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JeffSolves: A New Way of Thinking

JeffSolves: A New Way of Thinking

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Medical and industrial design students team up to develop medical devices to solve healthcare challenges.

Design isn't what most aspiring doctors think about when considering medical school. But for Emily Marshall, a second-year medical student, design drew her in when interviewing to attend Sidney Kimmel Medical College at Thomas Jefferson University.

Through the JeffSolves MedTech program, Jefferson offers medical students like Marshall a rare opportunity to design and develop a novel medical device from the ground up.

"People who go into medicine don't have exposure to designing medical devices, even though we're using them every day," Marshall says. "The JeffSolves program is a very unique opportunity to learn about what goes into product development in the medical space."

Now entering its seventh year, JeffSolves teams medical students up with industrial design students to identify a real-world healthcare challenge that a medical device could solve.

The student-teams work with clinicians, patients and experts in engineering and design to conceptualize and develop a medical product. The process includes giving products a name, creating a brand and submitting provisional patents on the products to protect the intellectual property.

This year, 19 students who broke into four product-designing groups worked on their project over the course of six months, plus full-time over the summer. In addition to guidance from Industrial Design and Health Design Lab faculty, JeffSolves partnered for its third year with Bresslergroup, a local design firm that specializes in medical devices. Teams also worked with Savvy Cooperative, an organization where patients are compensated for their expert knowledge about their conditions. The new partnership helped to provide teams with patient insight and to foster patient-centered designs.

The program culminates in public disclosure of the student-teams' ideas to seek interested parties that might help move the product forward, with the ultimate goal of selling the intellectual property to a medical device company to manufacture the product. Students from this year's program presented their products to a combined in-person and virtual audience as part of Design-Philadelphia, an annual 10-day festival that highlights the city's impressive design community.

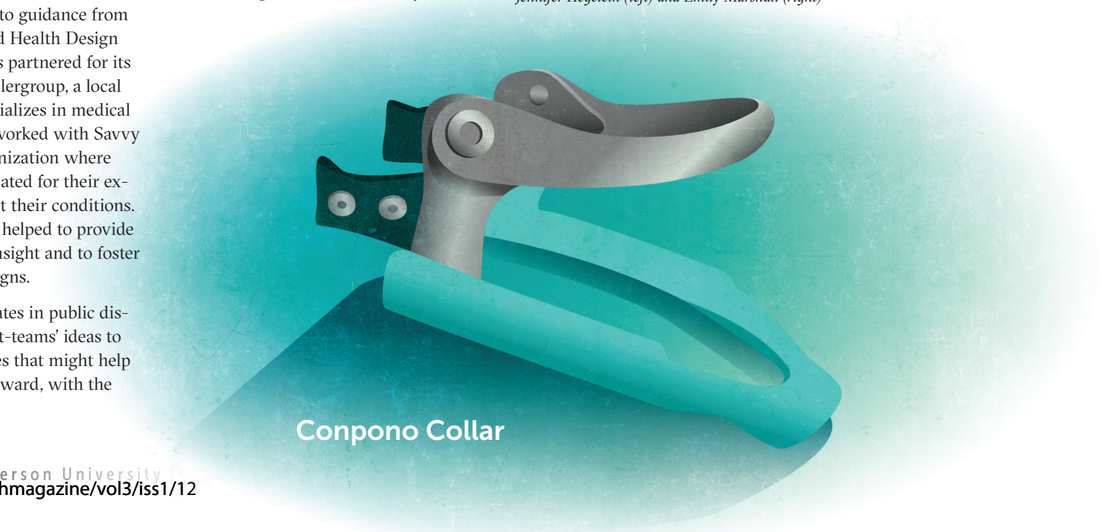
"The idea of the program is to empower students," says Rob Pugliese, PharmD, director of innovation design and co-founder and managing director of Jefferson's Health Design Lab, out of which the JeffSolves program runs.

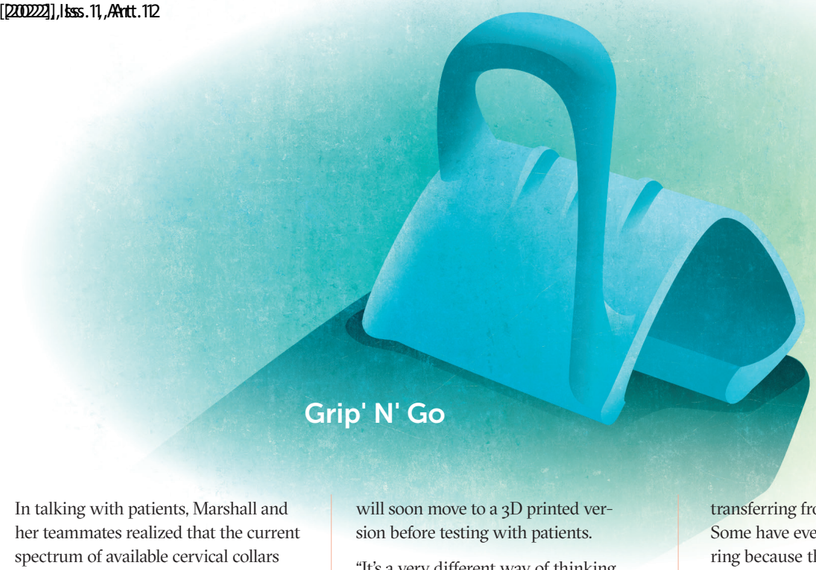
Conpono Collar

Marshall had first heard about JeffSolves from a former participant before she enrolled at the medical school, and the program intrigued her. But when the time came to come up with a project, she and her team struggled to zero in on a problem to address. In prior years, the JeffSolves program started with a reverse pitch night," where clinicians and physicians would lay out a smorgasbord of problems for the student teams to solve with their products. This past year, however, identifying key health problems to solve was up to the students. They had to identify problems that they felt strongly about and believed had market viability within this year's program theme: neurology, neuroscience and rehabilitation.

Marshall and her group, mentored by Morgan Hutchinson, MD, director of education for the Health Design Lab, went to the experts. They met with Jefferson neurologist Hristelina Ilieva, MD, PhD, who specializes in amyotrophic lateral sclerosis (ALS), a progressive neurodegenerative disease more commonly known as Lou Gehrig's disease. The conversation revealed that patients with ALS and other neuromuscular conditions wear cervical support collars to help weakened neck muscles support the head.

Jennifer Hegelein (left) and Emily Marshall (right)





In talking with patients, Marshall and her teammates realized that the current spectrum of available cervical collars on the market weren't meeting patient needs. Collars were either intense medical-grade collars intended for immobilizing the neck to prevent spinal cord injury, or over-the-counter collars that did not provide sufficient support. One patient explained how difficult it is to eat with a collar on. "That stood out to us," Marshall says. "The device should permit patients to do the things they still can do at this point in their disease, because eventually those things are taken away from them."

Drawing on patient input, the team aimed to create a collar that is not only sturdy enough to provide sufficient head support for patients, but also flexible enough that they can eat and do other routine activities while wearing the collar. To achieve this, Marshall and her teammates designed a collar with a pivoting jaw piece. They started by hacking apart existing collars and trying to re-configure them to include an adjustable and movable mechanism.

But the design truly came together when they discovered a mechanism on helmets that welders use to protect their eyes and faces from ultraviolet light and sparks when heating metals. Welding helmets have a part that rotates the helmet into different height settings. Marshall and her team took this mechanism out of a welding helmet and put it into one of the handful of prototype collars they made, "and it works pretty well," she says.

Throughout the design process, the team tested their prototypes on themselves to find out what was and wasn't working. The group is now working on refining the model and will soon move to a 3D printed version before testing with patients.

"It's a very different way of thinking about diseases than we do in typical medical education," says Marshall. "Going forward, I want to make sure I always ask questions about a patient's needs and issues with medical devices."

Emily Marshall (medical student), Jennifer Hegelein (industrial design graduate student), Nia Robinson (industrial design undergraduate student), Eshika Agarwal (medical student)

Grip'N'Go

With a background in biomedical engineering, second-year medical student Sara Belko found that the JeffSolves program was a natural fit.

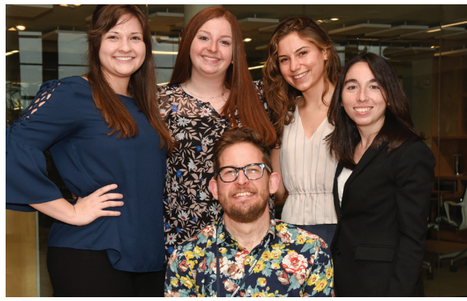
"I want to be that link between medicine and engineering, because right now there's a big gap," she says. "Engineers are making products that don't necessarily solve patients' problems, and doctors are taking these products and actually modifying them to be better."

Belko and her team decided to focus on spinal cord injury and interviewed patients who use assistive devices like wheelchairs, walkers and canes to find out what issues come up for them in their everyday lives. A topic that kept cropping up was sanitation concerns around using public restrooms.

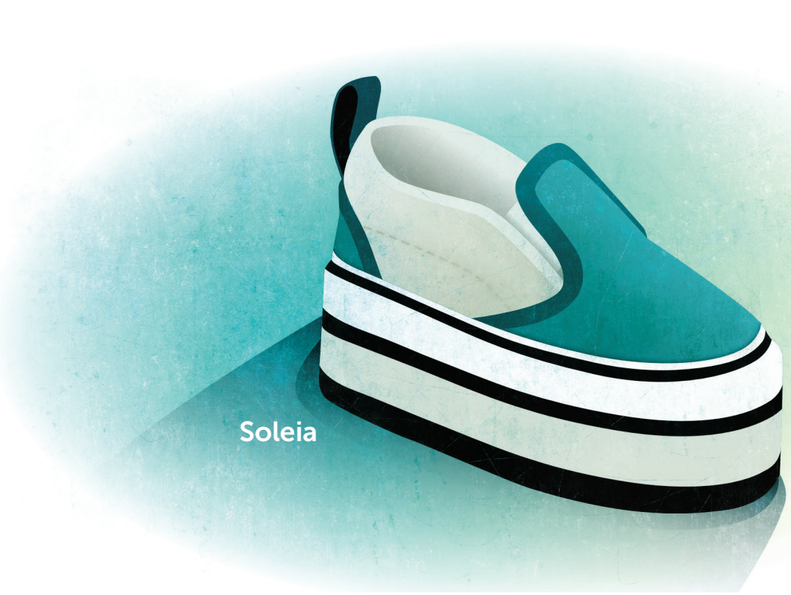
To use the toilet, people who use wheelchairs often have to grab the toilet seat with their hands to transfer their bodies from the chair to the toilet. The lack of sanitation hinders people from wanting to use public toilets. Also, toilet seats aren't very sturdy. People who use wheelchairs don't feel very stable when transferring from their chair to the toilet. Some have even fallen while transferring because the seat snapped. Wheelchair-accessible stalls with bars aren't always available or in the right position.

To design their product, the team started by understanding what the transfer from wheelchair to toilet seat looks like. Guided by teammate Aaron Anderson, who uses a wheelchair, they broke down the process into 28 different steps. The team went into public restrooms to observe different versions of the environment they were working in. Then they went a step further. They bought and installed a toilet and set up a mock environment so they could practice transfers themselves and better understand a user's perspective.

Belko and her teammates, mentored by Kristy Shine, MD, PhD, assistant professor of Emergency Medicine and director of Scholarly Inquiry at Sidney Kimmel Medical College, went through many iterations of concept design and testing, 3D printing more than a dozen prototypes. After testing on 30 toilet seats, the team produced Grip'N Go, a portable weight-bearing handle that attaches to the



Left to right: Blake Rivas, Aaron Anderson, Hannah Anderson, Emily Furstenberg, Sara Belko present their device at the pitch event at the Bresslergroup which took place on October 13, 2021.



Left to right: Anusha Koka, Zane Gouda, Kathryn Bormes.

toilet to enhance stability and sanitation. With the device, no bigger than a purse, users no longer have to touch the toilet seat during self-transfer. Belko and team are now moving forward with two designs and hope to test them with patients who use wheelchairs soon.

The project helped Belko embrace areas of medicine and life that often feel taboo to speak about. "No one really likes to talk about how private toileting is," Belko says. "All the patients we talked to were super appreciative that someone was finally talking about these issues."

Sara Belko (medical student), Aaron Anderson (industrial design graduate student), Emily Furstenberg (medical student), Hannah Anderson (medical student), Linda "Blake" Rivas (medical student)

Soleia

Industrial design student Gigi Geary participated in JeffSolves in 2020 with a team that developed a flexible barrier to minimize contamination in IV lines, a device called Conexo. This year, Geary and her new teammates chose to work on cerebral palsy, a condition that affects movement, balance and posture. It is often the result of abnormal brain development before birth. Many individuals with cerebral palsy who are able to walk do so with an altered gait.

The team, mentored by Bon Ku, MD, assistant dean for Health and Design and director of the Health Design Lab, met with doctors, physical and occupational therapists and patients to learn more. Patients noted that their shoes would wear down very quickly. Online support groups revealed that many patients require shoe lifts because one leg is significantly shorter than the other. Shoe lifts can be expensive and often must be special-ordered from a shoe company. Because children grow so fast, kids with cerebral palsy are often limited to one pair of shoes, which doesn't always match their attire or the occasion.

Team Soleia's goal is to make walking more comfortable for pediatric patients with leg-length discrepancies, and to increase the longevity and adjustability of shoe lifts. Using some of their old shoes, the team met up over the summer to try out different design ideas and materials. "Sometimes it felt like carpentry," says Katie Bormes, a medical student on the team. "We were in the design lab using a band saw to cut out shoe shapes from foam."

To test out their design ideas, Bormes, Geary and their teammates would attach prototypes to their old shoes, then walk, run and jump while wearing them. There were multiple rounds of tweaking the design. Bormes says the iterative design process provided a new way of thinking, compared to the step-by-step problem solving and diagnosis in medical school.

To address patient concerns with current shoe lifts, the group's designs are sleek, either incorporating design elements of patients' existing shoes, or creating lifts in neutral colors that blend in rather than stand out.

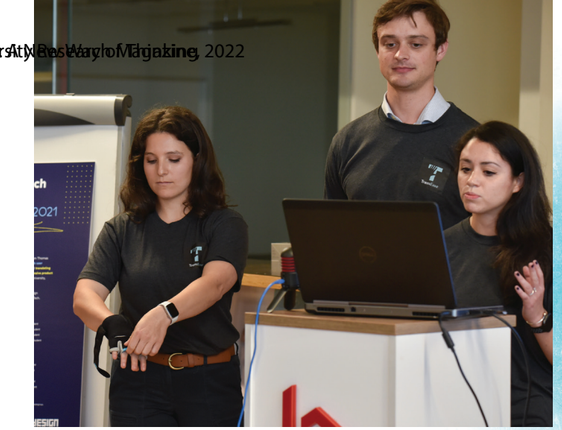
Ideally, the team would like the shoe to adjust over three shoe sizes and be interchangeable between pairs of shoes. They're working on refining the attachment mechanism. Given that their target patient population struggles with maintaining balance, they want to be certain that their product is highly stable for everyday activities. Once they are confident in the safety, the team will send it out for user feedback to continue to improve the design.

"It's going to go far and help so many people, and at the end of the day, that's what I want to do as a designer," Geary says.

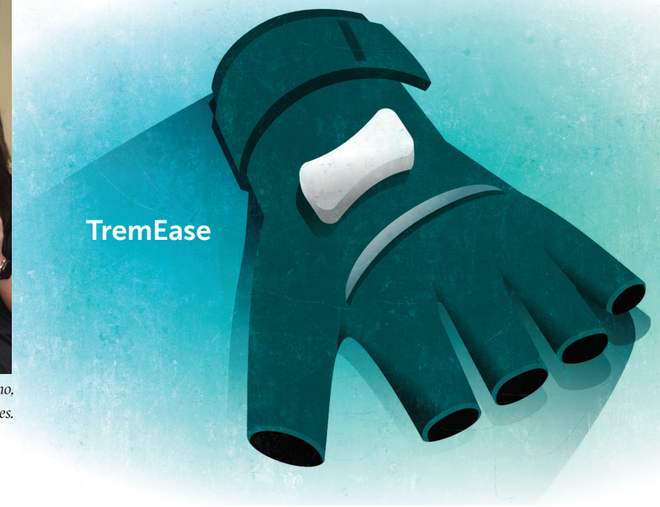
Gigi Geary (industrial design graduate student), Katie Bormes (medical student), Jane Won (industrial design undergraduate student), Anusha Koka (medical student), Zane Gouda (medical student)

TremEase

Medical student Jenna Mandel and her teammates decided to develop a customizable weighted glove for patients with benign essential tremor, a neurodegenerative disorder that is personal to Mandel. Her grandmother has the condition. Benign essential tremor causes involuntary, rhythmic shaking that is often most prominent in the hands. Movement exacerbates the tremor. There are limited treatment options, and, for many patients, the available treatments only work for a short period.



Left to right: Jenna Mendel, Joey Paladino, Kayla Brockmeyer demonstrate the TremEase gloves.



It can be an isolating disease. Patients' hands shake when bringing food or a drink to their mouths, which causes spills, leading to embarrassing and frustrating experiences for patients that can deter them from going out in public. Over time, tremors get worse.

When Mandel and her team joined online support groups for people with essential tremor, they asked members about their biggest day-to-day problems. Then working with Savvy Cooperative, they conducted video interviews with patients. This intensive, patient-centered approach revealed a gap in currently available weighted gloves that help to dampen tremors. On one end of the spectrum, there are one-size-fits-all gloves that are cheap but do not work very well. On the other end, there are gloves that are tailored to an individual's specific tremor and work much better, but are very expensive, with poor insurance coverage. Moreover, each individual's tremor is unique, requiring personalized design elements in their gloves.

"We started to ask ourselves if we could create something cost-effective that could be tailored to each patient's tremor," says Mandel.

The team put together 50 prototype drawings and produced a handful of physical prototypes. Using a breathable material, the team designed anti-tremor weighted gloves that have a Velcro-like material on the backside, where small weights can be attached to any part of the glove, as more intense tremors tend to require more weight to dampen. "We wanted to make it as low-profile and as comfortable as we possibly could," Mandel says. They are easy to put on, pull off and wash, and moving or adding weights is simple.

Mandel and her teammates were able to test the glove with a few patients. At the DesignPhiladelphia event, Mandel and her team, who were also mentored by Dr. Ku, showed a video demonstration of a patient using the glove. Without the glove, the individual's hand shook visibly while performing an everyday work task; *with* the glove, his movements were fluid and without tremor. "It was powerful to be able to demonstrate the benefit of the gloves for actual patients," says Mandel.

Jenna Mandel (medical student), Justin Horst (industrial design graduate student), Fletcher Viders (medical student), Joseph Paladino (medical student), Kayla Brockmeyer (medical student)

Future Forward

The teams from this year's JeffSolves MedTech Challenge program are now refining designs and testing them on patients in the clinic.

Mandel and the TremEase team are currently in the process of applying for Institutional Review Board (IRB) approval, which will enable the team to assess the utility and validity of TremEase on patients in the clinic. In the meantime, they continue to modify the design based on user feedback. Ultimately, they hope to make TremEase available as an over-the-counter product or through an online provider, such as Amazon, as soon as possible.

Similarly, Sara Belko and her teammates are in the process of applying for IRB approval to test out different handle designs for the Grip'N Go and to see how patients will use it long-term. The team has submitted a provisional utility patent and is advertising the device on a UK-based digital partnering platform called IN-PART that connects university research with industry R&D, where they hope to match with licensing opportunities.

Marshall and her teammates are further refining a few design details before developing a computer-assisted design and 3D-printing the Conpono collars to test with patients in the ALS clinic at Jefferson, for example. Soleia is on a similar path.

"By connecting students with clinicians and patients, and empowering them to work with the engineers and designers who can give them the tools to solve problems by creating a product, JeffSolves operates much like a start-up," Pugliese says. "All these devices have promising futures." ■