of Hong Kong, McConohy lived in the dorms. "The dorms were interesting," McConohy says. "Everything in Hong Kong is vertical." McConohy explains that most of the dorms were at least 16 stories tall.

A Wisconsin native, McConohy also had to adjust to the hot tropical weather. On top of that, he had to get used to constant construction and noise. "Hong Kong is very dense," McConohy says.

Even with all of the differences, McConohy adjusted easily and was excited by the prospects of traveling around Asia and the great transportation system in Hong Kong.

While in Hong Kong, McConohy visited both mainland China and Thailand. One of his happiest moments while studying abroad was during his trip to mainland China. While there, he and a friend hiked the Tiger Leaping Gorge, one of the deepest gorges in the world. "The view was amazing," McConohy says. His hike left him in awe.

McConohy also had a great experience with the classes he took. His professors came from all over and the material was similar to what he had learned in the College of Engineering. Even better, McConohy took his classes as "pass-fail," which allowed him to really focus on his cultural experience.

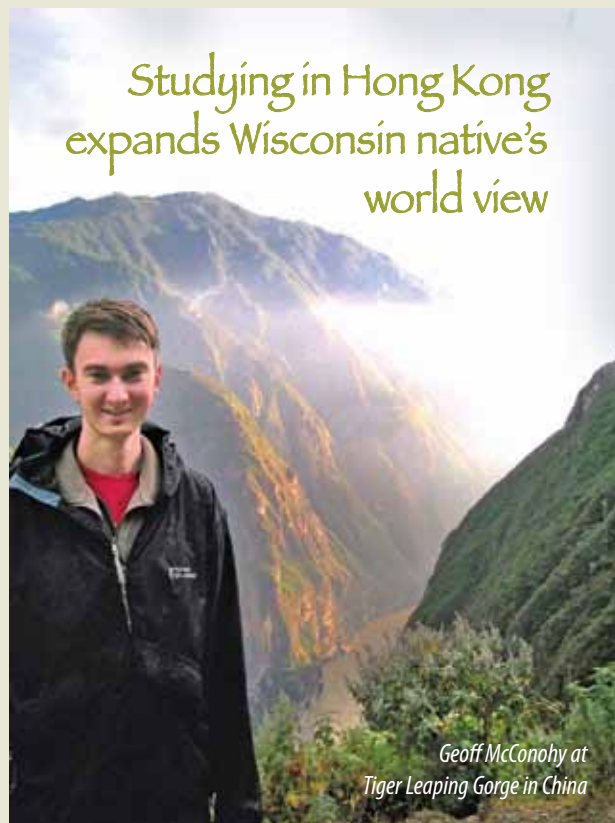
According to McConohy, Hong Kong is very international. He made many friends from the United Kingdom and mainland China. "You could find food from anywhere in the world in Hong Kong," McConohy says.

While his trip left him with many memories, it also left him with a sense of gratitude. "My trip gave me an appreciation for where I grew up and a gratefulness for the education system I grew up with," McConohy says. He notes the extreme academic competition for Chinese students that starts at a young age.

While McConohy had a great time abroad, he also is making a difference on the UW-Madison campus. He takes part in the UW-Madison Engineering Expo, which attracts elementary, middle and high school students to engineering by showing them the power engineering has to produce innovative products and technology. Music is also a big part of McConohy's life. He grew up playing the saxophone and plays in multiple jazz ensembles on campus.

On top of it all, he was a winner of the 2014 Barry M. Goldwater Scholarship, a prestigious national award for undergraduates studying the sciences. He was one of four UW-Madison students to win the award and among 300 students nationwide. Even with such a major accomplishment, McConohy remains humble and says he did not apply for the Goldwater Scholarship for recognition, but rather to help pay

Studying in Hong Kong expands Wisconsin native's world view



*Geoff McConohy at
Tiger Leaping Gorge in China*



*View of Hong Kong
from Victoria Peak*

for school. "I of course was happy to receive the scholarship and I plan to use it to help with student loans," McConohy says.

And now, nearly a year after he first arrived in Hong Kong, McConohy says he would love to return. "I am very interested in the relationship between Hong Kong and mainland China," McConohy says. "I would like to go back in 20 years to see what has changed."

McConohy's time studying abroad has definitely left him with the travel bug. The United Kingdom, India and Ireland are just a few of the places he'd like to go. "I want to visit everywhere," he says.

FOCUS ON NEW FACULTY: OLIVER SCHMITZ



For the global fusion science communities to one day realize nuclear fusion as a commercially viable energy source, a number of scientific challenges still need to be overcome.

One of the biggest challenges is finding a suitable material choice for inside the fusion chamber that can hold and withstand the boundary conditions around extremely hot plasmas—the high-energy ionized gases that are the media in nuclear fusion experiments.

Some of the most promising plasma fusion experiments have been based on the tokamak concept. A tokamak is a magnetic-confinement fusion device that is shaped like a doughnut. It uses powerful magnetic fields to confine and stabilize the plasma as it flows through the device's vacuum chamber. As the plasma reaches high temperatures—potentially as hot as the corona of the sun—the particles that make up the plasma collide, fuse and release energy through a nuclear fusion reaction.

To magnetically confine a high-temperature plasma, researchers also must ensure the vacuum chamber walls avoid transient heat and particle loads to their plasma-facing materials in order to maintain the walls' material integrity. Plasma instabilities—so-called edge-localized modes—which occur in high-performance tokamaks, can affect material performance and reduce material lifetimes, and degrade material properties in large experiments. As these repetitive instabilities occur at the edge of a plasma, the plasma impacts the tokamak's inner walls, eroding the surface of the material wall and releasing particles—impurities—that can penetrate into the plasma. These impurities dilute the fuel and radiate away energy, which degrades the overall device performance.

"The challenge we are facing now is generating a plasma wall interface that is able to confine such extremely hot plasma," says Assistant Professor Oliver Schmitz, who joined UW-Madison in spring 2014. "This plasma wall interaction is a very critical issue nowadays. I think it is the critical issue on the way to demonstrating that we can build an economic, feasible reactor. If the container wall gets degraded by the plasma after running for only some days or even only weeks, for example, there couldn't be a viable reactor device."

In his research, Schmitz is investigating ways to optimize the transport in the plasma edge and the resulting interaction between the plasma and plasma-facing components of the container wall.

He sees promise in an innovative technique for plasma edge control in a tokamak. The technique involves applying 3D magnetic perturbation fields to the device to better control the plasma edge transport and minimize the impact on the material wall elements. However, applying this external 3D control field breaks the symmetry in a tokamak's magnetic fields, inducing a 3D plasma edge topology and turning it into a 3D system, which Schmitz says poses a whole new challenge for the tokamak community. That's because some of

the physics mechanisms at work in a tokamak with the usual axisymmetric magnetic fields may be significantly altered in a tokamak with 3D magnetic field topologies.

As a result, standard assumptions about tokamaks need to be reevaluated when dealing with a tokamak with a 3D plasma boundary, Schmitz says.

Schmitz's research involves assessing how these 3D control fields affect the plasma as a 3D system and what that means for the plasma surface interaction. Working within a collaborative international research effort funded by the ITER (International Thermonuclear Experimental Reactor) organization, he was among the first researchers to make such an assessment for ITER in France, and this assessment drew a lot of attention to this issue in the fusion science community.

"This aspect of 3D plasma wall interaction is an innovative scenario that not many people are working on yet, and we have a premier role in this area," Schmitz says. "I think it's valid to say—together with my fellow faculty in the department and on campus, as well with our national and international partners—we are at the forefront with our modeling and experimental expertise and capabilities in this field, and that's what I want to expand on here at UW-Madison as a main focus of my research."

Schmitz says he was attracted to UW-Madison not only because the university is at the forefront of this research but also because it offers the ability to work with three different magnetic-confinement plasma experiments on campus.

"These devices are all really complementary and they make up an excellent set to address basic physics questions about confinement of fusion plasmas," Schmitz says. "I think the excellent plasma physics science environment here is unique worldwide. You won't find that anywhere else."

He earned his physics diploma (equivalent MSc physics) at the University of Bonn in Germany and his PhD in plasma physics at Heinrich-Heine University in Duesseldorf, Germany. Schmitz says that when he came to the United States to collaborate after earning his PhD, he noticed that many of the top researchers he met had completed their graduate degrees at UW-Madison.

"And that's a testimony to the university's excellence in research and education in this field, because so many outstanding people in leadership positions within the fusion program worldwide have come from UW-Madison," he says.

**Optimizing
3D plasma
edge transport and
wall interaction for
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Mackie receives highest honor in medical physics

Thomas “Rock” Mackie, emeritus professor of engineering physics and medical physics, has received the highest honor in the field of medical physics for his far-reaching contributions to medical imaging.

Mackie received the William D. Coolidge Award from the American Association of Physicists in Medicine (AAPM) on July 21, 2014. The award is named after Coolidge, the inventor of the X-ray tube that paved the way for modern medical X-ray technology.

Highlights of Mackie’s career in UW-Madison medical physics include mentoring 40 PhD students, generating 42 medical technology patents, and founding two influential Wisconsin companies. The most well known is TomoTherapy (sold to Accuray in 2011), which markets a technology that delivers radiation doses that are precisely sculpted around tumors. The company has more than 600 employees and has generated more than \$1.5 billion in sales.

The other company, Geometrics Corp., produces radiation therapy treatment planning software under the name Pinnacle and used in more than 300,000 patient treatments annually. Now owned by Philips Healthcare and based in Fitchburg, Wisconsin, the company has more than 70 employees.

Mackie, who retired from medical physics in 2011, says he considers himself an “accidental entrepreneur” who pursued commercialization primarily to keep good ideas moving forward. In the case of Geometrics, Mackie says his team planned to give the software away—a typical academic research practice—until the FDA informed him that software is regulated as a medical device and he needed to incorporate to get FDA approval.

TomoTherapy was a similar accident, in that it began as a corporate sponsored research project. But when the supporting company shifted out of the radiation therapy business and eliminated funding, commercialization became the only way to keep the project alive.

Mackie credits UW-Madison for its accommodating and forward-thinking approach to technology transfer, noting that it would have only taken one “no” from university leadership to have shut down both ventures, which were not without risk and posed a major time commitment.

“I’m very proud of being allowed to have so many facets to my career—certainly the academic facet, the entrepreneur facet, and getting involved in policy,” Mackie says. “I can’t be more proud of being at UW-Madison, and of this university’s ability to allow me to have such a rich career.”

