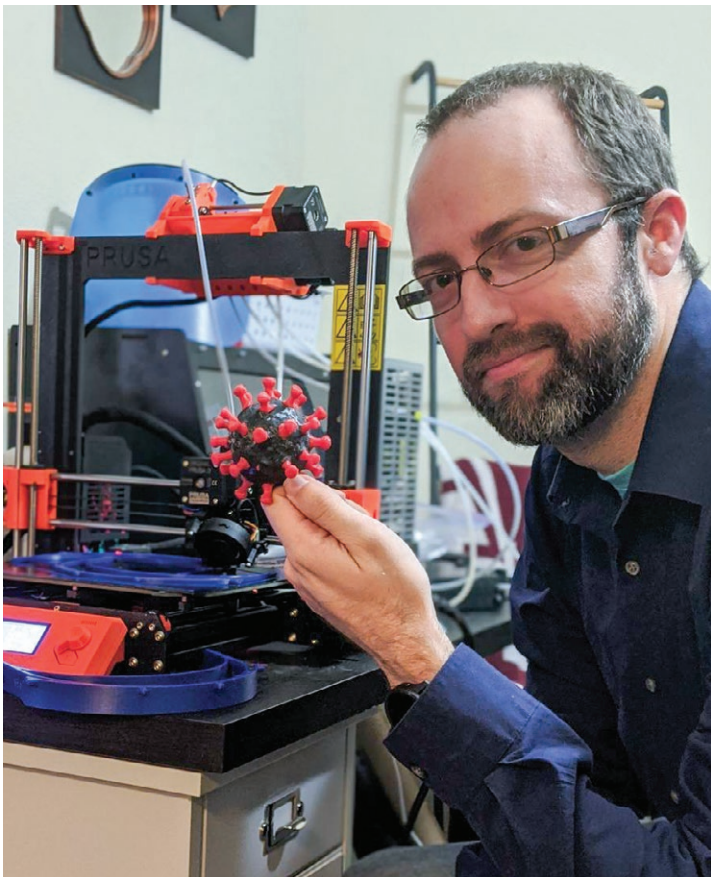


A Vision for Engineering Grounded in the Liberal Arts

by Cynthia Mwenja, PhD

Eric Bubar, Associate Professor of Engineering at Marymount University, has a background of research in astronomical stellar spectroscopy, an area of applied physics that relies on a great deal of computer programming and data analysis. A student request to complete a 3D printing project under his guidance, however, has led him to draw on the array of skills he developed in applied physics to guide the establishment of an entirely new engineering program at Marymount.

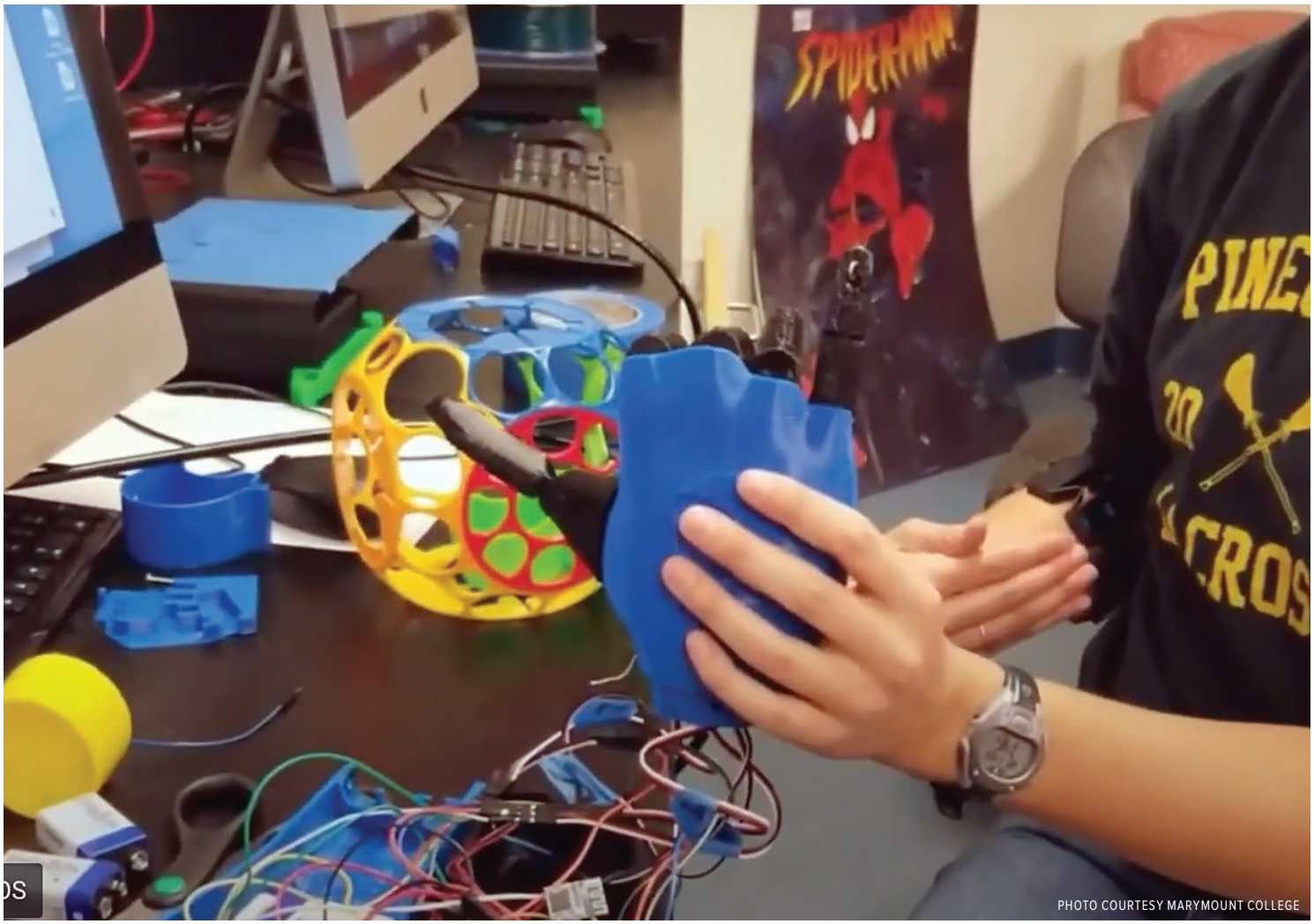
The First 3D Printing Project at Marymount

A few years after Bubar was hired to teach physics at Marymount, a student wanted to do a 3D printing project—she had heard about a group called e-NABLE that was making and donating prosthetic upper limbs to people around the world. Of all of the faculty members on campus, Bubar's research focus aligned the most closely with this project, so he agreed to work with the student. Marymount underwrote the cost of one 3D printer and supplies, and they set up the printer in the computer lab Bubar used for astronomy research. In the term following that first project, twenty more students expressed interest in creating similar designs. That keen student interest "was a clue that we should go deeper" into this work, Bubar observes drily. He was able to secure an internal grant for five more printers and to teach other faculty members how to work with the equipment. Professors across campus have been interested in using the 3D printers within their disciplines, including fashion design, education, business, interior design, and art.

Beginning with the first 3D printing project on campus, Bubar has continued to work with e-NABLE. The organization works systematically to improve its designs, and Marymount students who improve on existing designs—or create their own—can decide if they would like to make their work available as open source resources. Open source computer software is available for users to freely use, modify, and share. Astronomy research, Bubar says, relies on computer programming that is fairly open, but the world of 3D printing is "ridiculously" open source. Not only are the plans for 3D-printable objects open source, but the plans for the 3D printers themselves are freely available, as well.

Having created some prosthetics, students wanted to add bionics to the mix. Prosthetics, Bubar explains, are body-powered through the use of cables, while bionic designs are electronic and use sensors on the arm to detect muscle activity. The prosthetics can be attached with a suction system or by using Velcro for a lower tech option; people who are creating these devices are experimenting with other options for their attachment and control. Interest in 3D printing has become even more interdisciplinary and widespread at Marymount, with around twenty printers currently scattered in schools across the campus; eight of these are housed in Bubar's lab, including a few resin printers.

Todd Rimkus, Director of Marymount's School of Science, Mathematics, and Engineering, ties that student interest in these 3D printing projects to Marymount's last Quality Enhancement Plan (QEP), which was to "empower students for service." He says that faculty members seek opportunities to use their own areas of research to involve students in community service. That first 3D printing project provided a prosthetic hand to a young girl at Christmas, and this combination of truly meaningful service with innovative, hands-on research has students from many majors flocking to the opportunity, Rimkus says. Currently, Bubar reports, between forty and fifty students want to engage in 3D printing projects each semester. Rimkus says that these students' 3D printing service projects inspire him to continually re-examine how he might expand opportunities for community service within his own research with students.



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Face Shields

In response to the pandemic, Bubar developed another community service project. A week after Covid lockdowns began, someone contacted Bubar about potentially 3D printing face shields for healthcare workers. This person had a sister working in the hospital that was, at that moment, at the epicenter of the crisis in New York City, where workers had little access to any personal protective equipment. Bubar enlisted help on campus and in the Arlington public schools; as a result of his organizing, a group of thirty local people spent several months continuously 3D printed face shields and ear savers for healthcare workers. Bubar also worked with a biomedical group at the University of Buffalo and e-NABLE to experiment with 3D printing face masks; they had trouble sourcing the raw materials for mask filtration due to supply chain issues, but that research is ongoing, Bubar says.

From 3D Printing to an Engineering Program

Everyone involved traces a direct line from the original 3D project to the development of Marymount's engineering program. The interest in 3D printing on campus was already well-developed when Hesham El-Rewini became the new Provost and Senior Vice President for Academic Affairs in 2019. A computer engineer by training, El-Rewini had the goal of establishing a school of engineering at Marymount; he knew from his own experiences that the engineering disciplines provide unique contributions to society through their approaches to not only seeking solutions to current problems but also preventing problems before they occur. Further, El-Rewini knew that engineering programs will always be in demand, so this direction would be a sound avenue of growth for Marymount. El-Rewini's first step in this

Having created some prosthetics, students wanted to add bionics to the mix. Prosthetics are body-powered through the use of cables, while bionic designs are electronic and use sensors on the arm to detect muscle activity.

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direction was to establish a dual degree program with the University of North Dakota, where he had been dean and professor in the College of Engineering and Mines from 2008 to 2019. Under this agreement, students can attend classes in person at Marymount and online at UND to earn a degree in mechanical engineering from UND, along with a degree in liberal studies or mathematics from Marymount.

El-Rewini became aware of Bubar's work with 3D printing and approached him with a question: "If we were to do engineering at Marymount, how would we do it, and what niche could we fill that is currently unfilled?" The Provost's office had already done a preliminary analysis of engineering programs in the area around Marymount. As Bubar built on this research to answer the question that the Provost had posed, he realized that there was a gap in local engineering programs—no other programs offered engineering related to issues of rehabilitation, such as prosthetics, orthotics, exo-skeletons, and the like. Marymount already has strong nursing and rehabilitation programs established; both Bubar and El-Rewini saw that an engineering school with a focus on biomedical engineering would compliment those existing programs beautifully.

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Center for Optimal Aging

Marymount's Center for Optimal Aging also extends Marymount's strengths in innovative directions. Bubar is involved with this initiative, which focuses in part on identifying and developing technologies that can help people age better. One example he gives is that of a self-balancing spoon for people whose hands may tremble. Bubar's main focus in this area, however, is using virtual reality for exercise—basically gamifying movement to produce anti-aging effects. Bubar say that playing games for exercise is helpful in getting people to move more, and interacting with virtual reality environments can be instrumental in helping people recover from health setbacks such as strokes more quickly. Many commercial virtual reality products have limitations on their general usability for anti-aging applications—they require participants to be seated, which is not ideal for full-body movement, and they can be very expensive. By contrast, the new Meta headset—the Oculus Quest—is only $300 and doesn't need a computer or wires, so it opens new opportunities for anti-aging and rehabilitation. What's more, Bubar says, is that within six months, the user's hands will be the controllers, so only the headset will be needed.

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Marymount's New Engineering Curriculum

As Bubar weighed directions for the new engineering program, he looked specifically at commonalities between programs at other schools of engineering, along with determining the standards set by the accrediting body. Beyond those parameters, he considered ways in which Marymount might like to customize its program to fit the biomechanical engineering niche. Bubar has identified open-source wearables—think Apple watches or pedometers—as a prime area for the new program to focus on. All of these wearables, Bubar says, work on basic principles of physics and can be built with off-the-shelf components. Such projects can provide hands-on, active learning for students in the program. Students will also be able to explore bio-3D printing, in which structures are printed from a gelatin-like material which can provide the support for living cells to grow.

Bubar joins the new program as a professor of engineering; El-Rewini says that Bubar is, "at heart, an engineer." In addition to the focus on biomedical engineering, the curriculum includes mechanical engineering, which is the basis of most engineering programs, according to Bubar. The program will begin this fall with two new faculty members: Mechanical Engineer Shama Iyer focuses on cell, tissue, and muscle regeneration, and Farzad Ahmadi works with fluid flow, de-icing solutions, and water de-salinization.

All first year students in the engineering program will take a yearlong foundational course in which they will "build stuff that real people will use," says Bubar; as El-Rewini puts it, they want to establish an engineering program that "works with real people on real problems." This project-based curriculum spanning the entire first year will be unique to Marymount. In particular, students will work with Marymount's physical therapy program to learn how to build prosthetic arms, as many students have already done in the 3D printing labs. Bubar wants to prioritize this model of collaboration and discussion, noting that such an approach generates many additional ideas for projects to explore. Drawing on the strengths of the liberal arts model, the program will feature small class sizes and substantial amounts of personal attention from the professors.

Additionally, building on Marymount's firm commitment to undergraduate research, all of the research projects in the program will be led by undergraduate student researchers. Rimkus points out that Marymount students have an advantage over those at other institutions because they do not have to compete with graduate students for meaningful research opportunities. Students in the engineering program and in the 3D printing labs have opportunities to solve real problems through designing and field testing their work. For a project of this magnitude, El-Rewini says, "you need a champion, and I couldn't have asked for a better champion" than Bubar.

Diversity in Engineering

Bubar says that one of the new program's big goals is to increase diversity, to "welcome everyone to engineering." Rimkus agrees, saying that not only are women and people who are members of minority groups under-represented in the field of engineering, they also represent an incredible and largely untapped opportunity for the school to grow. Marymount, he says, has an established culture of welcome for people of all backgrounds, and their Diversity, Equity, and Inclusion Office builds on those foundations of acceptance in more systematic ways. El-Rewini points out that women are in the majority on campus, and Marymount is already designated a Hispanic-serving institution, meaning that at least 25% of the student body is Hispanic. As El-Rewini points out, solutions are stronger when they are generated by groups including people from diverse backgrounds, so the school's existing diverse populations and DEI focus will support the strong growth of the engineering program.

According to El-Rewini, all graduates of Marymount's engineering programs will have developed strengths in four major areas, grounding their technical competencies, business acumen, and leadership skills in the liberal arts. As the founding Marymount engineer, Bubar represents a shining example of how these elements intersect.

ABOUT THE AUTHOR: Dr. Cynthia Mwenja teaches Composition and Rhetoric at the University of Montevallo.

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