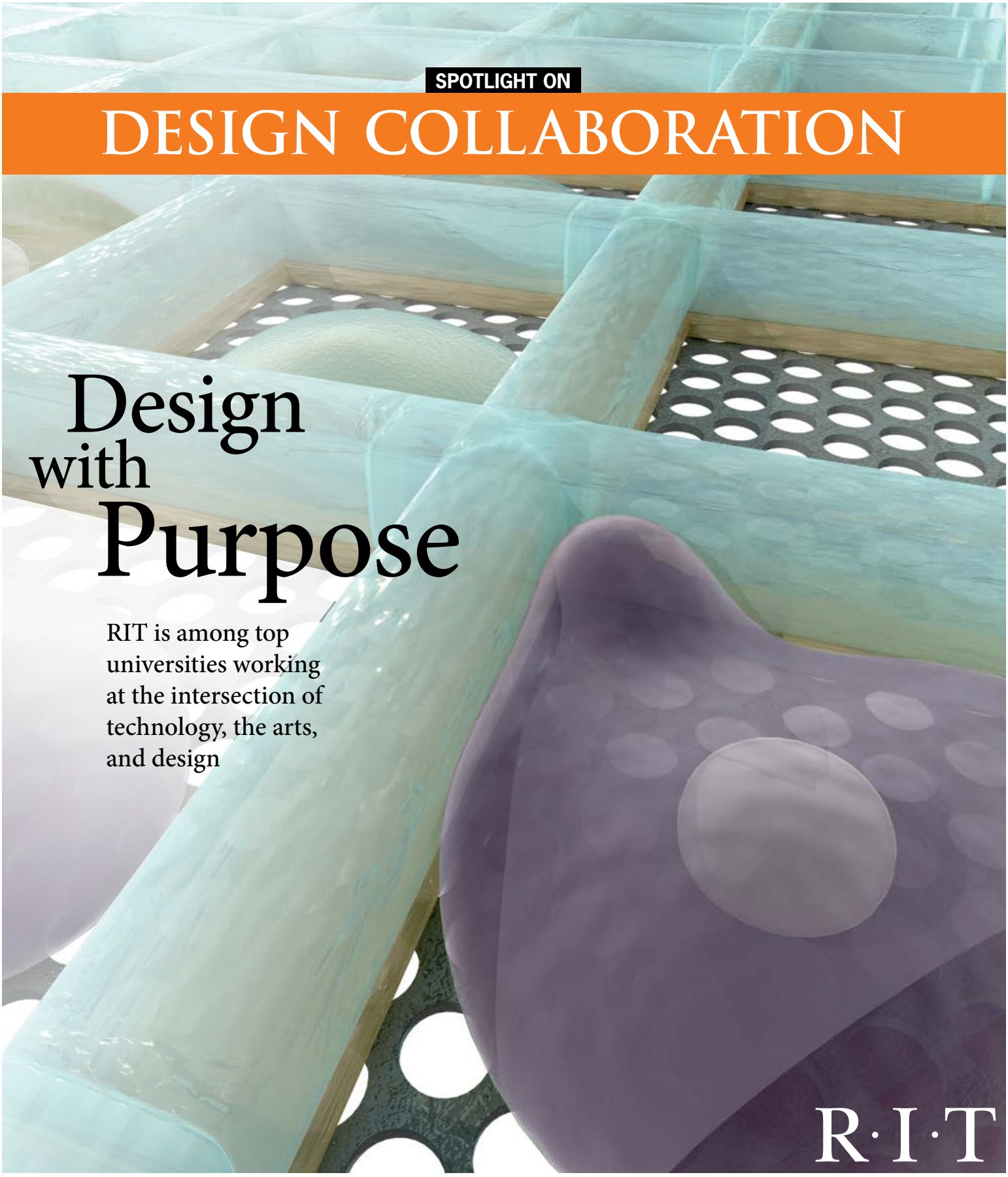
RESEARCH at RIT

Rochester Institute of Technology Research Report

Spring/Summer 2018



SPOTLIGHT ON

DESIGN COLLABORATION

Design with Purpose

RIT is among top universities working at the intersection of technology, the arts, and design

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RESEARCH at RIT

The Rochester Institute of Technology
Research Report–Spring/Summer 2018

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Strength in Design Puts RIT in Right Place at Right Time

RIT has found itself in the right place at the right time on several occasions over its long history. I believe we find ourselves in a similar position today with our strength in design.

In nearly every field one can imagine, and some that are just emerging, the importance of design has never been greater. In all areas of manufacturing, software, graphic arts, and others, good design is recognized as paramount and critical to success.

This is indeed good news for RIT as we possess what are arguably some of the best design programs in the world.

Our programs in video game design and development and industrial design are regularly ranked globally. The 2015-16 DesignSchoolsHub rankings recognize four of RIT's design programs: first for jewelry design, offered by the School for American Crafts (SAC) in the College of Imaging Arts and Sciences (CIAS); fourth for furniture design, also offered by SAC; fourth for video game design, offered by the B. Thomas Golisano College of Computing and Information Sciences; and ninth for industrial design, offered by the School of Design in CIAS.

This issue of *Research at RIT* will shine a light on some of the people and programs that have contributed to all of these high rankings and recognition.

For example, students in RIT's Kate Gleason College of Engineering's multidisciplinary senior design program get a start-to-finish design-and-build experience similar to what they can expect in industry.

By partnering with industry, RIT's industrial design department's Metaproject teaches students the role of research at every stage of the design process.

Through three collaborative courses—Packaging Development, Packaging Design, and Senior Studio One—students learn how the design process in the packaging industry works by creating designs for a sponsoring company.

And we showcase how student and faculty researchers are working to change the culture of computing in an effort to make technology accessible for all.

I do hope that in perusing this issue you will gain an appreciation of how good design improves so many aspects of our daily lives. I also hope you'll learn more about how RIT is taking the lead in training the next generation of great designers.

Best regards,

Ryne Raffaelle
Vice President for Research
and Associate Provost

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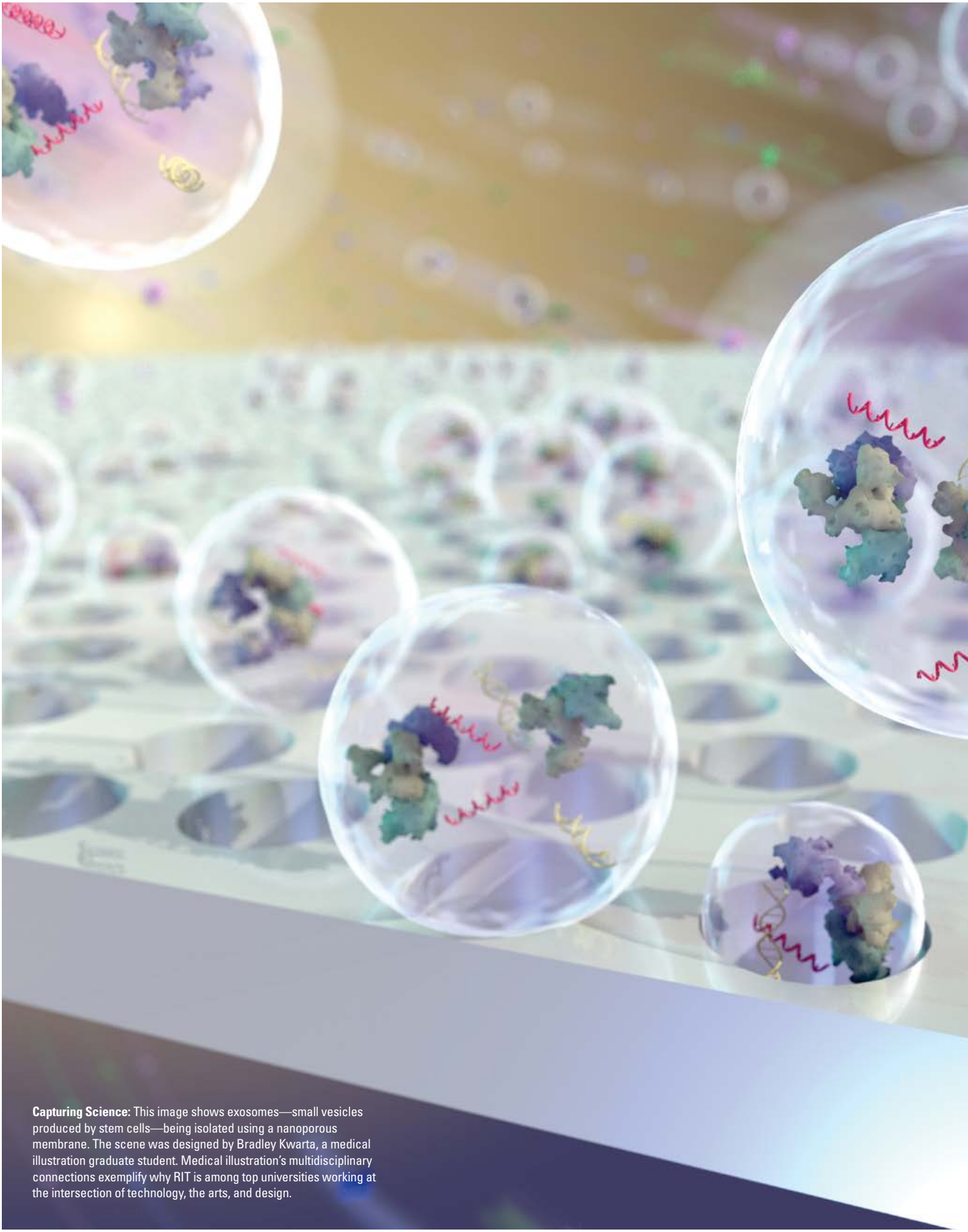
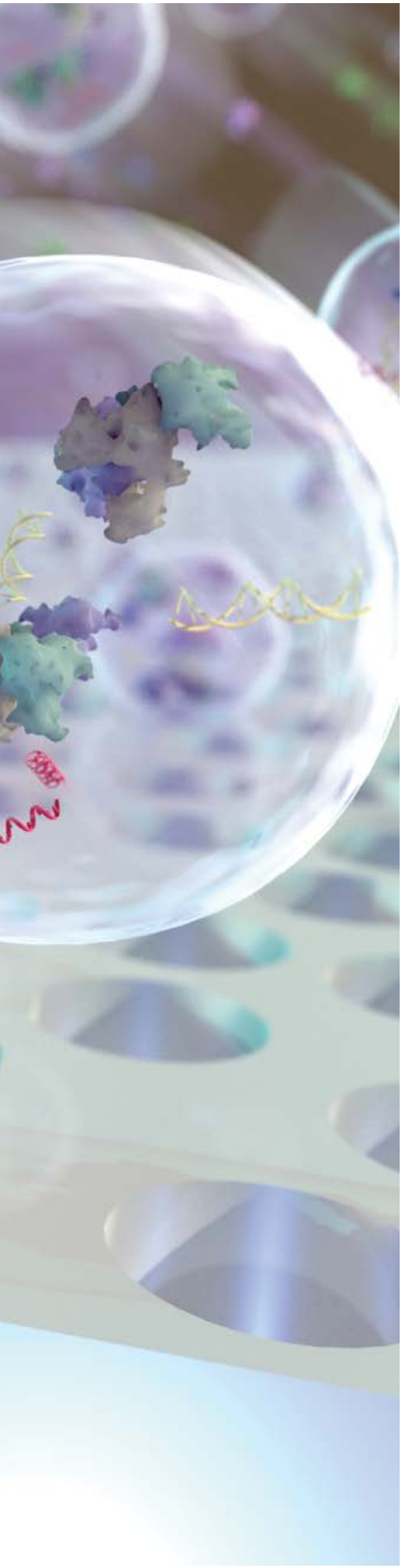


Capturing Science: This image shows exosomes—small vesicles produced by stem cells—being isolated using a nanoporous membrane. The scene was designed by Bradley Kwarta, a medical illustration graduate student. Medical illustration's multidisciplinary connections exemplify why RIT is among top universities working at the intersection of technology, the arts, and design.



Research Fuels Ideas and Creativity that Power RIT Designers

by Rich Kiley

RIT is one of the top universities in the nation working at the intersection of technology, the arts, and design. The university's design programs are world ranked due to innovative students and faculty, along with close ties to industry and alumni.

From Beaux-Arts to Modernism

Designers thrive when they have a working concept of what makes people tick, a context that allows them to shape their ideas by considering what people covet and use—along with a place to focus all of their creative energy.

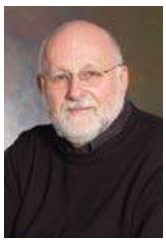
What provides the fuel for such new ideas? Research.

"Design research is foundational to understanding and meeting human needs," said Chris Jackson, associate dean of RIT's College of Imaging Arts and Sciences (CIAS). "The information gained through design research validates ideas. It translates assumptions into actionable knowledge. Applying this knowledge significantly raises the bar on delivering a successful design solution that resonates with users."

Chris Jackson

Design research emerged as a recognizable field of study at RIT and elsewhere in the 1960s. Some of the origins of design research are found in the emergence of operational research methods and management decision-making techniques after World War II, the development of creativity techniques in the 1950s, and the early beginnings of computer programs for problem-solving in the 1960s.

"When I first came to RIT in 1963, it was largely a beaux-arts school," said R. Roger Remington, RIT's Vignelli Distinguished Professor of Design, referring to the classical decorative style and influences of Paris from the early- to mid-1900s. "The change from a fine arts school into one of modernist design precipitated the dramatic shift from analog to digital and the advent of more intensive research here."



R. Roger Remington

In 1983, Remington, the author of six books on the history of graphic design with two more in the works for 2018, organized "Coming of Age," the first-ever international symposium on the history of design, with a particular focus on graphic design. From those early roots, RIT has become a world leader in emphasizing history, theory, and criticism in design education and research, including the acquisition of nearly 50 archives of design's modern masters.

No other school or institution of any kind can offer such extensive opportunities to learn and research from actual artifacts, rather than reproductions, Remington observed.

These resources complement RIT's wide variety of creative programs that rely considerably on research, from

Sustainable Design: As an extended faculty member of the Golisano Institute for Sustainability (GIS), Alex Lobos, associate professor and graduate director of industrial design, noted that researching and designing "green" or environmentally benign products has become even more important. Here he is leading a session with Callie Babbitt, an associate professor at GIS.

Generative Design: Designed by Alex Lobos, graduate director of industrial design, and industrial design graduate student David Villarreal, this lamp represents research using computer-aided design (CAD) to model organic forms in as few steps as possible, allowing the software to generate most of the shape. The lamp was modeled in Autodesk Fusion 360 and milled out of wood with a Shopbot CNC router.

industrial design, new media design, 3D digital design, and interior design to the fine arts and crafts programs in glass, metal, wood, and ceramics.

Design 'Explosion' Fuels Research

"Design has always had this focus on applying research as part of the visual language and the visual dialogue that we're creating," said Adam Smith '01 (MFA computer graphics design), chair of the new media design program and graduate director of visual communication design. "Fifteen years ago, design—especially interactive design—was very ad hoc. Here at RIT and elsewhere, designers were exploring new and different ways of using technology to present information, so in a way early design was a form of research."

Adam Smith

"What we lacked, however, in the early days, was the ability to necessarily understand how to leverage the power of the research methodologies," Smith added. "There's a method to analyze, to record and evaluate design research and build those improvements off of it."

One benefit of the huge explosion in design over the last two decades is that it has enabled designers to refine and hone ideas based on usability, usefulness, and functionality, according to Smith and other members of the RIT design faculty.

"After we started to see things like the iPhone come out, companies like Apple and others were for the first time publishing design guidelines around not just visual styles but also how humans interact with these devices," he said. "That provided us a compass to take this direction of interaction, visual design, and design language and place it under the umbrella of research patterns."

User-Centered Research a Key

Alex Lobos, associate professor and graduate director of industrial design, noted that research is essential to making the design process user-centered, iterative, and honest.

"Research can be liberating to designers because it provides important details on how users will respond or react to a product in a certain way, so it doesn't all fall on the designer," Lobos said. "In addition to being user-centric, good design has to be iterative so designers can refine their ideas with each stage of the process."

As an extended faculty member of the Golisano Institute for Sustainability, Lobos noted that researching and designing "green" or environmentally benign products has become even more important in recent years, particularly among younger generations.

"By minimizing waste in the research and design process, you end up with a product that's very honest and pure," he said. "Today's end user will react

Design research is enabling RIT students to solve real-world problems, according to Peter Byrne, administrative chair and professor in the School of Design.

Capstone Research: Alexa Boyd, left, interior design; Hannah Lutz, industrial design; and Victoria Tripp, mechanical engineering, pose with Dr. Armando Berlios of Hospital Escuela. They are working on capstone research projects, led by Mary Golden, with Little Angels of Honduras.

Neonatal ICU: Interior design students researched and proposed interior packages for a campaign to significantly expand a neonatal intensive care unit for Honduras' largest public hospital. Mary Golden's students are collaborating with Little Angels of Honduras, an organization dedicated to reducing infant mortality.

favorably to that because they can recognize that honesty."

Lobos arrived at RIT eight years ago from General Electric. Leveraging his industry background, he oversees multi-disciplinary collaborations between RIT and a number of partner companies, including Autodesk, the international software company based in San Francisco.

Since Lobos spearheaded RIT's relationship with Autodesk in 2011, the research and design collaboration has flourished.

He has attended joint conference presentations with company executives as part of Autodesk University, and the company has sponsored several multi-disciplinary research projects that are opening new worlds for people through effective access technology.

RIT is one of only four universities Autodesk has signed a memorandum of understanding agreement with to work together even more.

Lobos also works closely with Stan Rickel, faculty coordinator for Studio 930, a summer co-op in which RIT students research and develop projects from concept to prototype to commerciality. It's part of the Albert J. Simone Center for Innovation and Entrepreneurship, which helps to advance student ideas and projects through business development programs, funding opportunities, student competitions, and mentoring. A number of these projects has evolved into successful startup companies.

Solutions for the Real World

Design research is enabling RIT students to solve complex, real-world problems—both regionally and far away from Rochester, observed Peter Byrne, administrative chair and professor in the School of Design.

"We're asking students across all of our design programs, 'How do you figure it out?'" Byrne said. "The research process is giving our students the skills to develop design toolkits to do some amazing things."

For example, four RIT students, three from CIAS and one representing Kate Gleason College of Engineering, traveled to Honduras last fall with Mary Golden, interior design program chair, to advance three multidisciplinary capstone research projects and collect information for five other initiatives.

The capstone endeavors stem from RIT's interior design program's collaboration with Little Angels of Honduras (LAH), a nonprofit organization dedicated to reducing infant mortality in the Central American country. Last year, under the guidance of Golden and Shannon Buchholtz, adjunct professor, interior design students supplied LAH with proposed interior packages for its campaign to significantly expand a neonatal intensive care unit addition at Hospital Escuela, Honduras' largest public hospital, including designs

Photo by Eric Long

Sweet Café: Before joining RIT's industrial design faculty five years ago as an assistant professor, Mindy Magyar project managed the design of the Smithsonian Institution's restaurants and shops, including the Sweet Home Café and Museum Store at the National Museum of African American History and Culture.

Photo by Molly Stephey

Cultural Research: The Smithsonian's National Museum of the American Indian in Washington, D.C., features a tribal newsstand and coffee bar in the Mitsitam Cafe.

for premature baby examination tables and a mobile education unit.

"We had very full days of research and activities at the hospital," recalled Golden, adding that the projects in various stages of progression use a science, technology, engineering, arts, and mathematics (STEAM) approach.

LAH's core mission is to bring optimal conditions for maternal and infant care to Honduras, where the existing high maternal-infant mortality rates are traced to an extreme lack of space and medical equipment, hindering the quality of care.

Designing Solutions for the Smithsonian

Back in the United States, before joining RIT's industrial design faculty as an assistant professor in 2013, Mindy Magyar managed the design of the Smithsonian Institution's restaurants and shops, including the Sweet Home Café and Museum Store at the National Museum of African American History and Culture, as a project manager.

"When you're dealing with politically or culturally sensitive content, research is vital to delivering a culturally authentic narrative and experience," Magyar said. "And co-design, or participatory design, is necessary to successfully integrate the ideas and interests of varied constituents."

"An extensive research process—one that is highly collaborative—will guide you to a good result," she added. "But you cannot define what that result will be without the important input of others."

Magyar began her professional career as a financial analyst at J.P. Morgan, guiding the portfolios of corporate clients and later proprietary investors through research—a background that has served her well at RIT.

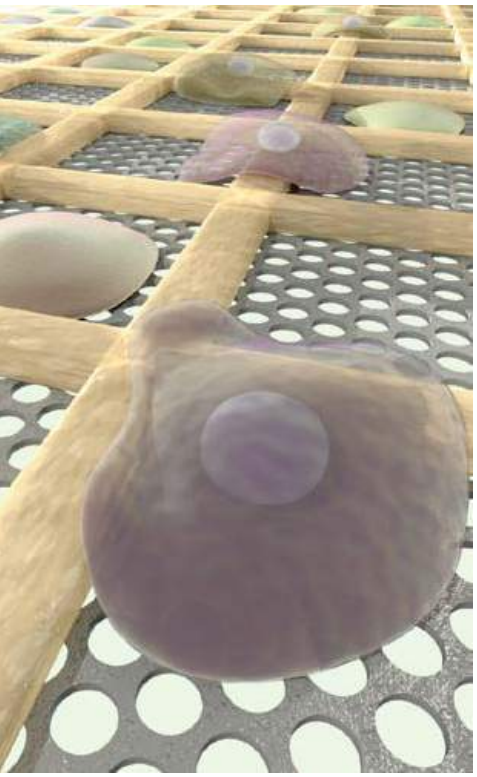
"I encourage my students to think critically, to always consider various perspectives when designing," she said. "Research methodology provides them with a framework to do this."

Supporting Traditional Research

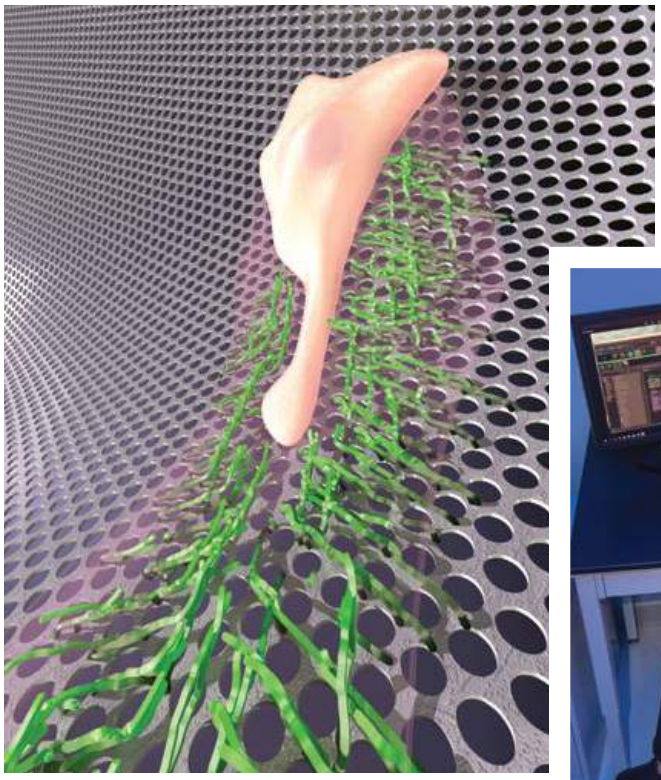
RIT design students are developing skills and techniques to succeed through service to more traditional research. As a faculty member supporting the personal health care technology group—a Signature Interdisciplinary Research Area at RIT—Smith is part of a group identifying university projects that will benefit from having design incorporated into university research.

Bradley Kwarta, a medical illustration graduate student, has been designing extraordinary imagery while embedded in RIT's NanoBio Device Laboratory during the past year.

Under the direction of Thomas Gaborski, associate professor of biomedical engineering in KGCOE, Kwarta is creating stunning illustrations to support the lab's



Alluring Arrays: This microarray image by Bradley Kwarta depicts the creation of arrays that can isolate individual cells on top of nanoporous membranes, allowing for individualized experimentation.



Membrane Matrix: This illustration by Bradley Kwarta shows a fibroblast laying down fibronectin (extracellular matrix) while traveling over the surface of a nanoporous membrane.

Lab Partner: Bradley Kwarta's medical illustrations support bioengineering lab research that includes developing porous membrane scaffolds for laboratory models of tissue barriers.

cutting-edge research that includes developing porous membrane scaffolds for laboratory models of tissue barriers like the blood-brain barrier, the intestinal wall, and the lung, among others.

"I'm actually inserted into the lab so that if I have any questions I can ask the researchers directly, in real time, to get a better understanding of what I'm being asked to illustrate," said Kwarta, a native of Pittsford, N.Y. "Many times there can be a disconnect between those doing the research and the creative mind, but by being embedded in the lab the process is much more streamlined."

While Kwarta came into RIT's medical illustration graduate program with an undergraduate biology degree and once considered medical school, the lab's research is extremely complex.

"I'm often designing new imagery that has never been created before," said Kwarta, noting that his highly detailed 3D model of an exosome he illustrated may be the first ever conceived. "I start with doing a lot of research in textbooks and online resources before beginning to develop simple sketches—even if I'm not exactly sure what it's going to look like in the end."

Continuing his research and frequently sharing his work with the lab team to make sure it's on the mark, Kwarta then moves into 3D modeling, shading, and lighting so that his polished illustration can be used for research papers, trade journal articles, or presentations at key bioengineering conferences.

For his thesis, Kwarta is illustrating one of the lab's major bioseparation projects—creation of a portable hemodialysis system—along with a video animation demonstrating the process.

The level of science knowledge that medical illustrators such as Kwarta need to know to perform their responsibilities has increased considerably as their role and research importance increases dramatically, according to James Perkins '92 (MFA medical illustration), professor and graduate director of the medical illustration program within RIT's College of Health Sciences and Technology.

"Medical illustrators need to be able to comprehend the latest research in an obscure topic in molecular biology or cell biology," Perkins said. "It's not uncommon for today's medical illustrators to regularly collaborate with physicians, scientists, and other health care professionals to translate complex scientific information into visual imagery that supports medical education, science research, and patient care."

While many of today's medical illustrations continue to be used in textbooks, modern-day medical illustrators regularly find themselves working in three dimensions, creating anatomical teaching models, facial prosthetics, patient simulators, and web-based media.

3D-Designed Dress: This Women of Rochester Dress was presented at a Costume Design and Technology panel, titled "Printing on Soft Goods," at the U.S. Institute for Theater Technology conference in St. Louis in 2017.

Growing Program: According to Program Chair Marla Schweppe, left, the 3D digital design program has grown to 130 students currently since graduating its first four students in 2011.

Keeping Up with Game Engines

It's not uncommon for program chair Marla Schweppe's 3D digital design students to have to research and learn how to model hair, steam, or water as "game engines get more and more powerful so they need to include more and more detail."

"We can use software to animate cloth in a very sophisticated way, and that means our students now need to know something about fabric—how different fabrics move, what kind of fabric is appropriate for certain types of garments, along with the history of costumes," said Schweppe, who early in her career designed for theater, dance, TV, and movies in New York City and elsewhere.

"To use software that creates trees, our students need to know if a certain tree grows in a particular climate," she added. "How do animals move? That's why they take anatomical figure drawing and have to abstract that to wildlife."

For "live design" and productions, Schweppe said, students must research and learn how to use infrared cameras to track dancers and integrate their images into projections, including how to use facial tracking software for game engines or 3D software, virtual reality, and augmented reality systems.

Students' work spans computers and video games, virtual reality, medical and scientific simulations, data visualization, and more. Their powerful displays of cascading colors and images often can be seen at city festivals, including the KeyBank Rochester Fringe Festival.

Since graduating its first four students in 2011, the program has grown to 130.

While Schweppe's 3D digital design program and other programs in RIT's School of Design are uniquely specialized, each shares an inquisitive and dynamic educational community in which research, creativity, critical thinking, cross-disciplinary study, and social responsibility are explored, cultivated, and promoted to make a positive impact—both in the study areas and ultimately on the society in which we live, according to Robin Cass, interim dean of CIAS.

"There are outstanding design faculty in our college that have so much to contribute to areas of study and research across RIT," Cass said. "For example, 'design thinking' is becoming a popular and important tool used to grow business.

Robin Cass

"While in the past, design was brought into the product development process late in the game to 'doll up' an already developed product, it's now being called upon to play a strategic role from the start," she concluded.

On the Web

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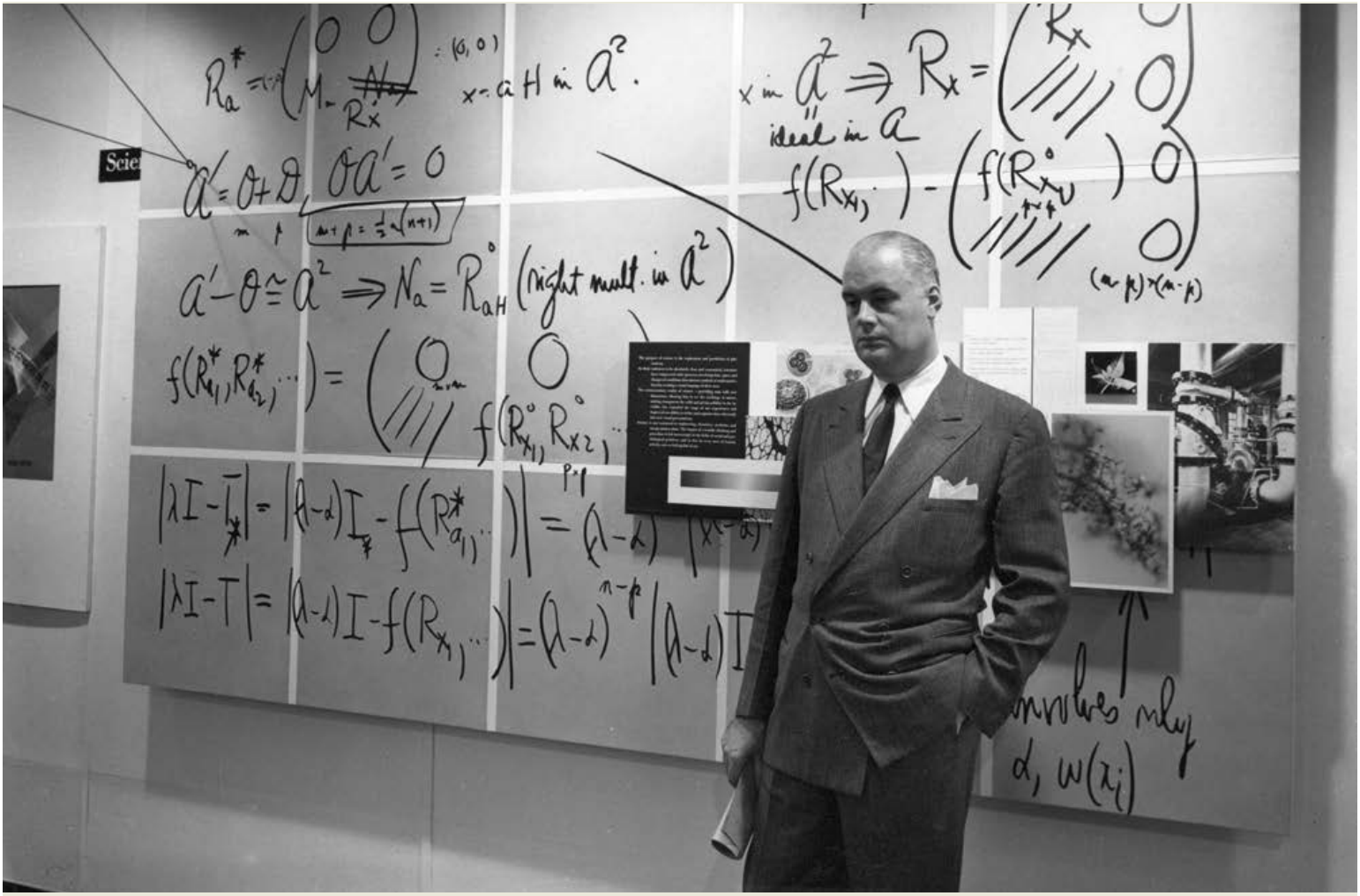

Photo by Arnold Newman

Design Pioneer: A graduate student is producing an augmented reality presentation that recreates designer Will Burtin's pioneering "The Communication of Knowledge" exhibit. Burtin is seen in this photo taken around 1970. The exhibit's panels are part of the holdings inside the Cary Graphic Arts Collection's Graphic Design Archives.

RIT's Archives Play Key Role in Research

by Rich Kiley

Active Archives

The Cary Graphic Arts Collection's Graphic Design Archives inside RIT's Wallace Library numbers 45 collections, including pioneering greats such as Lester Beall, Will Burtin, William Golden, and numerous others.

Today, RIT's archives have the relevant role of being both dynamic and didactic research and educational tools. Students, teachers, and researchers from around the world readily access these original resource materials, according to R. Roger Remington, RIT's Vignelli Distinguished Professor of Design.

The relationship between teaching, learning, research, and such vast design resources prominently positioned RIT for the acquisition of the archives of the late Massimo and Lella Vignelli, which became the university's capstone collection, located inside the Vignelli Center for Design Studies, in 2010.

"The design archives we have here at RIT make this university unique in the world," Remington said.

This fall, RIT's School of Design is adding a new sequence of courses to further leverage the archives. Design studies will complement the current areas of study in the visual communication design (VCD) MFA degree program, with curriculum that focuses on the critical relationships across design history, theory, criticism, and research.

To demonstrate how design research can be virtual and interactive—even when reaching across nearly five decades—John Koegel, a graduate student in the VCD program, is producing an augmented reality (AR) presentation for his thesis that recreates designer Burtin's pioneering "The Communication of Knowledge" exhibit. (The presentation is being produced and supported by the Vignelli Center.)

The iconic show, originally shown in 1971 at the gallery of the American Institute of Graphic Arts in New York City, displays Burtin's key lifetime achievements in design. The exhibit's 41 original panels, measuring 24-by-24 inches, are part of the holdings in the Burtin collection inside the Cary Collection.

Utilizing Microsoft's cutting-edge HoloLens Wearable Technology, Koegel, a Syracuse, N.Y., native, is creating a historical representation of Burtin's original exhibit to scale and dimension.

"My thesis focuses on creating an AR environment in which archival content can be virtually accessible through interaction for anyone, anywhere, anytime," said Koegel, who earned his BFA in graphic design at RIT in 2017. "Extensive research is a must to create and design from clearly defined and accurate historical references."

Moving People: Computer engineering student Jeff Barker, standing, checks the placement of a wide-angle camera while computer engineering student Greg Mullin, seated, tests the sensor technology on the Autonomous People Mover. Left to right, teammates Robert Relyea, computer engineering, Anthony Luciano and Noah LoConte, both electrical engineering, check vehicle wiring during an onsite test.

Students Solve Problems in Senior Design Program

by Michelle Cometa

Multidisciplinary senior design projects are the practicum for modern design thinking.

Human Solutions

Putting their autonomous vehicle prototype through its paces on the engineering quad, student team members monitor sensor responses as the full-sized golf cart skims quietly across the walkway. Under the hood, their artificial intelligence technology "taught" the Autonomous People Mover to recognize and avoid curbs, statues, and classmates walking to and from campus buildings.

Just a few years ago, full-system autonomy was limited, said Raymond Ptucha, associate professor of computer engineering and team faculty adviser.

"Technology is advancing at an exponential pace. It is awesome to watch it evolve in front of us," he said. "Due to the popularity and proliferation of driver assistance and autonomous driving, the platforms these students are working on today will be commonplace in a few years. They will look back and say they were one of the first pioneers working on making autonomous vehicles a reality."

The Autonomous People Mover is one of 80-plus projects in the multidisciplinary senior design (MSD) program. A two-course sequence for students in RIT's Kate Gleason College of Engineering, MSD gives them a start-to-finish design-and-build experience similar to what they

can expect in industry.

Grounded in a structured engineering design process, it begins with detailing customer requirements and ends with delivery of a product or process tested against those requirements. RIT's students are learning to develop real, human solutions using modern technologies.

Defining and Researching

What do customers need? How will they use a product? Can technology be integrated to improve a design or a process? These are some of the questions being addressed through the program, said Beth DeBartolo, director of the multidisciplinary senior design program and associate professor of mechanical engineering.

"It may be one of the few times students will see an entire project all the way through, from defining the problem for the customer to delivering a prototype," she said.

She works with faculty and guides—mostly retired engineers from local corporations—to assess projects and determine appropriate scope. Projects align with tracks in specialty areas of the engineering college such as biomedical systems and technologies, vehicle systems, autonomous systems and controls, energy and sustainable systems, printing, and imaging.

Projects are further categorized by process improvements, corporate product improvements and skill acquisition, social impact, or possible commercialization.

Preparation begins with instruction about logistics and elements of the design process including how to write customer requirements and conduct interviews. Working on site in a large design space in the engineering college, guides mentor students through the process where they are judged on project outcomes, adherence to the design process, and their ability to function effectively on teams.

There is no "normal" for projects, DeBartolo added. Team makeup is always different and approaches taken vary with students' experiences from early co-ops and ideas. All projects, however, are based on design research philosophies and situational guidance emphasizing the importance of real-world solutions.

Students must approach solutions logically and strategically. That is where the design process comes in—it is a model to solve complex problems by breaking them into small, manageable pieces.

Prototyping and Testing

"The scope was huge," said Jeff Barker, a fifth-year computer engineering major from Valatie, N.Y., who helps lead the Autonomous People Mover (APM) project, now in its fifth iteration.

The goal is to have the autonomous golf cart respond to an individual's text message requesting a ride to specified campus locations, he explained. In previous designs, the APM moved to and from several programmed destinations. This year's team decided that full autonomy meant the cart had to be able to detect, in real time, curbs and other obstacles to get to designated locations.

"Prior MSD teams have not used machine learning; this year's team is the first to do so," said Ptucha, whose background is in computer vision, robotics, and embedded control systems. "They are using deep learning to determine how to steer the APM. Data from a wide-angle, front-mounted camera is passed into a deep-learning algorithm that labels each pixel as road or non-road, good or bad. It helps the golf cart stay on the path, regardless if it is driving on brick, cement, or blacktop."

The 16-channel LiDAR—light detection and ranging equipment—was moved from the top of the vehicle and mounted on the front of the chassis for better range. Additional sensors were added to side panels.

With the wide-angle camera, sensors, and deep neural network techniques, important data is produced about terrain and objects that gives the team the ability to refine the vehicle's trajectory in real time. LiDAR, vision sensors, and image recognition are at the root of how autonomous vehicles function. The refitted design the students implemented is part of that trend.

At the most recent Consumer Electronics Show, top car companies

Another Design Project: From left, Andrew Lints, computer engineering, and Devin Cooley, mechanical engineering, answer questions about their Smart Mountain Bike Suspension System prototype from Sarah Burke, co-op/placement career services coordinator, and Louis Beato, project guide and computer engineering faculty.


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How it Works: Technology necessary for autonomous vehicles includes a series of high-tech sensors and light detection and ranging equipment, all programmed and tested by the project team.

demonstrated their latest autonomous vehicles, many using similar sensing technologies.

"We are trying to show that we have a system confident enough to avoid obstacles while still 'smartly' determining where it should go," said Barker, part of the team of computer, electrical, and industrial engineering students working on the project with Ptucha and guide Ken Mihalyov. Mihalyov is an adjunct engineering faculty member and former chief innovation officer for Xerox Corp.'s public sector services business and its Palo Alto Research Center.

Some projects are sponsored by university faculty to further research goals, including the creation of a tool or capability not currently available, demonstrating that RIT students have the skills to support larger or more wide-ranging grant opportunities, said Mihalyov.

"This second outcome is one of the primary goals that Dr. Ptucha has outlined for the Automated People Mover project. He enables both the challenge and the opportunity for student teams to build on previous work and demonstrate competence in emerging technical fields," he explained. "The addition of computer vision approaches for cart path identification is one example of a technical field being added for this project."

In the past few years, MSD teams began including peers from RIT's business and imaging arts colleges, particularly those from the industrial design program, and their input has made an impact.

"Their design process is similar," said DeBartolo. "The way they address each of the steps may be different, the words they may use to describe those steps may be different, but when it comes right down to it, what they are doing is identifying a problem, coming up with solutions, picking the best one, and then implementing it or building it.

"Once you figure out where the similarities are and where the processes overlap and figure out how to translate the information, it turns out we are all doing the same thing. What I call low fidelity mock-up, they may call initial product testing. We just have a different name for it, but we don't view results that differently."

DeBartolo requires project teams to write "use cases"—details of how customers intend to use the product or process.

"What does that interaction look like, and once they understand the different scenarios, they can understand performance boundaries and start to develop requirements," she said.

This information is required for identifying potential solutions and determining how the final engineered solution will be tested to verify that it meets requirements.

Making Improvements: Data acquired by the autonomous vehicle is continually tested and refined by the team to ensure it 'learns' to recognize campus obstacles.

Making a Difference

Testing is a significant part of the design process, and the MSD program is also a means for established groups like the university's performance racing teams to assess different technology and equipment before it is integrated into vehicles when competition seasons open.

For example, the Baja Off Road team sponsored a project to build a hybrid drive train for the car, and the Formula SAE team explored active aerodynamics.

In addition to new or improved products, some teams have seen products evolve toward possible commercialization. Other teams build new products or systems that are specific to a company, and students are acquiring specific industry skills. Other project ideas include international connections.

"It is work that makes a difference," DeBartolo said. "Look at the field of sanitation in developing nations, for example. Students are doing work that can literally save lives. Projects include everything from developing the prototype to coming up with a manufacturing process that is viable onsite with materials and skills available in the country. That is a very different set of design challenges. The products are not complex, but it takes some creativity to find a feasible solution."

Projects are often done on limited budgets. Some teams seek grant funding, and this past fall three groups received financial support from national organizations such as NASA and ASTM.

Projects are also part of larger faculty grants from the National Science Foundation, National Institutes of Health, and Department of Defense. Student-engineers also participate on projects with other college faculty.

For example, working with faculty in RIT's College of Science, students helped improve imaging technologies for archaeological monitoring and built lift equipment for the high-tech cameras used to take photos of oversized artwork at the Museum of Modern Art in New York City. They are creative projects driven by the need for realistic solutions.

"Some people have a romanticized idea of what an autonomous vehicle is and what it can do," said Robert Relyea, a fifth-year computer engineering student from Doylestown, Pa., and lead engineer on the APM project. "The ideal solution is a seamless system that can drive like a human can drive. But underneath that layer of abstraction, there are all these systems we are working on. We have to collect more data for different scenarios and would need thousands of images to have a fully reliable data set on conditions for image detection and classification."

Relyea and the team resumed work on the APM during spring semester. Drives around campus were more than joy rides, but data-gathering opportunities. Their project is as much about integrating autonomous technologies as it is about exploring complexity and finding alternative ways to solve problems.

On the Web

Multidisciplinary Senior Design
www.rit.edu/kgcoe/seniordesign

Metaproject 08: Industrial design students re-imagined how dinner out could be interpreted as part of the most recent Metaproject. They created a pop-up restaurant within Good Luck in Rochester.

Metaproject Lifts Student Designs to Professional Level

by Stacey Freed

By partnering with industry, RIT's industrial design department's Metaproject teaches students the role of research at every stage of the design process. After eight years, this senior studio has proven itself to be a successful vehicle for fostering innovative thinking and thoughtful product design.

In the Beginning

Metaproject is the brainchild of professor and chair of RIT's industrial design department Josh Owen, who came to RIT in 2010 just as the Vignelli Center for Design Studies was coming into being.

"I wanted to create a bridge between the newly completed Vignelli Center for Design Studies and the industrial design program. I hoped to leverage the assets of the Vignelli Center to help teach fundamental design lessons. With the Metaproject I would create a platform for students to collaborate with design-centric industry partners of the highest caliber," said Owen, who chooses one company each year for his senior design studio to partner with.

After more than 20 years as a professional designer and professor, Owen, who has worked around the world, has been able to connect RIT with such powerful brands as Wilsonart International, a creator of laminate surface materials; the Corning Museum of Glass; Areaware, an avant-garde accessories manufacturer; Herman Miller, the iconic furniture

A: Professor Josh Owen, who started Metaproject, talks with Meghann Ferreri, assistant manager/event coordinator at Good Luck.

B: The salad course was a bouquet of greens and edible flowers packaged in paper.

C: Coasters printed with inspiring phrases were changed between courses.

D: A seafood course—one of four—was served on skewers placed in blocks of wood.

E: Students altered the look of the table before each course by putting a runner down the center.

maker; Kikkerland, which manufactures products for a variety of consumer markets; Poppin, a maker of unique office products; and Umbra, a Toronto-based housewares manufacturer. Most recently, the students worked with Rochester's Good Luck restaurant on a unique experiential—rather than product-based—project.

Students are tasked with real problems to solve. As Owen put it, "What itch can we scratch for you? What territory has your company not been able to allocate resources to address? What is too conceptual, future-driven, or just plain out of reach for your team? We want to know how we can help move you forward."

Students research, design, develop, test, and ultimately build their responses to the issue they're tasked with. Their projects are critiqued by the industry partners then often ranked into winners and honorable mentions.

All this happens within the confines of the fall semester; in the spring the group exhibits at the International Contemporary Furniture Fair (ICFF), held annually in New York City.

In 2016,

Feedback: In the spring, students will exhibit at the International Contemporary Furniture Fair (ICFF), held annually in New York City. They are now working on how to present the program at the event.

Metaproject 03: James Paulius created toy building blocks called Blockitecture when he participated in Metaproject in 2012-2013. The product is now sold all over the world.

Metaproject 06: Afifi Ishak's Sticky Memo Ball, with 12 pentagonal faces, was a desk accessory presented to Poppin in 2016. Twenty-two students were tasked with creating innovative accessories for the company.

RIT's Metaproject 06 was chosen from 14 university participants to win the Editor's Choice Award for its show exhibit. One thing that sets the project apart is its branding—the typeface, color palette, the press-quality photography, the 100-page published book that collects the output—it announces itself to the world as much more than a senior project.

Usually at least one project is chosen each year to be produced by the partner company and put into the marketplace. Blockitecture, toy building blocks, created by James Paulius for Areaware (Metaproject 03), is one of that company's most popular items and is sold all over the world. Paulius has since created several other related products, the most recent being Blockitecture Tower.

Sticky Memo Ball, a 12-sided sticky-note ball created for Poppin (Metaproject 06) designed by Afifi Ishak '17, is one of the The Container Store's top-selling items.

Collaborative Foundation

Veronica Lin '17 was part of Metaproject 06, which asked students to create innovative accessories for Poppin's new line of office furniture.

Lin, who now works as an industrial designer with Pensa in Brooklyn, N.Y., focused on creating a foot rest. "I had to think like a millennial who spent a lot of time in front of a computer and not moving," Lin said. "How could I make that experience better?"

Lin's Foot Pebble, one of four winners that year, is a solid cork curved foot rest that allows users to rock their feet back and forth as they sit. It's both functional and playful. Lin had to research ergonomics as well as product materials and product dimensions but felt confident doing so because, she said, "by the time you're a senior at RIT, it's been ingrained in you how to tackle a project."

She began drawing ideas and making models, which "in this case were more important than sketching. I needed to see people of all heights putting their feet on it and seeing whether it worked."

She said that collaborating with her classmates was integral to her research as well. Even though other students focused on designing different elements, she said, "I learned so much about the office workspace when my classmates and I stayed up late at night suggesting ways to tackle products from different angles."

Ultimately, Lin's product was not chosen to go to market (that year it was Memo Ball) because of the difficulties of using cork, but it was featured in the international design magazine *Azure*. These were lessons in themselves since the products have to be able to stand up to marketplace scrutiny as well as actual use.

That's one of the most important aspects of these kinds of projects within the industrial design program. "Students are

Foot Pebble: Veronica Lin made a foot rest when students were asked to create accessories for Poppin's new line of office furniture as part of Metaproject 06 in 2016.

A

B

C

D

A: Wilsonart Challenge: Kicking off the project in 2010-11, students came up with prototypes celebrating Wilsonart International's laminate surfacing materials. Dan Fritz '11 won first place with this chair made from 280 individual laminate hexagons welded to 280 steel asterisks.

B: Corning Museum of Glass: Students created protoype designs celebrating recycled glass in 2011-12. Casey Schneider's '12 Watering Rocks were put into production.

C: Herman Miller: Students addressed challenges associated with interactions in the workplace in 2013-14. Alex Bennett's '14 Invitation Chair was the winning design.

D: Kikkerland and Bed Bath & Beyond: Students in 2014-15 addressed challenges associated with designing for home and dorm room storage. Hanging Facades, a closet organizer by Brian Keyes '15, went into production.

exposed to real-world parameters but are safely guided through the process," Owen said. "In my view, that's a perfect formula for setting students up for success."

Beyond Production

The industry partners play a crucial role in helping participants through the marketing and business research part of the program.

"When we traveled to Umbra's Toronto headquarters, founder Les Mandelbaum, who took his company from his garage to a powerhouse global brand, stood in front of all of the students of the class and told them his personal story," Owen said. "Our group met with leaders, managers, designers, marketing and communication staff who showed them what works and what fails in the wider conditions of their experience."

Students were able to touch and feel the company's products, take things apart and put them back together, see them in the context of the company itself.

Jeff Miller, Poppin's vice president of product design, said that he was impressed by the "level of inquiry, skill, and technology" that the Metaproject students brought with them.

"I saw quite an amped-up ability in terms of what students could do and bring to the table and in terms of their discussion with us as pros. They were already thinking at a near-professional level about real-world concerns, what we as an industry might be thinking in terms of requirements for our products. The speed they needed to turn these from process into reality with a high degree of technical quality and ability—I couldn't have done that (when I was their age)."

The hands-on, interactive aspects of Metaproject mean students learn about products from "psychological, engineering, and material perspectives (among others)," Owen said. "By the end of that decoding (period with the industry partners), they have opened a massive window into the machine that is industry that they can more than look through—it is big enough for them to jump into, walk around, and explore."

Experiential Design

The most recent challenge, Metaproject 08, was different than all the others. Owen connected with RIT industrial design graduate Chuck Cerankosky '03, co-owner of Good Luck, a high-end restaurant in Rochester named by *Esquire* magazine in 2016 as one of the top 18 bars in America.

When discussing the project, they shied away from kitchenware, said Cerankosky. "Those can be subjects of get-rich-quick schemes or just some gadget you throw in a drawer. I wanted to look at the restaurant as a whole. What inspires me as a designer is not because I get to design a new plate, but it's the whole of things, designing the experience." He views restaurant ownership "as live perpetual industrial design performance art."

Students worked with Good Luck employees to break down the dining experience beginning with customers getting out of their cars, coming through the doors, hanging their coats and having drinks, all the way through dessert and coffee.

Dinner and a Show: In the most recent Metaproject, students worked with Good Luck restaurant employees to break down the dining experience beginning with customers getting out of their cars, coming through the doors, hanging their coats and having drinks, all the way through dessert. While people dined, students used vegetables to make artwork on the back wall. They later removed paper letters to reveal "Designing Dining" in negative space.

Cerankosky describes it as students creating songs for an album. "The songs could be different, but it had to have a theme."

"Designing Dining" ended up as a successful, curated dining experience for 60 people. Students built on Good Luck's "inspired table," a *prix fixe* menu that it does a few times a year, and came up with a celebration of seasonality as a theme. They broke into teams in charge of sound and lighting, furniture, parking, coat checking, and meal planning.

"It was a challenging project but really cool that we could bring industrial design principles into a completely different field," said fourth-year student Fuijae Lee.

Every detail was planned. For example, they determined that coats shouldn't be hidden away. Coat check became part of the décor, with coats hanging on numbered hangers—which they created and fabricated out of laminate—along guide wires.

At one point, a "reverse pickpocket" team slipped cork coasters—that still smelled of burnt wood where they had been laser cut—into guests' coat pockets.

Each course began with a change of table cloth, the last being a heat-sensitive cloth that changed color from the warmth of the cups and plates. Other highlights included a bouquet of salad, specially designed wooden platters that held intricate bamboo skewers during the appetizer segment, and a sauce pen from which diners could add flavoring to their meal. "(The pen) was really transformative," said Cerankosky, who added that the pen and the skewer holder will likely be incorporated into the restaurant's offerings.

Owen said the dinner was not a tough sell, and the 60 tickets were all sold out. RIT Provost Jeremy Haefner, one of the attendees, said it "was a great experience, a big success. The world of design involves not just products but experiences and the way that people engage with each other. This fit the bill nicely."

(At press, Owen was still determining how to present the program at ICFF in May.)

Metaproject 09 has not yet been revealed. It's always a mystery to the students prior to the first day of class, Owen said, "and they want it that way—designers like constraints and challenges."

Much like any design challenge, the unknowns and the failures are part of the process.

But, as Owen said, "These projects almost demand a leap of faith from those outside the design fold. The strongest companies are design savvy. They know the iterative process that we demonstrate—test, fail, repeat until we deliver value and beauty. The companies that don't take the leap of faith to work with designers tend to make a lot of mediocrity. Or they simply follow trends. We lead by example and teach others to do the same."

On the Web

Metaproject
metaproject.rit.edu

Caring About Education: RIT Professor Matt Huenerfauth is investigating new ways to teach accessibility to computing students, including supporting research teams that have both hearing and deaf students working together.

RIT Experts Focus on User-Centered Design to Make Computing Accessible

by Scott Bureau

RIT's student and faculty researchers are working to make technology accessible for all by changing the culture of computing.

In Someone Else's Shoes

A new smartphone or computer program is supposed to improve a person's life and make it easier. But for the more than 1 billion people around the world who have some form of disability, it can sometimes feel more like a barrier.

"Computing accessibility becomes a problem when, for example, apps aren't designed with features for those who are deaf and hard of hearing or if some website can't be used because you are blind," said Matt Huenerfauth, professor in the Department of Information Sciences and Technologies at RIT. "There's a lot of examples out there, but it certainly doesn't have to be that way."

At RIT, student and faculty researchers are working to change the culture of development in an effort to make technology accessible for all.

The group hopes to do this by creating new technologies of their own that incorporate computing accessibility and people with disabilities throughout the design and development process. Experts are also changing the future of accessible computing by evolving education and the way that future developers are taught.

Coming together in RIT's Center for Accessibility and Inclusion Research, or CAIR (pronounced "care"), researchers are working on everything from motion-capture technologies to produce linguistically accurate animations of American Sign Language to new pedagogies for teaching accessibility. Created in 2015 in RIT's B. Thomas Golisano College of Computing and Information Sciences, the center is now home to more than 25 faculty and students looking to make a difference.

"Computers, smartphones, and the internet have become essential for communicating and getting a job, but there are a lot of people potentially being left out," said Vicki Hanson, a distinguished professor of information sciences and technologies at RIT and co-director of CAIR. "This is a great opportunity for RIT/NTID to tap into its diverse and longstanding culture of accessibility."

CAIR: Researchers in RIT's Center for Accessibility and Inclusion Research are working on everything from motion-capture technologies to produce linguistically accurate animations of American Sign Langague to new pedagogies for teaching accessibility.

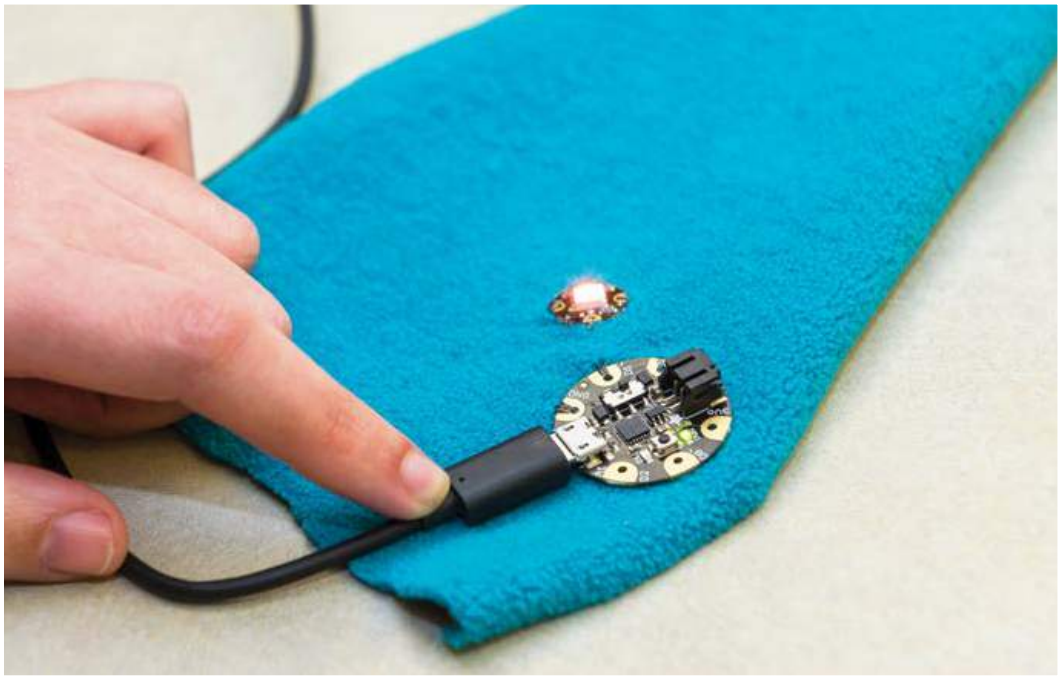
Vicki Hanson

With computing accessibility, the goal is for technology creators to put themselves in other people's shoes and understand the perspective of people they are designing for. This comes naturally in the center, as several of the researchers have disabilities themselves.

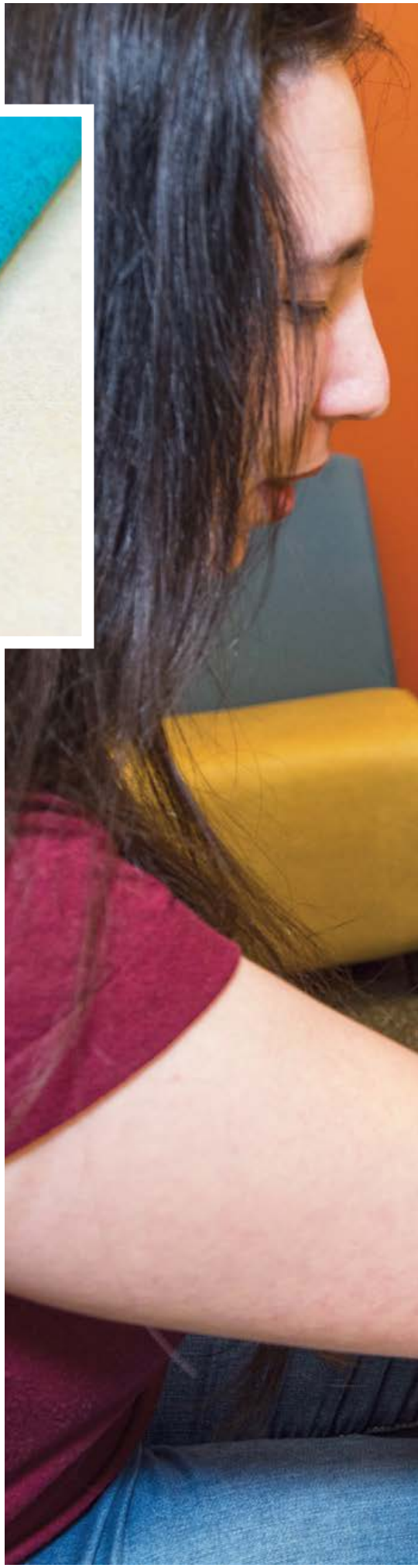
Even the setup of the CAIR lab has accessibility in mind. The room has circular gathering spaces and transparent glass walls that provide line-of-sight for users of ASL and designated wide access paths for wheelchair users. Regardless of ability, it's important that people with disabilities are participating in the design process, so they can contribute their firsthand perspective when creating technology that benefits everyone.

"When you're creating any technology, you should ask 'what do real human users need and want out of this?'" said Huenerfauth, who is also co-director of CAIR. "But your users are not always like yourself and that's really important for designers to realize."

Throughout the creation process, RIT experts are also implementing elements of user-centered design. This process is an



Smart Fabric: Electronic textiles (e-textiles) are fabrics, yarns, and threads that incorporate conductive fibers or elements directly into the textile. RIT researchers hope to conduct a pilot study where people with intellectual disabilities create their own e-textiles.



important part of the undergraduate and graduate human-computer interaction programs at RIT and is based around the idea that the user is the most important source of information.

"The user is at the center of everything we create," Huenerfauth said. Working from the ground up, RIT researchers are hoping to make the computing world a more inclusive and universally accessible space.

How to Teach Accessibility

For Huenerfauth, the introductory computing classes at RIT have become a little laboratory. As part of a nearly $450,000 National Science Foundation grant, he and Hanson are exploring the best practices for training future computing professionals about inclusive technology development.

While many computing professionals want their work to be accessible to all, it's typically not something that is explicitly taught in the classroom. Students may not have the chance to work with someone with a disability, and equal access is not always addressed as part of the ethics curriculum.

To address this gap, the RIT team is investigating the efficacy of multiple educational interventions on accessibility. Focusing on undergraduate human-computer interaction courses, Huenerfauth and other instructors are modifying classes to see what moves the needle and gets students thinking about accessibility.

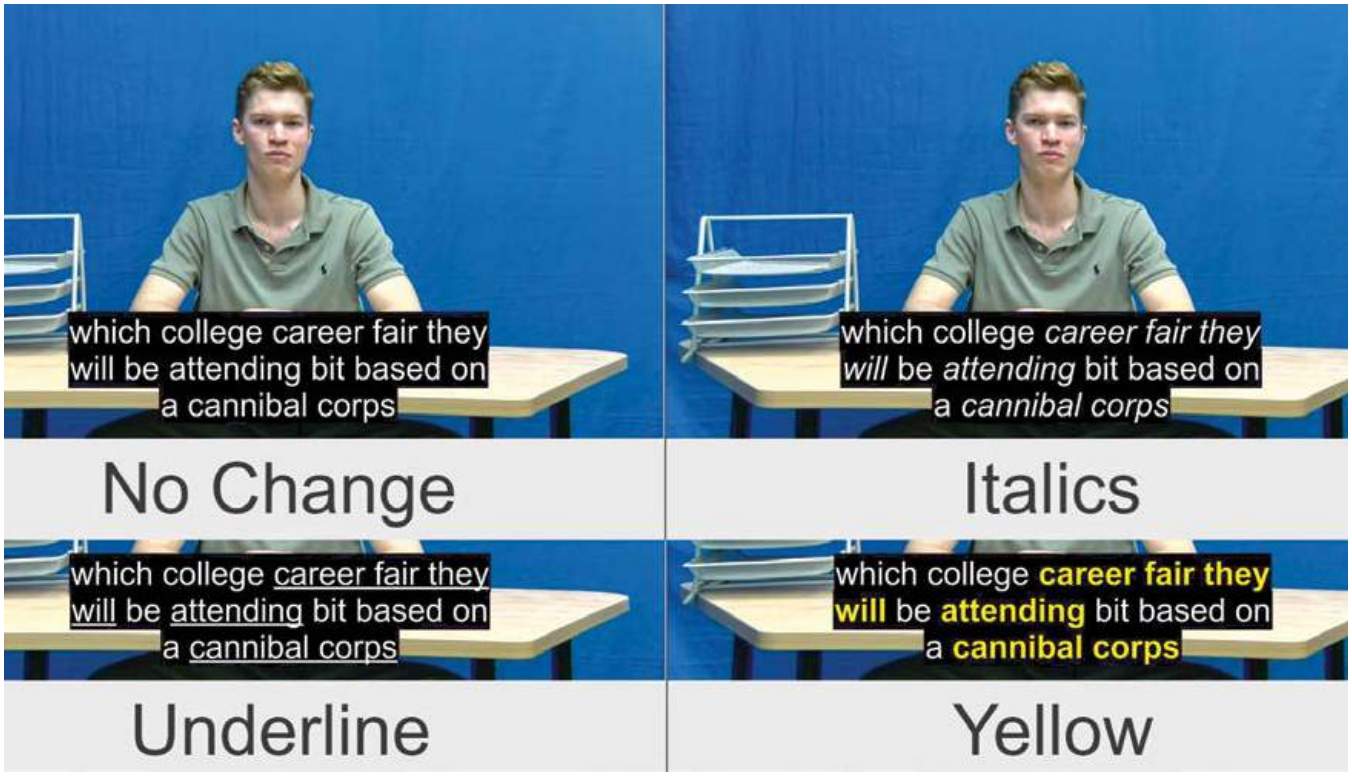
"We might add an activity where students learn how to read braille or a day where students interact with a blind or deaf guest who visits the class," said Huenerfauth. "Throughout this long-term study, we hope to see how effective different pedagogies are at getting students to apply accessibility within their work."

In the future, Huenerfauth and Hanson plan to share their findings and help faculty replicate these interventions at other universities.

For Kristen Shinohara, an assistant professor in RIT's Department of Information Sciences and Technologies who is also researching accessibility pedagogy, the key is to think about accessibility from the beginning—and not simply as a means of compliance.

Since 1998, the section 508 amendment

E-Textiles: RIT student Taylor Gotfrid, left, and Assistant Professor Kristen Shinohara are researching how adults with autism might use e-textiles, including an Arduino Gemma microcontroller and a NeoPixel LED that are sewn onto fabric with conductive thread.



Displaying Confidence: The captioning is supposed to say, "which college career fairs they will be attending based on the candidate requirements." But automatic speech recognition software sometimes gets it wrong. RIT researchers are investigating how different visual cues, such as italics, underlining, and color, can help users determine which parts of the caption may not be accurate.

to the Rehabilitation Act of 1973 has required federal agencies to make their electronic and information technology accessible to people with disabilities. In recent years, many other organizations, including Google and Microsoft, have also made commitments to include accessibility in their products.

"Right now, many designers are conditioned to think of accessibility as an afterthought or add-on," said Shinohara. "We need them to believe in these ideas and incorporate them from the beginning of the design process."

To help change the thought process, Shinohara is developing a set of method cards used to get designers thinking about accessibility. For example, a card might prompt the designer to think about situations where a visually impaired person might use a screen reader. Will they want to use a speech synthesizer in public or might they prefer using a braille display?

"Oftentimes, it's important to think about the social setting and functionality of accessibility features," said Shinohara. "I hope to make it easier for designers to incorporate accessibility compliance, so they don't think of it as a burden and so they can see the benefits."

Perceiving the World Differently

Taylor Gotfrid, a human-computer interaction graduate student at RIT, embraces the importance of accessibility research and is working to better understand the ways that people with cognitive disabilities interact with smart technology.

"Technology has the potential to improve so many people's lives in different ways," said Gotfrid, who is from Santa Rosa, Calif. "It would be unkind not to think about people with disabilities."

Gotfrid and Shinohara are researching how adults with autism interact with e-textiles—fabrics and clothing that have digital components, including batteries, lights, sensors, and other electronics embedded in them. Through the project, they hope to create a framework that can be used by developers creating products that may be used by those on the autism spectrum.

"You might think that everyone knows how to use a toy car a certain way, but researchers have observed that people with autism might flip the car over and just play with the wheels," said Shinohara. "Similarly, adults with autism might perceive and interact with e-textiles in different ways than we expect."

Collaborating with Annuska Zolyomi, an information sciences Ph.D. student at the University of Washington, the team plans to conduct an exploratory workshop. By observing how adults with autism play with different buttons, lights, and e-textile objects, Gotfrid hopes to see what participants like and what they get frustrated with. She also wants to know how different materials affect the way an item is used.

Zolyomi plans to use e-textiles in a weighted blanket that helps people with autism relieve stress. Touch-activated lights embedded in the blanket can be used in conjunction with breathing exercises that help reduce anxiety.

Accessibility Pedagogy: Kristen Shinohara, an assistant professor, said the key is to think about accessibility from the beginning of the process.

In the Lab: The setup of the CAIR lab keeps accessibility in mind. The room has circular gathering spaces and transparent glass walls that provide line-of-sight for users of American Sign Language and designated wide access paths for wheelchair users.

"We want to learn how a person would intuitively know to press a certain spot of the e-textile to make the lights turn on," said Gotfrid. "People perceive the world differently, so we need to include them in the process to make sure these technologies are actually useful for them."

Participatory Design

Many ideas for accessibility projects stem from real-life problems that students and faculty encounter on a daily basis.

"As someone who is deaf, I personally understand the need for communication and oftentimes feel frustrated by the lack of access," said Larwan Berke, a computing and information sciences Ph.D. student from Fremont, Calif., who is working in CAIR. "It is my goal to help deaf people have greater accessibility in various places."

Berke is part of an interdisciplinary team researching how automatic speech recognition (ASR) captioning technologies can be used by deaf people in one-on-one meetings with hearing individuals. Collaborating on the project are students in CAIR and at NTID; Huenerfauth; and NTID researchers Michael Stinson, Lisa Elliot, James Mallory, and Donna Easton.

Throughout the evolving project, the group has developed an app that integrates ASR into instant messaging on a smartphone or computer. This technology allows for two-way conversations, where deaf and hard-of-hearing people can type out and read responses, while hearing colleagues speak into the device.

However, ASR technology is known to be imperfect and deaf users often have to cope with errors in the captioning. Berke is investigating ways to alter the display style of the captioning, based on how confident the ASR technology is in its output.

Adding onto the work, Huenerfauth and Sushant Kafle, a computing and information sciences Ph.D. student in CAIR, are inventing a new metric for automatically evaluating the accuracy of ASR. The technology allows a user to know when they can't fully trust certain words in the captions.

"We conducted experiments to determine whether our metric matched the judgments of deaf and hard-of-hearing users, as to which automatically produced captions were understandable," said Kafle, who is from Nepal. "In the future, we will continue to investigate variations on this metric and evaluate them in experiments with deaf and hard-of-hearing users."

For RIT accessibility researchers, the key to this and any project is including real users and those with disabilities throughout the entire design process.

"It's easy to be wrong when you're just imagining what another group of people needs out of a piece of technology," said Huenerfauth. "Ideally, development teams of the future are going to continue being more diverse and more inclusive."

On the Web

Center for Accessibility and Inclusion Research
cair.rit.edu

Presentation: Team Jet-2k presents its prototype to Mondelēz International representatives. From left are RIT students Katherine Larson, Jo Qiao, Katie Buschmann, Erika Bushey, and Tayler Clow.

Creating Better Packaging Design Through Collaboration

by Felicia Swartzenberg

Professors from packaging science, graphic design, and industrial design worked together to provide students with a unique opportunity for collaborative design.

Real-World Project

Karen Proctor, professor of packaging science, wanted to give her students a taste of the packaging design industry before they graduated. She realized that if she provided collaboration that mimicked the real world, her students' designs could potentially be improved.

"I found our packaging students, of course, did the structural design stuff fine, but the graphics and the industrial design aspects of packaging design is not in their skill set. They were structural people, and when they did their prototypes they weren't complete," said Proctor.

She reached out first to graphic design and then industrial design.

Through these three collaborative courses, Packaging Development, Packaging Design, and Senior Studio One, students are able to draw from the strengths of their peers in other majors and learn more about how the design process in the packaging industry works by creating designs for a sponsoring company.

Dave Geier, the operations manager for the engineered laminations and coatings division at American Packaging, has worked with Proctor as a sponsor for the courses in the past and believes this collaboration is a great way to introduce the industry environment to students before they graduate.

"Each of those three functions has a totally different perspective on packaging design, and that's the real world," said Geier. "You have to meet all those characteristics. You can't just think about how it looks or what's the most optimum design for shipping, you have to bring all those perspectives together."

Different Disciplines

American Packaging is just one of the many companies that have sponsored the design challenge for these classes. In the past, the classes have worked on design projects for Wegmans, Seventh Generation, Colgate-Palmolive, Unilever, ABVI, and others to design packages for products like laundry detergent, dish soap, juice, yogurt, and pasta.

This year, the students are working for Mondelēz International, Proctor said. Five teams work on three projects for the semester, and each team creates its own prototype for each project.

Sustainable Packaging: In previous years, design teams have collaborated with Wegmans to create more sustainable and unique packaging for Wegmans-brand orange juice and other products.

New Design: When students create their prototypes, they must find ways to make their designs better than the current product packaging. This student design makes it easier for Wegmans to ship and store the yogurt containers.

Jo Qiao, a fifth-year packaging science major, worked with a team to design packaging for the confectionery, food, and beverage company last fall. Being the only packaging science major in the group made her nervous at first, but after they started brainstorming ideas, her worries were put to rest.

"I think everyone on our team was passionate about packaging design and development, even though we're all from different disciplines. It was so great and easy to work with everyone," Qiao said. "We just wanted to do the best work we could and to continue to learn the best methods of sustainable design."

Erika Bushey, a fourth-year graphic design student and Qiao's teammate, said that the different points of view offered by her teammates from other majors made their designs more unique and refined.

"Usually in group projects everyone is an expert in the same field, so to have minds from different backgrounds think together to design something is really cool. You can bounce ideas off each other and you all have your own section that you can be the best at. You fill in each other's gaps," said Bushey.

The team enjoyed working together and learning about the different design techniques each major offered.

Tayler Clow, a fifth-year industrial design student on the team, said the most difficult part of the project was deciding on one final idea.

"We had an inch-high sticky note stack of original concepts for this project, so getting everyone on the same page with what aspects of the design worked with each aspect of the project, packaging, industrial design, and graphic design, was hard," said Clow. "But at the end, seeing something that you worked so hard on right there in front of you is so cool. I sent pictures to my mom to brag."

Real-World Challenges

Amy Gosselin, director for global gum and candy packaging at Mondelēz, was impressed by the work that came out of the classes and emphasized the importance of collaborating with students.

"The projects we had students work on in this term are challenges we are actually having in Mondelēz, and bringing those challenges to this audience gives us the opportunity to really extract the creativity that students have and bring value to the company in a different way," said Gosselin.

Lou Fenech, associate principal engineer for gum and candy packaging, felt that this experience was "almost like getting five mini-design agencies to work on a project."

"We think all of the teams did an excellent job," said Fenech. "We plan on bringing the students' designs all to our consumer research focus groups."

Proctor and her colleagues believe that the biggest thing that contributes to the success of these projects is the inter-major collaboration.

"Every team is composed of every discipline. The project requires some talent from every discipline to pull off the final projects that you see," said Proctor. "We parrot the industry in our evaluation rubric, and this is what the industry would consider a critical aspect of the design process."

On the Web

Department of Packaging Science
www.rit.edu/cast/packaging

Remanufacturing Leader: Nabil Nasr, associate provost and director of RIT's Golisano Institute for Sustainability, began exploring remanufacturing in the late 1980s.

What's Old is New Again Through Remanufacturing

by Kathy Lindsley

Remanufacturing involves rigorous research to make a product useful again.

Growing Field

It's safe to say that nothing lasts forever. Fortunately, the useful life of many products can be extended through remanufacturing, which saves energy, reduces waste and pollution, conserves natural resources, creates jobs, and saves money.

"Reman is the rebirth of a product," said Nabil Nasr, associate provost, director of RIT's Golisano Institute for Sustainability (GIS) and founder of the Center for Remanufacturing and Resource Recovery (C3R), a research unit of GIS. Nasr, an expert on the subject, began exploring remanufacturing in the late 1980s, about the time he joined the faculty of RIT's Kate Gleason College of Engineering.

Since then, the field has grown significantly. U.S. production of remanufactured goods is more than $43 billion, supporting 180,000 full-time jobs, according to a 2012 report of the U.S. International Trade Commission.

"We see significant demand," said Nasr. "The industrial community knows that in order to be competitive, to be productive, they must be doing these things."

Established in 1991 as a partnership between industry, academia, and the government, C3R works on a wide variety of projects with government agencies and diverse businesses of all sizes.

Remanufacturing involves a rigorous engineering process designed to return a worn or nonfunctional product to a "like-new" or "better-than-new" condition. Remanufacturing is *not* the same as recycling or repairing.

The steps in the process include:

Condition Assessment

"The work of remanufacturing begins with discovery, diving through systems, materials, sources," Nasr said. "Our work starts with rigorous research, building our capabilities to work on solving challenging problems."

A team of engineers begins a project by conducting an extensive analysis using a variety of "non-destructive inspection" (NDI) methods including ultrasonic imaging, computer-controlled scanning, or even a laser-vision technique designed by C3R for inspection of submerged welds in large steel tubes.

C3R has also designed sensors and software systems that monitor equipment

while it is in use to predict and prevent breakdowns. In partnership with the U.S. Marine Corps and the Office of Naval Research, C3R created a vehicle health management system that was deployed, in partnership with Lockheed Martin, on military vehicles and subsequently made its way to the commercial sector.

Cost Evaluation

If the cost of remanufacturing exceeds 60 percent of the cost of new components, it generally is not considered worthwhile.

Cleaning

"The most expensive, most labor-intensive aspect of remanufacturing is containment removal through surface cleaning processes," explained Michael Haselkorn, senior staff engineer and research faculty, GIS.

Conventional cleaning can generate wastewater and significant quantities of environmentally unfriendly materials. "We spend a lot of time on this. How do you do it better, cheaper, safer?"

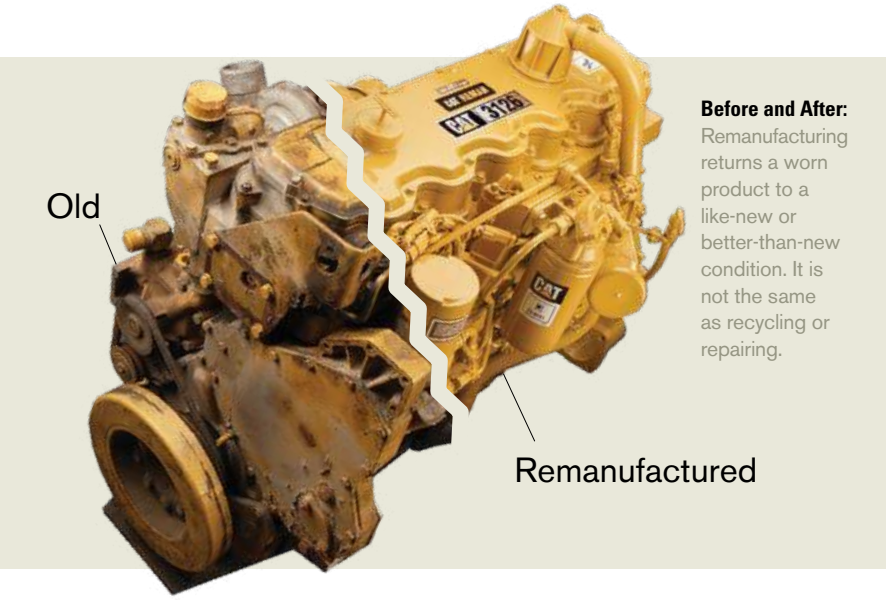
Restoration

C3R engineers design practical solutions for each project using, if possible, equipment and materials readily available to the sponsors. A variety of processes can be explored, including additive manufacturing techniques such as 3D printing, application of coatings using various methods, and laser engineered net shaping (LENS).

In a project with the U.S. Marine Corps, C3R researchers helped solve a problem with drive shafts on Light Armored Vehicles (LAVs), which were failing when a coating separated, causing about 80 percent of these expensive components to be scrapped. C3R designed a process to remove the original coating and apply and machine a new coating using thermal spray techniques. This cost less than 22 percent of the cost of new shafts. The engineers also resolved the original design flaw.

With access to more than $70 million in state-of-the-art equipment, testbeds, and laboratory facilities throughout GIS, as well as a diverse staff of more than 100, C3R is one of the premier remanufacturing research facilities in the world.

"When somebody comes to us with a problem," said Haselkorn, "we've got a whole toolkit we can use."



Before and After: Remanufacturing returns a worn product to a like-new or better-than-new condition. It is not the same as recycling or repairing.

Photo by Caterpillar

Test and Recertify

Before a remanufactured product or component can go back into service, it must be thoroughly tested and determined to be "good as new" using simulations designed to demonstrate long-term performance.

Training

The final step in each project is transferring the process to the client's personnel. In addition, an important part of the center's mission is providing hands-on technical training to industry through workshops and seminars.

Advancing the Industry

Beyond working with dozens of clients on individual projects, C3R, GIS, and Nasr are committed to promoting remanufacturing worldwide. Among RIT's partners in this effort is Caterpillar Inc., which remanufactures more than 85 million tons of material annually.

"The global reach of Caterpillar coupled with our mature remanufacturing business allows us to speak with authority on issues that impact our business," said John Disharoon, director of market access. "Dr. Nasr's wealth of information and his Rolodex of international contacts is a powerful complement to help us further open reman markets around the world. Our relationship has evolved (over two decades) from casual conversations about industry roadblocks to the establishment of the Caterpillar Professorship in Remanufacturing and a true partnering in growing our industry."

To that end, several key projects are underway at GIS. Following more than two years of research, the *Technology Roadmap for Remanufacturing in the Circular Economy* was published in 2017 by GIS with support from Energetics Inc. and the U.S. National Institutes for Standards and Technology Advanced Manufacturing Technology Consortia.

Noting that "remanufacturing is a fundamental component of the CE (circular economy)," the 60-page report aims "at identifying opportunities to enhance the industry competitiveness and advancement and addressing the significant technical challenges facing the remanufacturing industry."

The roadmap was unveiled at the World Remanufacturing Conference, which brought 150 industry leaders from around the world to Rochester last June.

Also in 2017, GIS was selected by the U.S. Department of Energy to lead its new Reducing Embodied-Energy and Decreasing Emissions (REMADE) Institute—a national coalition of universities and companies focused on clean energy.

This high-profile initiative represents a direct outcome of the work begun at C3R three decades ago. "We think we're going to change the world," said Nasr.

On the Web

Remanufacturing
www.rit.edu/gis/remanufacturing

Research Awards and Honors

RIT values the research contributions of its faculty, staff, and students. Below are some members of the RIT community who have received recent international, national, and university recognition.

James Winebrake

James Winebrake, dean of RIT's College of Liberal Arts and an expert on the environmental impact of transportation, is among a team of experts who are applauding the shipping industry's decision to burn cleaner oil beginning in 2020.

Their study, published in *Nature Communications*, finds that cleaner shipping fuels will result in a 3.6 percent reduction of childhood asthma globally. But cleaner air will also mean fewer clouds will form, and the Earth's climate may experience a temperature increase as a consequence.

The regulation for ships to use fuel containing about 85 percent less sulfur, by the International Maritime Organization, is the most significant improvement in global fuel standards for the shipping industry in 100 years and is intended to achieve significant health benefits on a global scale.

Winebrake worked with an international team of researchers on this study. They evaluated the impacts of sulfur emitted by ships using current marine fuels, which produce air pollution particles that are small enough to be breathed into the lungs and are considered harmful to human health.

Sukanya Chakrabarti

The outskirts of spiral galaxies like our own could be crowded with colliding black holes of massive proportions and a prime location for scientists hunting the sources of gravitational waves, said researchers at RIT in a paper in *Astrophysical Journal Letters*.

The RIT study identifies an overlooked region that may prove to be rife with orbiting black holes and the origin of gravitational-wave chirps heard by observatories in the United States and Italy. Identifying the host galaxies of merging massive black holes could help explain how orbiting pairs of black holes form.

Conditions favorable for black-hole mergers exist in the outer gas disks of big spiral galaxies, according to **Sukanya Chakrabarti**, assistant professor of physics at RIT and lead author of "The Contribution of Outer HI Disks to the Merging Binary Black Hole Populations."

Until now, small satellite or dwarf galaxies were thought to have the most suitable environment for hosting black-hole populations: a sparse population of stars, unpolluted with heavy metals like iron, gold, and platinum—elements spewed in supernovae explosions—and inefficient winds that leave massive stars intact.

Chakrabarti realized the edges of galaxies like the Milky Way have similar environments to dwarf galaxies but with a major advantage—big galaxies are easier to find.

Rebecca Scales

An associate professor of history at RIT has received a fellowship from the National Endowment for the Humanities to support 12 months of full-time study about the effects of polio in France, from 1920 to 1980.

"After Jonas Salk developed his injectable polio vaccine in the mid-1950s, most Western countries chose to use it to combat epidemics," said **Rebecca Scales**, who plans to write a book about her research. "But in France, the government insisted on using a French vaccine developed by the Pasteur Institute, which was manufactured and distributed in relatively small quantities in the late 1950s and early 1960s. One of the questions that interests me is why French researchers, physicians, and politicians made this choice, and what in turn their decision can tell us about cultural perceptions of epidemic disease, public health, and disability in France."

Scales plans to dig through at least 18 public and private archives in France, including repositories in Paris, Lyon, and Rennes. She'll examine hospital records, scientists' papers, television and radio broadcasts, material objects, and the archives of several disability associations.

"I also hope to interview polio survivors and their families to better understand their everyday experiences of discrimination and integration in French society."

Scott Franklin

Scott Franklin, director, RIT's Center for Advancing STEM Teaching Learning & Evaluation, gave a talk on "Emergent methods of science education research: quantitative and qualitative studies" at University of Rwanda's College of Education in Rukara.

He presented to the first class of Ph.D. students in the World Bank African Center of Excellence for Innovative Teaching and Learning Mathematics and Science, of which RIT is a primary international partner. Franklin's trip, Jan. 13-23, was funded by Jim Myers, RIT associate provost of International Education and Global Programs, and the Paul and Francena Miller Chair in International Education.

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Using sensors, big data, and predictive analytics, cities can proactively manage natural resources, energy consumption, and waste management. Faculty and students at RIT Dubai are collaborating on the Dubai Smart City Accelerator, which encourages startups to develop solutions to today's pressing urban challenges. This is creative urban design for cities of the future.

Dr. Yousef Al Assaf is the president of RIT Dubai. The university offers a master of city science degree, and will add additional programs that will explore the technological, social, and sustainability issues key to smart city development.

The power to effect change lies in our ability to use technology, the arts, and design to create solutions that shape the future and impact the world.

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The university is internationally recognized and ranked for academic leadership in business, computing, engineering, imaging science, liberal arts, sustainability, and fine and applied arts. RIT also offers unparalleled support services for deaf and hard-of-hearing students. The cooperative education program is one of the oldest and largest in the nation. Global partnerships include campuses in China, Croatia, Dubai, and Kosovo. Visit us at www.rit.edu.

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