UMaine Today

CREATIVITY AND ACHIEVEMENT AT THE UNIVERSITY OF MAINE

WINTER 2017

Engineering
Special Edition

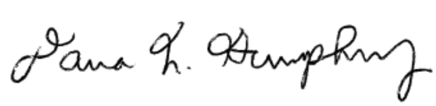
The student experience in UMaine engineering


2017
Huhtamaki
unum
Charter
MAIN-LAND
USDA
CES
WBRC
ONYX
FMI
TEXAS INSTRUMENTS
ENROLL IN ARMY ROTC
GARMIN
beat yesterday.
Looking for a New Beginning?
LANCO INTEGRATED
Empowering
POWER ENGINEERS
INTERNSHIP OPPORTUNITIES
CIVIL / STRUCTURAL
ELECTRICAL
COMPUTER ENGINEERING
MECHANICAL
JOIN THE TEAM
MaineDOT

THE COLLEGE of Engineering is proud to be the state's only comprehensive engineering program, with 11 bachelor's degrees as well as eight master's and five Ph.D. degrees. We continue to experience record demand for our programs from students in Maine and beyond. We are adding faculty and expanding our facilities so that we can meet the demand for more engineering graduates.

In this issue, we feature our students' hands-on projects, which is the hallmark of a UMaine engineering education. You'll learn how we are making composite parts that are lighter and more durable than steel; building capstone senior-design projects to solve real-world problems; leading a regional partnership for cogeneration to increase energy efficiency; using our new Power Relay and Automation Lab to train the next generation of engineers for the electric power industry; and launching a high-altitude balloon into space to research the solar eclipse.

The college is excited to share plans to build a new Engineering Education and Design Center to expand our capacity and enhance the education of our students. The project was given a boost in July thanks to a bipartisan agreement reached by the Maine Legislature to commit $50 million toward an estimated $80 million construction cost. The building is now in design. Up to $30 million remains to be raised to make this building a reality. I know that I can count on your support.



Dr. Dana Humphrey
Dean, College of Engineering
Saunders Professor of
Engineering Leadership and Management

The 19th annual Engineering Job Fair in October had the largest turnout of employers ever — 133. Those companies came based on the well-known strength of UMaine's engineering education. The recruiters on campus for the job fair included 72 alumni. The next day, nearly 150 engineering majors received on-site interviews to fill much-needed jobs.

Contents

Features

4 **Shaping the future**
The new state-of-the-art Alfond Advanced Manufacturing Laboratory for Structural Thermoplastics is designed to promote research into long-fiber reinforced composite materials.

10 **Mud Season Challenge**
Mechanical engineering seniors spend a year designing and building autonomous vehicles that are up to tackling a tough mission — patrolling the U.S.-Canada border in the complex terrain of the northern Maine woods, in all seasons.

14 **Diverse concentrations**
Engineering physics majors emphasize science and mathematics in their capstone research projects addressing real-world issues.

16 **Championing cogeneration**
The School of Engineering Technology will lead one of eight DOE regional partnerships dedicated to the promotion, technical support and deployment of combined heat and power (CHP) technologies.

20 **Dark side of the moon**
In August, members of UMaine's High Altitude Balloon group took their technology to Clemson, South Carolina for a launch as part of NASA's Great American Eclipse project.

26 **Higher power**
State-of-the-art power industry equipment is the focus of the Automation and Protective Relay Lab for electrical and electrical engineering technology students.

30 **Breathing lessons**
An award-winning biomedical engineering capstone project to create a pediatric breathing simulator capable of displaying realistic lung and diaphragm movements has led to a startup company gaining state and national recognition.

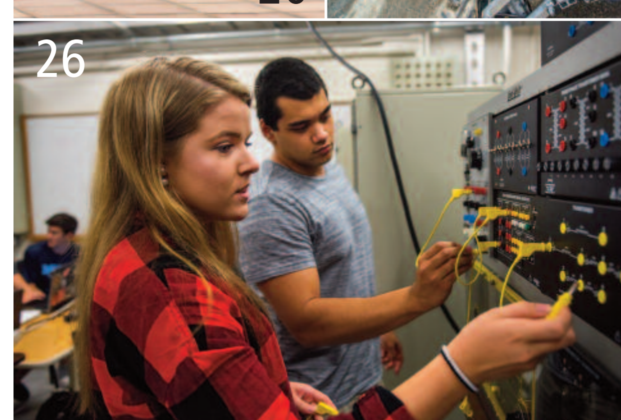
Departments

Student profiles
9 Medical designs
29 Summers in the lab
34 Flow fields

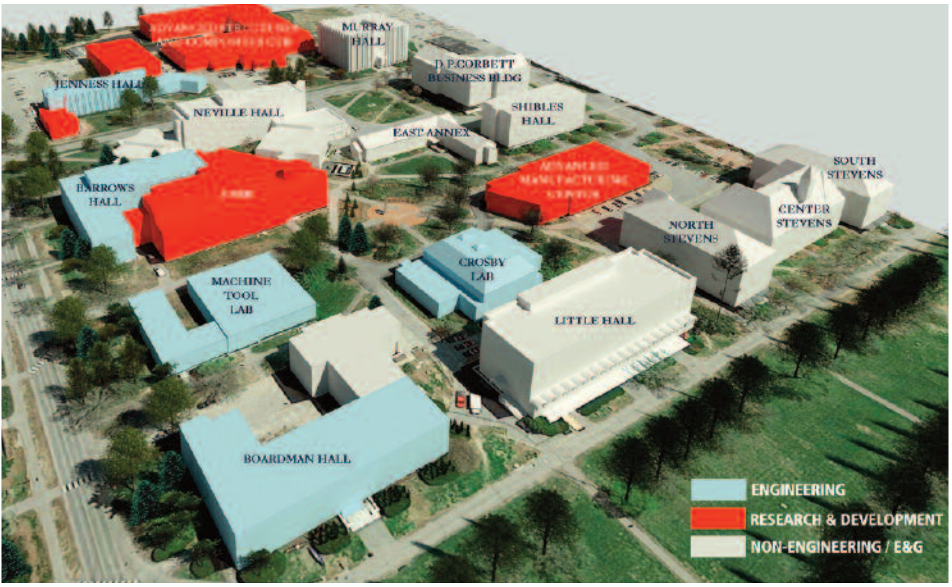
Alumni leadership
18 Onstage engineering
36 Sea systems

News briefs
3 Next steps
39 Students
40 Faculty

On the cover
For College of Engineering undergraduates, hands-on learning begins in the first semester and culminates with year-long senior projects. Here, students in ECE 101 — left to right, Joseph Patton, Brandon Ramos and Elizabeth Willard — complete their circuit boards.



engineering.umaine.edu



UMaine's engineering landscape

Next steps

Fundraising underway for Engineering Education and Design Center

THE TEAM of WBRC Architects Engineers, based in Bangor, and Ellenzweig, an architecture and planning firm in Boston, has been selected to design the Engineering Education and Design Center at the University of Maine, proposed to be up to $80 million. The team, which includes five other Maine firms and five out-of-state specialty consultants, was one of 18 that responded to the request for qualifications for design services this past fall.

Site selection is scheduled for late April, with the schematic design to be completed by this coming summer. Final design should be completed by fall 2019.

An estimated $30 million remains to be raised to make the Engineering Education and Design Center a reality. Significant private fundraising efforts are underway as part of the University of Maine Foundation's Vision for Tomorrow comprehensive campaign.

Successful fundraising will allow UMaine to break ground by early 2020, with completion projected for 2022.

College of Engineering faculty, staff and students, as well as other members of the UMaine community and constituents, will provide critical input in the design process.

The Engineering Education and Design Center, which could to be up to 120,000 square feet, will help meet Maine's engineering workforce needs and address increased enrollment demands for UMaine's high-caliber engineering programs. The facility is considered critical infrastructure to serve the demand from incoming students and industry.

The academic and laboratory building will become the heart of undergraduate engineering education, and the new homes of mechanical engineering and biomedical engineering. A hallmark of the center will be hands-on, team-based laboratories for senior design projects, where students from multiple engineering disciplines will collaborate. Classrooms of various sizes will accommodate group learning, as well as some distance learning opportunities for select engineering courses originating at UMaine and shared with other University of Maine System campuses.

In early July, the Maine legislature provided $50 million in debt service for the new building. Taking into account interest costs, the state funding will yield about $45 million. In addition, UMaine is funding $5 million of the project.

In September, the University of Maine System Board of Trustees approved the expenditure of up to $1 million to begin the schematic design of the facility.

WBRC has been designing buildings on campus since 1903, including several projects for the College of Engineering. Ellenzweig focuses on teaching and research laboratories for engineering, science, and life and health sciences.

For information on giving to the project, contact Diane Woodworth and Pat Cummings at the University of Maine Foundation, 207.581.5100. ■


MAINE
composites center

Shaping the future

Thermoplastics research focuses on advancing manufacturing

LAST SUMMER, a team of students, staff and faculty reverse engineered the rear differential cover for a 1998 Dodge Dakota and made a new one.

That might seem like a rather routine engineering task unless you know that they created the new cover as a research project using the latest generation of tough, lightweight structural thermoplastics and high-tech equipment at the newest manufacturing lab at the University of Maine Advanced Structures and Composites Center.

The Alfond Advanced Manufacturing Laboratory for Structural Thermoplastics, named and supported through a gift from the Alfond Foundation, was created to advance research and development of this new class of structural composite materials, according to Roberto Lopez-Anido, the Malcolm G. Long Professor of Civil and Environmental Engineering at UMaine.

It is part of the evolution of the Composites Center, which for the past 20 years has focused on improving composite materials and the processes that create them for structural applications.

"One thing that came up over and over was how to make materials more efficiently, to make them faster, reduce waste, make them recyclable and at a lower cost, and how to make the process so that it is repeatable. Two years ago, we made the strategic decision to move into thermoplastic composites, a family of materials that have evolved into high-end applications," Lopez-Anido says.

Lopez-Anido has nearly a quarter-century of experience in the mechanics of fiber-reinforced polymer (FRP) composites for construction, durability analysis of composite materials, advanced experimental methods for composites, composites manufacturing, rehabilitation of civil infrastructure, design of composite structures, and structural health monitoring.

Roberto Lopez-Anido is the faculty lead for procurement and implementation in the Alfond Advanced Manufacturing Laboratory for Structural Thermoplastics, where the mission is to increase the market prevalence of structural thermoplastics through demonstration of automated, advanced manufacturing techniques. Research and development focuses on discovering mechanical properties, viscoelastic properties of materials during heating and forming, and computer-simulated modeling techniques for fiber-reinforced thermoplastics.

Research in the lab includes a process called tape layup, in which spools of pre-impregnated thermoplastics tapes are cut to length, orientated and ultrasonically welded on a two-axis motion table. The tailored blanks are then heated and formed in a 700-ton manufacturing press. Using this process, final parts can be up to 60 percent lighter than steel and 30 percent lighter than aluminum. The overall process can have up to a 60 percent reduction in waste during production.

"This is probably **the most important lab in the state** for industrial manufacturing and testing applications. **It is a great resource for Maine."** Roberto Lopez-Anido

Since 1998, he has contributed to advancing knowledge and developing advanced composite materials in civil infrastructure, energy, marine, aerospace and defense applications in the Composites Center.

Lopez-Anido has been the faculty lead in the procurement and implementation of the Alfond Advanced Manufacturing Laboratory for Structural Thermoplastics, located adjacent to the Offshore Wind Lab and Alfond W^2 Ocean Engineering Lab.

The new state-of-the-art lab is designed to promote research into long-fiber reinforced thermoplastics. The goal is to develop new automated, advanced manufacturing techniques that reduce cycle time and cost, and can then be transferred into industry.

THE PROCESS begins with deciding what materials to use for the thermoplastic composite tapes, and how to orient the tapes to create the optimal strength and stiffness to meet specific design standards. The lab equipment can utilize a variety of fiber reinforcement (carbon, glass, etc.) to strengthen the thermoplastic material tape.

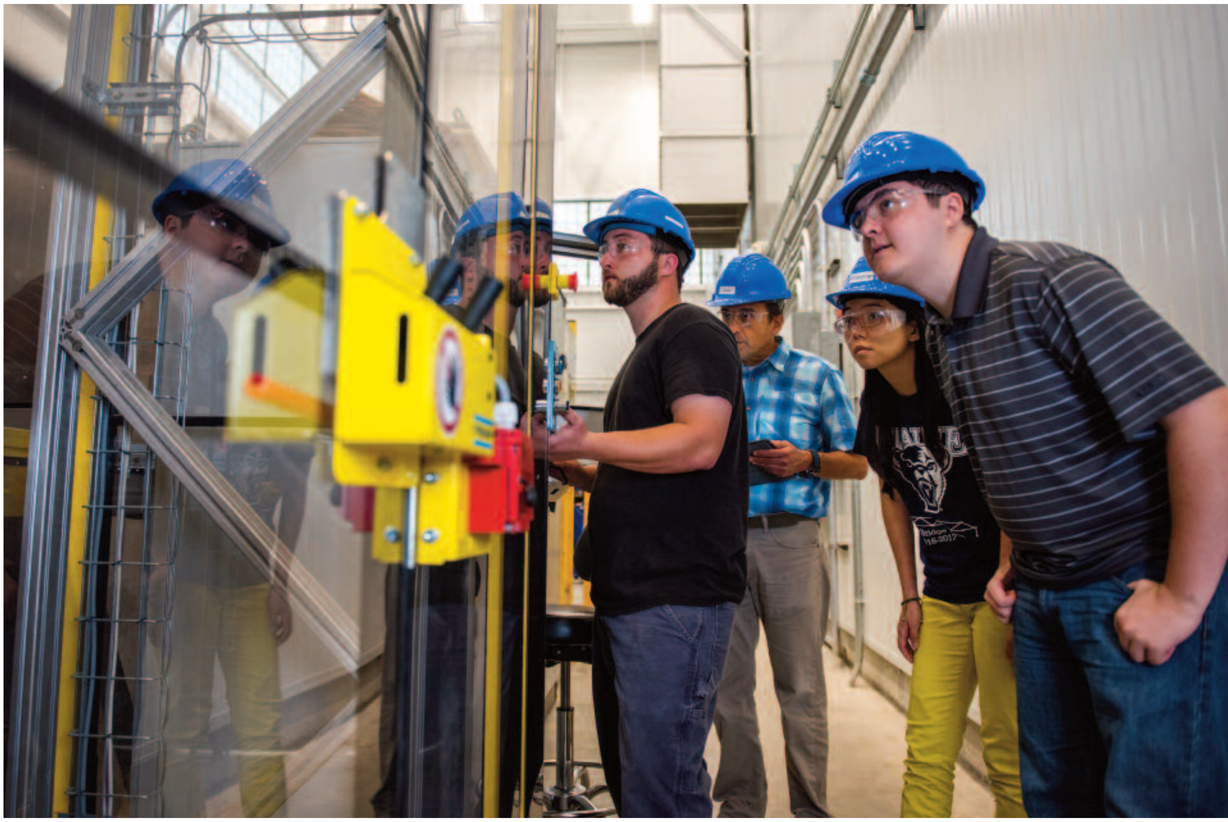
Computer simulations and models help determine the best materials and orientation for the end product. Often, as in the case of the differential cover, that process requires one or more trial-and-error tests to find the best layup, heating and processing parameters for the thermoplastic composite tape.

"When you work with these materials, you need first to design the materials. That implies that you understand what materials to select and how to make it," Lopez-Anido says.

"Materials engineering and manufacturing go hand-in-hand, and that's a very interesting aspect of this process. You need to both understand how to characterize and manufacture the materials in order to optimize the process."

The new equipment is set up based on a production line to manufacture commodity, engineering and performance thermoplastic materials, with processing temperatures up to 840 degrees F. Once the material is designed, the production process proceeds in five steps, according to Lopez-Anido.

First, the mold is created using additive manufacturing via a 3-D printer. Then, based on the predetermined design,



The 3-D printed thermoplastic molds can be developed for manufacturing parts up to 36-inch x 24-inch x 36-inch using 13 thermoplastic polymers. The high-temperature thermoplastic molds are used for thermoforming reinforced lower-temperature thermoplastics for prototyping and rapid development of custom tooling. The ability to quickly print a mold and demonstrate the successful manufacture of a part can help bring a new product to market in a shorter time.

spools of reinforced thermoplastic tapes are cut to length, oriented to meet specific design standards and ultrasonically welded to form a tailored blank using an automated tape placement machine.

An industrial robotic arm moves the blank to a thermoforming cell — an infrared oven — where it is heated to a prescribed temperature for forming. The robot then moves the heated blank to the 700-ton hydraulic press, where it is formed over the 3-D printed molds.

The final step in the process is the finishing — sanding, polishing, drilling, welding and whatever else is needed for the prototype.

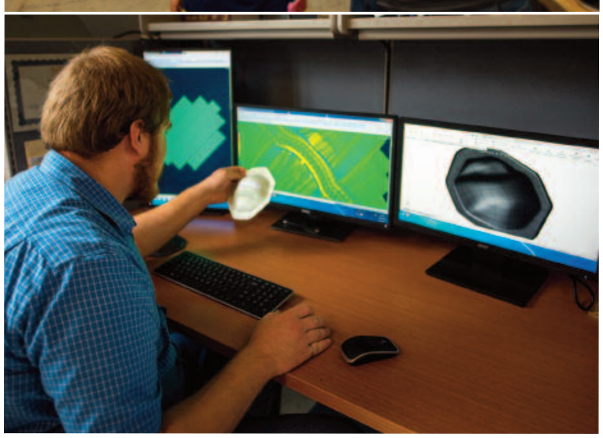
The lab uses this process to develop and test materials and manufacturing methods that can benefit industry. The automotive, transportation or building industries are the most common areas where these materials are used today.

The materials that students and faculty are working with also have applications in the marine and aerospace industries. They can be adapted to exterior or interior uses, and can be engineered for a variety of specifications, such as withstanding weather and ultraviolet radiation in outdoor applications, or limiting smoke and toxicity in the event of fires in indoor applications.

They also can be adapted to different manufacturing processes — a stamping process like the one used for the differential cover, or an extrusion process in which materials are fed into a heated mold, pulled from the other end and cut to length.

The goal, Lopez-Anido says, is to find new ways to use this new class of thermoplastic composites in industrial applications.

"We do not compete with industry," he says. "We have



Top: Once the thermoforming stage is complete, the product enters a post-processing cell, where machining, joining, cutting, grinding and drilling operations can be performed. The post-processing cell utilizes ultrasonic resistance and thermal welders to join thermoplastic parts and assemblies. Bottom: Graduate student Phil Bean performs modeling and computer simulation of the materials and thermoforming process to optimize the design and manufacturing method.

a process that is almost at industrial scale in terms of size and speed. It's not a benchtop process. That means that a company can come here and test a prototype without stopping its production line. Essentially, we can become the experimental production line. Because of the scale, they can transfer the technology directly."

LOPEZ-ANIDO and colleagues already are planning for a much larger lab with larger equipment. For example, the available 3-D printer, although larger than personal models, can "print" parts measuring 3 feet, by 3 feet by 2 feet.

He envisions one day having 3-D printing capabilities for 15 feet by 8 feet by 45 feet parts, allowing the Composites Center to develop and test larger molds at full size.

He refers to a looping video display in the lab that shows a tooling device shaping a scaled-down mold for a sailboat hull that had been created on a 3-D printer at another facility. With the larger printer, he says, the lab would have the ability to create that same full-size hull mold.

Developing and testing that kind of full-scale technology could be a boon to the boatbuilding industry by reducing the time and the cost of creating hull molds.

The large-scale capability could open up research in other areas, including floating platforms and blades for wind energy technology.

It is an exciting time for the lab, where these new technologies offer hands-on learning opportunities for students, he says. It also puts undergraduate and graduate students in contact with industry partners and suppliers, which can often lead to good jobs after graduation.

"(Here) they can go beyond the boundaries of their separate (engineering) departments and work in teams. That works also for the faculty.

"I love my department, but here I get to collaborate with people in other disciplines and to do things I could not do just by myself," says Lopez-Anido.

Lopez-Anido sees a great future for the Alfond Lab, with more and closer ties to industry, helping Maine companies provide solutions to manufacturing problems.

"This is probably the most important lab in the state for industrial manufacturing and testing applications. It is a great resource for Maine," he says. ■

Medical designs

Biomedical engineering major researched surgical toolmaking

MADELINE WEHRLE was interested in medicine from an early age. After being introduced to isometric drawing and CAD modeling in high school, she also became interested in biomedical engineering.

"It was more of a realization that innovation or engineering is applicable to whatever field you are most passionate about, which for me was medicine," says Wehrle, of Wiscasset, Maine, who graduated in December with a degree in biomedical engineering and plans to pursue graduate school.

Since 2013, she has worked in the Advanced Structures and Composites Center. Most recently, Wehrle was one of about a dozen students researching in the center's new Alfond Advanced Manufacturing Laboratory for Structural Thermoplastics under the direction of David Erb, a senior R&D program manager.

Wehrle and Erb worked as part of the Consortium for Manufacturing Innovation in Structural Thermoplastics (CMIST).

In May 2015, the National Institute of Standards and Technology (NIST) awarded the Composites Center $497,965 for mapping technical manufacturing challenges in structural thermoplastic materials.

Through the award, UMaine formed CMIST with the U.S. Army Engineer Research and Development Center, Celanese Corp., Eastman Chemical Co., PolyOne and Royal TenCate.

CMIST has more than 70 members and is led at UMaine by Erb and Roberto Lopez-Anido, professor of civil and environmental engineering.

Wehrle conducted a feasibility study on additive manufacturing in surgical tooling with the help of an orthopedic surgeon from New Hampshire. The tools Wehrle researched could potentially be created on-site in hard-to-access areas, including military sites and developing nations.

Wehrle now serves as CMIST project coordinator. And from the UMaine Composites Center, she works for the American Composites Manufacturers Association's Composites Growth Initiative as an industry-academia liaison. ■

Mud Season Challenge

Autonomous land drones take on the North Woods in a capstone course

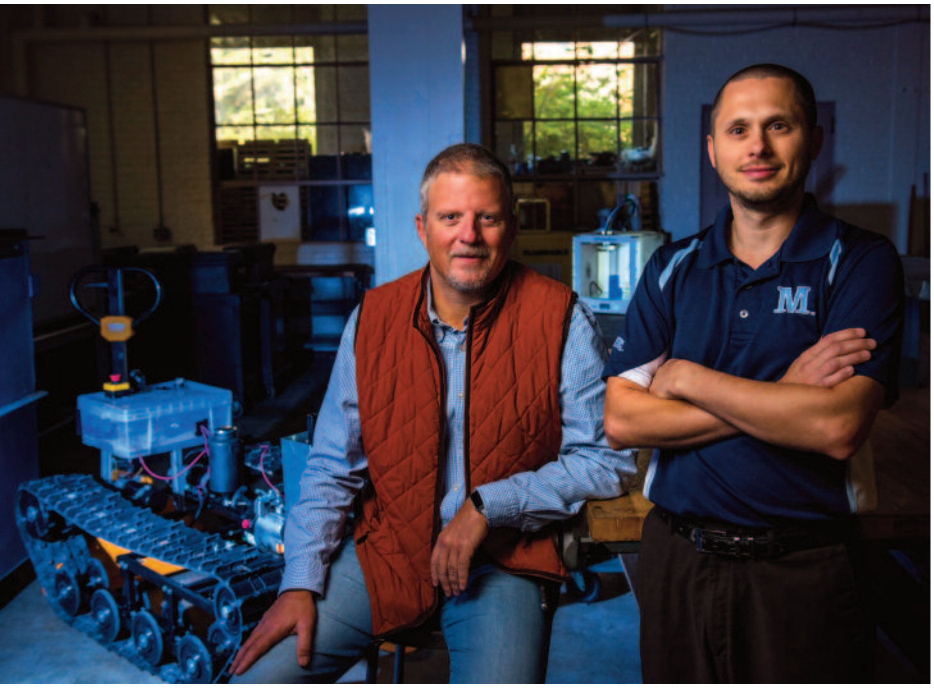
WHAT'S SMALLER than a snowmobile, runs on a chainsaw engine, uses GPS to traverse challenging terrain — water, mud, rocks, ice and other obstacles — and costs about $1,400 to build? At the University of Maine, it's an autonomous land drone. Best of all, mechanical engineering students design, build and test them as part of their capstone experience.

Dubbed the Mud Season Challenge, the initiative was inspired by the DARPA Grand Challenge, a contest to design an autonomous vehicle that could perform in desert terrain to monitor the southern border of the United States.

For the UMaine challenge, mechanical engineering seniors have to design a vehicle capable of operating on a very different border and terrain — the U.S.-Canada border in the complex terrain of the northern Maine woods in all seasons, including mud season.

"It emphasizes teamwork and technology, and forces them to think about things like the environment and ethics," says Wilhelm "Alex" Friess, an associate professor of mechanical engineering. "They make mistakes and they get frustrated, but they also get very excited about the project."

In their capstone projects, students work in teams to achieve four project milestones — design, manufacture, testing and running the final course — and they have to meet specific project deadlines.



Wilhelm “Alex” Friess, left, associate professor of mechanical engineering, and alumnus and assistant professor Andrew Goupee are leading this year’s Mud Season Challenge, teaching the capstone course for the first time. This year, the student teams not only will have to design land drones that meet a list of specifications, including the ability to collect visual and audio data, and use GPS to negotiate obstacles, but also have to consider the environmental impact and weight of their vehicles, and strive to create a smaller environmental footprint.

The challenge is straightforward, but by no means simple. Student teams must design a land drone to meet a list of specifications, which include the ability to collect both visual and audio data, and to use GPS to negotiate an obstacle course.

Their budget must come in under $1,400.

“It is challenging technologically. Students have to solve a number of complex problems. This builds on all the learning they’ve done in the past several years,” says Friess, who is teaching the capstone course this year with assistant professor and alumnus Andrew Goupee.

Students work in teams to achieve four project milestones — design, manufacture, testing and running the final course — and they have to meet specific project deadlines. They not only have to troubleshoot, but make major decisions regarding steering, propulsion, guidance, hydraulics and materials, Goupee says.

And they have to do it all in a school year.

THIS IS the first year that Friess and Goupee have collaborated on the capstone course, and they added a couple criteria to the Mud Season Challenge. The student teams will be required to consider the environmental impacts of their vehicles and strive to create a smaller environmental footprint, Friess says.

They also have added a weight component, so teams will have to think more about the materials they use to create their drones.

Throughout the capstone course, students have to demonstrate their engineering skills, Goupee says, and must work as a team to resolve the various technological problems posed by designing and building the land drone.

“Everyone on the team is a partner and they have to learn how that works. They have to work with each other in order to complete the challenge and make a viable project.

“Those are all skills that employers want,” Goupee says.

The hands-on technological experience students gain has applications in such cutting-edge innovations as driverless and electric vehicles.

Indeed, one recent mechanical engineering graduate now works at Tesla, a leader in electric car design.

The drone project, Friess says, provides one huge, over-

Scenes from the 2017 Mud Season Challenge.

arching learning opportunity with real, practical applications.

"They get to showcase what they've learned and this gives them the background to hit the ground running in the industry," he says.

And ultimately, with the construction of an Engineering Education and Design Center on campus, the land drone project can take on even more dimensions, according to Friess and Goupee.

The new facility will include an expanded lab that will offer opportunities for engineering majors in different disciplines to collaborate on senior projects like this.

For example, a chemical engineering student could work on creating composite materials for the drone structure while an electrical engineering student might work on an innovative propulsion design.

"The new engineering building will be a catalyst to developing a true multidisciplinary element in the capstone program," Friess says. ■

Diverse concentrations

Engineering physics capstones capitalize on collaboration

THE UNIVERSITY of Maine Engineering Physics Program, offered by the Department of Physics and Astronomy, and the College of Engineering, is designed for students interested in pursuing any one of the traditional engineering fields, with a strong emphasis on science and mathematics. The flexibility of the program allows students and their advisers to design an individualized curriculum tailored to interests and goals.

As a result, capstone projects are diverse. Co-advised by physics and engineering faculty members, the seniors pursue research projects with real-world applications.

The following capstone projects highlight the depth and breadth of the engineering physics students' research.

Generating airfoil models computationally for high-altitude applications

Mackenzie Dunning, advised by Samuel Hess and Charles Hess, physics

WITH A mechanical engineering concentration, Mackenzie Dunning's research in her senior year focused first on modeling and analyzing ice buildup on airfoil shapes, then turned to airfoil models for drones that could allow them to operate at high altitude.

In the spring, Dunning collaborated with mechanical engineering professor Krish Thiagarajan to model icing conditions on wind turbines. In her project, she used LEWICE, a NASA-created software to simulate flow fields and ice buildup on airfoils, and XFoil, another airfoil analysis program. The goal was to explore the compilation of data for use in wind turbine development and site assessment.

In the fall, Dunning again looked at airfoils, this time for drones. High-altitude operation could facilitate collection of weather and atmospheric data, Dunning says. However, atmospheric conditions — from air density to freezing temperatures, must be taken into account.

In the capstone project, blades were computationally analyzed to find a more effective construction for high-altitude use, with a goal to model them in Solid Edge software. Dunning created a more streamlined process for evaluating cross sections, assembling them into a blade, and then prototyping using 3-D printing.

Refining the evaluation process has the potential to efficiently produce computationally verified blades for physical testing, she says.

Dunning's project was based in the ongoing drone-focused research of physics professors Samuel Hess and Charles Hess.

Hydrological modeling and analysis of the Saco River near Conway, New Hampshire

Catherine Gillette, advised by Shaleen Jain, civil and environmental engineering; James McClymer, physics

CATHERINE GILLETTE created a hydrological model able to simulate the Saco River watershed near Conway, New Hampshire. She did it by combining two statistical modeling frameworks — the GR4J rainfall-runoff model and the CemaNeige snowfall model. Gillette's model was developed in the statistical programming language, R.

Gillette used 53 years of historical streamflow data recovered at a local United States Geological Survey stream gauging station, and precipitation and temperature data from NOAA Earth System Research Laboratory to configure, calibrate and test the accuracy of the watershed model.

ROBOTICS AIRFOIL ANALYSIS HYDROLOGICAL MODELING

Her assessment of the model showed great success in simulating the river's streamflow during much of the year and under certain conditions.

According to Gillette, the model was able to simulate spring streamflow more accurately than during the summer months. It tended to overestimate the streamflow during many of the summer months, and appeared to become more accurate during periods with increased precipitation in the summer.

She suggests that some of the model's inaccuracies could be accounted for by variations in a few of the model's fundamental parameters. According to Gillette, if the limitations of the model she identified are acknowledged, it could successfully be used to simulate watershed outflows in the Saco River year-round.

Designing an anthropomorphic prosthetic hand with Arduino and MATLAB-Simulink

Luke McCracken, advised by Mohsen Shahinpoor, mechanical engineering; James McClymer, physics

FOR HIS mechanical engineering-focused engineering physics capstone, Luke McCracken set out to design and build an human-like robotic hand capable of performing everyday tasks, such as making a fist or grasping a tool.

According to McCracken, the movement and physical interactions of the human hand are extremely difficult to model and translate into a mechanical device. Thus, the first phase of his project was to begin to understand and develop an analytical approach to the design, function and computer control of something as complex as human hands and fingers.

McCracken began his research by experimenting with a predesigned robotic hand, complete with four servo motor-controlled fingers. The movements of the device were controlled by a computer and programmed using an open-source Arduino electronic microcontroller interface and software.

McCracken learned to code the Arduino controller using a variety of training projects and through networking with other coders in the Arduino programming community. He developed code that successfully interacted with the robotic hand's servo motors, allowing each of the fingers to move in various configurations.

According to McCracken, the next phase of the project will be to take a closer look at the prosthesis' programming and further analyze the robotic hand using the more complex MATLAB-Simulink software.

He hopes to ultimately develop a 3-D printed device that includes embedded sensors for additional data collection and higher-resolution analysis of the fine motor controls necessary to simulate a real, organic, human hand. ■

Championing **cogeneration**

UMaine designated one of eight DOE combined heat and power centers

THE U.S. Department of Energy has selected the University of Maine to lead one of eight regional partnerships dedicated to the promotion, technical support and deployment of cost-effective and highly efficient combined heat and power (CHP) technologies nationwide.

UMaine, in partnership with the University of New Hampshire and Watson Strategy Group, will oversee the CHP Technical Assistance Partnership (TAP) center in the northeast region, including Maine, New Hampshire, Vermont, Rhode Island, Massachusetts and Connecticut.

The Northeast Combined Heat and Power Center (NECHPC) and the seven other CHP TAP program centers across the country will be supported by $25 million of DOE funding in the next five years. NECHPC will receive $2.5 million of that total.

CHP, also known as cogeneration, is an efficient and clean approach to generating both electric power and heat from a single fuel source, such as biomass or natural gas. In addition, heat and power can be produced on-site, reducing the need to purchase electricity from the distribution grid, greatly increasing energy security and resiliency.

"We are thrilled to be part of this important Department of Energy program," says David Dvorak, UMaine professor of mechanical engineering technology who directs NECHPC. "CHP systems offer real solutions to today's energy issues — supporting economic development through improved energy efficiency, increased energy resiliency and lower energy costs."

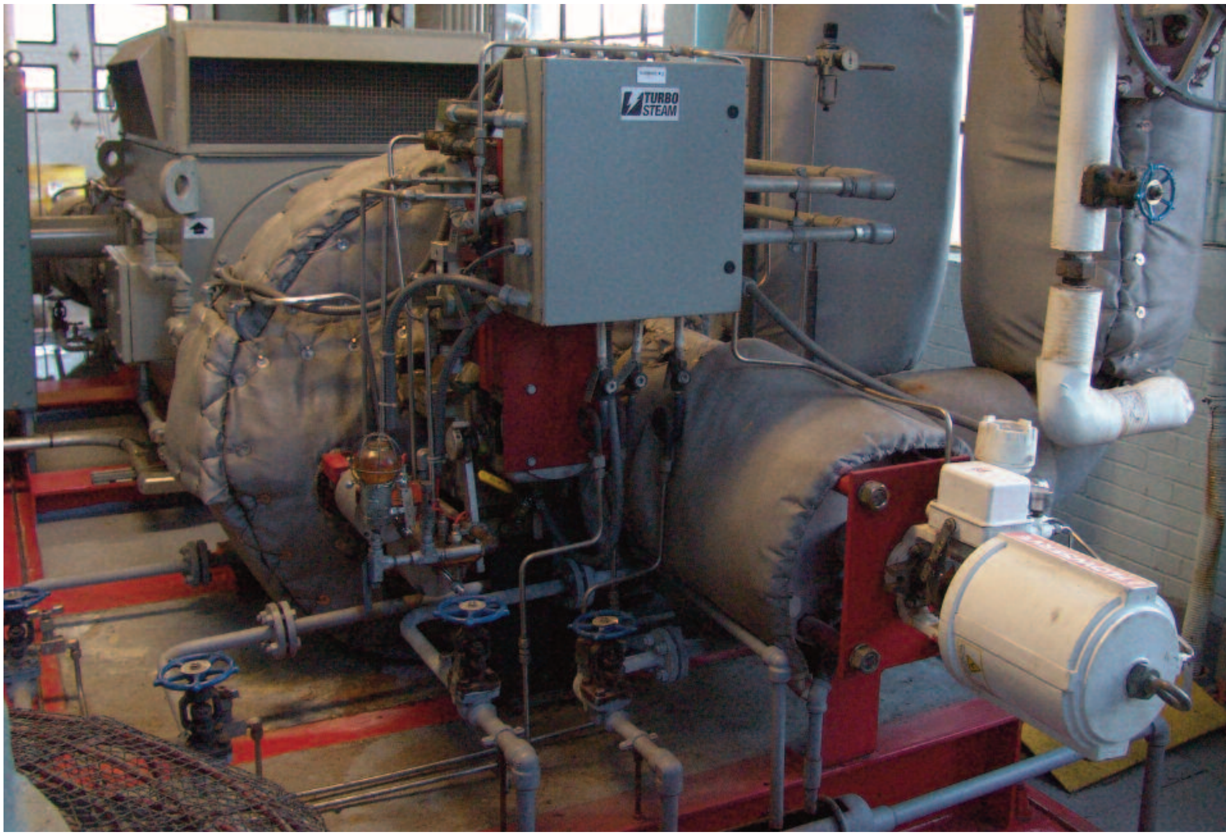
CHP systems are applicable for a broad range of industrial and commercial applications, including health-care facilities such as nursing homes and hospitals, large institutions such as universities and military bases, chemical and paper processing facilities, hotels, and even grocery stores, says Brett Ellis, UMaine assistant professor of mechanical engineering technology and NECHPC assistant director.

UMaine investigators also working on this project include Scott Dunning, director of the School of Engineering Technology. Engineering technology faculty are all licensed professional engineers with industrial engineering experience, and are focused on engineering practice and applied research. This project will enhance opportunities for faculty and graduate students to provide direct technical assistance to industrial and commercial clients.

According to Dvorak, over half of the fuel energy consumed to generate electricity at a large power plant is exhausted as heat energy and is often underutilized, even wasted. In many situations, electricity is purchased from the distribution grid, and additional fuel is used to heat a boiler or furnace to heat a building or facility.

CHP systems capture the "extra" thermal energy created in power generation and use it to provide heat in any required application — from staving off cold temperatures in apartment buildings and hospitals, to heating large amounts of water for industrial or food processing purposes.

Since the systems are self-contained and generate power and heat on-site,



One of two 300 kilowatt steam turbine generators that converts excess steam from the University of Maine's Steam Plant to produce electricity. The system is an example of an existing system that could benefit from CHP technology.

the facilities they are installed in can operate independent of the external power grid, thus providing resilience and security in the face of extreme weather events.

For example CHP-equipped hospitals, institutions and residential buildings were largely unaffected by power outages caused by Hurricane Sandy, Dvorak says.

The goal of the multi-institution NECHPC is to facilitate and accelerate the deployment of CHP technologies in the Northeast by providing assistance and technical support to businesses and institutions looking to invest in CHP technology.

"We have a strong team of experts at UMaine and the University of New Hampshire, and look forward to working together to promote cost-effective energy systems in Maine, New Hampshire and New England," Dvorak says.

CHP currently has an installed capacity of over 82 gigawatts of energy, a total representing roughly 8 percent of the nation's total generating capacity. In Maine, CHP accounts for 933 megawatts of the state's generating capacity.

According to Dvorak, CHP systems are not as common as they could be, but there is great potential for expanding the technology in the Northeast, and particularly Maine. The technology has the ability to efficiently use the state's abundant forest biomass, adding value to Maine's well-established forest industry, and the region's natural gas infrastructure is rapidly developing.

Coupled with the relative high-cost of energy in the Northeast, CHP technology can provide new energy options for the region's more rural populations and industries.

The program will offer unbiased information and education on potential technology solutions and installation, financing and utility contracts, as well as evaluation of project proposals for technical and economic viability. ■

Onstage **engineering**

Alumna Katie Doyle relishes designing for major touring acts

KATIE DOYLE was raised by a family of engineers who encouraged her to tinker and ask questions. "My grandfather gave me my first electronics kit when I was 5, and I made every project in the book," she says. "Engineering was always kind of on my radar as being something I would enjoy."

Doyle's family in Madison, New Jersey also had an affinity for the arts and frequently went to shows, including the Rockettes at Radio City Music Hall in New York.

"I remember staring in awe as dancers were raised effortlessly from below the stage," Doyle recalls of the performance. "I couldn't stop looking around trying to figure out where the lights were coming from and how everything worked."

She pursued both disciplines at the University of Maine, earning a bachelor's degree in mechanical engineering technology, with minors in electrical engineering technology and theatre.

"Theatre has always been a big part of my life, and when I realized that I could make a career out of creating those magical moments using technology, I knew that's what I wanted to do," she says.

Today, Doyle is a mechanical design engineer at TAIT Towers, a company headquartered in Lititz, Pennsylvania that designs, constructs and delivers live event equipment. She works on a team in the touring department to design staging and automation equipment for some of today's top concert acts.

"Our shows travel all over the world and are experienced by millions, if not billions, of people every year," she says.

She started at TAIT in the electrical controls design department in 2013. In January 2017, she switched from electrical to mechanical design.

Her projects include designing a control system for some pneumatically actuated flowers for Lady Gaga's 2014 ARTPOP Ball Tour. The stage went from flat to full of flowers in seconds.

The studio also recently designed the tree fascia for U2's 2017 Joshua Tree Tour, which features a massive stadium show with a 192-foot-wide stage. The tree fascia extended 30 feet above the 45-foot-tall video screen to create a seamless visual between the physical fascia and video wall content.

When designing for concert touring systems, Doyle says she and her team focus on making the load-in as easy as possible. It's really important that the system be simple and reliable with the least number of connections and cable runs.

"This job has allowed me to do things that my childhood self could have never dreamed of," Doyle says. "I've worked at Radio City Music Hall, spent a few days behind the scenes at a major theme park (and) designed equipment that flies people; (I) was in a video by (record producer) Deadmau5 that received 13 million views, and most importantly, I have had the honor of working with some incredibly talented and innovative people." ■

Dark side of the moon

High Altitude Ballooning group participates in NASA's Great American Eclipse project

UMaine High Altitude Ballooning team members prepare for launch prior to totality in Clemson, South Carolina. Team members, left to right: Jessica Eason, Michael Lloyd, Steve Jordan, Corbin Study, Justin Lipkvich, Austin Dube, Parker Eason, Helen Rose, Rick Eason, Jesse Warren, Jonathan Bland, Stewart Doe, Reid Rauch, Larry Schneider, Billy Bessette.

Photos courtesy of Clemson University

Dark side of the moon

Left to right, UMaine High Altitude Ballooning team members and support staff Parker Eason and Jessica Eason prepare the telemetry payload for launch; Keegan Wallace and Cameron Sullivan set up the backup ground station tracker; Derek Haas and Dustin Knight verify that telemetry is being received at the primary ground station. They were among those from the UMaine community who traveled to Clemson, South Carolina in August to participate in the first-ever NASA Great American Eclipse Project. UMaine's team was led by professor Rick Eason and engineering staff member Andy Sheaff.

THE TEMPERATURE was north of 93 degrees on Clemson University's Quad and Cameron Sullivan's computer keyboard was so hot it hurt to touch. You could have fried an egg on the rooftop of the nearby Watt Family Innovation Center, says Derek Haas.

But at 2:37 p.m. Aug. 21, the temperature dropped for 2 minutes and 37 seconds when the moon completely blocked the sun.

At that point, the two University of Maine sophomores took their attention off the equipment they had been monitoring and, like thousands of other eclipse fans on campus, they looked up.

People gasped, applauded and cheered.

Bats flew overhead. Cicadas sang.

"It was beautiful. It was just amazing," says Haas.

"It looked like a portal to another world," Sullivan says.

Throughout the summer, Haas, an electrical engineering major, and Sullivan, a computer engineering major, spearheaded UMaine's participation in the first-ever NASA Great American Eclipse project. The mission entailed students from 55 teams nationwide launching unpiloted high-altitude balloons to live stream aerial footage of the total solar eclipse from the edge of space to NASA's website.

During their first year at UMaine, Sullivan and Haas took an engineering course that included a high-altitude ballooning component. The unit provides students the opportunity to explore microcontrollers in a real-world application — collecting and analyzing data from 100,000-plus feet above the Earth.

After Sullivan and Haas completed the course, engineering professor Rick Eason invited them to be involved in the history-making NASA project and they signed on.

CLEMSON UNIVERSITY in Clemson, South Carolina was nearly smack dab in the middle of the 70-mile-wide path of totality, so the UMaine team traveled there to collaborate and obtain the best view of the eclipse from the balloons.

In addition to Eason, Sullivan, Haas and engineering staff member Andy Sheaff, 16 engineering students affiliated

"My work this summer allowed me to learn from real-world experience. **The eclipse taught me how valuable logistics are. Planning and communication are key to the success of an operation."**

Cameron Sullivan

with the UMaine High Altitude Ballooning (HAB) group also participated — Joey Arsenault, William Bessette, Jonathan Bland, Stewart Doe, Austin Dube, Dustin Knight, Justin Lipkvich, Michael Lloyd, Chris Martin, Reid Rauch, Helen Rose, Larry Schneider, Kent Seneres, Corbin Study, Eric Tuyishime and Jesse Warren.

High-altitude balloons are an effective way to provide millions of people a distinct perspective of the rare phenomenon, says Montana Space Grant Consortium director Angela Des Jardins,

Live-stream videos from 100,000 feet and above show the curvature of the planet, the blackness of space and the whole of the moon's shadow crossing the Earth.

"Total solar eclipses are rare and awe-inspiring events. Nobody has ever live-streamed aerial video footage of a total solar eclipse before," Des Jardins said prior to the event. "By live-streaming it on the internet, we are providing people across the world an opportunity to experience the eclipse in a unique way, even if they are not able to see the eclipse directly."

UMAINE'S HIGH-ALTITUDE balloons are made of latex. Bright orange impact-resistant payload containers — that hold video and still cameras, computers, radio modems and tracking devices — are tethered to each balloon. Per FAA regulations, the total payload per balloon must weigh less than 12 pounds.

When the balloons are filled with lifting gas, they swell to about 8 feet in diameter. When released, the balloons ascend about 1,000 feet per minute and expand to about 30 feet in diameter before popping at around 110,000 or 120,000 feet.

The cameras take photographs and transmit live video of the planet and sky back to Earth. And when the balloon pops, the cameras and other equipment — including the GPS tracker — parachute to the ground.

For their full-time summer jobs, Haas and Sullivan, who are from Old Town, wrote computer code, did radio transmission calculations, completed multiple practice launches with UMaine's ballooning equipment, and trudged into woods far and wide to retrieve the balloon's payloads.

On Aug. 14, one week prior to the total solar eclipse, Haas, Sullivan, Eason, Sheaff and several other students conducted a final test launch at the Pittsfield Municipal Airport.

Several days later, members of the UMaine contingent arrived in Clemson to scout launch locations, test equipment, and coordinate with Montana and Clemson officials.

Because of restricted early morning parking at Clemson (it was student move-in weekend and the Eclipse Over Clemson event was expected to attract as many as 50,000 people), at 4:45 a.m. Haas and Sullivan walked from their hotel to arrive on campus by 6 a.m.

In addition to setting up and testing the equipment, UMaine students and staff took part in multiple interviews with local, regional and media, including The Weather Channel, BBC and *The Washington Post.*

Being part of the event was beneficial and meaningful for students in a number of ways, says Eason, including witnessing a rare total solar eclipse, gaining hands-on engineering experience, collaborating with others, problem-solving and traveling.

"It was a good example of the kinds of opportunities that come up outside of classroom," he says.

MONITORING BALLOONS at the edge of space from Clemson was quite a distance from rooms in Barrows Hall at UMaine.

Haas says the adventure boosted his confidence.

"I feel like I'm a step ahead. At the Engineering Job Fair, I'll have a great opportunity to go up to a business, give my resume and have something to talk about," he said.

Sullivan, too. He was continually trying to keep one of the balloon's live streams working while simultaneously juggling queries from media broadcasting inches from his station.

"I really appreciate Eason offering this to us," says Sullivan. "My work this summer allowed me to learn from real-world experience. The eclipse taught me how valuable logistics are. Planning and communication are key to the success of any operation."

One by one, the high-altitude balloons of 55 teams from 30 state-based Space Grant Consortia across the United States were launched immediately ahead of the path of the eclipse in Idaho, Wyoming, Nebraska, Missouri, Illinois, Kentucky, Tennessee and the Carolinas.

UMaine's balloons were among the last to go airborne — at 1:10 p.m. and 1:20 p.m.

Prior to the UMaine launches, Eason, Sullivan and Haas took the stage to address thousands of people assembled on the Quad for the event.

Clemson was in full celebratory mode. Astronomy experts also addressed the crowd, the Clemson Tiger Band performed and the planetarium offered cosmic tours. The area around Lake Hartwell on campus provided "tailgazing" sites.

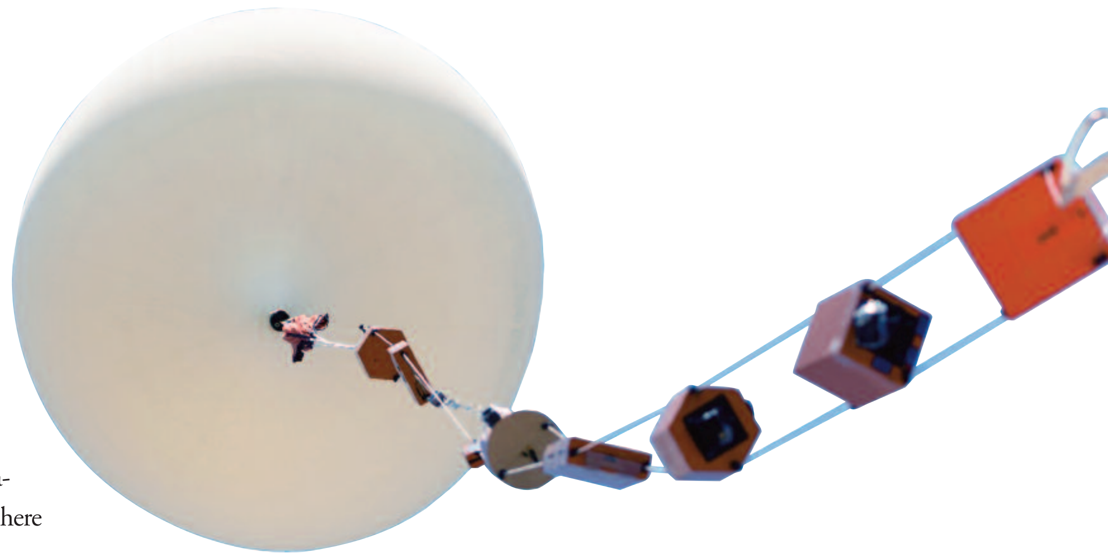
ON THEIR way to 100,000-plus feet, the balloons and their payloads were subjected to temperatures of minus 35 F. Because of that, NASA used one of UMaine's balloons for a MicroStrat experiment that simulates "life's ability to survive beyond Earth — and maybe even on Mars."

NASA provided UMaine with two small metal cards with environmentally resilient bacteria dried onto their surfaces. One card was part of a UMaine balloon payload and the other remained on the ground as a control.

The upper portion of Earth's stratosphere — with its cold, thin atmosphere and exposure to radiation — is similar to Martian conditions, according to NASA.

"The August solar eclipse gives us a rare opportunity to study the stratosphere when it's even more Mars-like than usual," said Jim Green, director of planetary science at NASA headquarters in Washington, on the NASA website.

"With student teams flying balloon payloads from dozens of points along the path of totality, we'll study effects on



microorganisms that are coming along for the ride."

David J. Smith, principal investigator for the experiment, said on the NASA website after the eclipse that NASA will have "about 10 times more samples to analyze than all previously flown stratosphere microbiology missions combined."

The payload that carried NASA's experiment snagged in a tree on its return to Earth, but UMaine retrieved it and returned it to NASA for study.

SINCE 2011, UMaine High Altitude Ballooning group has conducted 81 launches. Eason says while several landed in Canada, as well as in trees, lakes and the ocean, he's pleased to report the group has, to date, recovered all the payloads.

Sheaff says seeing the contingent work together was affirming.

"They represented the university in a positive way and I'm super proud of students who went and participated," he said.

"It was good to be able to have students work independently through problems and issues, and see them succeed."

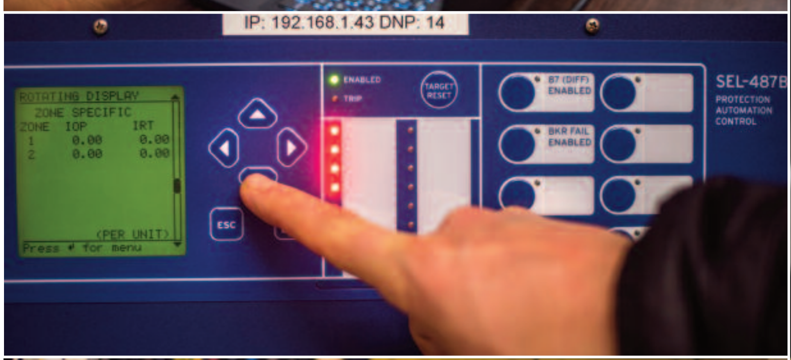
The next time there's a total solar eclipse in the United States — April 8, 2024 — any UMaine HAB group involved in a similar project won't have far to travel. The path of totality includes northern Maine.

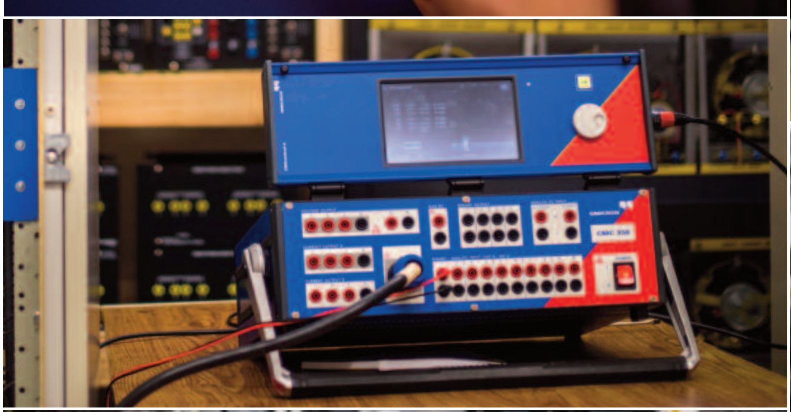
Both Sullivan and Haas say wherever they are in 2024, they'll make an effort to be in the path of totality, which in North America begins in Mexico and arcs toward Maine before exiting from Canada.

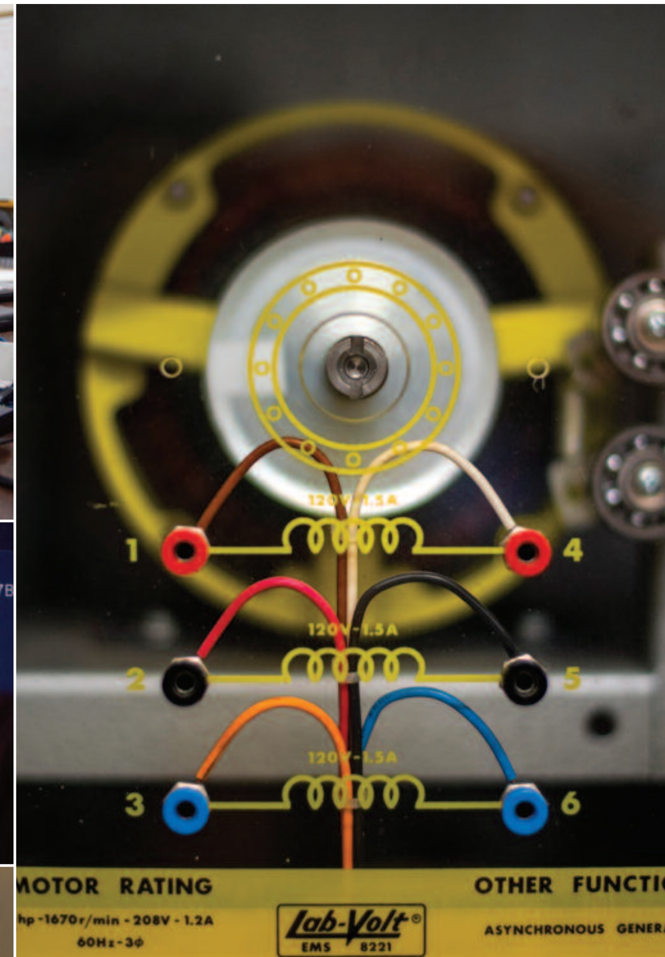
Sheaff says he'll be in Mount Chase, Maine — east of Baxter State Park — where totality is calculated to begin at 3:32.55 p.m. and last three minutes and 27 seconds.

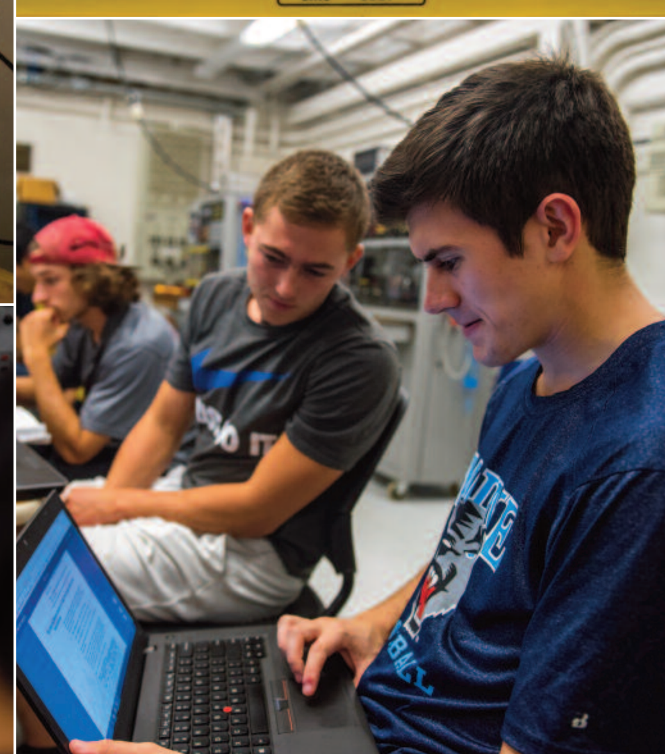
"It's going right over my camp." ■

What happens to a marshmallow at high altitude? Do seeds exposed to high altitude grow differently? With funding from the Maine Space Consortium, the UMaine High Altitude Ballooning group offers K–12 students the opportunity to conduct their own experiments at the edge of space. Teachers provide the STEM-related experiments, and UMaine students and faculty of the High Altitude Ballooning group launch them 100,000 feet or more, recover the payloads and return them. Schoolchildren also can participate in the launch and recovery, and can track the flight online.


IP: 192.168.1.43 DNP: 14
ROTATING DISPLAY
ZONE SPECIFIC
ZONE IOP IRT
1 0.00 0.00
2 0.00 0.00
(PER UNIT)
Press ♦ for menu
ENABLED
TRIP
TARGET RESET
87 (DIFF) ENABLED
BKR FAIL ENABLED
ESC
SEL-487B
PROTECTION
AUTOMATION
CONTROL




120V-1.5A
1
4
120V-1.5A
2
5
120V-1.5A
3
6
MOTOR RATING
OTHER FUNCTIO
hp -1670r/min - 208V - 1.2A
60Hz-3φ
Lab-Volt
EMS 8221
ASYNCHRONOUS



Higher **power**

New relay lab helps train utility industry's future workforce

WITH THE development of a new and expanded lab in the lower level of Barrows Hall, University of Maine electrical engineering and electrical engineering technology students will have more access to state-of-the-art power industry equipment.

The Automation and Protective Relay Lab features microprocessor-based protective relays donated by Schweitzer Engineering Laboratories Inc., and a relay testing tool from Omicron USA — all set up to mimic real-world conditions, says Paul Villeneuve, professor of electrical engineering technology. The expanded lab also will give students the opportunity to explore human-machine interaction (HMI), an increasingly important component in the industry.

Providing students with the opportunity to explore automation is one of the components that sets the UMaine lab apart from most others.

"This is one of the handful of labs in the country that does both the protection aspect and the automation. That's what makes us unique — the addition and, really, a focus on automation. We're not just setting relays, we're actually doing automation with them," says Villeneuve, noting that the lab also has the potential to support advanced graduate student research.

UMaine is one of the few universities to maintain power engineering as a key element of electrical engineering. After deregulation, many others reduced or eliminated their programs. As a result, the industry now regularly comes to Maine in search of new engineers.

Protective relays monitor systems for changes in operations and provide warnings or trip circuit breakers when a problem is detected. These relays have become an indispensable part of the modern electric power system and have evolved from simple electromechanical devices to multifunction microprocessor-based units. They function in all stages of the power industry — generation, transmission and delivery — and can be automated to perform thousands of different functions and to communicate with each other.

Engineers also can reprogram them remotely to do more or different operations as needed.

New capabilities, along with the increasing demands for energy and alternative energy production, and fewer resources for grid improvements, have created challenges for the engineers who have to design, configure, test and troubleshoot the power systems, and integrate systems. The expanded lab will provide students with the hands-on experience to help meet these challenges.

FOR THE past two years, the donated equipment has been used in UMaine classes. Now in the expanded lab space, Villeneuve says they expect to double the number of stations, allowing each of the six to be dedicated to a student team every semester. In addition, customized stations will be available for individual student projects.

The Automation and Protective Relay Lab addresses the need to prepare electrical engineering technology students to be able to select, configure, program, install and test microprocessor-based relays. Schweitzer Engineering Laboratories' microprocessor-based relays provide a platform for relay programming. An Omicron CMC 356 relay test and commissioning tool is used to verify proper relay programming and calibration.

The utility industry has been extremely supportive of the relay lab.The major benefit to industry is that students are equipped with the skills necessary to be immediately productive in the utility and consulting industries. They have a great deal of familiarity and exposure to the typical activities associated with substation design and automation, including relay programming and testing, power systems analysis, and wiring and schematic diagram development.

"This is **one of the handful of labs in the country** that does both the projection aspect and the automation. **That's what makes us unique."**

Paul Villeneuve

"Students were always fighting for time on the existing stations," Villeneuve says. "Now, they'll have a lot more time to work with a piece of equipment. And with more stations, we'll be able to integrate things earlier in the classroom, even for first-year students."

Programming a relay can be a complicated, time-consuming process, Villeneuve says. Using this real-world equipment, students will be able to create a program, then interface, debug and run it.

"They can verify that things work the way they were expecting it to work. They can download a file to the relays, hit a button, set up and run through a test to see if it trips when they expected, or did not trip.

"They can configure communications, verify operation and communicate that in real time. `Did I get the information? What was the delay across the system?' They'll be able to look at a lot of these things," Villeneuve says.

A key to being an engineer is to learn ways to improve the design process to make it more efficient, to make it simpler or to automate the process, and still maintain the safety and reliability of the system, says Villeneuve, who has more than 20 years of experience with conventional, nuclear and renewable energy generators, and specializes in power systems design, analysis and modeling.

"I'll show them one way to do something," Villeneuve says, "but I encourage them to think that there may be a better way. They're more willing to push the technology, but with the caveat that these things have to be reliable. They can't just say 'well it works on paper. Let's just go with it.' These things have to be proven out in the field.

"In the lab environment, you've got nothing to lose except you've spent two days or three days working on something that doesn't work. They can test out some of these things. That makes them think. They learn how to troubleshoot. If it doesn't work, why doesn't it work? They do the problem solving."

The University of Maine is student-focused and that gives them such a leg up, Villeneuve says.

"We get a lot of support from industry because we support them. We give them topflight students that can do a lot of different things," he says. ■

Summers in the lab

Physics, electrical engineering major a Goldwater Scholar

GRAHAM VAN Goffrier, a physics and electrical engineering major at the University of Maine, is a 2017–18 Goldwater Scholar. The Norwell, Massachusetts native received one of 240 scholarships to outstanding undergraduate sophomores and juniors nationwide who are studying mathematics, natural sciences and engineering, awarded by the Barry Goldwater Scholarship and Excellence in Education Foundation. **SUMMER RESEARCH:** Van Goffrier, who also is pursuing minors in nanotechnology and mathematics, has spent summers involved in UMaine research in the Maine Software Agents and Artificial Intelligence Laboratory, Biophysics Research Group, and Laboratory for Surface Science and Technology. This past summer, he participated in the University of Michigan's Research Experience for Undergraduates Program at the European Organization for Nuclear Research (CERN), where he worked with an analysis team of the ATLAS experiment. **BEYOND ACADEMICS:** Van Goffrier has been involved in various extracurricular activities, including ice skating and theatre, and also launched UMaine's first Rubik's Cube Club. Over the years, he has worked as a teaching assistant and has been very active in the leadership of professional associations, including the student chapters of the Society of Physics Students, IEEE and Tau Beta Pi. Van Goffrier plans to pursue doctoral research in theoretical physics, and next fall will enter the MASt program in applied mathematics at the University of Cambridge. He credits UMaine professors and staff for much of his success. ■

“Our manikin allows us to **more accurately and realistically simulate breathing in children.”** Banton Heithoff

Breathing lessons

Biomedical engineering capstone project launches spinoff

A NEW METHOD of simulating pediatric respiratory distress in medical training manikins to better prepare health care professionals is now an award-winning prototype for a startup company founded by the four biomedical engineering students.

For their biomedical engineering senior capstone design project in 2017, the students were tasked with creating a pediatric breathing simulator capable of displaying realistic lung and diaphragm movements.

The project won the undergraduate Innovation Award at UMaine's 2017 Student Symposium last spring.

In October, the spinoff company founded by the students, Zephyrus Simulation LLC, won $500 in the area's Big Gig pitch event for innovators and entrepreneurs.

This coming spring, Zephyrus Simulation LLC, based in UMaine's Foster Center for Student Innovation, will compete for a $5,000 cash prize offered by Big Gig, a partnership of municipalities, universities and organizations in the Penobscot River valley that has worked with local innovators and entrepreneurs to create a supportive network and catalyze economic growth.

"Pitching at Big Gig was awesome," says Patrick Breeding, who now serves as CEO of Zephyrus Simulation and is a UMaine graduate student in biomedical engineering. "It gave our company exposure to the community, funds to develop our next prototype, and the opportunity to refine the way we communicate the 'what, how and why' of what we are doing.

"For me, the most rewarding part was being able to meet more like-minded people (who) are doing similar things," he says. "(We) really appreciate the support of the warm and welcoming startup ecosystem in Maine."

Zephyrus Simulation is pursuing a patent for the prototype, and has received grants from the Libra Future Fund and Maine Technology Institute, allowing the startup to continue to develop and innovate the device.

And most recently, the entrepreneurial team was one of 18 selected nationwide to participate in the VentureWell E-Team Program, which funds, and provides immersive workshops and specialized coaching for student inventors and entrepreneurs "who want to address important problems in the world through new technology-based ventures."

IT ALL began by considering the current state of most manikins, which don't have the ability to simulate lung and abdominal breathing independently, according to Banton Heithoff, who worked on the project and is now an IDEXX researcher.

"Our manikin allows us to more accurately and realistically simulate breathing in children," says Heithoff. "The big advantage of this manikin is that it allows us to more properly simulate critical conditions, so if a child is going into respiratory distress, they typically only use their diaphragm or abdominal breathing patterns, and in current manikins you can't simulate this."

> "The right lung, left lung and abdomen don't always breathe together. If a baby aspirates a peanut in the right lung, then only the left side of the chest would be moving. **We'd like a physician or a nurse to be able to recognize that when they saw a baby in the emergency room."** Dr. Denham Ward

Manikins designed to show different rates of breathing could potentially allow training doctors and nurses to make a diagnosis based on the breathing pattern, according to biomedical engineering professor Caitlin Howell.

Howell and biomedical engineering professor Karissa Tilbury advised the students — Breeding of East Granby, Connecticut; Heithoff of Oldwick, New Jersey; Amber Boutiette of Skowhegan, Maine; and Madeline Mazjanis of Portland, Maine.

Like Breeding, Boutiette and Mazjanis now are pursuing master's degrees in biomedical engineering at UMaine.

Having more realistic training manikins can help health care professionals be better prepared for when emergencies occur, the students say. Current high-fidelity simulations for training doctors and nurses are expensive, and cheaper simulations are often not accurate, according to Howell, who is the faculty adviser to Zephyrus Simulation.

Tilbury says she believes the design could be implemented into high-fidelity manikins to train nursing staff and future doctors, or even used in parenting classes that teach CPR.

In their capstone year, the students were given a full-size training manikin by the UMaine School of Nursing to better understand how they are built. Using widely available materials — stretchable plastics, tubing, fittings and an air compressor — and a budget of about $500, the students designed a system that can accurately replicate four types of breathing patterns in pediatric lungs and diaphragm.

Biomedical engineering majors are required to build a device during their senior year, and students usually work with clients from outside the university, Howell says.

FOR THIS project, the students worked in collaboration with Dr. Denham Ward and Dr. J. Randy Darby of the Hannaford Center for Safety, Innovation and Simulation (SIM) at Maine Medical Center in Portland, who acted as the clients.

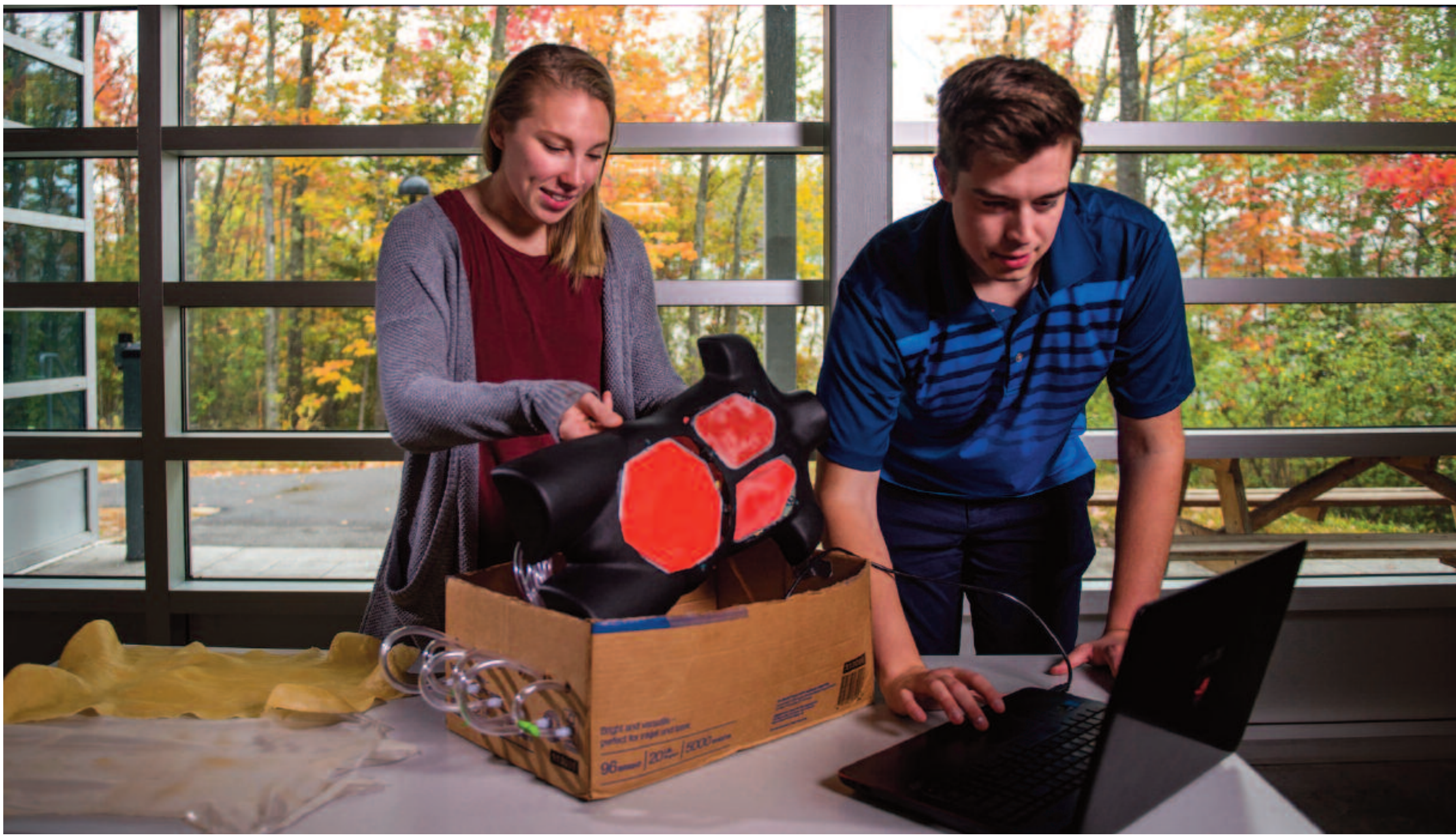
Ward received a bachelor's degree in electrical engineering from UMaine in 1969, and his professional career has spanned both the engineering and medical fields.

Darby is a graduate of Knox College and the Tufts University School of Medicine, and directs the SIM Center. Ward and Darby worked with the UMaine College of Engineering and the students to develop the capstone design project.

"My research interest has always been respiratory physiology," Ward says. "One of the things I've noticed on the simulation manikins is the breathing pattern is not very realistic, particularly in babies."

Ward says babies have a soft chest wall, which allows for a lot of movement that is not simulated in most manikins.

In pediatric breathing simulations, Ward pointed out that training manikins only have lungs that fill and empty, but when children have trouble breathing, they use all their muscles and move their diaphragm, according to Howell.



Two of the student entrepreneurs — Madeline Mazjanis of Portland, Maine, left, and Patrick Breeding of East Granby, Connecticut — demonstrate their pediatric breathing simulator at the University of Maine Foster Center for Student Innovation, where their spinoff company, Zephyrus Simulation LLC, is now headquartered. Mazjanis and Breeding, Banton Heithoff of Oldwick, New Jersey, and Amber Boutiette of Skowhegan, Maine developed the now award-winning simulator as their capstone project last year, under the direction of professors Caitlin Howell and Karissa Tilbury, and in collaboration with Dr. Denham Ward and Dr. J. Randy Darby.

"The right lung, left lung and abdomen don't always breathe together," Ward says. "If a baby aspirates a peanut in the right lung, then only the left side of the chest would be moving. We'd like a physician or a nurse to be able to recognize that when they saw a baby in the emergency room."

Ward asked the students if they could create a manikin that would simulate the different breathing patterns. He gave the students specifications and offered feedback throughout the process.

"Dr. Ward was an invaluable resource because he works with the simulation manikins that are currently available," Heithoff says. "By showing us what is currently available on the market and where those manikins are lacking allows us to see the holes we need to fill and also the standards we need to be at."

The lessons learned are life-changing.

"This has been an incredibly exciting experience for all of us," Breeding says. "We are meeting and working with so many fantastic people. It's truly amazing what can happen when driven people get together with a passion for helping others." ■

IN A small lab in the basement of Boardman Hall sits a scale model of an oyster farm — two small metal cages complete with a net bag containing miniature plastic oysters.

The mini-aquaculture farm is key to the research of Zhilong Liu, a doctoral student in civil and environmental engineering who is studying the hydrodynamic impacts of expanding an existing oyster farm in the Damariscotta River. Liu's work has implications not only for the growing aquaculture industry in Maine, but for a variety of other activities that can affect the flow of water in a river or along the coast.

"All (aquaculture) farms are obstacles that block the current, that cause reduction in flow and change the material transport and waste transport," he says. "Our goal is to be able to estimate or predict the flow around the farms before they are placed in the water."

Supported by Maine EPSCoR's Sustainable Ecological Aquaculture Network (SEANET), Liu's award-winning coastal and water resources engineering research combines field observations, numerical simulations and analytical models. A UMaine team led by Liu's faculty adviser Kimberly Huguenard, an assistant professor of civil and environmental engineering, conducted field observations at the Mook Sea Farm in the Damariscotta River last summer during a tide cycle, measuring the flow upriver and downriver from the oyster farm, as well as in the area immediately around the existing oyster pens. The results from the field tests, along with experiments in the lab utilizing the mini-oyster farm, will be used to validate the numerical model Liu developed.

Liu is attempting to calculate the impact of placing oyster farms in the river by comparing computer simulations with the results from the lab analysis and field observations. Experiments in the lab this fall focus on replicating the conditions in the Damariscotta River and using a laser to monitor the flow of water around the miniature oyster farm.

Placing an oyster farm in the water has different impacts in the river: It creates turbulence at the surface and slows the flow of the river around the pens, while increasing the velocity near the bottom, affecting erosion and sedimentation. Advanced knowledge of site-specific effects, Liu says, can be an important tool for farmer and regulators when choosing or expanding farm locations.

"If the flow is too fast, the oyster cannot open its mouth; if it is too slow, it will not get enough oxygen and enough nutrients," Liu says.

An analysis can be particularly helpful when the results show adverse impact on the flow, precluding a site from being developed.

Liu's research on the effects of aquaculture on flow fields, which was recognized with a UMaine chapter of Phi Kappa Phi award earlier this year, can be expanded to include environmental factors and installation of coastal structures — from a small temporary dock to a permanent footing for a new bridge. ■

Flow fields

Award-winning research focuses on hydrodynamic impacts

Sea systems

Nancy Chapman is on the frontlines of U.S. Navy shipbuilding

AS A young engineering student at the University of Maine, Nancy Chapman never imagined she would go on to work for the Navy building some of the most complex systems ever developed.

Today, the 1990 UMaine mechanical engineering graduate directs the Project Office for Supervisor of Shipbuilding (SUPSHIP) in Bath, Maine. Her office oversees five Navy shipbuilding programs in five states, including the Zumwalt ship class, the Navy's newest and most advanced destroyer being built at Bath Iron Works.

In addition to new ship construction, Chapman oversees aircraft carrier ship recycling, and supervises maintenance and modernization planning efforts for two ship classes — the Littoral Combat Ship and the Arleigh Burke.

Most recently, Chapman has supported the emergent planning efforts to repair two recently damaged destroyers, *USS Fitzgerald* and *USS John S. McCain.*

Her organization's diverse workload portfolio brings challenges, and Chapman finds the work highly rewarding.

"Everything we do impacts the Navy sailors we support," Chapman says. "The Navy needs more ships and we are on the frontlines of making that happen.

"Our organization takes great pride in our ability to work with our industry

Alumna Nancy Chapman directs the Project Office for Supervisor of Shipbuilding in Bath, Maine. Her office overseas five Navy shipbuilding programs in five states, including the Zumwalt ship class, the Navy's newest and most advanced destroyer being built at Bath Iron Works. In addition to new ship construction, the 1990 mechanical engineering graduate oversees aircraft carrier ship recycling, and supervises maintenance and modernization planning efforts for two ship classes — the Littoral Combat Ship and the Arleigh Burke. Most recently, Chapman has supported the emergent planning efforts to repair two damaged destroyers, *USS Fitzgerald,* left, and *USS John S. McCain.* Photos courtesy of U.S. Navy

partners to find technical solutions that meet the fleet's needs without adding undue costs to the taxpayer.

"I like the variety of projects, issues and challenges that come up. As project director, I also deal with a lot of different people, engineers and (those in) technical positions, business and finance positions. I like the breadth of that part of the job, as well," she says.

CHAPMAN BEGAN working at SUPSHIP Bath soon after graduation through the Navy's Engineer in Training Program. She spent 15 years in the engineering department, where she worked on design and configuration management issues. She then moved to the program department, where she managed testing and production before becoming the department's director, supervising more than 50 civilian and military personnel.

Chapman said her UMaine experience — the classes, the capstone project, campus life, sports, All Maine Women — all prepared her well.

"The university gave me a strong academic background, but I was also involved in campus life. I was a cheerleader back when that was a letter sport. My dad used to tell my mom, 'you know, she's up there majoring in cheerleading,'" she says.

In addition, Chapman says she got a strong technical background, and learned how to solve complex problems and manage multifaceted projects, which applies to any type of work, not just engineering issues.

"It also gave me the opportunity to become well rounded," she says. "All those things are a part of the package that UMaine gave me. They gave me the confidence and the tools to enter the workforce, and that affected my career."

Like the engineering profession overall, Chapman's jobs have changed over the years. Engineering has become much more multidisciplinary, she says, and engineers coming into the profession need to expect to work as part of an interdisciplinary team.

"With a mechanical valve, you had a wrench and you went down and turned that valve," she says. "Today, nothing is standalone. It's smart technology; everything has a sensor. It's electronically driven by computer controls and monitors. In some cases, it does its own diagnostics. From an engineering perspective, that's a huge change.

"That was just getting started when I was at Maine," Chapman says. "We were taking data with computers then — we'd gone beyond just writing on paper — but we were storing it on floppy discs."

> "All those things are part of the package that UMaine gave me. **They gave me the confidence and the tools to enter the workforce, and that affected my career."**
>
> Nancy Chapman

CHAPMAN SAYS she might have been a math or physics teacher if she hadn't become an engineer. It was her dad who encouraged her to give mechanical engineering a try. Her father, Ben Chapman, UMaine '52, '63G and a UMaine associate professor emeritus of mechanical engineer at the university, knew the value of a UMaine engineering education and was very pragmatic about it.

"He always said engineering teaches you to think, to solve problems," Chapman says. "It will take you anywhere."

For the Orono native, the Navy job in Bath gave her the chance to stay in Maine and pursue an amazing career. Shipbuilding also has taken a surprising number of UMaine engineering graduates to SUPSHIP Bath.

Until recently, when two UMaine alumni retired, every technical management position at SUPSHIP Bath was filled by a graduate of the University of Maine, she says.

Her immediate boss, Robert Footer, is mechanical engineering '89.

One of the newest Black Bear engineers, Cameron Dick, mechanical engineering '17, works right outside her office door, having done an internship at SUPSHIP before graduation.

Most of the alumni who were working there when she started had taken classes with her father.

"Everybody knew my dad. Everybody had him as a professor, but they all loved him, so that was good."

Chapman recently conducted an informal survey among UMaine alums at SUPSHIP Bath and received a very positive response from the grads she works with. One of the big takeaways from the survey was that the alumni engineers all looked back fondly on their days at the university and all felt they had a good, strong education, she says.

Most reflected on the UMaine education that prepared them for their careers. One noted that the College of Engineering had an "excellent program that I would stack up against any other school."

Another graduate noted: "(I) hold it in high regard and recommend that perspective students considering engineering as a profession look into UMaine."

LIKE MANY of those graduates, Chapman has maintained close ties with Orono over the years. In 2015, she received the Francis Crowe Society Distinguished Engineering Award and currently serves on the Mechanical Engineering Industry Advisory Council.

"I think it helps the professors understand what students do with the tools when they get out," she says. "There's a broad spectrum of people on that council and we can give them a perspective on how the industry is moving. I think it helps them to understand the skill sets engineers are going to need."

Chapman also serves on the board of the Maine Engineering Promotion Council, an organization that includes representatives from education and industry working to demonstrate STEM subjects and to encourage young people to consider working in STEM careers.

Her enthusiasm for her job and for her experience at UMaine make it easy for her to encourage young people to consider both engineering and the university.

"So many other things can happen — opportunities, choices, luck. But getting a strong educational foundation is the first building block." ■


Joshua Patnaude Donald Bistri

Top graduating students in 2017

JOSHUA PATNAUDE of Sanford, Maine was the 2017 University of Maine salutatorian and Outstanding Graduating Student in the College of Engineering. He double majored in computer engineering and electrical engineering. Patnaude was a 2013 Mitchell Scholar with numerous honors for academic achievement, including a Maine Space Grant Award. He held internships every summer of his academic career, working at Great Works Foundation Inc., in Sanford; Pratt & Whitney in North Berwick; Portsmouth Naval Shipyard in Kittery; and Modern Grid Partners in Portland. During the academic year, Patnaude was an undergraduate teaching assistant in the Department of Electrical and Computer Engineering. He also served as a peer tutor. For two years, Patnaude was president of the UMaine Black Bear Robotics Club. He is an Eagle Scout and holds a black belt in karate. In his electrical and computer engineering career, he wants to become a licensed professional engineer and pursue an MBA.

DONALD BISTRI of Tirana, Albania was the Outstanding Graduating International Student in the College of Engineering. His honors included the Alton S. and Adelaide B. Hamm College of Engineering Scholarship. The mechanical engineering major was a student research assistant for two years in the Advanced Structures and Composites Center (ASCC). There, his research focused on the structure of hypersonic inflatable aerodynamic decelerator (HIAD) technology. He also was a research assistant in the Alfond W^2 Ocean Engineering Lab. Bistri was awarded a full scholarship to pursue a master's degree in aerospace engineering at Georgia Institute of Technology.

UMaine, EMCC agreement to benefit transfer students

EASTERN MAINE Community College and the University of Maine signed a Memorandum of Understanding Aug. 1, that confirms the commitment of both institutions to allow EMCC students in designated programs to easily transfer credits toward a UMaine bachelor's degree.

The MOU supports the creation of program agreements to streamline admission opportunities for academically qualified students and graduates of EMCC, facilitate student academic transfer, and create a smooth transition for the EMCC transfer students.

Program-specific articulation agreements also signed: A.A. in liberal studies to Bachelor of University Studies, leadership track; A.A.S. in electrical and automation technology to B.S. in electrical engineering technology; and A.A.S. in civil engineering technology to B.S. in construction engineering technology.

UMaine has a history of EMCC students transferring to UMaine. From the fall 2014 through fall 2016, UMaine received over 300 transfer admission applications from EMCC students and alumni.

Those students included Logan Merrill of Norridgewock, who started in EMCC's Electrical and Automation Technology Program in 2014 and will graduate next year with a bachelor's degree in electrical engineering technology from UMaine.

He says EMCC gave him a strong foundation. At UMaine, he has pursued advanced topics in his field of study.

This past summer, Merrill interned as a primary application engineer at OMICRON Electronics Corp. USA in Waltham, Massachusetts, "learning different ways to apply my education to everyday problems, and gaining hands-on experience in the workforce."

Merrill's supervisor at OMICRON is UMaine alumnus Charles Sweetser, a Lewiston native who received his bachelor's and master's degrees in '92 and '96, respectively. Sweetser, PRIM engineering services manager at OMICRON, now lives in Falmouth.

First two Thornton Academy students headed to UMaine via partnership program

THORNTON ACADEMY seniors Caleb Bailey and Ben Leary have been accepted into College of Engineering with sophomore status through a first-in-the-state partnership forged to create a pipeline of Maine residents entering the engineering sector.

Both students are completing a rigorous curriculum that has included Advanced Placement courses in chemistry, physics, computer science, calculus, foreign language, the humanities, history/social science and English, as well as an Honors Introduction of Engineering course. First announced in 2013, this unique articulation agreement allows Thornton Academy students to complete 30 college credits, bypassing freshman year — an estimated savings of at least $24,000.

The partnership rewards motivated students with the ability to challenge themselves, reach their full potential, defray college costs and complete an undergraduate degree in three years.

Thornton Academy in Saco is a co-educational, private boarding and day school serving grades 6 through 12.

"I commend these two students for completing an entire year of engineering education through the UMaine College of Engineering–Thornton Academy partnership," says College of Engineering Dean Dana Humphrey. "This shows both the dedication of these students and the high-quality education provided by Thornton Academy."

Humphrey formally recognized the accomplishments of the two students at a ceremony held at Thornton Academy May 25.

Welcome new faculty

Warda Ashraf

Assistant Professor of Civil and Environmental Engineering

Ph.D. in civil engineering, Purdue University

SPECIALTY: Construction materials

WHY UMAINE? Both teaching and research opportunities.

Babak Hejrati

Assistant Professor of Mechanical Engineering

Ph.D. in mechanical engineering, University of Utah

SPECIALTY: Robotics dynamics and control

WHY UMAINE? I like the research opportunities here.

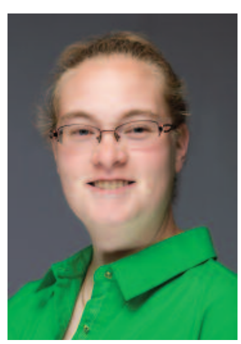
Meredith Kirkmann

Assistant Professor of Construction Engineering Technology

M.S. in civil engineering, UMaine; MBA, Husson University

SPECIALTY: Highway and site design, and project management.

WHY UMAINE? UMaine's College of Engineering was a welcoming and inspirational place to grow and learn as an undergrad and graduate student; joining the faculty to provide a similar space is an exciting opportunity.



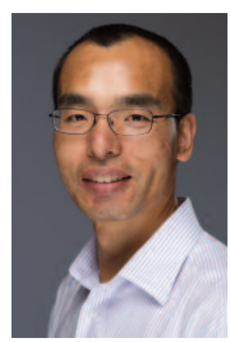
Lisa Weeks

Lecturer in Biomedical Engineering

Ph.D. in chemical engineering, UMaine

SPECIALTY: Fluid mechanics transport

WHY UMAINE? Commitment to fostering students and producing great engineers.



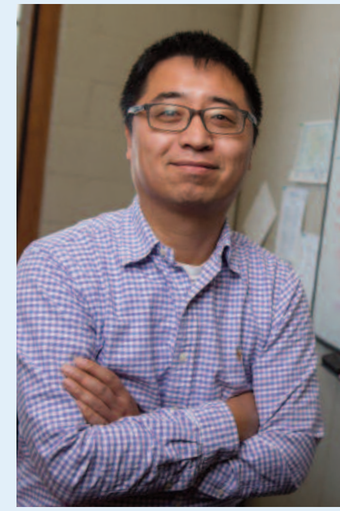
Yingchao Yang

Assistant Professor of Mechanical Engineering

Ph.D. in mechanical engineering, University of South Carolina

SPECIALTY: Nanomaterials and nanomechanics

WHY UMAINE? It's a wonderful place to carry out forefront research.



Xudong Zheng

Zheng receives NSF CAREER Award

CREATING A better understanding of how humans use and control their voice is the focus of a five-year study being led by Xudong Zheng, an assistant professor of mechanical engineering. The project that will use computer models to look at the role of mucosal wave propagation in sound production during phonation.

His long-term goal is to understand the mechanism that is responsible for the range, complexity and uniqueness of the human voice to provide personalized voice care.

The National Science Foundation awarded Zheng a $513,523 CAREER grant for his project, "Sound Production by Flow Induced Elastic Wave with Application to Human Phonation."

Zheng says the research will contribute to the fundamental understanding of flow-induced sound through flow-structure interaction, and also will advance the knowledge of voice production. The study will allow researchers to develop diagnosis metrics for mucosal wave-related voice diseases, determine the adjustments to the vocal folds to restore or improve a damaged voice, and predict the outcome of the adjustment.

Leadership and vision

DICK FOX of Athens, Maine received his engineering degrees from the University Maine in ’68 and ’70, and went on to serve as chair and chief executive officer at CDM Smith, Inc., an international engineering and construction company headquartered in Boston.

For his lifetime achievements, he received the 2008 Edward T. Bryant Distinguished Engineering Award from the College of Engineering.

Today, Dick serves as an active member of the College of Engineering Dean’s Advisory Council. Members help guide the college’s curriculum, facilitate partnerships, speak to the needs of industry, and serve as advocates for the state’s only comprehensive engineering program. In addition, he mentors aspiring engineers through Dean Dana Humphrey’s leadership course.

Dick and his wife Pat ’68 established the Arbor-Fox PaCEsetter Scholarship to benefit civil engineering students. They also support the Alfond Fund; Dick played on UMaine’s Tangerine Bowl team.

Most recently, the Foxes made a generous pledge to the Engineering Education and Design Center. This new academic building for the college is UMaine President Susan J. Hunter’s highest capital priority.

The Foxes have established “a very meaningful legacy that will impact our college forever,” Humphrey says.

For more information about giving to the College of Engineering, contact Pat Cummings, senior director of philanthropy, or Diane Woodworth, philanthropy officer, at the University of Maine Foundation.

UNIVERSITY *of* MAINE
FOUNDATION

umainefoundation.org

Two Alumni Place
Orono, ME 04469-5792
207.581.5100 or 800.982.8503

75 Clearwater Drive, Suite 202
Falmouth, ME 04105-1445
207.253.5172 or 800.449.2629

At UMaine, Dick Fox met his wife, Pat, who completed a bachelor’s degree in French.

1865 THE UNIVERSITY OF MAINE
College of Engineering
5796 AMC, Room 200
Orono, ME 04469-5796