From the school head

As I reflect on my first year as school head, I am grateful for the scope and breadth of our faculty and students’ work. They are impacting our community and the world in real and profound ways, and that impact is increasingly being recognized.

As you’ll note from the stories shared in these pages, our school continues to innovate and enhance our reputation. We have been tremendously successful securing federal funding, joining three more Manufacturing USA institutes. And three of our young faculty have achieved prestigious early-career awards.

These and other achievements signal that our school is poised to maintain a great trajectory.

I am excited to share these stories with you, and I encourage you to reach out and share your own by emailing info-MIME@oregonstate.edu.

Warm regards,

Harriet B. Nembhard, Ph.D.
School Head of Mechanical, Industrial and Manufacturing Engineering
Eric R. Smith Professor of Engineering

COVER: Cassie the bipedal robot at Amazon’s exclusive MARS 2017 Conference. (See story on page 3.)
Photo courtesy of Amazon.
Cassie steps into the limelight

Oregon State University College of Engineering’s robotics program is growing rapidly, propelled by breakthrough innovations, and industry leaders are taking notice.

The college has recently spun off one of its first businesses, a company focused on legged locomotion that may revolutionize robot mobility and enable robots to go anywhere people can go.

The company, Agility Robotics, was co-founded by Jonathan Hurst, associate professor of mechanical engineering and College of Engineering Dean’s Professor, with Oregon State alum Mikhail Jones and Hurst’s graduate school classmate Damion Shelton. Based in Albany, Oregon, and Pittsburgh, Pennsylvania, it is licensing technologies first developed at the university and helping other academic and research institutions to grow the research community and educate a new generation of robotics engineers.

“This technology will simply explode at some point, when we create vehicles so automated and robots so efficient that deliveries and shipments are almost free,” said Hurst.

“Robots with legs can go a lot of places that wheels cannot. This will be the key to deliveries that can be made 24 hours a day, 365 days a year, by a fleet of autonomous vans that pull up to your curb, and an onboard robot that delivers to your doorstep.”

The company’s latest creation, a bipedal robot named “Cassie,” is getting a lot of attention, even garnering Hurst an invitation to Amazon’s exclusive MARS (Machine-Learning Automation, Robotics and Space Exploration) conference, where he showed off Cassie to a distinguished crowd of academics and business leaders.

Cassie can stand, steer, and take a pretty good fall without breaking. It’s half the weight of and much more capable than earlier robots developed at Oregon State.

“Our previous robot, ATRIAS, had motors that would work against each other, which was inefficient,” Hurst said. “With Cassie, we’ve fixed this problem and added steering, feet, and a sealed system, so it will work outdoors in the rain and snow as we continue with our controller testing.”

The particular issue of motors working against one another prompted some extensive theoretical research, to create the mathematical frameworks needed to solve the problem. The resulting leg configuration of Cassie looks much like an ostrich or other ground-running bird.

“We weren’t trying to duplicate the appearance of an animal, just the techniques it uses to be agile, efficient, and robust in its movement,” Hurst said.

“We didn’t care what it looked like and were mostly just working to find out why Mother Nature did things a certain way. But even though we weren’t trying to mimic the form, what came out on the other end of our research looked remarkably like an animal leg.”

Cassie, built with a 16-month, $1 million grant from the Advanced Research Projects Agency of the U.S. Department of Defense, is already one of the leading innovations in the world of legged robotics.

Company officials said they plan to do all initial production in Oregon and will focus their business on the commercial applications of legged robots. Hiring is anticipated for research, production, and development.

“The robotics revolution will bring with it enormous changes, perhaps sooner than many people realize,” Hurst said. “We hope for Agility Robotics to be a big part of that revolution. We want to change people’s lives for the better.”

Company officials said that access to the research base and education of students at Oregon State will aid its growth, providing the needed expertise and trained work force. Oregon State has already been ranked by Grad School Hub as the best in the western United States and fourth leading program in the nation in robotics research and education.
School of MIME expands role in Manufacturing USA

School of Mechanical, Industrial & Manufacturing Engineering

The National Network for Manufacturing Innovation (NNMI), also known as Manufacturing USA, is a collective of research institutes in the United States that focuses on developing and commercializing manufacturing technologies through public-private partnerships between industry, universities, and federal agencies.

To date, 14 manufacturing innovation institutes have been established or announced. Oregon State University first joined the network in 2014 when it was chosen to be part of the Digital Manufacturing and Design Innovation Institute. In the past year, OSU has been selected to join three more institutes — Advanced Robotics Manufacturing Institute, Clean Energy Smart Manufacturing Innovation Institute, and Rapid Advancement of Process Intensification Institute.

“A major part of the College’s strategy has been to invest in advanced manufacturing,” said Harriet Nembhard, MIME school head. “These new awards are clear evidence that MIME is now firmly positioned as a key partner in that field.”

In addition to the MIME faculty who serve as leaders and PIs in these institutes, over 300 faculty and students across MIME and the College of Engineering are expected to be involved.

“The partnerships will also have a transformative impact on research and curricular innovation. They will help push our ability to prepare new engineers for 2020 and beyond,” said Nembhard.

Oregon State University will be a founding academic partner in one of the newest institutes, known as the Advanced Robotics Manufacturing Innovation Hub (ARM), which will be supported by $253 million from federal and matching funding. States, local governments, industry, universities, community colleges, and non-profit organizations will participate, and the U.S. Department of Defense is directing the federal effort. A primary goal is to better organize the current fragmented capabilities in robotics technology in the U.S. while preparing the nation to be more globally competitive.

Among participating academic institutions, Oregon State already has one of the nation’s leading educational and research programs in robotics.

“We’ll be leveraging our world-class robotics faculty in collaboration with our colleagues in mechanical, industrial, and manufacturing engineering, and electrical engineering and computer science,” said Bill Smart, an associate professor in the College of Engineering and one of the university’s leaders in robotics education and research.

“OSU is perfectly positioned for this institute, since it has strengths in all of the areas, and a long history of actually reaching out to and working with industry. This is squarely in Oregon State’s wheelhouse, given our long history and deep experience of working with Oregon companies on projects that bring real, tangible benefits to the local and national economies.”

ARM will conduct applied research and development; deliver education and workforce training; and create a nationwide network of “regional innovation” collaborations. Oregon State University will help lead one of those collaboratives in the Pacific Northwest.

As a partner in the Clean Energy Smart Manufacturing Innovation Institute (CESMII), the College of Engineering will significantly expand its outreach and collaboration with Pacific Northwest business and industry, helping them to save energy, waste less, create jobs and become more internationally competitive.

This broad program is supported by the U.S. Department of Energy, headquartered in Los Angeles and comprised of five regional centers. One of those centers is based at the Pacific Northwest National Laboratory, and in addition to Oregon State University, its partners include, Washington State University, the University of Washington and regional industry.

“Recent growth in the College of Engineering has positioned OSU well to have a regional and national impact in smart manufacturing,” said Karl Haapala, an associate professor of manufacturing engineering, and Oregon State University co-principal investigator of the program.

“We have new faculty hires in such areas as sensor design and fabrication, new facility investments, and growing partnerships with major regional industries. Oregon State University faculty are already undertaking leading research in advanced manufacturing, and this initiative will give us the ability to bring more of our work to the industries that can benefit from it, while giving our students the opportunity to gain experience working with industry.”
The university is also partnering with the Pacific Northwest National Laboratories (PNNL) to co-direct a key component of a five-year, $70 million advanced manufacturing institute, with the goal of greater energy efficiency, increased manufacturing innovation, and more jobs in the nation’s chemical industries.

The institute, Rapid Advancement of Process Intensification Deployment (RAPID), was announced by the U.S. Department of Energy. It will be coordinated by the American Institute of Chemical Engineers.

According to Matt Campbell, professor of mechanical engineering, digital manufacturing is a concept that greatly reduces physical prototypes and testing, as well as time to manufacture.

“In design, the idea is to fail early and often, so that we succeed sooner,” Campbell said. “Our digital tools will predict performance and where failure will occur, and reduce or eliminate the need for costly prototypes. Then we’ll use 3D printers and other tools to automate and streamline actual manufacturing.”

This approach, researchers say, will provide a fundamentally new way for digital information to flow among designers, suppliers, and customers, as well as to and from intelligent machines and workers on the factory floor.

The technology being created at Oregon State, and other partners in this initiative, translates almost every aspect of a mechanical system into data that can be mixed and matched in sophisticated computer systems – what a part will do, how it will perform, what materials it is made of, how much stress those materials can take before they fail, what will happen at the intersection where one component interacts with another, where failures might occur, and how those failures can be prevented.

Key industry investors in the project include General Electric, Rolls-Royce, Procter & Gamble, Dow, Lockheed Martin, Siemens, Boeing, Deere, Caterpillar, Microsoft, Illinois Tool Works and PARC. Thousands of small and mid-sized companies are also involved. And Oregon State’s research in this field, which will continue to assist regional industries, includes such companies as Daimler Trucks, Blount, PCC Structurals, ESCO, Intel, Xerox and HP.

The Digital Manufacturing and Design Innovation Institute (DMDII) is a world-class, first-of-its-kind manufacturing hub. As a unique public-private partnership, DMDII seeks to transform American manufacturing by ushering in the digital revolution.

According to Matt Campbell, professor of mechanical engineering, digital manufacturing is a concept that greatly reduces physical prototypes and testing, as well as time to manufacture.

“The selection of OSU and our colleagues at PNNL to lead this focus area is a tribute to 15 years of commitment by state leaders, Oregon businesses, and our research universities,” said Brian Paul, the Tom and Carmen West Faculty Scholar of Manufacturing Engineering and leader of the new focus area.

“That long-term commitment is what it takes to become a national player that can advance technology with industry and create new job opportunities for Oregonians.”

The new focus area, Paul said, is an outgrowth of the collaboration between Oregon State University and PNNL through the Microproducts Breakthrough Institute which began in 2001. The success of that partnership has evolved into the Advanced Technology and Manufacturing Institute, located on the Hewlett-Packard campus in Corvallis. It focuses on the research and commercialization of advanced materials and technologies being developed within the university, in concert with research partners across Oregon and throughout the world.

“The cumulative economic impact from these industries could one day mean billions of dollars and thousands of high-wage jobs for Oregonians,” Paul said. “We are creating the building blocks for an economy with staying power and the ability to export sustainable technologies to the world.”
Three School of MIME faculty have achieved early-career benchmarks by earning prestigious and competitive research awards from the National Science Foundation (NSF) and the Office of Naval Research (ONR). This is the second year in a row that the school can boast three winners in a single year, and it now lists 14 of its 50 research faculty as past winners. Altogether, research funding for this year’s awards totals more than $1.5 million.

“We’ve seen such impressive growth in recent years, and the recognition of our newer faculty members shows that MIME is poised to remain in a strong position on the national and international stage for years to come,” says School Head Harriet Nembhard.

Two professors, Ross Hatton, assistant professor of robotics and mechanical engineering, and Julie Tucker, assistant professor of mechanical engineering, received the CAREER award, NSF’s most prestigious honor in support of early-career faculty who exemplify the role of teacher-scholars through research, education and the integration of research and education to forward the mission of their organization.

The third professor, Geoff Hollinger, assistant professor of mechanical engineering, won an ONR Young Investigators Award, which support candidates from a pool of college and university faculty who have obtained tenure-track positions within the past five years. This year’s 33 winners were selected from over 360 highly qualified applicants.

Hatton’s research interests lie at the intersection of robotics, mechanics, and biology. He will receive a $500,000 CAREER award for his project titled Geometric Understanding of Locomotion. The project will create a rigorous mathematical framework for analysis of the ways in which animals propel themselves. The goal of the work is to design bio-inspired robots that approach and surpass the capabilities of natural systems.

“Animals and robots move through the world by pushing against their environments,” explains Hatton. “Even though the physics of these interactions vary with differences in anatomy, scale, and surrounding material, there exist fundamental principles for how animals and robots can best exploit the resulting forces.” His research seeks to identify and concisely express these principles.

The CAREER award will support his investigation of new classes of systems — e.g. snakes with scales that prevent backwards sliding. The resulting framework for studying locomotion will contribute both to the design of robots able to travel in new and hazardous environments, and to our understanding of how animals interact with their ecosystem.

Tucker’s research focuses on thermal/irradiation stability of structural alloys used in nuclear power systems and leverages both modeling and experimental techniques.

Her CAREER award will provide $522,000 to study alloys kept in service for many years at temperatures from 200–500 degrees Celsius – a range where temperature effects are very low in the short run but become significant over time. Knowledge of how alloys behave in this middle range of temperatures...
are essential in many important industries, including the aerospace, energy production, and petrochemical industries. As the materials degrade, their ability to perform as designed is compromised, which can lead to safety hazards. But because degradation can take decades, laboratory studies are impractical because they could last years. Tucker proposes to use radiation to accelerate the alloy degradation process, thus making laboratory evaluation feasible.

Tucker’s project is also designed to act as a vehicle for both recruiting and retaining a future generation of engineers and scientists from under-represented groups by integrating with two mentoring programs that bring Oregon high school, undergraduate and graduate students together in the lab.

She sums up both her research and teaching philosophy in two succinct sentences: “I bring real life examples into the classroom and lab so my students see why this might matter. And I try to create a supportive, caring environment in which students can thrive.”

Hollinger conducts fundamental research in the quickly growing area of robotic systems. Among the major goals of his Robotic Decision Making Laboratory is formulating more effective ways for networks of autonomous robotic systems to work together to plan and coordinate their actions and learn how to make optimal decisions during complex data-gathering missions.

He was awarded $510,000 for his proposal, Information-Aware Decision Making in Teams of Autonomous Vehicles and Humans.

“Teamwork requires consulting with each other for assistance,” explains Hollinger. “In the future, this assistance may come from autonomous robots/vehicles, mission commanders, and humans deployed in the field. However, determining when to ask for assistance and what type of assistance is needed (e.g., information, guidance, or clarification) is a challenge.”

With the award, Hollinger will develop new decision making algorithms that reason intelligently about the effects of observations on mission objectives. The impact of this project will be significantly reduced communication, decreased computation, and optimized performance in naval-relevant autonomous systems.

**MIME student awarded Fulbright Scholarship**

At the end of August, Caitlyn Clark, graduate student in mechanical engineering, will travel to Aalborg University in Denmark for ten months to conduct research and represent the United States through the Fulbright Program.

“I’ll be researching risk and reliability in co-located wind-wave energy systems,” Clark says. “That is, I will explore how risk and failure can propagate through a system that involves both offshore wind turbines and wave energy converters in the same leased ocean space, and potentially how to mitigate those failures.”

“Caity is a brilliant and dedicated researcher and I’ve been so impressed by her drive,” says Bryony DuPont, assistant professor of mechanical engineering and Clark’s advisor. “This award is truly a testament to her motivation to solve marine energy problems, and I’m very proud of what’s she accomplished so far.”

By quantifying and communicating the risk and uncertainty inherent in these novel offshore energy systems, Clark hopes to provide information that can help stakeholders make informed decisions about design of and investment in these systems.

“The researchers I will be working with are trailblazers in risk and reliability in offshore renewable energy systems, so I’m ecstatic to have the chance to learn from them, and to start to develop a relationship between them and the Northwest National Renewable Energy Center at Oregon State,” she says. “This is a fabulous opportunity for growth not only for me, but also for MIME and Oregon State University.”
On many days, you can find Ph.D. candidate A.J. Fillo in the School of MIME's Niemeyer Research Group offices studying the turbulent combustion of liquid jet fuels.

While his current research is focused on numerical simulations using a supercomputer, Fillo explains that the Combustion, Ignition, Radiation, and Energy (CIRE) Lab, where he did his master’s research, is where he gets to “light things on fire for science.”

“Basically, I built a really fancy Bunsen burner that produces highly turbulent, premixed liquid jet-fuel flames,” Fillo said. “We can then use it to measure what’s called the turbulent flame speed.”

Earlier this year, Fillo won first place at the College of Engineering’s Graduate Research Showcase for a presentation based on his thesis, titled “Impact of fuel chemistry and stretch rate on the global consumption speed of large hydrocarbon fuel/air flames.”

His research comes as the world’s dependence on hydrocarbon fuel remains high and interest in energy conservation and fossil-fuel alternatives gains traction. He cites U.S. consumption data from 2014 at 18.49 million barrels of oil a day, of which 70 percent is used in transportation.

“Despite their extensive use, the turbulent combustion of these fuels is poorly understood,” he said. He expects that his research will help alleviate this gap in knowledge and provide turbulent combustion data needed to improve the industry’s understanding and approach to jet engine design and analysis.

“My research has the potential to generate a new, affordable methodology for evaluating alternative fuels enabling reduced fossil fuel dependence and lowering emissions,” he said.

Yet, for all the attention on his own research and burgeoning career, Fillo has managed to carve some time out for a new project aimed at inspiring the next generation of engineers and scientists.

Taking his knowledge of science and a knack for the theatrical—he subsidized his undergraduate education working as a professional magician and actor—Fillo has developed an educational video series called “LIB LAB,” short for Library Laboratory. The series is targeted at K-12 students to boost interest in STEAM (science, technology, engineering, arts and math) concepts and activities.

In partnership with Corvallis videographer Yancy Simon, the Emmy Award-winning Video Dads production team, and the Corvallis-Benton County Public Library, Fillo launched LIB LAB March 1. He’s also the star of the videos.

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A cleaner-burning stove for the developing world

Oregon State University’s Humanitarian Engineering Program focuses on finding science- and technology-based solutions to address basic human needs and improve quality of life particularly for those in underserved communities. One problem the group is tackling stems from one of the most basic of needs: a way to safely cook food.

In most industrialized nations, whenever we want to prepare a meal, or even a quick snack, we can just turn a knob and an electric burner lights up or a clean, blue flame ignites on the stovetop. Yet for nearly half of the residents of Planet Earth, this kind of luxury simply doesn’t exist.

About 40 percent of the world’s population currently burns biomass (wood or other organic material) to prepare their meals and heat their water and homes. “If you’ve ever sat around a campfire, you know that biomass fires produce a lot of smoke,” says Nordica MacCarty, assistant professor of mechanical engineering. “And being in the same time and confined space that cooking is happening, women and children are suffering severe health effects because of this necessary practice.”

Indoor air pollution is a huge problem in the developing world, where smoke inhalation and related illnesses are among the leading killers of women and children, accounting for about 4 million premature deaths each year.

But the problem of cookstoves doesn’t stop at its health risk. It’s also a major gender-equity issue. In much of the developing world — and much more so than in advanced industrial countries — women and children perform a disproportionate amount of household labor, like cooking and collecting the fuel wood.

“When they’re using inefficient practices like traditional open fires for cooking, they spend a lot more time collecting fuel wood,” says MacCarty. “So a typical woman will spend about two to four hours round-trip to go collect fuel wood and carry that back, often in very heavy loads. These problems are exasperated in regions where the forests are retreating around communities.

And in areas experiencing conflict, MacCarty explains, leaving the safety of places like displaced person or refugee camps is extremely dangerous for women, who are often at a risk of being attacked or hurt in some way.

The technical problem with traditional open-fire cooking is incomplete combustion: Not enough air gets to the fire, and it doesn’t get hot enough, so instead of a clean flame, it produces smoke and carbon monoxide.

In response to this problem, researchers like MacCarty and have developed small, inexpensive technologies that burn the fuel more efficiently and combust it more cleanly. These devices have an insulated combustion chamber where the fuel is mixed with air and smoke is kept in a confined space where it stays hot, and the emissions burn more completely before they exit. They’re also designed to transfer heat more effectively into the cooking vessel.

While researchers have an important role to play in figuring out how to adapt cleaner burning stove technologies to meet the needs of local communities, figuring out how to market those technologies and make them accessible and desirable to end-users isn’t a problem that engineering can solve on its own.

“You’re trying to market these devices to people who don’t have any disposable income,” says MacCarty. “You’re asking people to change their behavior and often times their cooking styles to accommodate this technology.”

To that end, MacCarty has partnered with an Oregon organization called Stove Team International to examine what might be done. Last year, they brought a group of students from mechanical engineering, public policy, and economics to Guatemala. “We looked at cookstoves from an interdisciplinary perspective and evaluated their performance when we were working with local cooks doing controlled cooking tests.” The team also surveyed rural homes to better understand the needs cookstove users.

And MacCarty and her team aren’t settling with simply improving cookstove technology for use in the household kitchen.

“One of the most exciting things that’s happened recently is that we’re partnering with InStove, which is another nonprofit based here in Oregon,” she says.

InStoves have the ability to be equipped with other devices, like medical tool sterilization autoclaves and rapid water pasteurization systems that require only about a pencil’s weight of wood per liter of water.

For their work with institutional cookstoves and water pasteurization, InStove and MacCarty’s team won the Impact Invention Award from the Lemelson Foundation at the Elevating Impact Summit sponsored by Portland State University. The team hopes to perform field trials with this technology this coming summer, hopefully in Haiti.

“It’s really the Humanitarian Engineering Program at Oregon State that attracted me to come here,” says MacCarty. “I really believe in using engineering to benefit low-resource populations.”
New MIME faculty reflect on their first year

Zhaoyan Fan, Ph.D.
Assistant Professor of Advanced Manufacturing

“I enjoy very much the supportive and collaborative research environment created by the school of MIME. I am looking forwarding to contributing more efforts to this community through my research, teaching, and services.”

Fan’s major research interests include physical sensing methodology, multiple sensor data fusion, system monitoring, cyber-physical systems, and cloud-based manufacturing. His present research focuses on the analytical and numerical modeling methods, and design methodologies to advance measurement technology for manufacturing process monitoring.

David A. Nembhard, Ph.D.
Professor of Industrial Engineering

“It is an exciting time to be at Oregon State, and I have started several projects and initiatives with my new colleagues here. The energy, enthusiasm, and talent of the young faculty paints a bright future for MIME.”

Nembhard’s research in industrial engineering focuses on topics including workforce engineering, staffing, scheduling, learning and forgetting, workforce cross-training, human performance in complex systems, and transportation of hazardous materials.

Somayeh Pasebani, Ph.D.
Assistant Professor of Advanced Manufacturing

“I am impressed by the amount of collaboration between faculty from different research fields, building strong multi-disciplinary research programs. This is absolutely exciting and I am very supportive and look forward to establishing my research program while collaborating broadly with my colleagues.”

Pasebani’s researches advanced materials and advanced manufacturing. Her research interests are in the areas of development of high temperature alloys, ceramic-reinforced metal matrix composites, aerospace and energy materials via advanced manufacturing.

Donghua Xu, Ph.D.
Assistant Professor of Materials Science

“I have been impressed by the diversity of faculty and students and the collaborative atmosphere among faculty colleagues. I look forward to making more progress in research and teaching and doing more services to our community.”

Xu’s scientific interest centers around advanced metallic materials (e.g., glassy alloys), including their fabrication, processing, characterization, and fundamental understanding of their behaviors in demanding applications (e.g., nuclear reactors) through both experiments and computation.
Oregon Stater Award: Academy of Distinguished Engineers

Robert Bergstrom
B.S. Mechanical Engineering, 1968

While studying mechanical engineering at Oregon State, Robert Bergstrom specialized in heat transfer. After graduating, he earned a master’s and Ph.D. from Purdue, and applied his knowledge to the problem of climate change. “Climate change is really a heat transfer problem,” he said.

Bergstrom joined NASA’s Ames Research Center as a national research associate in 1974. He was called to testify as an expert witness in several court cases, and those experiences piqued his interest in the law, so he obtained a law degree from Stanford in 1983. He became a member of the California Bar and worked as an environmental attorney for about a year before signing on at the Environmental Protection Agency as assistant regional counsel for the San Francisco region. He received an EPA Gold Medal for Meritorious Service in 1991.

During that time, Bergstrom also co-founded Legisoft, which produced a best selling software application called WillMaker (now an Intuit product).

Bergstrom wanted to continue his research on air pollution, so he sought funding to quantify the effects of soot on increased solar radiation in the atmosphere and its consequent contributions to climate change. He reconnected with his colleagues at Ames, and by 1992 had founded the BAER Institute, a nonprofit research group, to facilitate funding for his research.

The BAER Institute has grown to provide a research home for about 100 scientists. “It gives researchers a home where they get decent benefits — a retirement plan, medical insurance, and that kind of thing — so it’s actually worked out quite well,” said Bergstrom.

Bergstrom was the recipient of the Academy of Distinguished Engineers Award at the 2017 Oregon Staters Awards.
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