

Enabling the Future

Student group
Yale e-NABLE
provides customized
prosthetics and
new opportunities





For 11-year-old Emily Reid, playing the cello with her standard prosthetic was cumbersome. Heavy and rigid, it caused her to overextend her arm to get the right angles — all of which would take a toll on her shoulder. With the help of the new student group Yale e-NABLE, though, she now has a new prosthetic for her lower arm. It's lightweight and porous, both of which are important for long sessions of cello-playing. And because it's easy to make, the student group can make different versions without much trouble.

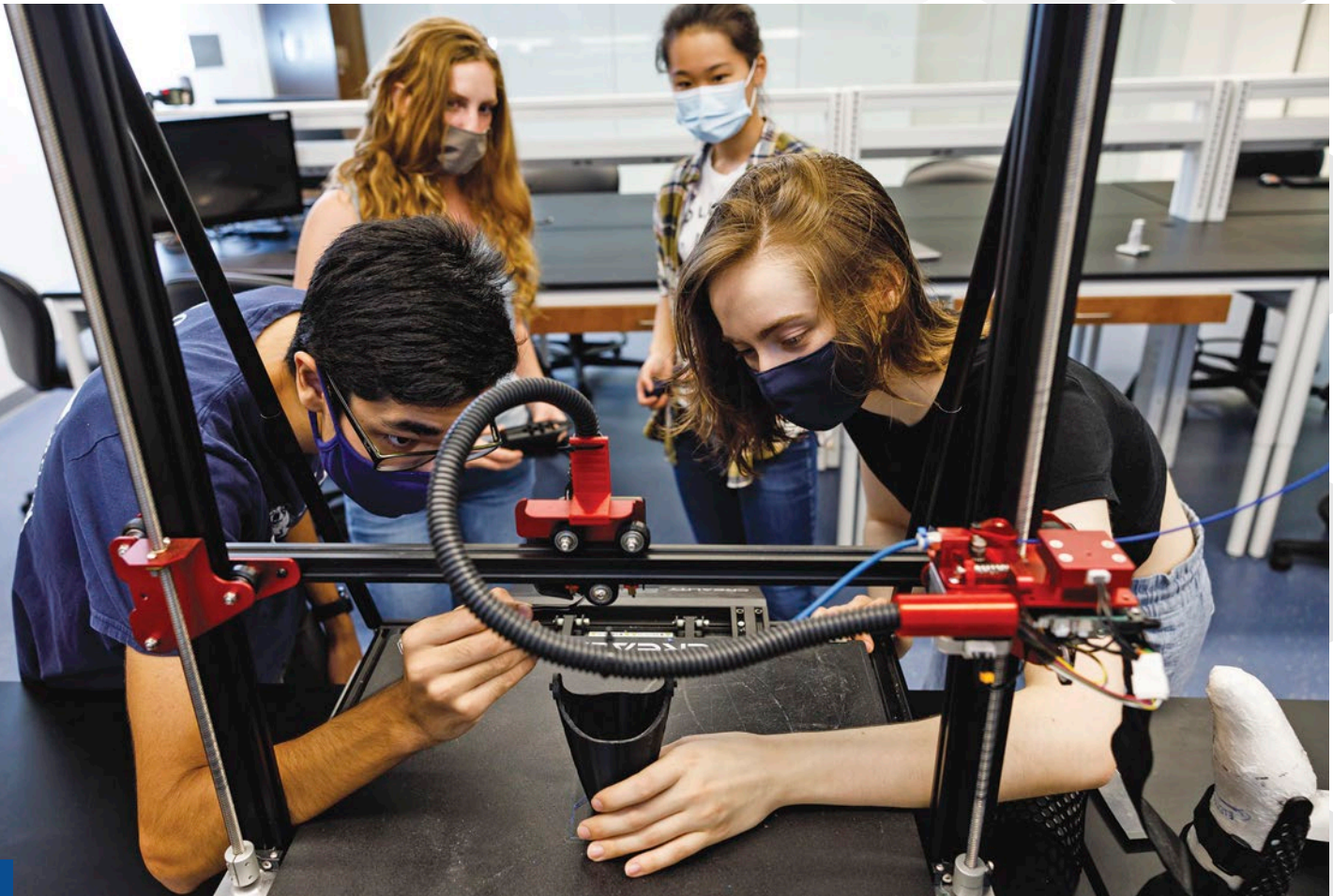
It's the first major project for Yale e-NABLE, a group founded last year by Grayson Wagner '23. It's a chapter of the international group e-NABLE, made up of volunteers who use their 3D printers and skills to create free prosthetic limbs for those in need. They focus on helping people who are missing fingers, hands, or arms below the elbow. The 3D-printed devices are especially helpful for children who don't have the option of a traditional prosthetic device, either due to cost, time, or to the uniqueness of their limb difference. The Yale chapter focuses on reaching the broader New Haven community.

Wagner had been thinking about starting a chapter since high school, when she worked on a project involving 3D-printed prostheses.

"I thought it was incredible that e-NABLE is able to give these devices for free all over the globe, and also in fun colors," said Wagner, who is majoring in biomedical engineering. "You see kids picking up water bottles and Barbie dolls for the first time, and it's just really inspiring."

Once she put the word out about Yale's chapter, a team of students assembled pretty quickly. At about the same time, Guy and Linda Reid of Cheshire, CT, were looking for a way to help their daughter, Emily, play the cello. Born with a left arm without the hand and wrist, Emily wanted a customized prosthetic that was better suited to the specific mechanics of playing a cello.

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Yale

“We’re very close to Yale, and I thought they’ve got to have some pretty smart engineering students,” Guy Reid said. “So, I sent an email.”

Above: Yale e-NABLE members use their 3D printers and skills to create free prosthetic limbs for those in need, focusing on helping people with missing fingers, hands, or arms below the elbow.

That email found its way to Deputy Dean Vincent Wilczynski, who then referred the Reids to Yale e-NABLE. The student team met with the Reids over Zoom, analyzed Emily’s playing method, and got to work.

“I think the first thing was figuring out the right angles for the bow clamp, because

we didn’t want to hinder her development by having her start playing in an improper way and then continuing that further down the road,” Wagner said, adding that they recruited a Yale student who plays the cello to offer some guidance. “Then we sent Emily three or four pieces, each with different angles on them, until she found which one suited her best.”

It was an ambitious start for the group, especially since most of the work was done remotely from various locations across the U.S. The group now has a printer at the Yale Center for Engineering Innovation and Design (CEID), but for much of its first year, members printed parts in their own homes and consulted with each other from across the country, due to COVID.

“We were virtual, so it was a bit all over the place,” Wagner said. For the group’s Build A Thon, an annual



Left: The prosthetic is lightweight and porous allowing for extended use.



event in which new members develop their skills by trying to build a wrist-actuated prosthesis for the hand, Wagner sent out packages to students who were dispersed around the U.S. with printed parts in them that they could assemble at their own homes. When it came time to work on the project for the Reid family, it again meant shipping out parts and molds to members' homes.

To help them with the design, the Reid family made their own plaster mold of Emily's arm, and then sent it to the student team.

"We had two really talented designers, Audrey Whitmer '23 and Zubin Kremer Guha '24, who have been working on this and they have put so much effort into it," Wagner said. "So it's really rewarding to see their design coming to fruition and to see how Emily's using it."

For Whitmer, who's been making small toys and geometric shapes since high school, joining Yale e-NABLE was a good fit — and a bit of a challenge.



Above: The device intentionally bends allowing Emily to comfortably place her bow at the right angles on the cello. Below: The group consulted a Yale student that plays the cello to ensure the bow clamp was designed so Emily learns the proper way to play the instrument.

"Making prosthetics was an aspect of 3D printing I've always been interested in, but designing for a human is very hard," she said. "The organic shape of the arm is very different from anything I've designed for before."

It took some trial and error, but it wasn't long before they had a prosthetic device that Emily could use. Emily said she noticed a big difference once she began playing the cello while wearing the Yale e-NABLE device.

"I thought that it was way easier to play with since it bends and now I have the

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right angles, so I'm not struggling to place my bow in the right spot on the cello and making my arm uncomfortable," she said.

The low-cost of 3D printing is also a major benefit. The Yale e-NABLE prosthetic was free for the Reid family. Insurance will cover costs for conventional prosthetics, although there are still deductibles and co-pays. It gets really pricey when you look for customized prosthetics for specific activities. Those can run thousands of dollars. There aren't many companies that make them, and insurance companies rarely cover their costs.

Drs. Lisa Lattanza and Daniel Wiznia, both orthopedists at the Yale School of Medicine, are the faculty advisors for Yale e-NABLE. Lattanza was already familiar with the use of 3D printing to make prosthetics, having done some work with it before she came to Yale. She said the student group is

Below: Members of the Yale e-NABLE group: Zubin Kremer Guha '24, Tenzin Kunsel '23, Grayson Wagner '23, Christy Zheng '23, and Audrey Whitmer '23.

"It was nice for her (Emily) to get some special attention and to have an opportunity to play an instrument that may have been more difficult without this."

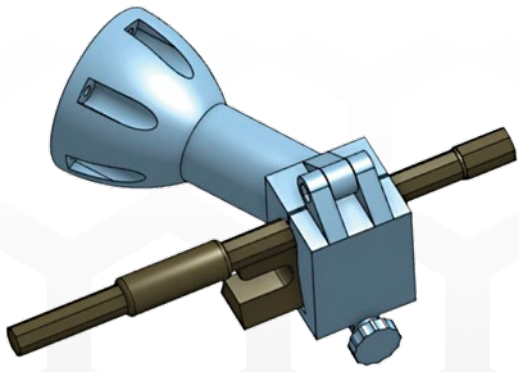
› Linda Reid

getting in on the ground floor of a field that's likely to take off dramatically over the next few years. Besides being lightweight and less expensive, she said, 3D-printed prosthetics are much easier to customize to the specific patient.

"I've been aware of 3D-printed prosthetics for probably five or six years, and it continues to be honed," said Lattanza, chair of the Department of Orthopaedics and Rehabilitation. "And 3D printing has become so much more commonplace — some people now have the printers in their homes or offices — and it's just a lot more accessible. So I think it's going to really catch on with the folks who do traditional prosthetics and orthotics."

Yale





Emily has two older siblings who both have leg prosthetics. Lower limb amputations tend to get more attention from the prosthetics community, Linda Reid said, so it was great to see that e-NABLE focuses on the upper limbs.

“It was nice for her to get some special attention and to have an opportunity to play an instrument that may have been more difficult without this,” she said.

The ease and low-cost of 3D printing allows for multiple iterations, so even after Emily was fitted with a working prosthetic, e-NABLE will continue to tweak the design to get it perfect. Part of that is the color scheme. Emily requested a teal and black design, so that will be coming up soon. The Reids said they’ll spread the word about e-NABLE to other families with limb differences. Prosthetic adaptations for playing music, sports, and other activities can make a huge difference in kids’ lives, Guy Reid said. Too often, though, families don’t realize what resources are available.

For their part, the success of the first project has emboldened the e-NABLE group to seek out new projects. Beyond their time at Yale, both Wagner and Whitmer are both considering careers that involve 3D-printed prosthetics. As vice president of the group, it was Christy Zheng’s job to organize and coordinate meetings and communications — not



an easy task while working remotely. She said all the work was worth it, though, when the Reids sent a video of Emily playing the cello with the Yale e-NABLE device.

“We were overjoyed,” she said. “It’s amazing, and that project inspired me incredibly, because the orchestra teacher at my high school has a prosthetic device, and he’s a world-renowned violinist. I think nothing is impossible.” 🎻