

3D printers are on the front lines of the COVID-19 pandemic

On March 20th, as the coronavirus situation in New York City hurtled toward full-blown crisis, Madiha Choksi was packing a taxi with two Flashforge 3D printers and as much filament as she could fit.

Choksi, a librarian specializing in research and educational technology, had received an urgent email the night before from Pierre Elias, a cardiology fellow at NYP-Columbia University Medical Center. Elias desperately needed to produce more protective gear for hospital workers treating COVID-19 patients. He hoped Choksi, the administrator for Columbia University's 3D printing lab, might be able to help.

"The email was very long and really concerning," Choksi tells *The Verge*. Normally, she *could* help. "But I don't have any printers," she remembers thinking, "and we were already on day three or four of remote work."

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Thankfully, Columbia handed over its printers. "Within hours, they were like, 'Yeah, of course,'" she says. Choksi got to work in her apartment producing prototype face shields by modifying an open-source design, from a company called Budmen Industries, and 3D printing the plastic visor that holds the shield and rests on the forehead with a piece of foam-like material in between. She used supplies purchased from Staples to slap together about six units she then handed off to Elias a day after receiving the email from the doctor.

"He took them straight to the hospital and tested them out," she says, "and he came back and said, 'Can we have 1,000 more?'"

Photo: COVID Maker Response

The US continues to struggle to respond to the COVID-19 pandemic, both at a state and federal level. So DIY efforts from academics, hobbyists, manufacturing experts, and professional firms have coalesced around COVID hotspots like New York City to meet the needs of health care workers and others on the front line of the response effort.

Some of these initiatives are highly organized, involving partnerships across state lines to source materials and make use of industrial-grade manufacturing facilities. Yet almost all began in the living rooms of people with access to a 3D printer and the ingenuity to put together stopgap measures as existing supply lines struggled to keep up.

“In a perfect world, we have coordination across the nation, where we have hotspots and we focus the resources there so the health care workers are protected and patients are protected. And as that dies down, we ship what remains to the next location,” says James Hudspeth, an assistant professor of medicine at Boston University and a COVID response lead at Boston Medical Center.

“The shield acts as a reminder you shouldn’t touch your eyes and shouldn’t touch your mouth.”

That ideal world is far from reality. Face shields, which Hudspeth says are rarely used in standard medical environments outside surgeries and very select procedures, ended up being second in demand only to face masks, which have also been in short supply. “One way people get infected is by touching surfaces and then touching the face or mask. The shield acts as a reminder you shouldn’t touch your eyes and shouldn’t touch your mouth,” Hudspeth explains.

The problem is that shields are only made by a limited number of manufacturers, some domestic but many overseas. And large

manufacturers only ship units in batches based on orders from procurement offices of large medical institutions and local and state governments.

“We have a central supply, and some of the states have the supply. But there isn’t the capacity to dictate where privately produced or purchased stuff is going,” Hudspeth says. “States are battling each other for these supplies, and every hospital in the country is doing the same thing.” That’s left doctors, nurses, and health care workers across the nation scrambling to get as much PPE as they can, regardless of where it comes from.

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A face shield of the DIY variety typically consists of a molded or printed plastic semi-circle visor, sometimes called a bracket, that is attached often by glue to a piece of foam that rests on the forehead. The unit then attaches to a long sheet of transparent plastic film that sits just above the face.

Everything is held together with a rubber band or a similar elastic device. It’s a simple way to protect someone’s face when interacting with a potentially COVID-positive patient. These shields can be cheaply manufactured, easily sanitized, and then reused. They also aren’t as complicated or bound by regulatory restrictions as, say, respiratory face masks.

The lack of regulations surrounding face shields have made them an attractive option for manufacturers large and small looking for a way to pitch in. Apple CEO Tim Cook announced in early April that his company would produce tens of millions of face shields for California health care workers, and Apple’s website now features a tutorial for assembling the units.

Apple is dedicated to supporting the worldwide response to COVID-19. We’ve now sourced over 20M masks through our supply

chain. Our design, engineering, operations and packaging teams are also working with suppliers to design, produce and ship face shields for medical workers. pic.twitter.com/3xRqNgMThX

– Tim Cook (@tim_cook) April 5, 2020

In the Pacific Northwest, Nike, which has its headquarters just outside Portland, has repurposed to produce face shields, too. Countless other companies, from Jeff Bezos-funded rocket outfit Blue Origin to Alphabet's life sciences division Verily, are putting resources toward emergency face shield production.

The efforts aren't stopping at just shields but extending to face masks and even ventilators, too. Razer, the gaming accessory maker, even built its own automated face mask production line in Singapore, equipped with vending machines for dispensing them around the city-state.

It doesn't hurt that out of all the PPE in short supply during COVID-19, face shields are among the easiest to produce – a single unit can be constructed with basic materials by anyone with a 3D printer or even a laser or waterjet cutter. "The nice thing about shields is that they're easy to produce relatively quickly," Hudspeth says. "People who have larger 3D printers and a relatively basic piece of plastic that is flexible enough to bend can make a face shield."

Nearly two months after she'd received that first, frantic email, Choksi and her fellow Columbia University librarians Alex Gil and Moacir P. de Sá Pereira now run a DIY volunteer effort called COVID Maker Response. So far, the group has assembled more than 19,000 face shields and distributed units to over 50 institutions, including hospitals, clinics, fire departments, and other groups of first responders.

The operation now has an almost factory-like scale and

sophistication. They moved from Choksi's apartment to the 92nd Street Y, a historic community center in Manhattan's Upper East Side. They have two official manufacturing partners: 3D printing design firm Tangible Creative, out of Newark, New Jersey, and Brooklyn-based 3D printer creator MakerBot.

Both firms supply the single 3D-printed visor to which the shield attaches. After receiving the parts in large batches, Choksi has a group of 10 to 12 volunteers, mostly medical students, on four-hour shifts assembling the shields and ferrying them by taxi or car to hospitals.

Photo: COVID Maker Response

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Gil and de Sá Pereira, both data librarians and scholars specializing in areas like data visualization and digital mapping, have experience in rapid crisis response through their academic careers. Now, Gil handles incoming face shield requests and spends all day in communication with hospitals. And de Sá Pereira is helping manage the operation's resources and ensuring they're using Columbia's funding as efficiently as possible. The rest of their limited free time is spent helping other groups in the US and overseas start their own DIY operations.

"When this whole thing hit, first and foremost in most of our minds was the lack of PPE, which was pretty harrowing in those early days," says Jason Hill, an emergency room doctor at the Columbia University Irving Medical Center. "In particular, I had a pretty crazy overnight very early on where I had to intubate," he says, referring to the insertion of a tube into the body, "in the middle of the night without one of the face shields. It was early on and nobody was expecting the onslaught to be that intense at the time, and we burned

through our entire stash during the day.”

Uptown at the Harlem Hospital Center, Stephen Nicholas, a doctor who came out of retirement to help treat patients during COVID-19, watched as the PPE shortage was fast becoming a crisis of its own.

“After the first distribution, they were all gone instantly.”
“I cannot tell you how horrible it was,” he says of the situation in late March. His hospital began using a special emergency code, “777 Gold,” over the loudspeaker when a COVID-19 patient had entered respiratory arrest and needed staff attention immediately. The “gold” was to tell hospital workers to wear appropriate PPE due to the heightened risk of infection, but the building was burning through its stash of face masks at an alarming rate. “There were periods every 20 minutes you would hear overhead, ‘777 Gold.’”

Nicholas, a former professor at Columbia, heard about Choksi’s efforts through his daughter, a medical student at the school. Gil began helping the doctor coordinate face shield deliveries for his colleagues. “After the first distribution, they were all gone instantly,” Nicholas says. “Second batch was 200. I was out of those in a day and a half. Next was 500, and that lasted about two days.” He says the PPE shortage is no longer as much an issue now that most workers have their own shields they can sanitize and hold onto.

Hill, the ER doctor, also found his way to Choksi’s group through word of mouth. He says, as the crisis accelerated, every doctor became acutely aware that acquiring more PPE as fast as possible would be crucial to keeping health care workers safe. COVID Maker Response is now helping supply his hospital with hundreds of these shields every week.

“Every few days, I’ll gauge the needs for our particular ERs and ICUs with some colleges and we’ll swing by and get a box of 200 or so of these face shields to drop off,” he says.

“When I walk through the ER, the vast majority of people I see are wearing these face shields. At this point it really feels like we have a surplus, which is a wonderful thing to feel.”

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COVID Maker Response is far from the only operation like this. Choksi and Gil tell me they’ve been in contact with at least three others around New York City alone, and they continue to field messages from others around the country and even overseas that are interested in doing the same.

Countless groups have also spun up elsewhere in the US, typically around schools and libraries with the space and resources to set up these makeshift factories. Some, like the Washington State 3D Face Shield Hub and the Illinois PPE Network, have taken similar approaches to coordinating massive, factory-like volunteer efforts that employ individuals in their homes all the way to corporate partners and universities.

“Part of our model is not to become the one supplier of face shields,” says Gil. “The idea of this grassroots, distributed model is to help others be able to do what you’re doing so many more distributed teams can aggregate to some kind of impact. This is of course in the absence of industry or city stepping in.”

Photo: COVID Maker Response

One hurdle facing the PPE-producing projects is knowing when to shut them down, as more conventional manufacturing methods continue to ramp up. Choksi and Gil say they’re still receiving daily requests for more face shields, and shortages will continue so long as the novel coronavirus continues to overwhelm the US health care system and its hospital and other frontline workers.

"I think we're just going to keep going until the need dies down," Choksi says. "There's so many other efforts we're hearing about, and until we stop receiving requests, our plan is to just keep at it. Full speed ahead until the needs are met."

For Choksi and her partners at COVID Maker Response, the willingness for her volunteers and partners to keep helping has been one of the few glimmers of light in an otherwise awful and often grim situation. She says the maker community and 3D printing in general have shown that they can fill gaps and help vulnerable communities in times of need, using their expertise and ingenuity.

From left to right, the core volunteer group has consisted of Jess Ho, Rin Allen, Elisa Mala, Joe de Jonge, Madiha Zahrah Choksi, Rajat Sethi, Matt Car, Victoria Colozzi, and Cullen O Brown.

Photo: COVID Maker Response

"I think the situation has really shown what 3D printing is capable of, which is not long-term mass production, but filling a need for very rapid production, on-demand and highly customized items," says Dave Veisz, MakerBot's vice president of engineering, who now works closely with COVID Maker Response on the volunteer effort. "[COVID-19] has just shown the vulnerability in the global supply chain. The fact that these parts are needed so badly has been eye-opening, as well as the fact that a lot of these parts only come from a handful of factories."

Veisz says that under normal circumstances, you would just injection mold a face shield design and have a factory spin up to mass produce it. "But these things take months," he says. "It's been eye-opening to the general public that 3D printing can be used as a stopgap for emergency needs like this and can be used to kickoff production for the item."

Choksi says the novel coronavirus has been the kind of situation the maker community prides itself on coming together to fight. "It's very organized and mobilized and fast moving and constantly iterating. If there is an emergency, a need for crisis response, there is a file out there that is open source, readily available for everyone," she says. "We're just humbled and grateful to put our wits and expertise to it and just go."

<https://www.theverge.com/2020/5/25/21264243/face-shields-diy-pe-3d-printing-coronavirus-covid-maker-response>