

marquette engineer

OPUS COLLEGE OF ENGINEERING MAGAZINE 2017

Behind the Building Boom

Milwaukee is experiencing a development explosion with young alumni igniting the way.



Research for the Greater Good

Advancements must come with responsibility.

Broadening the Education Spectrum

Faculty color the classroom with industry practices.

Unheralded Heroes

Directors add value to the student experience.

Ignatian Engineers

As I reflect on another year as Opus Dean, I am thankful for many things, but perhaps most of all, the people who have inspired the way I look to serve the very college that made me a Marquette Engineer. Take local philanthropist Michael Cudahy (p. 4), for example. From working as an intern for his then company, Marquette Electronics, to now considering him a close friend, he has shown me the true spirit of a servant leader who puts the greater good before making a profit. Of equal importance are the values with which our students graduate today. It is my goal that they ask themselves each day — how is my work impacting the greater good?

That is why we are changing the way we teach, research and engage with our industry and community partners. The world no longer needs the obedient engineer of the past, but rather entrepreneurially minded engineers — men and women who are creative, innovative and comfortable with being uncomfortable. Across all of our majors and classes, we are taking students beyond the books and equations, and challenging them to find new and interdisciplinary ways to solve the world's problems.

But beyond this new entrepreneurial mindset, we are challenging all Marquette Engineers — students, alumni, faculty and staff — to develop an Ignatian mindset. As a Jesuit institution, we are called to be servant leaders who use our work to positively impact humanity and make the world a more just place for all of God's creation. This is what differentiates the Marquette Engineer.

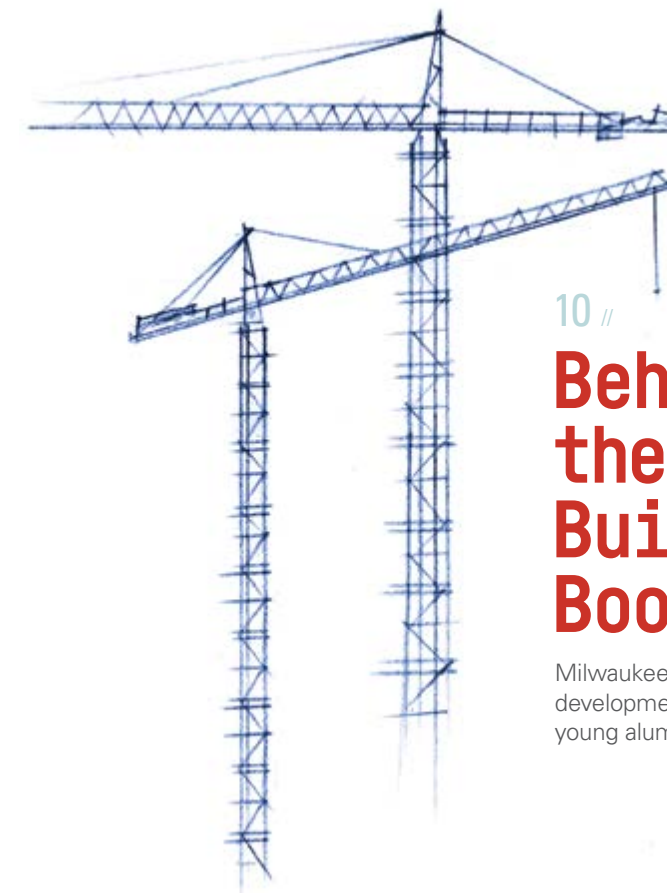
Consider our students who are modifying toy cars to provide mobility to toddlers with disabilities (p. 4). Or, note our six young alumni who are behind the building boom in Milwaukee, creating a vibrant, more connected community (p.10). Our faculty are innovating better electrical engines, safer roads and disaster-proof buildings (p.14) while embedding industry practice into the classroom (p.16).

This past spring, Tim Cook, CEO of Apple, urged college graduates to, "Measure your impact on humanity not in likes but in the lives you touch, not in popularity but the people you serve." I am proud that Marquette has a long history of preparing graduates to be men and women for and with others.

Dr. Kristina Ropella

Opus Dean
Opus College of Engineering

Follow the dean on Twitter @DeanRopellaMU.



02 // DESIGN DAY

Hours of collaborative work come together for a day of design.

04 // NEWS

The latest Opus College news in brief.

10 //

Behind the Building Boom

Milwaukee is experiencing a development explosion with young alumni igniting the way.

14 // RESEARCH FOR THE GREATER GOOD

"In the Jesuit tradition," means advancements must come with responsibility.

16 // BROADENING THE EDUCATION SPECTRUM

Faculty color the classroom with industry practices.

20 // OPUS COLLEGE RESEARCH AND INNOVATION

A special section highlighting how our researchers are discovering innovative solutions to the world's greatest concerns.

26 // UNHERALDED HEROES

Opus College directors add value to the student experience.

29 // A MARK OF FAITH

Alfombras deliver a message of global connectivity.

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OPUS
College of Engineering

MARQUETTE UNIVERSITY

The hustle and bustle of DESIGN DAY

THESE STUDENTS ARE EAGER FOR AUDIENCES

— it's Design Day 2017 in Engineering Hall, and more than 600 of them stand at attention, anxiously ready to promote their engineering design projects to the faculty, industry reps, parents and fellow students who have gathered around. The 100-plus displays and presentations today represent hours of collaborative work done for senior capstone, freshman and other courses, plus projects independently led by students.



MORE THAN
600
STUDENTS
PARTICIPATE

DESIGN DAY SAMPLING:
 LOW-COST MANUAL WATER PUMP FOR DEVELOPING COUNTRIES
 ONE-PERSON SOLAR CAR FOUNDATION
 BONE GRAFT SUBSTITUTE DESIGN
 CONCRETE CANOE

18
INDUSTRY SPONSORS

4
KEYNOTE SPONSOR PRESENTATIONS

SAVE THE DATE FOR DESIGN DAY 2018: MAY 4

Photo by Jonathan Kim



Opening doors

First-generation students hoping to earn an engineering degree from the Opus College have new scholarship opportunities thanks to Donald, Eng '66, Grad '68, and Frances Herdrich, who have donated \$3.5 million to the Donald J. and Frances I. Herdrich Endowed Scholarship for Engineering. It will fund a full-tuition, room-and-board scholarship for an incoming freshman each year. After five years, up to five engineering students simultaneously will hold Herdrich scholarships.

Also seeking to educate tomorrow's engineers is entrepreneur, business executive and philanthropist Michael Cudahy, who donated \$1 million to support five full-tuition, room-and-board scholarships for Opus College students who are the first in their families to attend college.

Welcome



Alexis (Lozinak) Schlindwein, Comm '13, has joined the Opus Dean's Office as a senior communication specialist and is responsible for managing our communication/marketing efforts including social media, website development, newsletters and media relations.

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Assistive technology to go, go

More Opus College of Engineering students are choosing to live out the university's mission and Be The Difference when it comes to their senior design projects. Thanks to a National Institutes of Health five-year \$108,000 grant received by Dr. Jay Goldberg, clinical professor of biomedical engineering, Marquette is able to fund several assistive technology projects each year.

"We have students who want to work on a project that will benefit a specific client, and they can see how their work improves somebody's life," Goldberg says. "This is a rewarding type of project that can reinforce their choice of a career path."

One such project is GoBabyGo, a national initiative aimed at modifying small play cars to provide mobility to toddlers with disabilities such as cerebral palsy or Down syndrome. A team of five Marquette engineering students developed several enhancements to the cars, including smoother acceleration and a remote control device for parents to use to steer or stop the cars. This year's GoBabyGo project was funded with \$2,000 from Goldberg's NIH grant.

Jessica Dreyer, Eng '17, a member of the GoBabyGo design team, says it was a great experience. "I feel that childhood is meant for learning, experiencing your surroundings, and socializing and interacting with other kids, so by developing these cars the children now have an opportunity to do that independently," she says.



Liam Balistreri and his canine cohort take a spin in the Marquette-modified GoBabyGo car.

Assistive technology projects support Marquette's mission, Goldberg says. "It's all about using our engineering skills to help someone in our community."

A 2016 Strategic Innovation Fund award from the university also will help Goldberg do that through a pilot program to support the development of a Center for Assistive Technologies. This multifaceted center would involve students from the problem-identification stage through commercialization of their products; create an online database for people with disabilities to learn what assistive technologies students have developed and how they can obtain them; and eventually offer resources to manufacture devices whose market size is too small to attract investment from established companies.

"My goal is to get technologies that students develop into the hands of people who can benefit from them," says Goldberg. —CAROLYN DUFFY MARSAN

"We have students who want to work on a project that will benefit a specific client, and they can see how their work improves somebody's life."

In demand

Not every engineering school offers students the chance to work at an industry-leading business right on campus.

Students in the Opus College of Engineering have had this opportunity for nearly 25 years — and those who take it end up running a small enterprise that deploys the natural gas industry's most accurate demand forecasts, saving utilities and their customers millions of dollars and reducing carbon emissions.

The venture is called GasDay, and it's the brainchild of Dr. Ronald Brown, director and associate professor of electrical and computer engineering.

Brown says Wisconsin Gas, now part of We Energies, came to Marquette for forecasting help in 1993. Brown learned about the utility's approach, then took the problem back to his students. Together, they designed a mathematical model to forecast gas consumption.

It wasn't easy. The biggest challenge, Brown says, was a scarcity of high-quality historical data — needed for building the forecasting model — from the meters that measure quantities of natural gas entering a utility's service area.

But the model worked, routinely beating the utility's own methods in terms of accuracy.

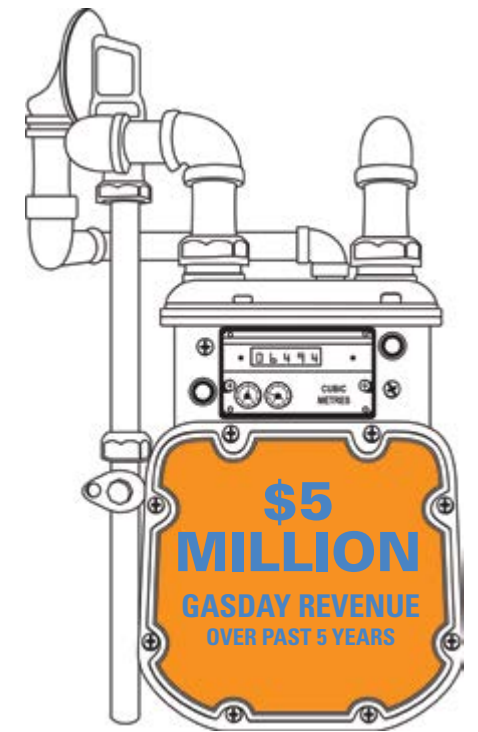
Today, GasDay serves approximately 35 utilities in 26 states, and Brown estimates his students are forecasting about 20 percent of the nation's residential, commercial and industrial natural gas demand.

Current initiatives include expanding GasDay internationally and revising the application software to create a cloud-based solution, which will be more convenient for clients.

GasDay is self-funded, bringing in more than \$5 million over the past five years. That's enough revenue, for example, to support a payroll of 27 undergraduates and six graduate students this past spring.

"I have a diverse group of freshmen through doctoral students, and they have to apply — this is a real job," Brown says. "We usually hire electrical engineering, computer engineering and biocomputing engineering majors. We also bring in computer science students from the math department, and we have some business students to help us with that side of the business."

The educational aspect of GasDay is Brown's priority. "We do not hide the fact that we are running this with students," he says. "They're the ones who talk to customers and support the



application. I think as vendors go, we're pretty reliable, and we're very helpful."

Colleen Dunlap, a computer engineering major, started working at GasDay in April of her freshman year and puts in about 10 to 15 hours a week.

"It's very much a real-world experience, and it's a huge resume booster," she says, adding that her accomplishments at GasDay helped her clinch a spot in a summer systems engineering co-op.

Brown agrees that the authentic experience helps prepare students for the working world: "There's an awful lot we can teach through this project that I haven't figured out how to do in the classroom yet." —PAULA WHEELER

Learn more at gasday.com.

Reaching out

Opus Dean Kristina Ropella and Dr. Lars Olson, associate professor and interim chair of biomedical engineering, have sparked an initiative to team up with fellow Jesuit engineering schools from around the globe. The goal of the International Network of Jesuit Engineering Schools and Universities — or INJESU — is to increase cooperation and collaboration among Jesuit engineering schools in the areas of research, faculty and student education experiences, cultural exchanges and product development.



"We have made contact with Jesuit schools in **GUATEMALA, EL SALVADOR, NICARAGUA and COLOMBIA** with more coming soon. There is lot of enthusiasm from our colleagues in the Americas for increased collaboration with us," says Olson.



Powering research

Marquette has joined two prestigious research organizations, bolstering its interaction with innovative corporations and putting the university on equal footing with the nation's leading technical institutions.

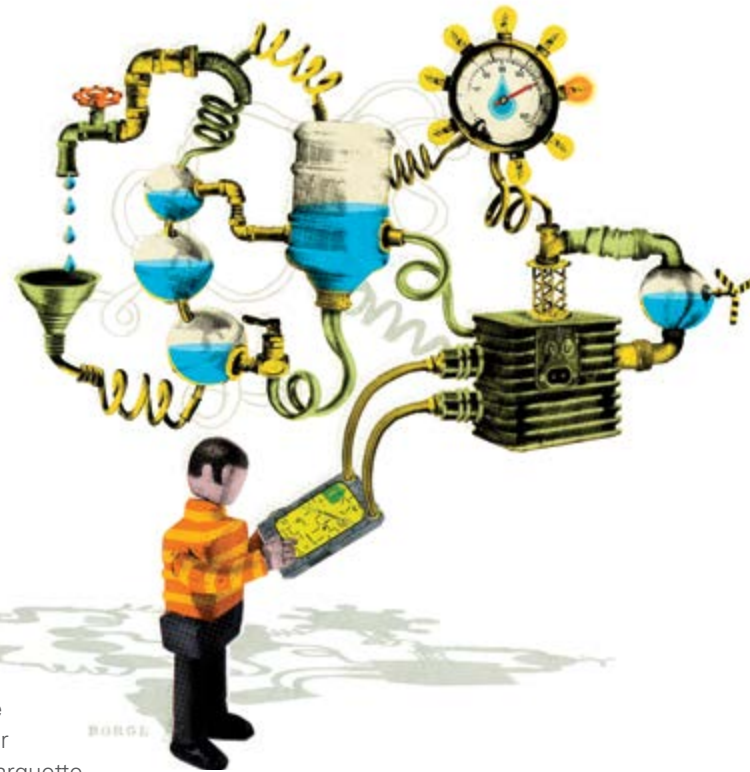
Now a member of the National Science Foundation's Engineering Research Center for Compact and Efficient Fluid Power, Marquette received its first industry-funded grant: a two-year \$160,000 award to develop efficient and flexible hydraulic actuators. Other universities involved with this center include Georgia Tech, University of Minnesota, Purdue and Vanderbilt.

Marquette also joined the Advanced Robotics in Manufacturing Institute, which is funded by the U.S. Defense Department and its contractors. Forty universities belong to the ARM Institute, including Berkeley, Carnegie Mellon, MIT, Northwestern and Rice.

Both organizations will help the university reach its goal of becoming a top-tier research institution and provide students with hands-on experience in high-demand fields.

The ARM Institute "is an opportunity to do applied research in an area of national need," says Dr. Joseph Schimmels, Robert C. Greenheck Chair in Design and Manufacturing and professor of mechanical engineering. "Robotics in manufacturing is an area that is developing significantly. The Defense Department is putting \$80 million in this effort, plus there is another \$165 million from industry."

To join the ARM Institute for the next five years, Marquette pledged \$1 million of in-kind support through its Flexible Assembly Systems Network (FASN) Advanced Manufacturing Center, and the center will receive \$1 million in external support.



"The ARM Institute allows us to tap into significant funding in an area where we are going anyway — advanced manufacturing," Schimmels, Eng '81, says. "It's a windfall for us; the timing is just right."

Likewise, joining the fluid power group allows Opus College faculty and students to collaborate with industry and solve real-world problems.

"There are many things that you can do with fluid power that you can't do with electronics, from agricultural equipment to robotics to power generation," says Dr. Mark Nagurka, associate professor of mechanical engineering. "It's a really hot industry."

Nagurka credits doctoral student Jonathan Slightam with helping develop the proposal that was funded by the fluid power group.

The grant covers equipment for designing and testing a new class of hydraulic actuators.

"It's quite an honor," Nagurka says of the grant. "It definitely helps position Marquette as a known player in fluid power research."

—CAROLYN DUFFY MARSAN

Both organizations will help the university reach its goal of becoming a top-tier research institution and provide students with hands-on experience in high-demand fields.



Leadership shaping

With its glass-walled collaborative spaces, exposed structural elements and 3-D printer, Marquette's 707 Hub has been the most-buzzed-about space on campus since its grand opening in March. But it might not have happened if Sam Wesley and Creighton Joyce, both Bus Ad '17, hadn't met at the Institute — a leadership retreat provided by LeaderShape, a national nonprofit, in partnership with the Opus College's E-Lead program. The Institute, introduced to Marquette in 2015, has grown to involve communication and business students, too.

"Creighton and I met at the retreat. It's where we realized how important it was to interact with different majors on campus," says Wesley. "That is one of the core reasons for the 707 Hub."

At the time, the two were underclassmen from different colleges — Wesley in business and Joyce in engineering (though he later transferred into business). Fired up by their Institute experience, they entered their hub concept in Marquette's Strategic Innovation Fund process and received support to pursue their vision.

This was the kind of student leadership college administrators had in mind when they partnered with LeaderShape three years ago. The immediate aim was extending opportunities for E-Lead students to develop from technical problem solvers

"...we realized how important it was to interact with different majors on campus."

into real-world leaders. Soon, however, Opus Dean Kristina Ropella spotted an additional opportunity to help students prepare for the multidisciplinary work teams they'll encounter in industry — by including communication and business students. The Institute now brings 60 students — 20 from each college — to a camp facility in Lake Geneva, Wis., each January for a six-day program led by Marquette faculty and staff, and LeaderShape instructors.

While there, students break into cross-disciplinary groups of 10, guided by leaders who just might be Ropella, Diederich College of Communication Dean Kimo Ah Yun, or other professors. Through core values of vision, action

and community positivity, the Institute encourages students to inspire change with integrity and a "healthy disregard for the impossible."

The lasting ties and campus leadership demonstrated by Joyce and Wesley aren't an exception; they're the expectation with the Institute, says Andrea Gorman, assistant director for engineering leadership programs and an Institute graduate herself as a University of Minnesota program participant. She cites another group of engineering and business students who met at Marquette's Institute that formed a 2016 Hackathon team and credited their cross-college makeup for boosting their winning effort proposing senior health care uses for robots. Hackathon sponsor Direct Supply liked their idea so much, it hired a few of the students part time to continue developing it.

—BRIAN BOYLE, Student Intern

Degree of dosage

Dr. Taly Gilat-Schmidt, associate professor of biomedical engineering, has received a four-year National Institutes of Health award totaling nearly \$2.5 million to develop and validate a software tool that can estimate the radiation dose delivered to a patient's organs during a CT exam.

The proposed tool will estimate radiation dose to the patient's specific anatomy, whereas existing clinical software tools estimate radiation dose to a plastic cylinder or a model patient. Once developed, the tool can be used for radiation dose tracking, developing protocols to reduce radiation doses, and large-scale epidemiological studies for estimating cancer risk due to CT exams. The project is a collaboration between Marquette University, Varian Medical Systems, Inc., the Medical College of Wisconsin and Children's Hospital of Wisconsin.





Growing STEM learners

For more than a decade the Opus College's outreach program has invested in the critical need to grow interest in STEM fields. Programming has included nearly 60 academies for K–12 students, residential programs for high school students, a partnership with a local STEM school, and training sessions for teachers delivering engineering in their curricula.

“We need to reach these students early enough so they stay on a path to pursue engineering.”

The success of the outreach program has led to a three-year \$210,000 grant from the Johnson Controls Foundation to start a robotics program within local, urban middle schools and to fund scholarships for the college's Engineering Leadership Academy, a weeklong on-campus immersion experience for high school juniors and seniors interested in engineering.

“We need to reach these students early enough so they stay on a path to pursue engineering,” says Dr. Mark Federle, P.E., associate dean for academic affairs. “Industry support from Johnson Controls and other corporations truly strengthens our outreach offerings.”

Learn more at marquette.edu/outreach.

CELEBRATING OUR DISTINGUISHED ALUMNI



DISTINGUISHED ALUMNUS OF THE YEAR

Richard L. Schmidt, Jr., P.E., Eng '80

As president and CEO of CG Schmidt, Rick Schmidt finds it extremely gratifying to create exceptional facilities that improve the lives of others, such as the newest silhouette of Milwaukee's skyline, Northwestern Mutual Tower and Commons; and the rebuild of Walnut Way Innovation and Wellness Commons in the Lindsey Heights neighborhood — two of the construction management and general contracting firm's current projects.



PROFESSIONAL ACHIEVEMENT AWARD

Ronald J. Schutz, Eng '78

Managing partner of Robins Kaplan LLP's New York office, Ron Schutz chairs the firm's Intellectual Property and Technology Litigation Group, which allows him to work with many distinguished inventor clients. He is a former chair and current board member of the Center of the American Experiment. Additionally, he is a member of the board of directors of the Guthrie Theater, the YMCA of the Greater Twin Cities and of the advisory boards of the William Mitchell Law School Intellectual Property Institute, and the *University of St. Thomas Journal of Law and Public Policy*.



ENTREPRENEURIAL AWARD

Michael S. Butler, Eng '95

Mike Butler is president and CEO of Life Spine, a multimillion-dollar spinal surgical tool and implant product company — his eighth professional startup and one of four companies he currently operates. Life Spine has brought to market more than 60 product families, focusing on micro-invasive technology. Holding more than 120 issued patents and 180 pending applications, the company is in the top-five innovative Chicago companies on the Eureka Index.



YOUNG ALUMNA OF THE YEAR

Dr. Kathryn A. Weiss, Eng '01

Now a principal ride control software engineer at Walt Disney Imagineering, Katie Weiss spent 10 years as a senior flight software engineer at NASA's Jet Propulsion Laboratory. She led the Core Flight software effort — JPL's next-generation software platform — served on NASA's Software Architecture Review Board, and was a member of the Mars Science Laboratory (Curiosity) systems and software engineering team, helping the rover land on Mars in 2012.

Nominate a deserving alumna/us for the 2018 Marquette University Alumni National Awards at marquette.edu/alumni/awards/nominate.php.

Honors roll

Opus Dean Kristina Ropella is both “honored and humbled” to have received a pair of awards this past year — the 2016 Outstanding Dean Award from The Kern Family Foundation, and the 2016 Engineer of the Year award from STEM Forward.

The foundation's award was presented at the Kern Entrepreneurial Engineering Network (KEEN) National Conference. Marquette is one of 30 partner institutions in KEEN collaborating to develop best practices in engineering education and champion the entrepreneurial mindset in undergraduate engineering students. (See related story on page 19.)

STEM Forward, a Milwaukee-based nonprofit organization, presented its award to Ropella for focusing her research and teaching career on biosignal processing, bioinstrumentation and medical imaging. The Engineer of the Year award has been a tradition since the 1950s, given to a remarkable person who has made an extraordinary contribution to the engineering profession.



Big year

It's not shocking that Dr. John Borg, P.E., has much to celebrate this year. This spring, Borg was named chair of the Mechanical Engineering Department, succeeding Dr. Kyle Kim, P.E., who served the department for 17 years in this capacity. Borg also received the Lawrence G. Haggerty Award for Excellence in Research and was named a fellow in the American Society of Mechanical Engineers.

Borg, professor of mechanical engineering, joined Marquette in 2002. His research in shock physics, fluid dynamics and aerodynamics has resulted in more than 25 refereed journal publications, significant funding from the Defense Threat Reduction Agency, an impressive number of mentored graduate student theses/dissertations and undergraduate research experiences and — not to be missed — plenty of press for his research on the knuckleball pitch.



**MAKE A
DIFFERENCE
FOR ONE.**

AND YOU MAKE A DIFFERENCE FOR MANY.

At Marquette University, students learn how to become fearless leaders, agile thinkers and effective doers. Your gift to scholarship aid will help provide a Marquette education for students who desire to Be The Difference for others, ready in the spirit of St. Ignatius to “go forth and set the world on fire.”

Make a gift in support of scholarship aid at marquette.edu/giveonline or contact Karlyn Agnew at 414.288.6958.



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Angie Helfert
Bucks arena

Illustrations by Christiane Grauert, photos by John Sibiski

Behind the Building Boom

BY JEFF BENTOFF

Angie Helfert, Eng '07, is leading one of Milwaukee's most talked-about projects — the new \$524 million Milwaukee Bucks arena under construction downtown. Helfert, with Mortenson Construction, Brookfield, Wis., is the project manager for structure.

"It's a once-in-a-lifetime opportunity to build this type of project in your backyard, and I'm extremely proud to be a part of it," Helfert says. "This is the most exciting time for development I've

seen during my time in Milwaukee, and I absolutely think the new Bucks arena influences that opinion."

Helfert says she's amazed by the pace and quality of work. "Seeing measurable progress is one of my favorite parts of being in construction, and every day the project changes significantly," she says.

John Peronto, Eng '03, Grad '03, with Thornton Tomasetti, is working on the \$122 million, 44-story Couture high-rise apartment on Milwaukee's lakefront. Peronto, lead senior structural engineer and engineer of record on the project, is excited about how the striking Couture tower will change Milwaukee's skyline.

"It is very slender and tall, and its location will transform the urban landscape of the southeast part of downtown, further connecting it to the lake and the Third Ward," Peronto says.

Mary Collins, Eng '06, is also helping build a new Milwaukee, but rather than bringing a signature new building out of the ground, Collins is focused on what lies beneath the ground. Collins, with Gilbane Building Co., is a project manager for the current \$13 million phase of the foundation restoration of Milwaukee's City Hall — a historic 122-year-old icon.

Collins is fascinated by restoring a historic building's foundation and learning about its original designs. The project involves a nontraditional design where the original limestone bases of each steel-support column are encased, shifting the loads from the old wood pilings underneath to the new concrete bases, tied in to new steel pilings driven 35 feet underground; it's a novel approach being used only for the second time in the United States.

Milwaukee is experiencing a development explosion with young alumni igniting the way.

The *Milwaukee Journal Sentinel* says an "extraordinary building boom is reshaping Milwaukee's skyline." The *Milwaukee Business Journal* describes a "Downtown Milwaukee Renaissance." And Milwaukee Mayor Tom Barrett crows that his favorite bird is the crane

— referring not to the avian variety but the flock of towering steel machines roaming our skyline.

Milwaukee's metamorphosis is undeniable. So is the excitement and sense of pride these projects are bringing. With billions of dollars being invested, Milwaukeeans are being put to work, and the groundwork for the city's evolution and growth is being laid before our eyes.

Leading this unprecedented wave of construction are six young, highly talented Opus College of Engineering graduates. These engineers are managing many of Milwaukee's latest signature projects worth more than \$1 billion combined. And they're thrilled to be literally building Milwaukee's future.



John Peronto
The Couture

Dr. Nicholas Hornyak
Zoo Interchange

Mary Collins
City Hall

Carolynn Gellings
Milwaukee streetcar

Mike Stern
Rev. Robert A. Wild, S.J.,
Commons

“On a daily basis, City Hall is a reminder to all where the city has been and how far it has come,” Collins says. “While the skyline is changing with the recent construction boom, I’m fortunate to be a part of the team that is allowing this building to continue to be a part of the skyline for another, hopefully, 100 years.”

Not all cranes around town are dedicated to buildings.

“Marquette promotes the person beyond just the technical, with an emphasis on service, teamwork and engagement.”

—Carolynn Gellings

One of three senior project managers for the nearly completed \$200 million Zoo Interchange’s Phase 1 project, Dr. Nicholas Hornyak, Eng ‘03, Grad ‘05, ‘10, sees how important highway improvements can be.

Now that the project is almost completed, Hornyak, with Edgerton Contractors Inc., Oak Creek, Wis., fully recognizes the overall impact it will have.

“During construction, everything is so busy, we barely have time to breathe. Now that we are done with construction for the Zoo (Phase 1) project, driving through and seeing how we contributed to a freeway that is safer, added capacity, and built something that will last much longer than the

original construction is where the satisfaction comes in.”

He enjoys the diversity of issues that he deals with. “The great thing about the construction industry is that there is no monotony,” Hornyak says. “There is no such thing as a perfect set of plans, and one of my specialties is tackling problems between what the plans indicate and what the actual conditions are.”

Carolynn Gellings, P.E., Eng ‘05, Grad ‘17, now with DAAR Engineering, went from serving as design and construction project manager of the \$193 million I-794/Hoan Bridge reconstruction to design project manager of the Lakefront Gateway redesign to, today, construction manager for the \$128.1 million Milwaukee streetcar project.

“Back when I was an undergrad in engineering at Marquette, if anyone would have told me I would have been afforded opportunities to lead projects like these, I would never have believed it,” Gellings says. “Being involved in projects in Milwaukee during this time of so much transformation feels like I’m part of something historic. It’s one of those moments in time you know you’ll be reliving to anyone that will listen, long into the later years of life.”

Gellings says her Marquette education taught her more than engineering. “Marquette promotes the person beyond just the technical, with an emphasis on service, teamwork and engagement,” Gellings says. “Marquette’s engineering

college has the same family-like feel I’ve grown to try to implement or be part of on the projects I work on.”

Mike Stern, Eng ‘10, is a proud Marquette grad who feels a special connection to his current project — the university’s new \$112 million coed residence hall, the Rev. Robert A. Wild, S.J., Commons, which will house 890 freshmen and sophomores when it opens in fall 2018.

“Marquette has helped me end up where I am right now, and I think the best way I can give back is by helping this project be successful,” says Stern, who is with J.H. Findorff & Son and a project manager on the residence hall.

“Knowing that I am working for a client that is collaborative and supportive makes it easy to come to work. And then, being able to be a part of something so substantial at my alma mater adds to the excitement.”

Beyond learning construction fundamentals, Dr. Yong Bai, McShane Chair in Construction Engineering and Management and professor of civil, construction and environmental engineering, says students are taught to think critically, develop problem-solving skills and perform effectively in real-world assignments.

“Besides technical know-how, our program provides students with essential non-technical skills needed to effectively work with and lead a diversified workforce in the construction

companies that operate in both domestic and global markets,” Bai says.

Dr. Mark Federle, P.E., associate dean for academic affairs, acknowledges that the successes of these six grads are representative of the impressive work being done by Opus College grads around the country — and the world.

“We’re fortunate that our alumni are proud to keep us updated on their latest accomplishments and ventures,” Federle says. “It’s inspiring to see how many of our grads are rising in the ranks of their firms, spearheading major projects in their cities, or continuing their education with licensing. They’re always going above and beyond.”

Peronto, the alum managing The Couture, is also working on Saudi Arabia’s Jeddah Tower, soon to be the tallest building in the world. But he says Marquette engineering alumni play a role in Milwaukee’s future that eclipses the size of their projects.

“It is not always about working on the flashiest jobs — it is about how you lead in the community and help build a better Milwaukee together,” Peronto says. “Marquette grads have a strong sense of community and service, which sets them apart.”

The Opus College of Engineering's vision is to develop and be "world-class engineers who will lead bold, innovative change to serve the world in the Jesuit tradition."

Research for the Greater Good

According to Opus Dean Kristina Ropella, "in the Jesuit tradition" means advancements must come with a responsibility to the consequences created by such change. Does the innovation benefit humankind and sustain the world in which we live? At Marquette, there is no shortage of faculty research projects that are focused on doing just that.

By Guy Fiorita

Breathing easier

DR. SOMESH ROY

Assistant Professor of Mechanical Engineering



How are pollutants such as soot or nitrogen oxides formed during combustion of fuel, how do they change as they age in the atmosphere, and how do they affect the global climate? Those are some of the things that occupy Dr. Somesh Roy's day. By using high-fidelity modeling tools and high-performance computing, or HPC, he and his team are able to predict emission and efficiency of various combustion devices such as engines, furnaces and power plants. "This will lead to better design choices for future combustion devices." Roy assembled his research group in the fall of 2016, and they have already built an in-house, state-of-the-art HPC cluster for detailed combustion simulations, especially in combustion engines, coal furnaces and small-scale fires. Roy considers outreach and disseminating the scientific knowledge to the public to be an integral component to his research. "I want this information to be accessible so that people are scientifically aware of the effects of combustion in our daily lives, and I hope that this knowledge will help generate an active interest in scientific research."

Better electric engines

DR. AYMAN EL-REFAIE

Professor of Electrical and Computer Engineering and Thomas H. and Suzanne M. Werner Endowed Chair in Secure and Renewable Energy Systems

As a principal engineer and project leader at GE Global Research Center in New York, Dr. Ayman EL-Refaie worked on and led projects focusing on developing advanced electrical machines and drives for hybrid vehicles, mining vehicles and hybrid propulsion applications for aerospace. Named the Werner Chair in January 2017, EL-Refaie plans to focus his work on improving next-generation electrical machines, drives for renewables and transportation electrification, as the demand for sustainable transportation grows. "In addition I will tackle broader areas of hybrids like energy storage, energy management and charging issues. This is applicable to land as well as aerospace applications." At present EL-Refaie is in the writing phase for proposals to various government and industrial partners. In the meantime his plans include expanding his scope from working at the component level to the system level, covering topics like smart buildings, microgrids and the integration of renewables into the grid.



Safer roads ahead

DR. RONALD A. COUTU, JR.

Professor of Electrical and Computer Engineering and V. Clayton Lafferty Endowed Chair in Electrical Engineering



Before coming to Marquette in 2016, Dr. Ronald Coutu was an associate professor at the Air Force Institute of Technology. Among his areas of expertise are microelectronics, microelectromechanical systems (MEMS), advanced microsystems and device fabrication. Currently Coutu is putting these skills to work conducting electrical and mechanical testing for Solar Roadways, Inc. "The company has developed solar pavers for horizontal surfaces like sidewalks, roadways and parking lots. These panels are designed to support heavy vehicle weight and offer the same traction as standard road pavement, and they include LED lighting for signage and heaters to minimize snow and ice buildup." At present Coutu is involved in the mechanical testing of freeze/thaw, moisture conditioning and shear testing. Working with him is a team from Marquette that includes Dr. Jim Crovetti, Dr. Nathan Weise and Dave Newman. Soon he will begin heavy vehicle simulator testing in a pilot project with a heavy wheel load traversing the area for approximately six months. Solar Roadways will first use the tested pavers in parking lots and driveways, but expects to see the nation's highways safer to travel thanks to the pavers' intelligent design.

Disaster-proof buildings

DR. TING LIN

Assistant Professor of Civil, Construction and Environmental Engineering



Understanding climate change and its effects on our coasts is vital for any future building in these areas. Dr. Ting Lin's work in multihazard sustainability aims to improve system reliability for the natural and built environments under multiple hazards in the face of climate change, which would ultimately save lives and rebuilding costs. Today part of her research focuses on Probabilistic Sea-Level Rise Hazard Analysis, a novel framework used to develop informed engineering and policy decisions that affect coastal infrastructure, populations and ecosystems. "My research is in the general area of sustainable and resilient infrastructure, with parallel tracks in earthquake engineering and climate change. Interfacing engineering with earth science, I currently focus on earthquake and sea-level rise hazards, risk and uncertainty." As the inaugural vice-chair of the American Society of Civil Engineers (ASCE) Structural Engineering Institute (SEI) Committee on Advances in Information Technology (AIT), Lin is also helping to shape the vision for the future in advanced technologies for building more resilient and sustainable communities.

No more basement backups

PAIGE E. PETERS

Graduate Research Assistant

While developing her master's thesis, "Advanced, High-rate Wet Weather Treatment," Paige Peters, Eng '11, has blossomed her research into the startup company Rapid Radicals Technology. "For the last two years, I've been working to create a two-step process for the rapid treatment of wet weather flows for high-intensity rain events, so we can prevent combined and sanitary sewer overflows and basement backups." Along with civil, construction and environmental faculty Drs. Daniel Zitomer, Brooke Mayer and Patrick McNamara as co-investigators, Peters is working with the NSF's Water Equipment and Policy Industry-University Cooperative Research Center to develop the technology. Eventually it will be developed to handle overburden or blended flows at wastewater treatment plants; in the watershed for overflow treatment; and as a mobile unit for high-rate, high-quality treatment during disaster relief efforts. "I am currently forming a board of directors and searching for a chief operations officer to help with our growth. My hope is that the technology will be able to handle wet weather flows to meet the needs of municipalities, and that our success will encourage similar efforts focused on water treatment, public health and environmental stewardship."





How Opus College faculty are coloring the classroom with industry practices.

Illustration by Taylor Gallery

BROADENING THE EDUCATION SPECTRUM

BY CHRIS JENKINS

Students already have the chance to work with \$300,000 worth of machinery that came straight from a real-world industrial training program. Soon, they'll also have access to a flexible assembly systems lab and a Class 1,000 clean room.

As faculty members work to bring engineering industry practices to campus, one professor decided to bring himself to industry instead, taking a yearlong sabbatical to find out what life is like as an entry-level engineer today.

The Opus College of Engineering is emphasizing an entrepreneurial mindset and innovative teaching methods, tailoring Marquette engineering students' education to the demands of today's working world.

"We no longer have to train 'obedient' engineers," says Opus Dean Kristina Ropella. "When I was in school, a lot of time was spent number crunching and working through equations. You still need to understand the theory, but those computations are all being done by computers today. So what do we need to do as engineers? I think we have to have a much higher-level systems approach, seeing how all the pieces fit together."

NEXT-GENERATION MANUFACTURING

As a senior project engineer at Rockwell Automation, Dr. Aderiano da Silva brings 22 years of invaluable industry experience into the classroom as an adjunct instructor of mechanical engineering. In a stroke of good fortune, he also found a way to bring in significant industrial hardware.

Da Silva already was developing a graduate-level industrial automation course for the college when he found out that Rockwell was looking for

something to do with \$300,000 worth of surplus equipment from a training program.

"It was a good coincidence!" Da Silva says.

He used the equipment to build six stations that students use to develop and test projects they design for his Industrial Automation and Controls course; in a recent class, students had to design a machine that makes cookies, and another one that can fill, form and seal a bag of potato chips.

Da Silva, Grad '06, '15, also coaches students on how to build their resumes and teaches them the differences between writing a technical report for industry and writing one for class, which they practice while writing their reports for each project.

"It opens their eyes to things that they were not aware of," Da Silva says.

This class has students apply academic knowledge to practice by bringing the latest technology, methods and design techniques used in the industry today into the classroom. "It helps them build a better relationship between what they learn in their other classes and what's used in industry," he says.

Students' real-world manufacturing experience is about to become even more robust. On the first floor of Haggerty Hall, Dr. Joseph Schimmels, Eng '81, Robert C. Greenheck Chair in Design and Manufacturing and professor of mechanical engineering, is overseeing the construction of a Flexible Assembly Systems Network (FASN) Advanced Manufacturing Center. Once complete, it will give students the chance to work with a set of machines that can adapt to assemble different kinds of products — a significant area of growth in industry.

“In order to teach them how to use hardware, you have to have the hardware,” Schimmels says. “We will have the hardware now. Students working on projects will get a very immersive, hands-on experience.”

The center will expose students to next-generation manufacturing, and it will allow Marquette to build industry partnerships and take on projects that it didn’t have the capacity to tackle in the past.

“This is something that’s in demand,” Schimmels says. “When I mentioned to people in industry that we were developing this, they said they would like to become members — not necessarily because they have projects they want us to run, but just to get access to students who are being trained in this area.”

GOOD, CLEAN FUN

Making modern microelectronic and micromechanical devices requires an environment that’s almost completely free of potentially contaminating particles.

In the basement of Engineering Hall, construction is underway for a Class 1,000 clean room — meaning that, once operational, there will be no more than 1,000 particles that are half a micron in diameter per cubic foot of space. (Your garage might have 100,000 such particles per cubic foot, and a classroom has about 10,000.)

“The reason why we make our devices in the clean room is that a really small particle, even one of those in the wrong spot, can destroy a device,” says Dr. Ronald Coutu, Jr., professor of electrical and computer engineering and the V. Clayton Lafferty Endowed Chair in Electrical Engineering. “A human hair is about 100 microns in diameter. And we’re talking about particles that are 0.5 microns — so really tiny. If you have too many of those particles on a device in the wrong spot, it can destroy it.”

Students will be able to work on micromechanical and microelectronic devices such as a transistor or resistor in the clean room, and researchers will be able to work with more advanced topics such as thin film material properties.

“I’m hoping to add a lab component where the students get suited up and actually make a device that we’re learning about in class,” Coutu says.

WHO’S THE NEW GUY?

When Dr. Philip Voglewede decided to trade his Engineering Hall office for a cubicle at Eaton Corp. to work as an entry-level engineer for a year, he wanted his experience to be as authentic as possible — even if the person in the cube next to him was one of his former graduate students. When they needed someone to run basic device testing, he was there at 5:30 a.m. to do it.

Why make a temporary return to the real world? Voglewede had previous industry experience at Whirlpool, but that was in the 1990s.

“All my examples had this staleness to them,” Voglewede says. “I’m like, ‘yeah, when I was working back in the mid-1990s,’ and you look at your students and they were born in the ‘90s. I’ve got to come up with better stories. And now I can do that.”

Back on the job, the associate professor of mechanical engineering was struck by the availability of technology; computer-aided drafting and dynamic simulation programs, once rare, now are on everyone’s desktop.

“I’ve got to have my undergrads ready to be able to do computational analysis straight out of school,” Voglewede says. “They have to analyze systems at a much higher level.”

WHERE INNOVATION MEETS ST. IGNATIUS

So if engineering students don’t need to spend quite as much time crunching numbers as they used to, what should they do instead? Ropella believes the college’s focus on teaching theory in the context of industry application will help students in the job market. She also wants to increase collaboration with industry partners, academic institutions and other academic units at Marquette.

“Our best work will be done when we’re teaming with others,” Ropella says.

Beyond that, Ropella wants to train engineers to work not only with an entrepreneurial mindset, but also with a Jesuit and Ignatian mindset — something she calls “Ignatian innovation.”

“Our engineers are continually reflecting on the impact of their work on humanity as a whole,” Ropella says. “Our engineers should be doing that, given who we are as Marquette University.”

CULTIVATING CURIOSITY

As one of its strategic efforts to incorporate entrepreneurial learning throughout the engineering curriculum, the Opus College has partnered for the last several years with the Kern Entrepreneurial Engineering Network (KEEN). A national partnership of 30 universities engaged in teaching undergraduate engineering students how to think and work with an entrepreneurial mindset, KEEN fosters inter-university collaboration to develop lessons on cultivating curiosity, developing connections and creating value.

Dr. Lisa Bosman, research assistant professor in the Opus College, has worked with KEEN to develop faculty training that gives educators the tools and resources necessary to incorporate the entrepreneurial mindset into their own undergraduate engineering courses. So far, 80 percent of the college’s faculty has participated in the KEEN training, with 60 percent going on to incorporate the lessons into their own curriculum.

One such example is Dr. Taly Gilat-Schmidt, who creatively incorporated KEEN teachings into her biomedical engineering courses. Gilat-Schmidt, associate professor of biomedical engineering, required her undergraduate students to research articles on new medical technologies before venturing out to the Medical College of Wisconsin to learn how some of these high-tech methods are being used. Students also engaged in a formal debate over the pros and cons of computer-aided

mammography and ended the course by presenting their own ideas for viable new technologies.

“I think that going about the project in this way led to much more active

learning and helped the materials become more engaging and relevant for the students,” says Gilat-Schmidt. “It made them think about the big picture and how the theories they learned are put into practice.”

A side benefit to the KEEN courses has been inter-faculty engagement. “It’s created a forum where we can get together and share ideas,” adds Gilat-Schmidt. “It’s been great to have an opportunity to get together to talk about teaching.”

This May Marquette was awarded a \$742,000 grant from the Kern Foundation to incorporate the entrepreneurial mindset into industry co-ops and internship experiences, in addition to the engineering classroom, further broadening the scope of students’ exposure to this progressive school of thought.

—JENNIFER ANDERSON

“It’s created a forum where we can get together and share ideas.”

IN-HOUSE ENTREPRENEUR

Adonica Randall was eight months pregnant with her first child, Monique, in 1979 when the call came from the White House.

A certified radioisotope handler, Randall was summoned to help officials determine the scope of the Three Mile Island accident in Pennsylvania. Despite being on a no-fly restriction from her obstetrician, Randall made the trip to help with the incident that transfixed Americans’ attention.



“I didn’t have a choice,” she says. “The president called all of the nation’s isotope handlers to Washington.”

At the time, Randall was near the beginning of a long career that led to many different technical and business occupations. Her latest is a new role as the Opus College’s first entrepreneur-in-residence, a position she will hold for a year.

What is an entrepreneur-in-residence? Typically, he or she is a successful businessperson who dedicates a specific amount of time pursuing academics on campus — becoming a guest lecturer, mentoring student startups, coaching entrepreneurs, assisting with business plans or serving on advisory boards.

Randall, Grad ’79, appears to be a great fit for the job. She has held positions at General Electric, IBM, General Motors and A.O. Smith, and has owned and operated her own consulting business in the Milwaukee area for the past 15 years. She brings real-world expertise and entrepreneurial practice to students and academia by giving practical tips and guidance while sharing her real-world stories.

“You don’t have to own your own company to be an entrepreneur,” she says. “The entrepreneurial and innovative mindset is critical to the growth of students.”

It’s clear that Randall has that mindset.

At GM, she worked at its Milford Proving Ground in Michigan, the automobile industry’s first dedicated automobile testing facility, and also worked on a joint project with Ford to design catalytic converters, widely used in new cars beginning in 1975. At A.O. Smith, she worked on the first ATMs, called TYME (Take Your Money Everywhere) machines. Her team also conducted 3-D mathematical modeling for magnetic properties, working on systems for tandem machines, as part of a windshield wiper project for farm equipment.

Now, she’s at Marquette to help students have the same success she’s experienced.

“The world wants these people who have no boundaries,” she says. “They just rise to the occasion.”

—JOE DIGIOVANNI, Jour ’87

OPUS COLLEGE RESEARCH & INNOVATION

The Opus College of Engineering is transforming engineering education by preparing today's engineers to be creative problem solvers. We invite you to read how our professors and programs are seeking **THE NEXT SOLUTIONS TO OUR WORLD'S GREATEST CONCERNS**, all the while leading the way for the next generation of Marquette engineers.

HEALTH & HUMAN PERFORMANCE



DR. BARBARA SILVER-THORN
BIOMEDICAL AND MECHANICAL
ENGINEERING

COLLABORATION FOR THE CAUSE

Dr. Barbara Silver-Thorn's research has often led to improving the well-being of lower-limb amputees — novel prosthetic design development and testing, as well as biomechanics and gait analyses. After spending part of her 2015 sabbatical in the University of Wisconsin–Milwaukee's Mobility Lab of Dr. Brooke Slavens, Grad '04, '08, Silver-Thorn continues to collaborate with the alumna on similar initiatives. Slavens, an associate professor of occupational sciences and technology, has innovative lab equipment to conduct gait, balance and muscle-activation analyses for individuals with mobility impairments, particularly those who use walkers, crutches or wheelchairs, and her research often assesses the load demands on shoulder, elbow and wrist joints to decrease risk for developing upper extremity pain or injury with assistive device use.

Silver-Thorn and Slavens' research includes assessing the balance and gait of lower-limb amputees during both indoor and outdoor activities, as well as assessing and modeling energy use during wheelchair propulsion. They have plans to investigate the effects of Tai Chi exercise on recent lower-limb amputees' balance and gait.

Silver-Thorn, associate professor of biomedical engineering and mechanical engineering, has also collaborated with colleagues in Marquette's College of Education, Drs. Jill Birren, Ellen Eckman and Leigh van den Kieboom, Grad '08. A five-year \$1,199,886 National Science Foundation award will further their initial NSF-supported STEM teacher preparation program by integrating teaching co-ops into a master of education program for STEM teachers.



45
MINUTES

With this short amount of training, humans can learn to use a completely new form of sensory feedback to improve threefold the accuracy of reaching motions.

Dr. Robert Scheidt, Eng '89, professor of biomedical engineering, and his NeuroMotor Control Lab colleagues are finding ways to streamline the use of such vibrotactile sensory substitution in rehabilitating stroke patients. In recent studies, the team has used small vibrating motors — like those found in cell phones — on a subject's arm to apply vibrations in four locations. They control and change the intensity of vibrations to provide the user with information about how their arm is moving. For example, if the arm is moving forward, the vibration intensity of the motor that is correlated with forward movement will increase, telling the user how their arm is moving. They have found that subjects are able to use the vibrations applied to one arm to improve motor control of the opposite arm, which may have acquired sensory deficits after stroke.

twelve
RESEARCH PROJECTS

The number of funded research projects within the Marquette University and Medical College of Wisconsin Department of Biomedical Engineering with collaborators from both institutions.

This number is included in the total 36 funded research grants of the joint department, which brings together the renowned engineering education and research expertise of Marquette and the innovative medical research and clinical practice of MCW to provide an extraordinary education for the next generation of engineers, scientists and physicians. With state-of-the-art labs at both campuses, undergraduate and graduate students are advancing their learning and research experiences through exposure to engineering leaders and faculty physicians who have a strong reputation for research in biomedical imaging and biological applications, rehabilitation, trauma and neurotrauma, as well as device-to-marketplace expertise.

<5

The percentage of women screened for cervical cancer at least once in low- and middle-income countries.

While cervical cancer is a highly treatable disease if detected early, it remains the leading cause of death among women in most developing countries. Dr. Bing Yu, assistant professor of biomedical engineering, has developed a device called SmartME — built upon smartphones, cloud services, high-resolution fluorescence microendoscopy, and diffuse reflectance spectroscopy — to transform current cancer diagnostic practices in developing countries. The smartphone platform makes the device substantially more portable, affordable and easy to use, and also connects medical staffs in remote areas to better-equipped urban health care centers. SmartME allows for data collection, diagnosis and treatment to be completed in a single physician visit, while significantly decreasing false-positives of current testing, which would reduce the number of women unnecessarily biopsied by almost 62 percent. Yu is seeking additional funding to bring the device into clinical trials.

GIVING BACK

As a 1999 Marquette biomedical engineering alumna who earned her medical degree at the Medical College of Wisconsin, Dr. Jennifer (Schilling) Connelly saw the perfect opportunity to give back to two institutions that helped her "achieve successes in life" by supporting the recently formed Marquette University and Medical College of Wisconsin Department of Biomedical Engineering.

"It was a way to remember my roots, where my career began, and to be part of the Ignatian spirit," she says of her donation — the first gift designated to the department.

Connelly, an associate professor of neurology/neuro-oncology at MCW, manages treatment for patients with brain and spine tumors and cancers that spread to the central nervous system. She also works closely with MCW's translational research program, which focuses on advanced MRI imaging and diagnostics in brain tumors.

"Academic medicine strives to bring research from the laboratory to direct patient care," says Connelly. "The partnership between Marquette and MCW is a direct response to that initiative; it's designed to remove the divide between clinicians' problems and the engineers who solve those problems."

To support the joint Department of Biomedical Engineering, contact Karlyn Agnew at karlyn.agnew@marquette.edu, or Abigail Scher at ascher@mcw.edu.

WATER



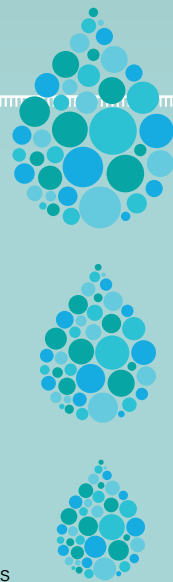
DR. ANTHONY PAROLARI
CIVIL, CONSTRUCTION AND ENVIRONMENTAL ENGINEERING

AFTER THE DUST SETTLED

A massive dust storm in 2015 killed at least a dozen people and sent scores more to hospitals, while covering parts of the Middle East in a historic haze. Media reports blamed land-use changes linked to regional military conflict — deserted farmland, reduced irrigation and military vehicle traffic.

Specializing in ecosystem-water cycle interactions, Dr. Anthony Parolari, assistant professor of civil, construction and environmental engineering, knew how to test that theory. He and his team studied measured surface-air temperatures, humidity levels and wind speeds, and used weather simulation models to study the storm's atmospheric circulation patterns. The more likely causes, they found, were extremely hot and dry conditions coupled with cyclonic winds, followed by an unusual reversal in wind direction. Above-average vegetation levels in 2015 further refuted theories that agriculture abandonment was a factor in creating more dust.

Compared to potentially reversible conflict-related conditions, the storm's actual causes raise more long-term concerns. "If such dust storms result from aridity and atmospheric conditions that could be significantly affected by climate change, then prolonged impacts in the Middle East may be unavoidable," says Parolari.



94%

Approximate percentage of the nation's public water systems that serve populations of 3,300 people or less.

Smaller systems face financial and operational challenges to provide drinking water that meets EPA standards. A Marquette research team led by Drs. Brooke Mayer, Patrick McNamara and Kyana Young thinks electrocoagulation-electrooxidation — a treatment process of passing electrical currents through water to create reduction and oxidation reactions that can directly mitigate micropollutants and pathogens — could be particularly helpful in reducing contaminant risks in small drinking water systems. The group received a grant from the EPA's Water Innovation Network for Sustainable Small Systems Center to research using this technology to treat bacteria, protozoa and trace organic compounds in such systems. This spring, Mayer received the Way Klingler Young Scholar Award.

Nineteen

Number of antimicrobial chemicals, including triclosan, banned from use in soap by the Food and Drug Administration because of their propensity to spread antibiotic resistance throughout the environment. Dr. Patrick McNamara, Eng '06, assistant professor of civil, construction and environmental engineering, who studies how triclosan disrupts the microbial communities used in wastewater treatment facilities, applauded the action but went further in a commentary published in *Antimicrobial Agents and Chemotherapy* by saying, "Moving forward, caution should be exercised when considering what chemicals, if any, are placed into everyday consumer products. ... Behavior that promotes antibiotic resistance needs to be stopped immediately when the benefits are null."



19 ANTIMICROBIAL CHEMICALS BANNED FROM USE

TRANSPORTATION & INFRASTRUCTURE



DR. JAMES CROVETTI
CIVIL, CONSTRUCTION AND ENVIRONMENTAL ENGINEERING

ON THE ROADS

The American Society of Civil Engineers' 2017 Report Card gave the country's infrastructure a D+, a grade reflective of its overall poor physical condition and the significant investment needed to improve it. In Wisconsin, it is estimated that \$60 million is spent annually on concrete pavement repairs alone, of which about \$15–30 million is spent specifically on repairing concrete joints due to durability issues.

With a \$150,000 grant from the U.S. Department of Transportation, Dr. James Crovetti is hoping to positively impact such figures by investigating the sawing of transverse joints soon after paving, a critical operation done to eliminate random cracking that can form as fresh concrete hardens.

Crovetti, director of the Transportation Research Center and associate professor of civil, construction and environmental engineering, implemented a controlled field experiment to test a wide range of joint sawing operations, varying the saw-cutting conditions by changing the time within the curing process that the concrete joint was cut, and using both good- and poor-quality sawing equipment. He then performed detailed laboratory testing of samples obtained from the various sawn joints to isolate those conditions where the joint sawing operations might induce damage into the joint face, which could result in accelerated joint durability distress.

Crovetti's research findings are expected to provide better guidance for paving contractors and state departments of transportation, enhance long-term concrete pavement performance, and contribute to significant taxpayer savings.



six hundred sixty-nine

The number of vehicle-crash fatalities in work zones in 2014. Dr. Yong Bai, McShane Chair in Construction Engineering and Management, has studied the most effective placement of portable changeable message signs (PCMS) used in work zones to reduce truck-related crashes. The difference of speed changes between trucks and cars was considered one of the major reasons for such accidents and reducing it could improve safety in work zones, Bai says.



Dr. Casey Allen, director of Marquette's Combustion Systems Lab and assistant professor of mechanical engineering, recently commissioned a specialized engine test cell for the development of autonomous vehicle engines. The test cell is capable of using advanced control algorithms to optimize fuel consumption under known road and traffic conditions — data often available through GPS and onboard sensors.

"Imagine that you remove the driver from the equation, with all of their inefficient driving habits," says Allen. "If we give control to a computer, the vehicle can be optimally controlled to save on fuel and reduce emissions. In the future, this will be especially important for applications where batteries have no clear pathway to replacing the power density of the internal combustion engine."

TECHNOLOGY & SYSTEMS

20

MILLION \$



DR. RICHARD W. MARKLIN, JR.
MECHANICAL ENGINEERING

RESEARCH ON THE LINE

It was an ergonomics project sponsored by the Wisconsin Electric Co. (now We Energies) in 1995 that led to the first Electric Power Research Institute research project at Marquette more than 20 years ago. Since then Dr. Richard W. Marklin, Jr., professor of mechanical engineering, has received more than \$2.5 million in research funds from EPRI — an independent, nonprofit organization for public interest energy and environmental research — to investigate more than 10 research projects aimed at improving the safety and occupational health of electric power field-workers. From this research funded by EPRI's Environment Sector, eight ergonomics handbooks have been distributed by the institute to its utility members, and these have helped utilities implement physical ergonomics interventions for common tasks performed by field-workers. The most notable and effective ergonomic interventions are battery-powered tools for cutting cables and making crimp connections.

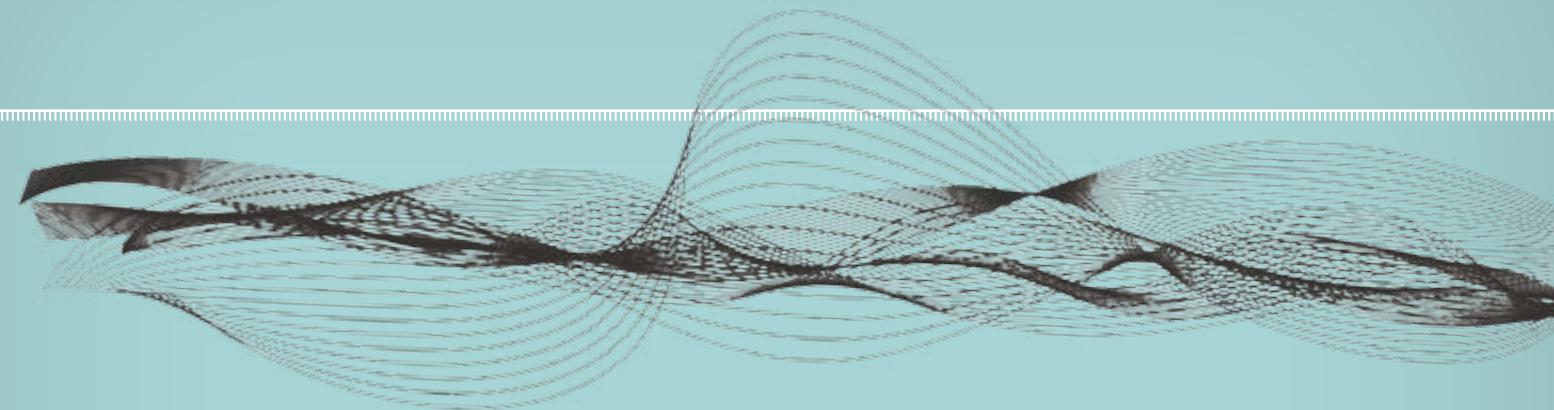
Marklin's current project is to design a new pistol-grip control for aerial-bucket trucks that requires less manual force than current models require. Dr. Mark Nagurka, associate professor of mechanical engineering, is a co-investigator of the project. At the Applied Ergonomics Conference this spring, Marklin presented a paper summarizing how the results of EPRI-sponsored field testing substantiated reports that line workers who operate pistol-grip controls experience forearm muscle fatigue. The results of this work have led Marklin, Nagurka, and Jonathon Slightam, a mechanical engineering graduate student, to design an advanced, reduced-force pistol-grip control to decrease muscle fatigue. The trio submitted a provisional patent application with Marquette in February 2017 for the new design.

The amount of U.S. Department of Energy grants received by Dr. Ayman EL-Refaie for his research on advanced traction motors for hybrid applications

while he worked as a principal engineer and project leader for the Electrical Machines Lab at General Electric's Global Research Center. EL-Refaie, now the Opus College's first Thomas H. and Suzanne M. Werner Endowed Chair in Secure and Renewable Energy Systems, has brought his sustainable energy research clout to Marquette where he plans to continue his research and teach courses in energy sustainability, highlighting the key trends and challenges as well as the suitability of different locations for renewable energy installations within the United States. The Werner Chair was established with a \$5 million contribution from Suzanne and Tom Werner. Tom, Eng '86, is CEO of SunPower Corp., a sustainable energy company that provides solar solutions and services worldwide.

8 Million Metric Tons

The total weight of wastewater biosolids produced annually within the nation's water resource recovery facilities, which are then challenged to generate energy, recover nutrients and remove pollutants from such biosolids. Pyrolysis — a process of heating organic solids at high temperatures in an oxygen-deprived environment — has proven to be an effective method of generating energy and fertilizer (biochar) while removing pollutants. Dr. Simcha Singer, assistant professor of mechanical engineering, along with environmental engineering colleagues Drs. Patrick McNamara and Zhongzhe Liu, is working on optimizing the pyrolysis process for industrial use. With a \$156,936 grant from the Milwaukee Metropolitan Sewerage District, Singer is investigating the ideal temperature and time spent in the reactor to produce biochar as energy-efficiently as possible.



20X

The amount of energy power that can be harvested from waves compared to that from wind or solar sources (given the same amount of incident area), feasibly making it a lower-cost option of renewable energy. Dr. Nathan Weise, assistant professor of electrical and computer engineering, is part of a team that got to the final round of the Wave Energy Prize, a public prize challenge sponsored by the U.S. Department of Energy, which aims to achieve "game-changing improvements in the efficiency of wave energy converter devices." Weise built the powerful programmable, digital, motor-control system for his team's 1:20-scale wave energy converter prototype. Weise's was one of nine teams (out of 92) to get to the testing stage of the contest.



DR. HENRY MEDEIROS
ELECTRICAL AND COMPUTER ENGINEERING

BLOOM COUNTING

According to the U.S. Department of Agriculture, more than 870 million people around the world lack access to nutritious and safe food, a staggering statistic that has compelled the government agency to make global food security a top priority.

"Significant advances in agricultural automation are essential to improving food security for an increasing population," says Dr. Henry Medeiros, assistant professor of electrical and computer engineering. Medeiros and his Computer Vision and Sensing Systems Lab colleagues have partnered with the USDA to solve some of the most relevant and challenging problems in agricultural automation — crop-load estimation and pest management.

Crop-load estimation is the process of determining the expected productivity of a fruit orchard based on the number of flowers and fruitlets present soon after bloom. Proper crop-load estimation allows for more efficient management of crops, labor and harvest equipment. Manually counting flowers is labor-intensive and prone to human

errors. Roboticists and agricultural engineers have been trying to automate this process for decades, according to Medeiros, but existing approaches using machines have had limited success because retrieving field data in variable light conditions with visual obstacles challenges the machines' accuracy.

In a research project funded by the USDA, Medeiros and graduate student Philippe Dias developed an algorithm that applies new learning methods to the problem of machine crop-load estimation. In their system, the images collected by a ground robot are processed by machine-learning algorithms that determine how many flowers are present in the image. Their approach shows improved performances of up to 90 percent in certain conditions and significantly outperforms previous approaches.

In the future they plan to integrate their algorithms with the robotic platform and perform field tests in the USDA orchards.

Engineering Hall's

Delivering a transformational education to engineering students requires all hands on deck. From leadership to faculty to support staff, each partner adds value to this learning environment that prepares students to Be The Difference. Let's meet the Opus College's team of directors who help make a Marquette engineering education one of a kind.



CHANGING THE FACE OF TECHNOLOGY

BRAD BONCZKIEWICZ | DIRECTOR OF TECHNOLOGY

The Opus College's head of technology doesn't toot his own horn. But Brad Bonczkiewicz fills the essential role of providing and maintaining information technology for engineering faculty, students and the entire academic and support staff. It's a position he stepped into in 2012 after serving as Marquette's computer systems manager for four years. The needs have changed significantly over time, and Bonczkiewicz must stay on top of developing technology needs such as virtual computer labs, media-based classrooms with lecture capture and video conferencing, and cybersecurity threats. He also manages a student-staffed help desk. Last year, Bonczkiewicz started the Mobile Applications Development Lab with the purpose of instructing students from colleges across campus on how to program apps. His goal of "changing the face of technology" at Marquette does not go unnoticed by his fellow directors. As Laura Lindemann, director of industry relations, aptly puts it: "Everyone needs technology!"

Laura Lindemann, ENG '00 | DIRECTOR OF INDUSTRY RELATIONS

"Our office is this amazing hub of chaotic connections that result in employment," says Laura Lindemann of helping students determine and realize their career dreams. Lindemann's department first meets the engineering undergrads in their sophomore year and starts helping them move in the direction of "what's calling them." Connecting students and employers is also a central goal of industry relations. Because of the industry relationships cultivated by her office, 75 percent of engineering undergraduates work in industry through the co-op and internship program. An example of the industry relations office bringing practical engineering applications to life is the Marquette Hackathon, an initiative that began in 2014 and gives students a real-life problem to solve with engineering. "We have the unique challenge of trying to get them to network and dream," says Lindemann.



75% OF STUDENTS PARTICIPATE IN THE CO-OP AND INTERNSHIP PROGRAM

THE OPUS COLLEGE IS PROGRAMMED TO POSITIVELY IMPACT THE STUDENT EXPERIENCE

DAVE NEWMAN | DIRECTOR OF OPERATIONS

Dave Newman wears two hats at the Opus College — director of operations for the entire college and director of laboratory operations for the Engineering Materials and Structural Testing Laboratory. One has him leading the team that keeps the college running from a functional perspective; the other has him closely interacting with students on their research projects. "I enjoy both," he says. Having been at Marquette for 17 years and director of operations since 2011, Newman says that even if students aren't aware of it, the college is programmed to positively impact the student experience. "From having the Discovery Learning Lab open on weekends and ensuring we have the most up-to-date equipment we can afford to ensuring they have a safe place to work and study ... we are doing a thousand small things that either enable or enrich their experiences here," he says.



Contributions from Ann Christenson

Unheralded Heroes

I HELP STUDENTS NAVIGATE THEIR JOURNEY



JULIE MURPHY | DIRECTOR OF ENROLLMENT MANAGEMENT AND OUTREACH

Telling the "story" of the Opus College to the future wave of students is a crucial task for Julie Murphy, who helps incoming students understand how Marquette's programs differ from those of other universities. Campus visits are, of course, key. Murphy, who instituted a new way of structuring visits when she joined the college in fall 2016, combined the assets of the formal presentation of engineering opportunities with tours of the college's showpiece Engineering Hall, led by a newly formed team of student ambassadors. "This is where prospective students come alive," she says "when they can see themselves embracing the opportunities that current students are engaged in." As the college moves forward with its plans to sync its outreach efforts with its strategic goals, efforts will be focused on increasing racial and gender diversity and deepening the ways in which potential incoming classes "experience all the different engineering disciplines through lectures and hands-on lab experiences," Murphy says.

TELLING THE "STORY" OF THE OPUS COLLEGE



BRIGID LAGERMAN, ENG '83 | DIRECTOR OF ACADEMIC ADVISING

"We are directors and decision makers," says Brigid Lagerman, who, since 2013, has served as director of academic advising. That is the same year the college founded the Academic Advising Center, a profound change from the campus' faculty advising model, with a full-service base offering support to every one of the college's 1,200-plus engineering undergrads. The center's goal is to be a resource that not only helps students navigate their journey at Marquette but also builds accountability and independence. From freshman to senior year, students visit the center for assistance with pre-registration advising, curriculum, course withdrawal, transfer credit approval, study abroad planning, graduation requirements and much more. Students are also assigned a faculty mentor for major-specific career advising. Lagerman says that along with the greater responsibility this evolved system has generated in the students, it has also helped work out the occasional kinks in the graduation timing process. "I feel like I'm the luckiest employee in the college," says Lagerman. "I have the opportunity to interact with every student and hopefully have a positive impact."

CHRIS PEREZ, ENG '92, GRAD '96, '03, LAW '13 | DIRECTOR OF STUDENT STUDIES AND RECORDS

Working closely with Brigid Lagerman in the Academic Advising Center, Chris Perez considers himself the "behind-the-scenes guy" who handles curriculum, academic procedures and records. The native of Guam is part of the backbone of this "unique" model of advising that both he and Lagerman say has created a much higher level of satisfaction for students and faculty. The latter are able to fulfill their role as faculty mentors in a "more effective, meaningful way," he says. Perez works with students on several fronts, starting with orientation, providing assistance with academic records and course registration, conducting final degree audits and distributing diplomas at Commencement. He also teaches a few courses and advises students interested in the study abroad program. His hardworking, academic-minded parents were integral to building his attitude of serving others — a quality he says he shares with Lagerman. And the two have ideas for making the process even more successful: The mission is "to serve the students. We have an important job to do, but I don't think a lot of people outside our walls know about it."

Continued on next page

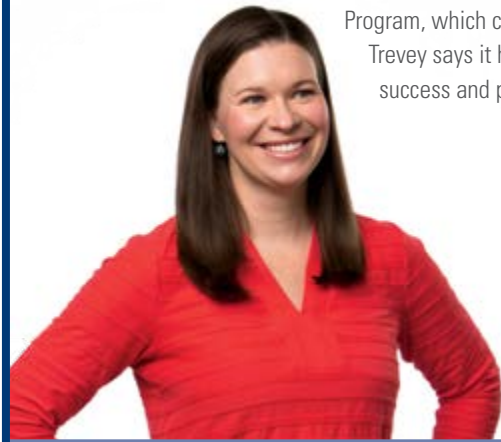


THE MISSION IS TO SERVE THE STUDENTS

Photos by John Sibilski

KATE TREVEY, Bus Ad '04 | **DIRECTOR OF ENGINEERING LEADERSHIP PROGRAMS**

It's not an overstatement to say that Kate Trevey challenges students to "live and lead with integrity." E-Lead (Engineers in the Lead), the three-year undergraduate leadership development program that Trevey spearheads, empowers students to consider their role as Jesuit-educated leaders and engineers who are called to guide change, solve problems and serve others. And Trevey's preparation of students doesn't stop at graduation. "We prepare them for their lifelong journey of leadership development," she says. Another facet of her work is supporting students in three full-tuition scholarship programs in the Opus College of Engineering: Opus Scholars; Donald J. and Frances I. Herdrich Scholars; and Michael J. Cudahy Scholars. These scholarships are awarded to students who are the first in their family to attend college. Of the Opus Scholars Program, which celebrates its 10th anniversary in 2017, Trevey says it has proved to have "incredible retention success and postgraduation job placement."



CHALLENGES STUDENTS TO "LIVE AND LEAD WITH INTEGRITY"

TOM QUINN, Arts '84 | **DIRECTOR OF SALES AND MARKETING, GASDAY**

Marquette's GasDay is a self-funding research lab that forecasts energy demand for about 35 natural gas utilities across North America. (See related story on p. 5.) And part of Tom Quinn's job as director of sales and marketing for the past 12 years is to work with these utilities to help them understand its value and develop proposals to offer its products and services to support their businesses. GasDay's forecast modeling is implemented in software applications developed by graduate and undergraduate students. Quinn also facilitates the students' work for GasDay customers, does all the hiring, makes sure they have all the resources they require, and mentors them as they work with real-world customers at companies around the country. "For most of our students, this is their first job, and one of the best parts of my job is helping them learn how their chosen field of study can lead them to a fulfilling career," says Quinn. "I get to watch students grow their confidence in their skills and their abilities to provide meaningful value to very large companies."



FOR MOST OF OUR STUDENTS, THIS IS THEIR FIRST JOB

SEARCHING FOR ALTERNATIVE COST-SAVING METHODS SO THE STUDENT EXPERIENCE REMAINS UNAFFECTED



PHIL RAWSON | **DIRECTOR OF ACADEMIC BUSINESS AFFAIRS**

The economic climate universities are operating in is a challenging one at best. And it's Phil Rawson's job to constantly balance the needs of the college and its students with the funds available to meet them. Since 2004 Rawson's most important responsibility as director of academic business affairs is budget maintenance and monitoring. "Since behind all of the student experiences are underlying costs, every action I take can somehow be related to the student experience," Rawson explains. "We do our best to provide an environment such that the student never knows the financial challenges facing the university as a whole. I am always searching for alternative cost-saving methods so the student experience remains unaffected."

ALFOMBRAS:
A Mark of Faith



Photos by Jonathan Kim

On a cold, gray November day, engineering students and faculty gathered to brighten up the sidewalk near Olin Hall with vibrant colored salt designs called *alfombras* (carpets), a cultural expression of faith among Latin Americans.

This marked Marquette's first time participating in the tradition, which allowed students and faculty from the Opus College to craft the designs in memory of those who died for their faith. Every November the campus community of the University of Central America, a Jesuit university in El Salvador with which Marquette has collaborated over the years, makes *alfombras* to remember six Jesuits and two women who were assassinated on its campus on Nov. 16, 1989.

Dr. Lars Olson, associate professor and interim chair of biomedical engineering, organized Marquette's event along with Julie Griep, Eng '17, who conducted research with Olson on his human-powered nebulizer project in Guatemala. While there, Olson's research team attended the Corpus Christi Festival, where *alfombras* were displayed in the surrounding neighborhood. They then decided to host a similar event on Marquette's campus to spread cultural awareness.

"I hope students learned about the world outside of Marquette and the global engineering opportunities they can be a part of through campus initiatives," Griep says.

Describing the process of creating the *alfombras*, Olson reflected on receiving a large amount of participation and resources, including the chance to get free salt from a local spice company, which they used to color and create the designs.

"We turned one of their waste products into art and religious expression," Olson says. "We also got participation from the Theology Department and our Jesuit community. They, too, know the importance of *alfombras* in Latin American faith."

Esther Baas, a civil engineering senior, highlighted the benefit of this cultural event. "Most engineering students do not fully learn from a book — we learn by doing," she says. "The *alfombras* event provided students and faculty with the opportunity to learn about and appreciate traditions in this way."

—MEGAN KNOWLES, ARTS '17

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