COVID-19

Lost Summer? Not at SEAS

A first-of-its-kind program keeps students innovating, even in lockdown

Like many college students at Yale and throughout the U.S., Marley Macarewich ’22 suddenly found her summer plans in disarray.

“I was originally in the last rounds of interviews for internships related to patent law,” she said. “But all the internships dropped their interview processes. Then I was going to work at a Wild West-themed summer camp as a camp counselor that I grew up going to — but that also got cancelled.”

Rather than giving into the circumstances, Macarewich continued to look for ways to make it a productive summer. Fortunately, there were plenty of opportunities in SEAS, including the new SEAS 2020 Summer Design/Research Scholars. Created by the SEAS Dean’s Office, the summer program was designed specifically around the unique circumstances that students are faced with this year. SEAS Deputy Dean Vincent Wilczynski said the aim of the internship program was to counteract some of the loss of this year’s internship, research, and academic opportunities.

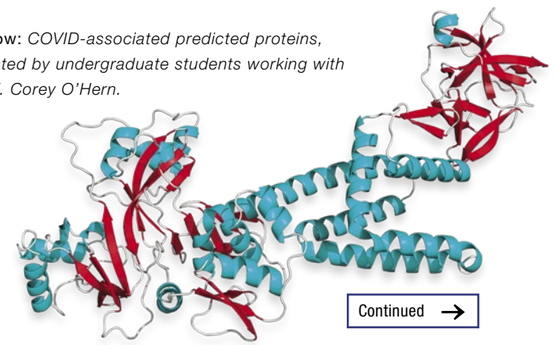
“Thanks to the support of the Yale Engineering faculty, staff, and supporters, the School of Engineering & Applied Science — in partnership with the Office of Career Strategies — was able to quickly find opportunities for students to pursue research and design projects when previously scheduled internships and fellowships were canceled due to the pandemic,” he said.

The program enrolled more than 60 students, working remotely in the labs of numerous faculty members. Projects included evaluating airflow on Connecticut passenger trains, designing exhibits for the Smithsonian Institute for visitors with disabilities, and assisting with a medical software design textbook.

Corey O’Hern, professor of mechanical engineering & materials science and applied physics, said he usually has one or two undergraduate students working in his lab over the summer; this year he had eight. He noted that the summer program allows rising sophomores and juniors to be paid for their research through Yale’s Domestic Summer Award (DSA) funding, as well as obtain course credit toward the Mechanical Engineering major. Most upperclassmen, however, have already applied for a DSA over previous summers (only one DSA is available per student).

“Because a lot of them lost their internships, they need summer funding to pay their expenses during the academic year or provide funding for their summer housing and food,” O’Hern said. So, he used funds from Yale’s National Science Foundation-funded Research Experiences for Undergraduates Site Program to support the additional Yale students in his lab. Students working with O’Hern this summer helped identify the structure of several of the proteins associated with the COVID-19 virus; studied the fluid-driven erosion of granular beds; and in collaboration with Jan Schroers, professor of mechanical engineering & materials science, explored the crystal structure of high entropy alloys.

Below: *COVID-associated predicted proteins, created by undergraduate students working with Prof. Corey O’Hern.*



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Making Trains Safe

In Macarewich's case, she joined the program and teamed up with Nathan Pharr '22 (his summer architecture-related internship was canceled) to work with the Connecticut Department of Transportation (DOT) on ways to curb the spread of COVID-19 on train cars. Assistant Dean for Science & Engineering Sarah Miller was the students' mentor for the project.

"We came in not knowing anything about this, really, so there was a lot of background reading, reaching out to professors and experts in the field regarding aerosols and infectious diseases, and then seeing how all this could be applied to the railcar itself," said Pharr, who majors in environmental engineering.

DOT officials provided the students with background information on the railcar layouts, the HVAC system, and the electrical wiring that goes throughout the layout of the car itself. One of the first things the students learned was that the issue is a lot more complicated than it initially appeared.

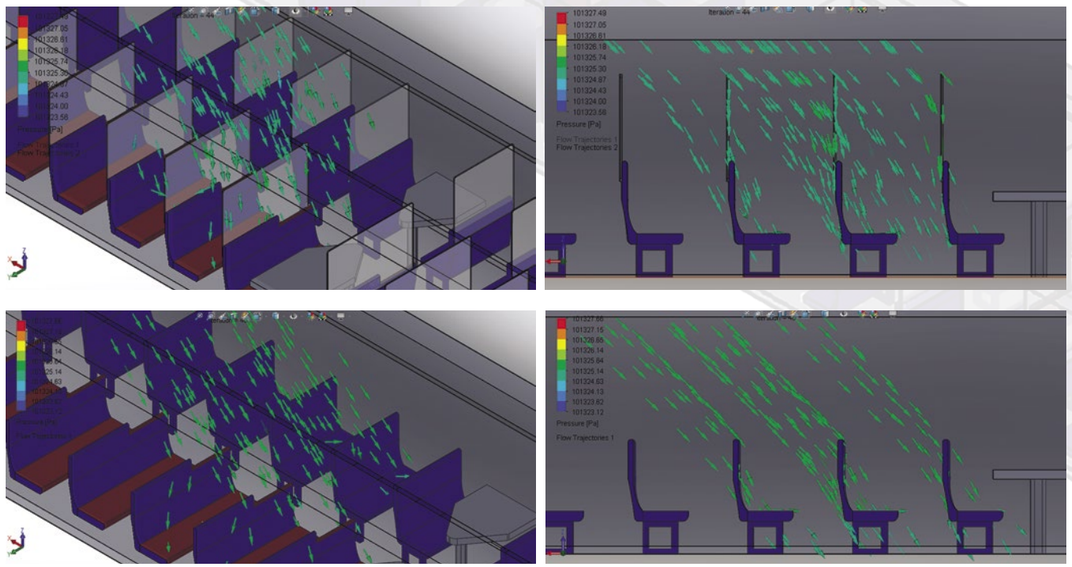
"There were things where I thought, 'Oh, this will be easy — slap on a HEPA filter and call it a day!'" said Macarewich, a chemical engineering major. "Then, after looking at all the diagrams and talking with experts around the world, we realized it's not as simple as that."

One complication is that the particular trains aren't designed for the filters they had in mind. "We really had to question how we thought about air flow," she said.

After eight weeks, Pharr and Macarewich wrote a highly detailed 40-page report that they submitted to the DOT. Miller said their work "represents the best of Yale Engineers."

"They approached this critically important project with optimism, determination, and an inspiring spirit of collaboration," she said. "Their hard work and fortitude resulted in extremely helpful guidance that will keep Connecticut and all its rail riders safer."

Richard Andreski, the DOT's bureau chief for public transportation, also praised the work and said it "provided invaluable research on ways to reduce the potential transmission of COVID-19 on passenger trains."



Top: *Close-up of model demonstrating airflow after the implementation of plexiglass shields in Connecticut railcars.* Bottom: *Approximate airflow without implementation of shields.*

"Connecticut DOT is grateful for its partnership with Yale's School of Engineering & Applied Science," he said. "They dove into the problem as a true partner, listening to their client and taking the time to understand our operational challenges. Their efforts yielded practical, straightforward solutions to improve public safety that will be implemented across the state's passenger rail system."

Overall, students in the program worked on more than a dozen projects. Some of these include:

- A team of students worked with the Smithsonian Institute on developing ways to design museum exhibits with equity and accessibility in mind. One exhibit, "World on the Move" has an interactive token-based system of representing global human migration and its motives. The team created a way to help blind and low-vision patrons participate in and experience this traditionally visual representation of data. With "Painting Sound," another team reimagined how patrons with hearing impairments could experience the emotion of music and sound that are often a critical part of museum exhibits.

"Think about a Civil Rights Movement exhibit with music; then think of it without," said the students' advisor, associate research scientist Katherine Schilling. "That powerful emotion is what the students wanted to make available to every visitor."

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Keeping the City's Frontline Workers Safe

Elsewhere in SEAS, computer science students Rachel Sterneck '21 and Varsha Raghavan '20, were instrumental in developing a program that keeps track of personal protective equipment supplies.

When the COVID-19 pandemic hit, personal protective equipment (PPE) such as gloves, masks and respirators was in high demand and managing inventories proved difficult. Nathaniel Raymond, a lecturer at the Jackson Institute for Global Affairs, wanted to create a user-friendly way for municipal and state agencies to manage their PPE.

Rachel Sterneck '21 and Varsha Raghavan '20 joined the project and led the coding work to get the open-source program up and running. The program, **PPETrackr,** gives both governments and healthcare facilities tools to help them understand their inventory changes. Users can log their daily inventory of PPE and see their data in various forms on the app's dashboard. It also allows government officials to oversee PPE inventory across healthcare facilities in their communities to help them make good decisions about acquiring and distributing PPE supplies.

"Our main priority was ease of use for the app because we knew that would be a big obstacle for us getting it adopted," said Sterneck, adding that they set a goal of "a few minutes or less."

The City of New Haven was the program's first adopter. That included police and firefighters, as well as personnel with little experience using PPE, such as city engineers, park officials, and mortuary workers.

Lt. Justin McCarthy of the New Haven Fire Department, who's in charge of tracking the city's PPE, called it "a huge help."

"When you're trying to manage something on this scale, it's extremely difficult because it's constantly changing," he said. "On top of that, you have requirements set forth by the federal government of what needs to be tracked and how."

With Face Shield Evaluations, Students Work Internationally

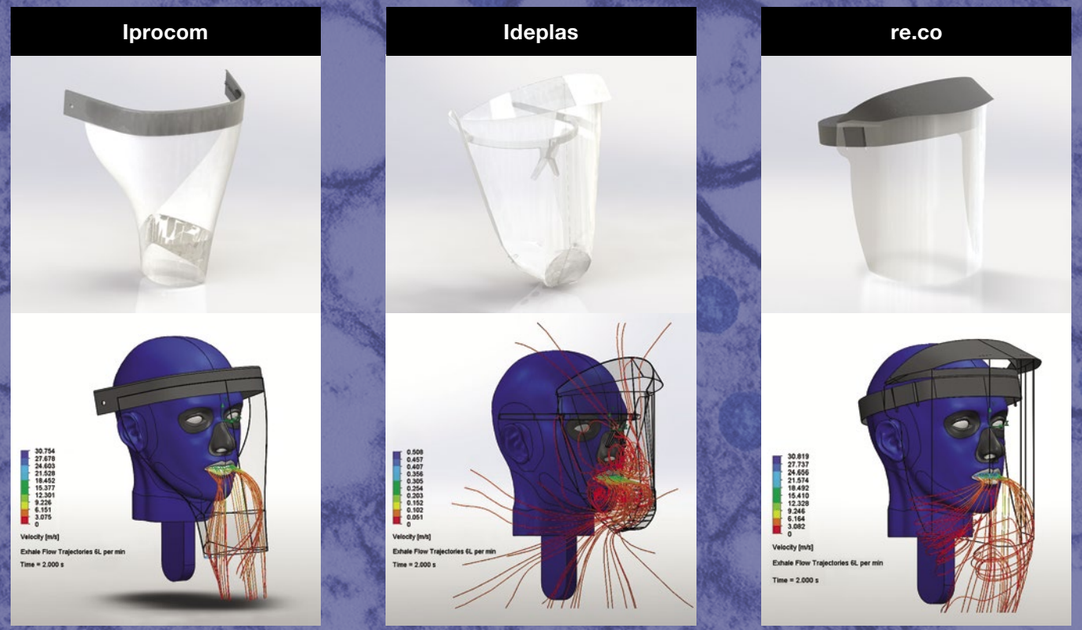
Other students stayed busy during the summer through the Yale Center for Engineering Innovation & Design's Summer Fellowship. The 2020 Fellowship, now in its eighth year, featured five teams working on projects that included stabilizing display cases holding invaluable sarcophagi, building a small satellite, an automated food-dispensing machine, and a multi-screen display system. The team of J.R. Stauff '23 and David Ewing '23 spent their eight weeks in the program helping the nation of Colombia develop guidelines for the use of face shields.

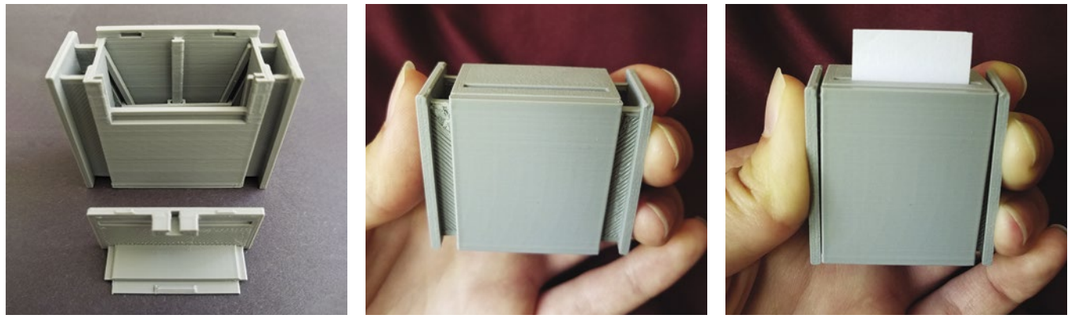
Earlier this year, the United Nations Development Program (UNDP) chose three face shield designs out of 300 that were submitted for a national contest in Colombia. To get more data on these three designs, UNDP member Alejandro Pacheco — a 2014 Maurice R. Greenberg Fellow at Yale — contacted his former advisor, a connection that led him to the Summer Fellows.

Stauff and Ewing were tasked with developing computer simulations to assess which of the three models best redirects airflow to prevent coronavirus infections for both wearers and those around them. The two students took the three physical face shields and designed 3D models for each. They combined those models with a mannequin head and built a test chamber in accordance with international test standards.

The assessments focused on facial coverage, effective curvature and air redirection, ventilation, and internal air flow. While each of the models had their strong points, Stauff and Ewing deemed the model called "re.co" as the best overall, adding that "sometimes, the simplest design is the most effective." They noted that it displayed excellent protection from airstreams from above and in front of the mask. For the benefit of future designs, they also listed the best qualities of each mask.

Juan David Martin Jimenez, one of the UNDP partners working on the project with Pacheco, noted that they've been meeting with representatives from the World Health Organization about the face shield designs. The feedback from the Yale students was very helpful, he said and confirmed many of their hypotheses. The nature of the situation, Pacheco added, required that their work gets done at a much faster rate than normal, and the Summer Fellows' contributions were a big part of that.





Above: *Students created a handheld device that provides prompts designed to break the user out of a negative thought cycle and cope with mental health challenges.*

- A group of students worked with Ron Adrezin, professor and chair of Mechanical Engineering at the U.S. Coast Guard Academy, to develop a system designed to help students cope with mental health issues, particularly during a difficult time like the pandemic. The system includes a device that gives prompts — "go for a walk" or "call a friend," for example — to break the user out of a negative thought cycle. Another component is a digital tool that helps students get away from their screens. Serena Riddle '21, who had started the project in the spring semester, said the student team expected to continue their work into the fall semester.

  "It's actually blossomed into a whole student-led mental health initiative," Riddle said. "Our mission is to become an extracurricular group at Yale, a group of students committed to raising awareness about mental health. We also want to bring people out of the shadows, because a lot of people struggle in silence, and also to equip people to take care of each other."

- Three students worked with Dr. Daniel Wiznia, assistant professor of orthopedics and rehabilitation and mechanical engineering & materials science, and Dr. Steven Tommasini, research scientist at the School of Medicine. The students focused on knee replacement research, innovating ways to prevent hip fractures, and how to treat geriatric patients with finger fractures. Wiznia said the program proved invaluable for both the students and their mentors. He and Tommasini were able to expand some of the projects, while the students were able to stay busy and get course credit.

  "We felt really bad for those students, and this a really good opportunity to do some medical device design research," he said. "It's a display of the engineering faculty really stepping up for these students and making sure that they can make good use of their time and learn. We want them to succeed down the road."

- Yehia Khalil, a Yale-affiliated researcher, served as advisor to two students. Alexandra Saczawa '22 explored the topic of valorization of mixed plastic waste in the U.S. The project included parsing the different types of plastic waste management approaches and the pros and cons of each. JR Im '23, looked into the safety risks and economic viability of blending hydrogen into the natural gas grid by reviewing recent experimental and theoretical studies. Both students wrote term papers and created posters on their topics.

  For Im, the program came at just the right time. The abrupt changes brought on by the pandemic were concerning, but Im was able to find a bright spot in SEAS.

  "There was a constant effort in SEAS and the Chemical Engineering department to communicate with students, to listen to their situations and thoughts, and to provide an opportunity for us to do something productive and rewarding over the summer," Im said. "The SEAS fellowship not only gave me an opportunity to learn, but it also helped me take my mind off the worries about my future and focus on working on a project that I was passionate about."

Background: *Students dug into medical device design research and created an innovative way to treat fractures in the foot and ankle.*