FALL 2017

ENGINEERING SOLUTIONS

A PUBLICATION OF THE FRANCIS COLLEGE OF ENGINEERING

UMASS LOWELL

Functional Fabrics Manufacturing

UML Extends Reach through Manufacturing USA Institutes

Page 2

Dear Alumni, Colleagues and Friends,

UMass Lowell has a long history of working with industry to solve problems on a local, national and global scale. The university's engineering roots date back to 1895, with the founding of the Lowell Textile School. The institution was developed to support the local textile industry, which was then at the forefront of the American Industrial Revolution.

That spirit of working with industry is alive and well today, most notably through our involvement with seven of the 14 institutes under the auspices of Manufacturing USA, the National Network for Manufacturing Innovation (NNMI). These include the following:

- **AFFOA (Advanced Functional Fabrics of America).** The goal is to integrate electronics and networking capability into traditional fibers and fabrics to enhance their properties. An initial project with Saint-Gobain is looking to develop smart fabrics that would help monitor civil infrastructure.
- **America Makes.** This original NNMI institute is focused on additive manufacturing and 3-D printing. UMass Lowell has worked closely with Raytheon to integrate electronics into traditional additive manufacturing processes, such as 3-D printing, which are generally limited in materials properties.
- **ARM (Advanced Robotics Manufacturing).** Working with UMass Lowell's NERVE Center, this institute will develop, test and deploy robotic solutions for industry.
- **IACMI (Institute for Advanced Composites Manufacturing Innovation).** This institute is focused on the continued development of composites. UMass Lowell's composites group is concentrating on applications in wind energy and automotive manufacturing.
- **NextFlex.** Arguably the most active institute for UMass Lowell, this group is looking at the development of flexible hybrid electronics. Projects to date have looked at the development of flexible substrates for RF devices as well as testing their capabilities.
- **NIIMBL (National Institute for Innovation in Manufacturing Biopharmaceuticals).** The focus here is to move the traditional batch processing of biopharmaceuticals closer to continuous manufacturing. The Massachusetts Center for Biomanufacturing at UMass Lowell is central to these efforts.
- **REMADE (Reducing Embodied-energy And Decreasing Emissions).** Efforts in recycling, most notably through our plastics engineering group, are aligned with this institute's goal of reducing waste in manufacturing processes.

What is unique about these institutes, which were initiated through federal funding, is that they require matching funds from state entities as well as companies. Thus, the research is focused on moving innovations from the lab into the manufacturing sector. Additionally, there is often funding available to support workforce-related training efforts.

This issue of Engineering Solutions takes an in-depth look at some of the research at UMass Lowell that is supported by the network. The research draws on faculty and students from across the college. Enjoy the read!

As always, please feel free to contact me (Joseph_Hartman@uml.edu; 978-934-2576 or via LinkedIn) if you have a story to share or would like to partner with the college. I look forward to hearing from you.

Sincerely,

Joseph C. Hartman, Ph.D., P.E.
Dean, Francis College of Engineering
University of Massachusetts Lowell

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IN THIS ISSUE

ON THE COVER

UMass Lowell's new Fabric Discovery Center (see page 2) will support research and development of new technologies that will revolutionize the way fabrics are made. The space-age textiles that would be developed include "smart" fabrics with sensors and communications features. These high-tech inventions can be woven into designs to do everything from detecting dehydration in soldiers to monitoring buildings for leaking pipes. Other functions embedded within the novel fibers and fabrics include "superomniphobic" geometries to repel all liquids (as shown on the cover photo illustration) as well as self-healing, energy-harvesting, flame-retardant and tunable mechanical properties.

Engineering Solutions is published by the Office of University Relations
University of Massachusetts Lowell
One University Ave.
Lowell, MA 01854
978-934-3224

Editor: Edwin L. Aguirre
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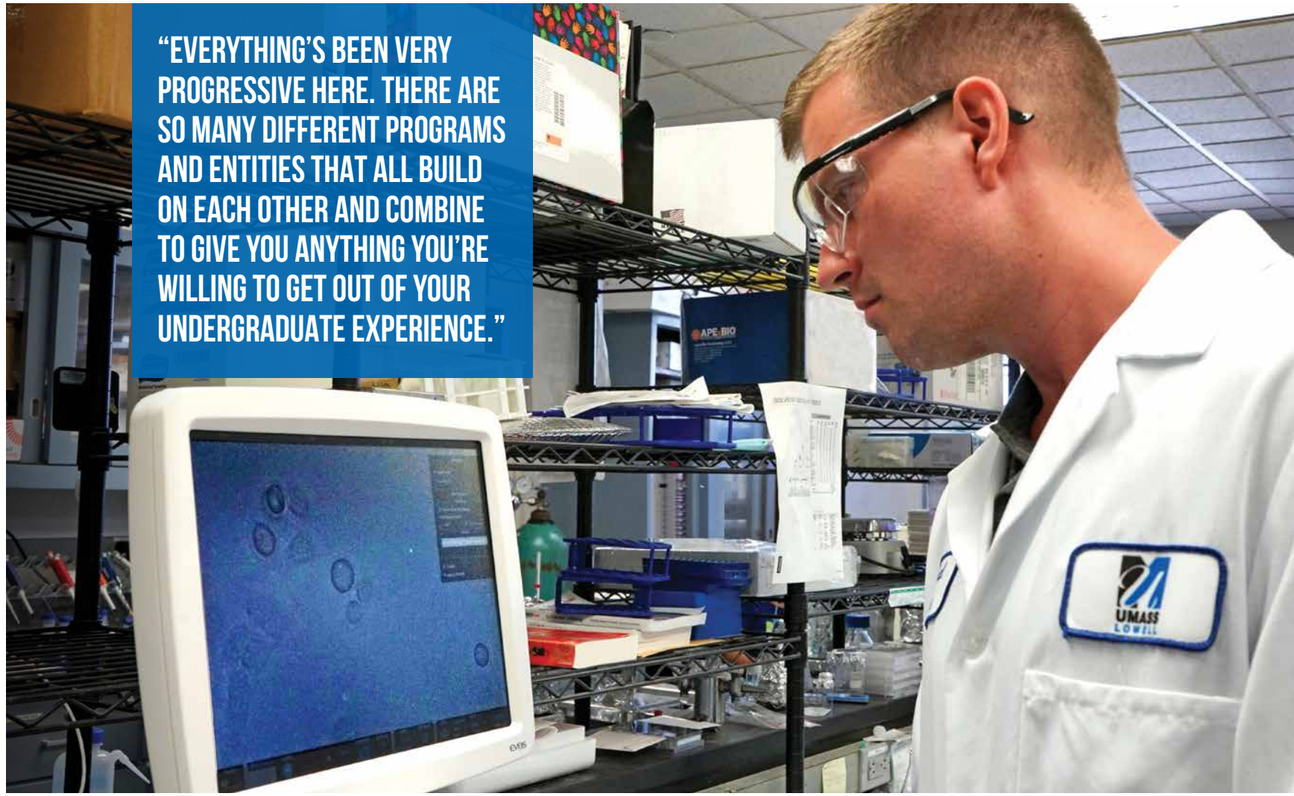


GOLDWATER SCHOLAR MAKES HIS MARK IN CANCER RESEARCH

Michael Doane is squeezing every experience he can out of his time at UMass Lowell.

Doane, who left community college in Hayward, Calif., when his mother was diagnosed with cancer, decided to return to college after she died. He plans to become a cancer researcher.

"Cancer is a peculiar and fascinating thing," he says. "An accumulation of genetic accidents can cause it, so there are lots of different ways we can try to target it."

He's well on his way. The honors student started off majoring in chemical engineering, then added a second major in biology. He also has three minors: in physics, biomedical engineering and math.

He got a work-study job doing computer modeling with chemical engineering Assoc. Prof. Seongkyu Yoon that turned into an Honors College research fellowship. He has worked with biology Prof. Matthew Nugent on emphysema-related research and with chemical engineering Asst. Prof. Prakash Rai on nanotherapy in pancreatic cancer, too.

Those experiences helped him win a National Science Foundation fellowship last summer at the University of Alabama, where he created a computer simulation of glioblastoma cell clusters for use in drug research—which led to his winning a prestigious, $7,500 Goldwater Scholarship for students who plan to pursue academic research careers in the sciences.

"I'm so happy I came to UMass Lowell. There's an abundance of research opportunities and everything's been very progressive here," he says. "There are so many different programs and entities that all build on each other and combine to give you anything you're willing to get out of your undergraduate experience."

Other experiences he's taken advantage of include the professional co-op program and the DifferenceMaker competition. Doane is completing a co-op at pharmaceutical giant Pfizer Inc., testing new equipment and processes for biotechnology research, and he plans to do a second co-op before he graduates in 2019.

Meanwhile, he's also working on a design for an anaerobic biodigester that can convert manure into methane gas and fertilizer. B.A.S.H.—Biodigester-Aided Solutions in Haiti—is a team effort that began as a 2016 DifferenceMaker project and continues through the university's Haiti Development Studies Center.

What hasn't he done? Study abroad.

"I'm still trying to figure out how to fit that in," he says. UML

UMASS LOWELL RETURNS TO ITS LEGACY AS TEXTILE INNOVATOR

State Awards University $11.3 Million for Advanced Functional Fabrics Manufacturing

Can the university help launch a 21st-century textile boom of smart fibers and wearable electronics?

That's what the state is banking on with Gov. Charlie Baker's announcement earlier this year of $11.3 million for UMass Lowell to establish a Fabric Discovery Center and to support its industry partnerships.

"Massachusetts is a competitive player in the global innovation economy because of our leadership in technology, strong workforce and educational institutions," Baker said. "This investment will ensure we continue to see that success and growth outside of Greater Boston, and that Lowell will have an opportunity to return to the center of the textile industry."

It's been decades since the city's mills hummed, but the state award—$10 million to create a hub where researchers and industry can collaborate on next-generation smart fabrics and $1.3 million to support a trio of projects with industry partners SI2 Technologies in Billerica and Raytheon in Waltham—sets the stage for Lowell's emergence as a 21st-century textile powerhouse.

According to the Baker administration, the funding will allow UMass Lowell to acquire the specialized equipment needed to develop materials that can be used in flexible hybrid electronics. Combined with more than $2 million in federal and industry funds for these projects, the investments will help spur future innovations and provide the resources to bring new technology from concept to commercialization.

Baker made the announcement at the university's Innovation Hub (iHUB) at 110 Canal St., a renovated manufacturing building in downtown Lowell. The building's third and fourth floors now house the university's two technology incubators—the iHUB and the Massachusetts Medical Device Development Center (M2D2). The state funding will be used to transform the first and second floors and part of the canal level of the building into the Fabric Discovery Center, with a total area of 28,000 square feet.

There will be room for prototyping and testing next-generation materials, a startup incubator for emerging businesses and space for workforce development efforts. There will even be a Fashion MakerSpace in which fashion designers and entrepreneurs can create runway-ready fabrics.

Tory Germann

Facing page, inset: The 110 Canal St. building in downtown Lowell will serve as home to UMass Lowell's new Fabric Discovery Center. The center will support research and development of new technologies that will revolutionize the way fabrics are made, reinventing the textile industry in the Mill City.

Above: UMass Lowell Vice Chancellor for Research and Innovation Julie Chen speaks about the university's plans for the Lowell Fabric Discovery Center at the 110 Canal building. Chen is shown speaking at the announcement of $11.3 million in state funding for the center and related research projects on May 31, 2017. Gov. Charlie Baker is shown bottom left.

Upper right: This is an example of some of the equipment that will be used in the Fabric Discovery Center. This particular machine automates the placement of fibers. Such fibers are examples of both functional textiles and flexible hybrid electronics, which are the focus of the center.

The space-age textiles that officials envision include "smart" fabrics with sensors and communications features, says Julie Chen, vice chancellor for research and innovation at UMass Lowell. The high-tech inventions can be woven into designs to do everything from detecting dehydration in soldiers to monitoring buildings for leaking pipes, she says. Other functions embedded within the novel fibers and fabrics include "superomniphobic" geometries to repel all liquids as well as self-healing, energy-harvesting, flame-retardance and tunable mechanical properties.

"The Fabric Discovery Center will leverage existing UMass Lowell capabilities and core research facilities, such as the Nanofabrication Lab, the Materials Characterization Lab, the NERVE Robotics and Rehabilitation Center and the Thermo Analysis and Materials Property Lab, for testing and prototyping," says Chen.

"With our ongoing leadership in the development of advanced fibers and textiles, medical textiles and flexible electronics, Gov. Baker's announcement continues UMass Lowell's strong partnership with the Advanced Functional Fabrics of America [AFFOA], NextFlex, the U.S. Army [Natick Soldier Research, Development and Engineering Center] and the Commonwealth to build the future of high-tech manufacturing in Lowell and across the nation," says UMass Lowell Chancellor Jacquie Moloney.

The Fabric Discovery Center represents the first collaboration between two national manufacturing innovation institutes, one focused on functional textiles (AFFOA) and the other on flexible hybrid electronics (NextFlex). "The center will help foster synergy between AFFOA and NextFlex. It will serve as a national model for forming a regional hub to connect manufacturing institutes," says Chen.

A Unique Innovation Ecosystem

The establishment of the Fabric Discovery Center harkens back to the university's engineering roots when the Lowell Textile School was established in 1895 to educate workers for the Mill City's booming textile industry. This was followed by the establishment of the plastics engineering program at the Francis College of Engineering in 1955 and the Craig Douglas Advanced Composite Materials and Textiles Research Lab in 1985.

UMass President Marty Meehan notes the "innovation ecosystem"—a critical mass of entrepreneurs, startups, university researchers and creative talent—that has developed in Lowell that will support the Fabric Discovery Center. Not only will industry have access to the university's research and business development support, but also a pipeline for highly skilled workers, he says.

The Fabric Discovery Center is a perfect fit for the Innovation Hub, where concepts, in the hands of small business, move from idea to industry.

"It benefits UMass Lowell, it benefits the community [and] it benefits the Hamilton Canal District," a former industrial area in downtown Lowell undergoing dramatic redevelopment, Baker notes. UML

NextFlex Awards $4.5M to UML Nanomanufacturing Center and Raytheon to Advance Flexible Hybrid Electronics Manufacturing

Engineers to Develop Multifunctional Substrates for RF Devices

NextFlex, America's Flexible Hybrid Electronics Manufacturing Institute, has awarded three grants totaling nearly $4.5 million to teams of researchers from the UMass Lowell Nanomanufacturing Center and defense contractor Raytheon IDS. The teams' goal is to develop innovative manufacturing processes to help advance the country's capability and leadership in flexible hybrid electronics (FHE).

FHE combines ultrathin silicon components, conductive and active inks and high-precision printing technologies to fabricate sensors that are lightweight, low-cost and can conform to irregular shapes. By printing electronic circuits on bendable, stretchable substrates, these fully functional devices can be applied to almost any surface or object—from medical devices, tents and backpacks to cars, jet engines and buildings—for wireless monitoring. The real-time monitoring can lead to improved health, safety and efficiency.

The first NextFlex grant, valued at $1.9 million, was awarded to Joey Mead, Alkim Akyurtlu, Carol Barry and Mary Herndon for their project, called "Multi-functional substrates and printing integration for RF [radio-frequency] devices." The manufacturing processes that are being developed during the project are being used to design the next generation of adaptive printed RF and microwave antenna components and devices required for GPS navigation and ground-based radar systems for military applications.

Joey Mead

Carol Barry

Mead and Barry are both professors of plastics engineering. Mead directs the Nanomanufacturing Center, while Akyurtlu is a professor of electrical and computer engineering (ECE) and deputy director of the university's Printed Electronics Research Collaborative (PERC). Herndon is an engineering fellow at Raytheon Integrated Defense Systems.

"UMass Lowell is a leader in plastics engineering and has significant expertise and facilities for multifunctional plastics manufacturing, nanoscale manufacturing and printed electronics," says Mead, who is the overall lead for the NextFlex initiative. "Our project will advance the manufacturability of printed RF electronics by creating continuous, roll-to-roll manufacturing processes for dielectric substrates and conductive patterning."

The faculty researchers are collaborating closely with Raytheon, a global leader in RF systems, along with other industry partners like Dassault Systèmes SIMULIA Corp. and CST, to accelerate the adoption of multifunctional substrates that are compatible with a broad range of inks and printing processes.

The substrates that the team is developing have novel electromagnetic properties, including tunability, which allows researchers to tune the behavior of the devices from one frequency to another, notes Akyurtlu.

"For example, we'll be able to steer a printed antenna's radio beam electronically, without the use of bulky, expensive and costly mechanical steering," she says. "The antenna is even foldable, which offers compactness and portability in the field."

Testing the Durability and Reliability of FHE Devices

The second grant, worth $1.1 million, was awarded to the team of mechanical engineering Asst. Profs. Alireza Amirkhizi and Scott Stapleton and Herndon for their research on methods for testing the electrical and mechanical durability of FHE devices—work they hope will influence the development of future testing equipment for the industry.

Alireza Amirkhizi

Scott Stapleton

"To accelerate the adoption of flexible hybrid electronics, it is important to predict their failure mechanisms and reliable life accurately," says Amirkhizi. "Currently, such evaluations are undertaken on a case-by-case basis."

The team will establish test methods and the necessary infrastructure for characterizing the mechanical strength and electrical integrity of selected simple and complex FHE devices when subjected to deformation, multi-axial stresses, impact loads and temperature extremes.

"The data collected will be used to calibrate existing or new constitutive models and will be introduced into computational software suites. This will also influence the design of the next generation of commercial test equipment. Ultimately, the protocols and infrastructure established in this effort will be available for use by the FHE manufacturing and R&D community," says Amirkhizi.

UMass Lowell's current state-of-the-art facilities for dynamic and impact testing on North Campus have been expanded with two new multi-axial load-frames, acquired from TA Instruments through the state's cost-share contribution.

"This will create a central hub of characterization facilities at UMass Lowell that will be available for use by the FHE community and NextFlex members. The knowledge and data gleaned will also be used for future workforce training workshops and seminars offered through UMass Lowell's Continuing Education program and NextFlex online seminars," says Amirkhizi.

Fabricating the Next Generation of Deployable Antennas

SI2 Technologies Inc., a Billerica-based manufacturer of advanced electronics for military and aerospace applications, has teamed up with Raytheon and UMass Lowell to develop the next generation of deployable FHE X-band antenna arrays. The project is supported by a $1.4 million grant, and the research team is led by SI2 Technologies.

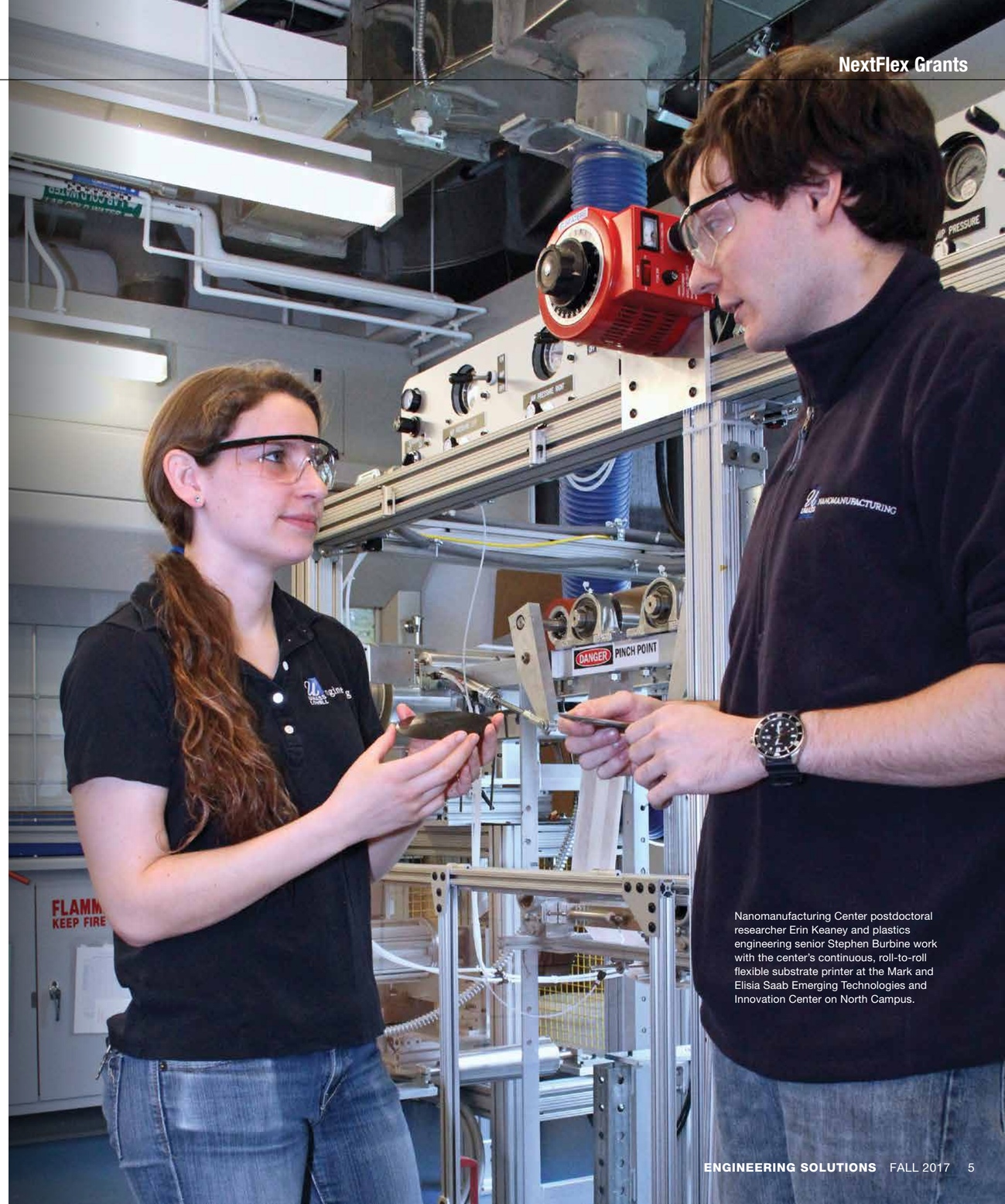
Alkim Akyurtlu

Craig Armiento

UML's role is in developing additive manufacturing solutions and antenna measurements. The effort is led by Akyurtlu as the principal investigator (PI) and ECE Prof. and PERC Director Craig Armiento as co-PI.

"Our cylindrical array FHE X-band antenna will respond to the aviation industry's need for a high-performance but affordable phased-array antenna," says Akyurtlu, explaining that most of today's civil and commercial radar systems rely on a rotating parabolic dish antenna, which is mechanically steered to provide 360-degree coverage.

"While acquisition and installation are affordable, the performance of a mechanically steered dish antenna is inferior to that of an electronically steered, or nonmoving, phased array. Furthermore, the moving parts in the dish antenna require maintenance, which can be costly," she says. UML



Nanomanufacturing Center postdoctoral researcher Erin Keaney and plastics engineering senior Stephen Burbine work with the center's continuous, roll-to-roll flexible substrate printer at the Mark and Elisia Saab Emerging Technologies and Innovation Center on North Campus.

RESEARCHERS TO DEVELOP SENSING FABRICS FOR MONITORING CIVIL INFRASTRUCTURES

The Zakim Bunker Hill Memorial Bridge, one of the widest cable-stayed bridges in the world, serves as the northern gateway to the City of Boston. University researchers are developing sensing fabric technology to help manage and maintain the safety, efficiency and sustainability of the nation's civil infrastructures.

Facing page: The research team includes, front row from left, graduate students Susom Dutta (civil and environmental engineering) and Sicong Tao (electrical and computer engineering), and back row from left, Prof. Xingwei Wang (ECE), Sahas Rathi (Saint-Gobain), Assoc. Prof. Tzuyang Yu (CEE), Nancy Brown (Saint-Gobain) and Prof. Pradeep Kurup (chair, CEE).

The Goal Is to Prevent Catastrophic Failures, Minimize Maintenance Costs and Expensive Repairs

A team of UMass Lowell researchers has partnered with a research and development company to create new, cost-effective sensor-laden textiles that can be used to monitor the structural health and integrity of vital infrastructures across the country, including buildings and skyscrapers, roadways, bridges, tunnels, railway tracks, dams and pipelines.

Prof. Pradeep Kurup and Assoc. Prof. Tzuyang Yu of the Department of Civil and Environmental Engineering and Prof. Xingwei Wang of the Department of Electrical and Computer Engineering are collaborating with researchers from Saint-Gobain, a multinational corporation with an R&D center based in Northborough, Mass., to develop fabrics integrated with optical fibers and sensors. These fabrics can be applied to existing structures to monitor strain or detect cracks in their early stages, thereby minimizing maintenance costs, environmental impacts and disruptions to the people's lives and businesses.

"Optical fiber sensors are very suitable for structural health monitoring for their light weight, low cost, survivability in harsh environments and immunity to electromagnetic environments," says Wang. "More importantly, they can provide fully distributed sensing information about an object's structural integrity. Combined with novel textile technology, the sensing fabrics will be relatively easy to install and maintain. They will be very useful for long-distance sensing applications."

The project is supported by an $853,000 grant from the Advanced Functional Fabrics of America (AFFOA), which is part of the National Network of Manufacturing Innovation Institutes. AFFOA's mission is to enable the manufacturing industry to transform traditional fibers, yarns and textiles into highly functional integrated and networked devices and systems.

A STATE OF DISREPAIR

In 2016, the American Society of Civil Engineers gave America's infrastructures an overall grade of D+, indicating that they urgently need major repairs and improvements to make them safe, sustainable and economically efficient. The organization estimates that a $2 trillion investment over the next decade is needed for the necessary repairs and upgrades.

"The unique sensing capability of our proposed fabric will enable engineers to better predict the structural health of civil infrastructures and assist decision makers and stakeholders to better distribute limited resources for infrastructure repair, rehabilitation or rebuild," says Yu.

For example, there are more than 614,000 state-owned highway bridges in the U.S., and about 53 percent of them—nearly 323,000—are in fair or poor condition. Most of the states' transportation agencies don't have enough budget to cover routine maintenance and repair to deal with infrastructure deterioration problems such as corrosion. According to the National Association of Corrosion Engineers, the direct cost of corrosion damage to highway bridges amounts to $13.6 billion a year.

"The use of our proposed sensing textiles can help proactively assess the structural integrity of concrete and steel bridges from corrosion," says Yu.

From 2014 to the present, there have been nearly 4,000 railway accidents in the country. Of these, more than 430 involved derailments and close to 450 were related to railway structural failures, according to the latest report from the Federal Railroad Administration's Office of Safety Analysis.

"Replacing the rails currently costs approximately $1 million to $2 million per mile," notes Kurup. "Our proposed sensing textile product can be used on concrete ties and steel rails as well as inside ballasts to monitor the structural health of railroad tracks. A distributed sensing system for railroads will enable engineers to mitigate local damages through effective repair and strengthening, thereby avoiding unnecessary and costly rail replacement."

According to Kurup, there are 473 tunnels owned by state transportation departments around the nation, along with more than 2.4 million miles of oil and gas pipes and 1.2 million miles of water pipes. "Maintenance of underground tunnels and pipelines presents significant challenges to local governments and the utility industry. For example, the American Water Works Association estimates $1 trillion of investment is needed over the next two decades to implement much-needed repairs and upgrades," he says.

Kurup says the team's sensing textiles will allow the states to detect damages early on, thereby preventing catastrophic failures. "In addition, our sensing system would also help to detect adverse impact to existing civil infrastructures such as buildings, bridges and rail lines that can occur in underground trenchless operations during the installation of new pipelines and tunnels," he says.

DEVELOPING A TECHNICALLY TRAINED WORKFORCE

Yu says that the development of the sensing fabrics will also create new business with the manufacture, installation and maintenance of the fabrics as well as the processing and analysis of the sensor data.

"This research project combines two traditional industries—textile and construction—to create innovative sensor and sensing system products for the aging infrastructure problem faced by all countries in the world," explains Yu.

"We envision that this Massachusetts-based R&D effort will expand the local economy by creating new products to address a critical need nationwide, as well as strengthen the technical edge of the U.S. in today's globally competitive market," he says.

In terms of workforce development, the team points out that scientists, engineers, interns and co-ops at Saint-Gobain will be trained in this emerging technology.

"At UMass Lowell, we anticipate that the project will be used to train future engineers at both undergraduate and graduate levels in civil and electrical engineering," says Yu. "In addition, Saint-Gobain and UMass Lowell will hold training workshops designed to educate users on the value of infrastructure sensing and system capabilities." UML

UML AND RAYTHEON ARE PIONEERS IN INTEGRATED ELECTRONICS

Grants from America Makes Help to Advance U.S. Manufacturing

"It's the Wild, Wild West out there."

That's how Craig Armiento, director of the Printed Electronics Research Collaborative (PERC) and professor of electrical and computer engineering, describes the emerging field of 3-D printing for electronics. "It's in the very early stages of development," he says. "Design is evolving, the materials are evolving, the printers are evolving and there are no standards."

At least not yet. Armiento and his team at PERC—a partnership between the university, industry and government agencies—are pioneers in that Wild West. And like pioneers, they're not only advancing the field, but they're also beating a path for others to follow. They're funded by grants from America Makes and NextFlex, a pair of public-private-academic manufacturing institutes established by the federal government to position the U.S. as a leader in manufacturing products using integrated and flexible electronics for everything from smartphones to satellites.

Raytheon took the lead on the two America Makes grants, thanks to a partnership Armiento formed between UMass Lowell and the defense and electronics giant in 2014, the Raytheon UMass Lowell Research Initiative (RURI). Both RURI and PERC are housed on the top floor of the Saab Emerging Technologies and Innovation Center on North Campus, which includes state-of-the-art labs filled with 3-D printers and testing equipment.

Both grants aim to help companies bring new products to market faster and at lower cost—first, by cutting down on the time it takes for engineers to get from a new design idea to a final product, and also by reducing waste. "Additive manufacturing doesn't waste expensive materials, because you're only using what you're printing, instead of starting with a chunk of material and then cutting some of it away or otherwise removing it," Armiento says.

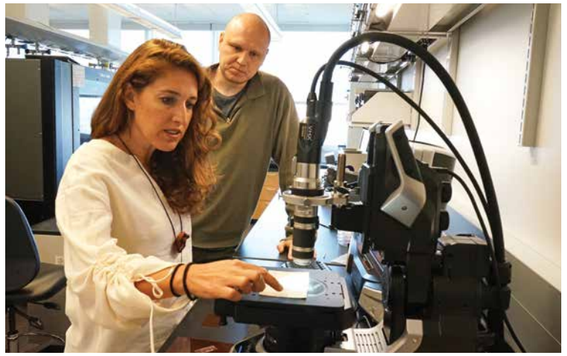
The first America Makes grant, nearly $1.7 million, helped researchers from Raytheon, UMass Lowell and the University of Wisconsin figure out an efficient design and 3-D printing process to connect silicon chips on the types of hybrid circuit boards used in virtually all electronic devices, including cellphones, cars and defense systems, says Alkim Akyurtlu, professor of electrical and computer engineering and deputy director of PERC. Currently, manufacturers use wire loops to connect the chips. Akyurtlu and Armiento wanted to figure out the best way to "print" the connections directly onto the circuit board to speed up the design cycle.

"If you have shorter, straighter signal-carrying lines between chips, you get better performance," Akyurtlu says. "And you have lower costs because 3-D printing allows for rapid prototyping."

That's where RURI comes in. In the labs, Raytheon engineers can work with graduate students on designing a component, "printing" a prototype, testing it and then improving the design—all within days instead of weeks or months. "We can get things done quickly here," Armiento says.

The second America Makes grant, for $2 million, is aimed at figuring out the best materials, printers and processes to use to optimize manufacturing for integrated electronics.

Raytheon, UMass Lowell and University of South Florida engineers are figuring out how to combine a structural plastic and an electrically conductive or dielectric "ink" in a single build, using a phased radar array as



their test product. They are also analyzing, testing and characterizing all the commercially available conductive and dielectric inks, structural materials, 3-D printers and other processes, such as curing times and temperatures, to figure out the best combination for manufacturing different products to various specifications. The resulting publicly shared database should greatly reduce the design, prototype, test and redesign cycle for new integrated electronics.

"Let's say you want to print this product, and it has to meet these specifications," says Akyurtlu, the principal investigator for UML on the grant. "You have to optimize the process for all these materials. We're taking a systematic approach and looking at how to bring everything together."

The benefit to students of all this research is immeasurable. Around 20 to 25 engineering students each year, about half of them undergraduates, get to work and interact with engineers from Raytheon and other companies on a daily basis at PERC. Some, like Elicia Harper '15, '17, go straight into jobs at Raytheon after earning a bachelor's degree, then continue their education while working. Raytheon also sends other employees to UML for advanced degrees.

America Makes grants are also aimed at workforce development, to help meet the demand for highly skilled workers that the industry requires. Akyurtlu and Armiento, working with professors in the Mechanical and Plastics Engineering departments, have designed an interdisciplinary graduate certificate on Additive Manufacturing for Radio Frequency and Microwave Applications. To earn the certificate, workers who already have a bachelor's degree in engineering must take three required courses—one each in electrical, plastics and mechanical engineering—and a fourth course from a list of options. The certificate program was approved last spring and will launch this fall, Akyurtlu says. UML

Above: Prof. Alkim Akyurtlu, forefront, and postdoctoral researcher Dmytro Volkov investigate the conducting ink line they printed on test coupons at the Printed Electronics Research Collaborative (PERC) lab in the Saab Center. They are trying to determine the RF (radio frequency) characterization of the inks.

Facing page: Prof. Craig Armiento and Ph.D. student/PERC research assistant Kyle Homan inspect the quality of a printed antenna under a microscope.

Joson Images

QUALITY AT THE TOP

Liz Blackwood '91 is the top quality executive in the pharmaceuticals sector of Johnson & Johnson.

Liz Blackwood ’91 takes a hands-on approach to leading Johnson & Johnson’s pharmaceuticals quality programs

When Liz Blackwood, vice president and chief quality officer for the Johnson & Johnson pharmaceuticals sector, visits one of her company’s manufacturing plants, she always takes her steel-toed shoes with her. Armed with the proper footwear and an open mind, she enjoys visiting the production floor—where she can see and feel the pulse of what’s happening.

“Just as students are constantly told that the best learning opportunities happen outside the classroom, working professionals should be encouraged to grow their expertise and network outside the office,” says Blackwood. “I often discover more about a process from seeing the machines work and talking with the operations team than I can sitting in a conference room listening to a presentation.”

Blackwood feels at home on the factory floor. In college, she worked for a machine shop that manufactured parts for computers. She quickly discovered a passion for making things—and a knack for figuring out how to make them better.

Now, Blackwood oversees the quality program for Janssen, the pharmaceuticals sector of Johnson & Johnson. As one of the top quality executives in an industry where there’s little room for error, Blackwood relies on skills she learned as an engineering student.

“I understand how to rule out variables and solve problems,” she says. “Problem-solving is a big part of my job. Whether it’s metal parts or molecules or microorganisms, I constantly apply the same skills I learned in college.”

In her education and career, Blackwood allowed her experiences and evolving interests to guide her decisions. Always a lover of math and science, she earned her associate’s degree in manufacturing technology from Keene State College in New Hampshire. After graduating, she worked as a technician in a factory that made circuit boards—and was quickly captivated by the world of engineering. She decided to go back to school and enrolled at UMass Lowell, taking classes at night while she worked days. It took her six years of hard work, but she earned her bachelor’s degree in mechanical engineering in 1991.

Blackwood’s journey toward quality was fueled by both her work and continuing education. As she was finishing her bachelor’s, Blackwood had already moved into a management role at Boston Scientific, a maker of stents and catheters. She decided get an MBA to broaden her business acumen, which she earned from Lesley College. Her thesis had to be on something she could apply to her work, so she wrote about her vision for designing quality into processes instead of testing it at the end. “I would crawl through factories. I looked at processes. I studied the science behind the processes—and I led teams that made process improvement,” she says.

Blackwood believes that an integral component of being an effective hands-on learner is a willingness to collaborate. She’s aware that searching for inefficiencies and the changes needed to address them have the potential to create unease, but believes successful change management is more likely when there is a willingness to involve the team.

“When I’m with my team, I put myself in learning mode,” she says. “I always ask ‘Can you show me how this works?’ and ‘Do you mind if I spend some time learning from you?’ People are eager to share their ideas and expertise—and these collaborations lead to stronger solutions.”

Blackwood’s career has taken her across the country and around the world. She joined Johnson & Johnson’s medical device sector in 2003 and was promoted to vice president. She spent a few years at GE as a senior vice president for quality, before returning to Johnson & Johnson.

Blackwood is quick to point out that her foundational years still give her a big advantage with the challenges she faces today.

“The people on my team appreciate my practical experience, which enables me to better understand what they are trying to accomplish. I’ve sat in microbiology labs; I’ve changed ball bearings on the machine shop floor; I’ve bought equipment; and I’ve run foundry,” she says. “It’s important to get the very practical aspects of the inner working of manufacturing and test methods to be able to understand the impact of your decisions.”

Blackwood is also passionate that students—particularly young women—have ample opportunities for hands-on experiences in the field. She lauds efforts like the Francis College of Engineering’s summer camps for girls that aim to spark their interest in science and math-related careers.

“We need to do more to get girls involved in STEM,” she says. “I was very fortunate that my father recognized my interest and fostered it. I worked side-by-side with him in his workshop, and he taught me how to use shop equipment at a young age.”

Just as Blackwood benefited from shared expertise throughout her career, she is more than willing to do the same as a way to give back to an industry that has brought her much success. She has served on industry advisory panels in Europe and Asia and the U.S. Food & Drug Administration’s Good Manufacturing Practices Advisory Committee. Blackwood also enjoys mentoring young professionals.

“I have two college-age sons, and I tell them the same thing I share with the colleagues I mentor: don’t be in a rush to climb the ladder,” she says.“Your career journey is just that—a journey. The experiences you collect along the way, especially those that offer hands-on learning and opportunities to collaborate, will build a career that shines. Ultimately, when you do what you love, you’ll be successful in life.” UML

“WE NEED TO DO MORE TO GET GIRLS INVOLVED IN STEM.”

MOLDING THE FUTURE

Wittmann Battenfeld President David Preusse ’85 is helping to develop the next generation of plastics engineers

What would David Preusse ’85 have said if, three decades ago, someone had told the freshly minted mechanical engineering grad that he’d one day be president at a multinational company with $400 million in global revenues?

“I would have thanked them for their optimism and handed them another beer,” Preusse says with a grin.

But thanks to a strong work ethic and willingness to sacrifice—qualities he says he inherited from his father—that’s exactly where Preusse finds himself today: president of Wittmann Battenfeld, a leading manufacturer of injection molding machines, robots and automation systems. Preusse has been with the family-owned Austrian company for 21 years, heading up its U.S. division in Torrington, Conn., since 2002.

“I like that we’re a global company with 2,200 staff worldwide, and yet I have a close relationship and can identify with the owners,” says Preusse, who notes that the company’s founder, Dr. Werner Wittmann, and his son, Michael, were ahead of the global economic curve by establishing operations in 52 countries. A key to the company’s success, Preusse says, is how each location is given the autonomy to operate according to its own local culture and market.

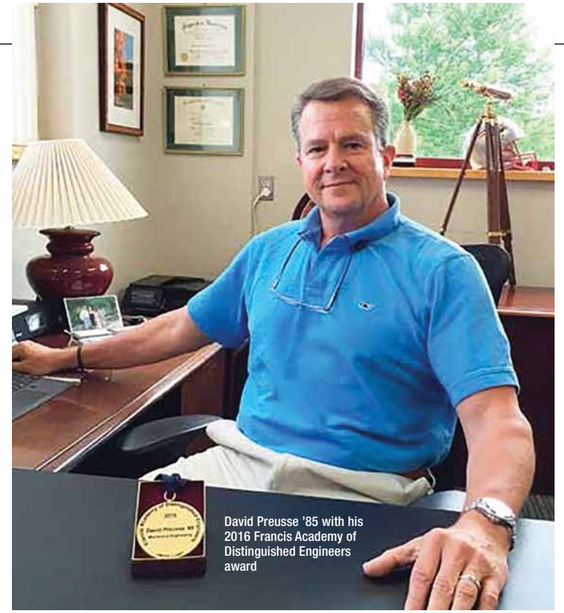
“AFTER I LEFT UML AND JOINED THE PLASTICS INDUSTRY, I CAME TO REALIZE HOW WELL-REGARDED A UML PLASTICS ENGINEERING DEGREE IS IN MY INDUSTRY.”

Wittmann Battenfeld’s U.S. operations have enjoyed considerable growth with Preusse at the helm. In 2015, the company set a new milestone for robot shipments, eclipsing its previous high by 10 percent. The company grew to 160 U.S. employees (up from 138 in 2014) and added a new 50,000-square-foot material handling and auxiliaries building next door to its main factory, which can now produce more than 500 robots annually.

Here at UMass Lowell, in the Wittmann Battenfeld Precision Injection Molding Laboratory, the company has been helping prepare Francis College of Engineering students for successful careers for decades. In March 2016, Wittmann Battenfeld supplied the lab with a state-of-the-art injection molding machine work cell, replacing one of two older models that were installed in t he 1990s. The new work cell gives students hands-on experience with leading-edge molding technology, including web integration, data storage and Industry 4.0—the “smart factory” era of industrialization.

At the ribbon-cutting ceremony, Chancellor Jacquie Moloney noted that “it’s critical for us to know that we’re educating and graduating students who are ready to immediately make an impact in their field. Wittmann Battenfeld’s generous support of our program with this brand new equipment helps ensure just that.”

While Preusse says the industry is still several years away from developing communications standards and connection guidelines for different molding cell equipment, Wittmann Battenfeld has already innovated a communications hub and patented a router that will allow plug-in and rapid production with all its equipment. It’s called the Wittmann 4.0 platform, and it’s already being integrated with the molding cell at UMass Lowell. In fact, senior plastics engineering major Patrick McCallum is currently interning with the company and upgrading the school’s cell for his capstone project.


David Preusse '85 with his 2016 Francis Academy of Distinguished Engineers award

“My goal has been for UML workforce development so graduates can walk into industry and capture their executives’ attention, because young people can carry these innovations that come along so fast,” says Preusse, who adds that the industry is “starving” for more talented and technically skilled new employees.

That’s why Wittmann Battenfeld recently established the “Wittmann Academy,” a program that gives graduate-level engineers the opportunity to spend a year working on a wide range of job assignments in several different departments to get a holistic view of the company. The first participant, plastics engineering grad Richard Heckbert ‘14, ‘16, started the program in February.

“Too often companies hire someone, stick them in a seat and say, ‘Now work and like it,’” says Preusse, who notes that the best learning experience of his career came in his first job out of college at Automated Assemblies Corp. He joined a training program and became a traveling service engineer, installing plastics robots across the country. Preusse eventually shifted to technical sales and marketing, where “I found my calling.” He spent four years in robotics sales at Sterling Corp. (while earning his MBA from Pepperdine University in 1994) before landing at Wittmann Battenfeld in 1996.

A native of Westborough, Mass., Preusse followed in the collegiate footsteps of his older brother, electrical engineering grad Eric Preusse ’83.

“We both felt a unique pride for the kind of hard-working kids who went to UML as opposed to Ivy League schools,” says Preusse, who still remembers professors such as Eugene Niemi and the late Robert “F.D.” Hollenbach (“Draw the free body diagrams!”).

“UML was a tough engineering education that weeded out plenty of students not ready for the tests, class loads, maturity and high work demands,” says Preusse, who received the Francis Academy of Distinguished Engineers award from the university in 2016.

Preusse is proud that his alma mater continues to turn out some of the most qualified young talent in the industry.

“After I left UML and joined the plastics industry, I came to realize how well-regarded a UML plastics engineering degree is in my industry,” he says. “No one can dispute that, of university graduates who grow into management positions in our plastics industry, most are from UMass Lowell.” UML

NEW FACULTY

- **Valmor de Almeida** has been appointed associate professor of chemical engineering. He earned his doctorate at the University of Minnesota, Twin Cities, and was previously a senior R&D staff member at Oak Ridge National Laboratory.
- **Onur Apul** has been appointed assistant professor of civil and environmental engineering. He received his Ph.D. from Clemson University and previously held a postdoctoral position at Arizona State University.
- **Bryan Buchholz** has been appointed professor of mechanical engineering. He obtained his doctorate from the University of Michigan and was previously a faculty member of UMass Lowell’s Zuckerberg College of Health Sciences.
- **Yan Gu** has been appointed assistant professor of mechanical engineering. She earned her doctorate at Purdue University.
- **Hang Liu** has been appointed assistant professor of electrical and computer engineering. He received his Ph.D. from George Washington University.
- **Dimitra Papagiannopoulou** has been appointed assistant professor of electrical and computer engineering. She obtained her doctorate from Brown University.
- **Anne Soucy** has been appointed lecturer of plastics engineering. She earned her doctorate at UMass Lowell and previously taught at Pennsylvania College of Technology.

FACULTY SUCCESSES

- **Juan Pablo Trelles**, assistant professor of mechanical engineering, was awarded a U.S. Department of Energy (DOE) Career Research Award for his proposal, “Non-equilibrium phenomena in plasmas in contact with liquids.”
- Chemical engineering Assoc. Prof. **Sukesh Aghara**, with his counterpart from the Czech Technical University, successfully concluded the Intercontinental Nuclear Institute (INI) program for the third year, hosting students from all over the world this past summer for four weeks of training on nuclear power, safeguards and policy in the Czech Republic and in Lowell.
- **Donald Leitch**, professor of civil and environmental engineering, was awarded the Manning Prize for Excellence in Teaching by the University of Massachusetts System. Leitch has been teaching in Lowell since 1968, when he joined the Lowell Technological Institute.
- **Robert Malloy**, professor emeritus of plastics engineering, has been inducted as a member of the Plastics Pioneers Association.
- E-Tongue, a device invented by civil and environmental engineering Prof. and Chair **Pradeep Kurup** that can detect toxic heavy metals in tap water, was chosen as a “Favorite New Product” at Mass Innovation Nights 95, hosted by the City of Lowell and the university’s Innovation Hub.
- **Zhiyong Gu** (chemical engineering) has been promoted to full professor.
- **Christopher Hansen** (mechanical engineering) and **Margaret Sobkowicz-Kline** (plastics engineering) have been promoted to associate professor with tenure.
- **Hengyong Yu** (electrical and computer engineering) and **Nese Orbey** (chemical engineering) have been granted tenure.
- **Edward Hajduk** (civil and environmental engineering), **Eric Maase** (chemical engineering) and **Michele Putko** (mechanical engineering) have been promoted to Senior Lecturer I.

STUDENT SUCCESSES

- Civil engineering graduate student **Susom Dutta**, advised by **Kurup**, has received a fellowship grant from the Geosynthetic Institute for his research proposal, “Novel geotextiles for energy harvesting.”
- The Thermoforming Division of the Society of Plastics Engineers has awarded the Thermoforming Division Memorial Scholarship to recent plastics engineering graduate **Stephanie Ternullo**. This fall, she is working on a master’s degree in plastics engineering.
- **Samadrita Roy Chowdhury**, Ph.D., a member of Asst. Prof. **Joyita Dutta**’s research lab, received the prestigious and competitive M. Hildred Blewett Fellowship for Women in Physics from the American Physical Society.
- Electrical and computer engineering undergraduate **Andrew MacGregor**, who studied abroad at Czech Technical University as well as interning with VALEO in the Czech Republic, served on the panel for the U.S. Study Abroad Capacity-Building Workshop sponsored by the Fulbright Commission.
- **Michael Doane**, a junior in chemical engineering, has won a Barry Goldwater Scholarship (see page 1). The award provides up to $7,500 per year for up to two years in scholarship funds.
- The UMass Lowell Design-Build-Fly team, led by mechanical engineering student **Evan Wilson**, finished 19th out of 95 teams at a national competition held in Tucson, Ariz. Mechanical engineering lecturer **Walter Thomas** advised the team.
- **Pegah Afsharlar**’s paper, “Delayed spectrum allocation for anycast advance reservation with flexible window in elastic optical networks,” co-authored with **Arash Deylamsalehi** and adviser Prof. **Vinod M. Vokkarane**, won the Best Paper Award at the IEEE ANTS 2016 conference in Bangalore, India.
- Civil engineering student **Chris Ingemi**, advised by Assoc. Prof. **Tzuyang Yu**, has been selected to receive the ASNT (American Society for Nondestructive Testing) 2017 Engineering Undergraduate Scholarship, one of only three national winners this year.
- Mechanical engineering doctoral student **Junwei Su** has been selected as a 2017 ASME Fluids Engineering Division Graduate Scholar of the Year, based on his paper entitled “Study of frequency response of quartz crystal microbalance to different wetting states of microvillar surfaces.” Assoc. Prof. **Hongwei Sun** is his adviser.
- **Ketki Behere**, a graduate student in chemical engineering advised by Assoc. Prof. **Seongkyu Yoon**, has been chosen to receive the 2017 AIChE Separations Division Graduate Student Research Award in the area of bioseparations.
- **Qian Wang**, a graduate student in electrical and computer engineering advised by Assoc. Prof. **Hengyong Yu**, won the “Women in Imaging” award from the SYF Foundation during the 2017 International Conference on Fully Three-Dimensional Image Reconstruction in Radiology and Nuclear Medicine in Xi’an, China.

NEW RESEARCH AWARDS

- **Tzuyang Yu** (civil and environmental engineering), Prof. **Xingwei Wang** (electrical and computer engineering) and **Kurup**, in partnership with Saint-Gobain, were awarded a grant for “Sensing textiles for civil infrastructure monitoring” by the Advanced Functional Fabrics of America (AFFOA), an initiative of the Manufacturing USA Network (see page 6).
- Mechanical engineering Asst. Profs. **Alireza Amirkhizi** and **Scott Stapleton**, in partnership with Raytheon, were awarded a grant for “Test methods for electrical and mechanical durability of flexible/rigid interfaces in multi-axial fatigue and dynamic loadings” by NextFlex, America’s Flexible Hybrid Electronics Manufacturing Institute (see page 4).
- **Dean Wang**, associate professor of nuclear engineering, was awarded a grant by the U.S. Department of Energy (DOE) for the “Design of a commercial-scale, fluoride-salt-cooled, high-temperature reactor with novel refueling and decay heat removal capabilities.” The award was given through the Nuclear Engineering University Program, in collaboration with MIT, the University of Cambridge (U.K.) and AREVA.
- **Hengyong Yu** was awarded a grant for “Low-cost X-ray CT system for in-situ imaging of roots,” by the DOE’s Advanced Research Projects Agency–Energy (ARPA–E) with UHV Technologies, Inc.
- **Seongkyu Yoon** (chemical engineering) and **Garry Handelman** (biomedical and nutritional sciences) were awarded a grant for “Data-fusion based platform development of population PKPD modeling and statistical analysis for bioequivalence assessment of long-acting injectable products” by the U.S. Department of Health and Human Services.
- **Yan Luo**, professor of electrical and computer engineering, was awarded funding for “CICI: RSARC: SECTOR: Building a secure and compliant cyberinfrastructure for translational research” by the National Science Foundation (NSF) with UMass Medical School.
- **Luo** also serves as a co-PI for the award “CICI: Regional: New England Cybersecurity Operation and Research Center (CORE)” by the NSF.
- **Stapleton** and plastics engineering Assoc. Prof. **Daniel Schmidt** were awarded a grant for “Functionally graded adhesive joints with improved strength and stability” by the NSF.
- **Ionnis Raptis**, assistant professor of mechanical engineering, was awarded funding for “Distributed fault diagnosis for large-scale nonlinear stochastic systems” by the NSF.
- **Fuqiang Liu**, associate professor of mechanical engineering, was selected for a CAREER award for his research on “High-efficiency regenerative solar energy storage by photoelectrochemical redox reactions” by the NSF.
- **Liu** was also awarded funding for “I-Corps: Solar cell for simultaneous electricity generation and storage” by the NSF.
- **Yoon** and chemical engineering Assoc. Prof. **Dongming Xie** were awarded a grant for “Control and estimation of glycosylation profile via media supplementation based on intracellular models in mammalian cell cultures” by the NSF.
- **Yuanchang Xie**, associate professor of civil and environmental engineering, serves as co-PI on “Ethical algorithms in autonomous vehicles” awarded by the NSF.
- **Siavash Pakdelian**, assistant professor of electrical and computer engineering, was awarded funding for “A compact and reliable generator for backpack energy harvesting” by the Office of Naval Research (ONR).
- **Hualiang Zhang**, associate professor of electrical and computer engineering, was awarded a grant for “Exploring metasurface-based beam-steering antenna systems” by the ONR.

UNIVERSITY AND COLLEGE NOTES

- The Baker-Polito administration has awarded a $10 million grant to UMass Lowell to create a new **Fabric Discovery Center** at 110 Canal Street that focuses on the development of advanced functional textiles (see page 2).
- The Massachusetts Life Sciences Center has awarded $5 million for the renovation of biomedical engineering teaching and research labs in **Perry Hall**.
- The state’s Board of Higher Education has approved a new bachelor’s degree program in **environmental engineering** at UMass Lowell. Classes will begin in the fall of 2018.
- UMass Lowell has been named an NSF Innovation Corps (I-Corps) Site through the efforts of **Nancy Saucier** and **Steven Tello**. The program enables academic institutions to catalyze teams whose technology concepts are likely candidates for commercialization.
- **Chris Niezrecki**, professor and chair of mechanical engineering, will serve as the PI for funding from the UMass President’s Science and Technology (S&T) Fund to support the formation of an Emerging Energy Innovation Institute, in which university researchers will work closely with established and startup companies to develop, validate, advance and license clean energy technologies.
- **Hengyong Yu** will serve as the PI for S&T seed funding to create a consortium for research on imaging and informatics in various medical applications, with an emphasis on fighting cancer. The Kennedy College of Sciences and the UMass Medical School are involved.
- UMass Lowell has been named among the **Top 25 public institutions** in the country for return-on-investment by Payscale.com.

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UMASS LOWELL

Learning with Purpose

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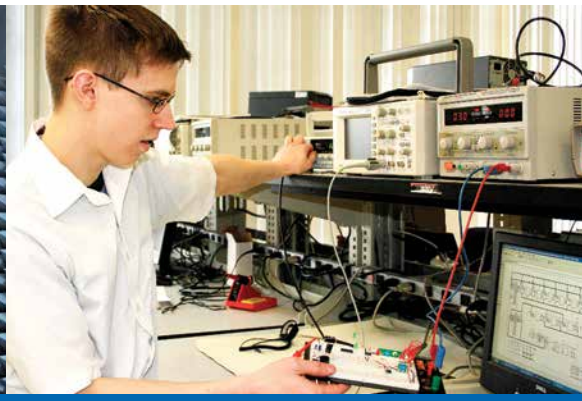

FRANCIS COLLEGE OF ENGINEERING

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Tap Into Talent for Results:

- Sponsor a senior design project
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To support the Francis College of Engineering, make a gift online at **www.uml.edu/givenow.**

Save the Date!

Francis College of Engineering Alumni Night and Hockey Game

UMass Lowell River Hawks
vs. Merrimack College
Saturday, Feb. 24, 2018
Game starts at 7:15 p.m.,
Tsongas Center at UMass Lowell

RSVP: Alumni_Office@uml.edu;
978-934-3140

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