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Collaboration at the Microscale
Whitworth University's Pioneering Research in Microdevices

BY CYNTHIA MWENJA, PhD

Dr. Philip Measor, associate professor of Engineering and Physics at Whitworth University, started and runs the campus Microdevices Lab, where he collaborates with campus colleagues and undergraduate researchers to develop and produce 3D-printed microdevices with a variety of applications.

Their interdisciplinary work, which spans biology, engineering, and computing, aims to revolutionize fields such as point-of-care diagnostics and cancer research, offering innovative solutions with significant real-world impact. The collaborative efforts of Measor's team are making strides toward revolutionizing fields that were previously limited by expensive, inaccessible technologies.

The Microdevices Lab at Whitworth University

Measor founded the Microdevices Lab in 2018 when he joined Whitworth University. His goal was to push the boundaries of research by developing and fabricating microdevices using alternative technologies. These devices work on the microscale—measuring from 1 to 500 micrometers (μm), a size range roughly comparable to spider silk, which measures between 1-5 μm, or a typical grain of sand, which measures about 500 μm. The potential applications of these devices are vast, ranging from acting as miniature fiber-optic cables to enabling significant advancements in diagnostics and cancer research.

Until 2017, the smallest unit of 3D printing was typically around 100 μm. However, just as Measor joined Whitworth, he discovered that it was possible to 3D print devices at smaller scales using a unique light source technology. This digital light processing (DLP) 3D printing technology projects a UV light onto a micro-structured mirror, which in turn cures each layer of a device simultaneously using liquid photopolymer resin. This breakthrough allowed the lab to start building devices that were much smaller and more precise than previously possible.

Taylor Burchard—PhD student in Biophysics at the University of California, Riverside—was one of the first students to begin working in Dr. Measor's Microdevices Lab. As a Biology major, she appreciated the way their research merged biology and engineering. Working toward their goal of working with microdevices that would later be 3D-printed in their lab, the group first designed and custom built the 3D printer they needed.

Once Measor and his team built the lab's custom 3D printer, he and his students began characterizing the optical properties of the resins available for this type of 3D design. They published their results, then used their findings to develop a custom resin for the devices they wanted to build. As Helio Ramollari, who was also one of the first students working in Measor's lab, says, 3D-printed technology simplifies the fabrication process; it does not need highly trained staff or state-of-the-art facilities, but it can produce devices that function as effectively as ones requiring expensive infrastructure. Ramollari—currently a PhD student in Electrical Engineering at the University of California, Santa Cruz—notes that 3D-printed microdevices can be revolutionary because they can make point-of-care diagnostics inexpensive and accessible. Such devices could have changed the course of the COVID-19 pandemic, so their development can have real-world impact.

Sorting Worms

One of the lab's most exciting features is the highly interdisciplinary approach that Dr. Measor fosters. His team combines biology, engineering, and computing to allow for

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creative solutions that bridge multiple fields. Dr. Aaron Putzke, professor of Biology and interim associate dean of the College of Arts and Sciences at Whitworth, remembers his excitement when he heard Dr. Measor discuss 3D printing microdevices. As a developmental biologist, he saw the opportunity to build a microfluidics device which could sort C. elegans, a microscopic roundworm that is about 1 mm in length and 50 µm in diameter. This worm is often used in biology research because it has a great deal of DNA in common with human beings. Researchers working with C. elegans often insert trans genes—genes from a different source which may make changes in the worm's morphology. They also mark the genes with green fluorescent protein (GFP) so that the altered area can be readily identified. Such research can help scientists understand genetic variation, and the findings can then be applied to understanding human diseases and identifying potential treatments.

Sorting and analyzing these worms in traditional lab settings, however, is often time-consuming and labor-intensive. The solution was to design a microdevice that could automate the process. Putzke states that he, Measor, and the student researchers began by talking about the outcome they hoped to achieve with the devices—ultimately, they would like a microdevice which can take worms from a container and sort them into separate containers according to the gene fluorescence they exhibit. Then they discussed how they could develop a microdevice which would lead to the desired outcome. Putzke appreciates how collaborative Measor is, wanting to work together, soliciting ideas from all team members, and actively including them in all of the conversations.

Putzke and the undergraduate researchers working with him developed the mutant worms with GFP for the project. Putzke points out that they also needed to make sure that the device had small enough channels for the worms, and then they needed to refine it so that the worms could be sorted. He explains that the team has made steady progress in addressing the next phases of the research process each year. Measor says that

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they started by choosing the materials and doing more materials characterization, then planned the next steps. The pilot device sorted beads, and the current student researcher has been able to use fluid to sort the worms. This student presented the latest results in January of this year. After that, their goal will be to combine accuracy and speed, and ultimately move to full automation of the process.

The student researchers are engaging in truly interdisciplinary work. Putzke points out that the students not only learn how to cultivate and work with the worms, but they also learn how to 3D print and refine the microfluidics devices. He appreciates taking part in lab meetings with researchers on other projects Measor oversees; Putzke delights in seeing the students doing an array of work that has clear applications in industry.

Diagnostic Testing

One of the most impactful areas of research at the Microdevices Lab involves diagnostic testing using photonics microdevices. As Dr. Kent Jones, professor of Mathematics and Computer Science at Whitworth, points out, the pandemic highlighted the need for fast, inexpensive, and accessible diagnostic tools. Measor and Jones had discussed the potential for creating diagnostic microdevices before the pandemic began, but the urgency of the global health crisis accelerated their work.

The lab's 3D-printed polymerase chain reaction (PCR) test microdevice—which has been developed over the past five years—is much cheaper and faster than conventional tests, uses only one square inch of material and requires 60,000 times less reagent than traditional tests. These attributes make it far more cost-effective, especially in resource-limited settings. Measor explains that these tests also work two to three times faster than the PCR tests currently on the market and can be kept at a more consistent temperature, improving their reliability. Now that the technology is developed, it could be adapted to identify any infectious disease or organism.

The lab successfully tested the PCR device for Covid-19, and the device has since been patented—only the second patent in Whitworth's history. The Microdevices Lab is now seeking industry partners to bring the revolutionary technology to the public. Measor has also become the first faculty member at Whitworth University to patent a technology.

Undergraduate Research Opportunities

Student researchers in the Microdevices

Lab participate in each step of the research and project development process, and they regularly present their findings at national conferences. Burchard particularly appreciated the opportunity to give an oral presentation at the SPIE Photonics West BIOS Conference.

Many of Measor's student researchers, such as Ramollari and Burchard, continue to graduate school. Burchard says that Measor encouraged her to pursue advanced degrees so that she could continue interdisciplinary research related to her field of biology. She appreciates his mentorship and guidance throughout her time in his lab. While her research focus is now moving to the field of astrobiology, it still involves the intersections of biology and engineering.

Jones notes that researchers in the Microdevices Lab could not have done the

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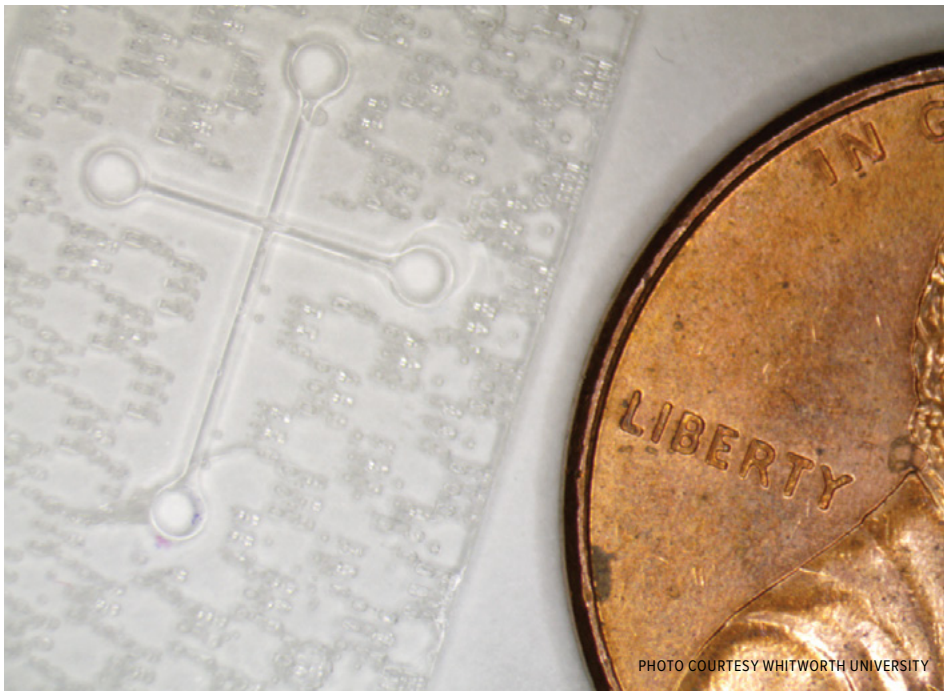

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work without a great deal of support at Whitworth for undergraduate research; such support includes providing summer research opportunities for students. Beyond being interesting research and good for faculty, Jones says, these are major opportunities for students. By the time they graduate, they have shown the real-world applicability of their research in both conference presentations and publications, thereby increasing their competitiveness for graduate studies and professional roles.

Science Communication and Mentorship

One of Measor's strengths is his ability to communicate complex scientific ideas clearly and effectively. Having worked in both industry and academia, he honed his communication skills in diverse settings, including his time as CEO and chief technical officer of a startup and during his years in the semiconductor industry. Measor learned to present his ideas in ways that were understandable to both technical and non-technical audiences, a skill he now passes on to his students. His students at times win presentation awards at national conferences, which speaks to his success in developing their science communication skills. His enthusiasm for research is contagious, and as Burchard says, "everyone likes working with him."

Through the collaborative efforts at Whitworth University's Microdevices Lab, Measor and his team are making groundbreaking strides in the development of affordable, high-impact technologies. By combining 3D printing, biology, and engineering, they are advancing the potential of microdevices to transform diagnostics and research. With a strong emphasis on hands-on learning and interdisciplinary collaboration, their work not only pushes the boundaries of scientific discovery but also equips students with invaluable skills for the future of innovation and problem-solving.

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