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# Engineers are hoping to perfect masks before the next COVID wave or pandemic

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Credit: Unsplash/CC0 Public Domain

In the coronavirus pandemic's early days, health care workers turned to bandannas and other makeshift protections because they lacked the official stuff. That gave engineers at the University of Maryland an idea.

They called a niche company, ActivArmor of Pueblo, Colorado, that they were helping develop custom 3D-printed casts to help set broken bones.

Could the company pause and make custom masks?

It could. It could even go further and make them clear, reusable and form-fitting without any bruising. And they were a protective N95-grade.

"Everyone just wanted to do something to help," said William Bentley, director of the Robert E. Fischell Institute for Biomedical Devices in College Park, which was at the time a new center in the university's engineering school. "We designed, built and tested masks, and ActivArmor made them."

The urgency to produce more masks has dropped as mandates eased around the country, reflecting waning cases from the omicron variant. There are ample supplies of masks, mostly disposable, for those who still want or require them.

But no one thinks omicron is the last dangerous coronavirus variant or the final pathogen to emerge. The break from mask-wearing requirements offers government regulators and researchers an opportunity, they say, to vet the many masks on the market and weed out those that are less effective.

They also can turn to their attention to innovation, so that during the next coronavirus wave or a new pandemic, health care providers, first responders and the public have something better that what's available now.

There has been little change or innovation in masks for decades, experts

say, though there are nascent efforts in the public and private sectors to develop a more perfect mask—one that is protective, comfortable, reusable and affordable.

Officials at ActivArmor and the University of Maryland institute think they are on to something.

"There is no reason to start from scratch," said Diana Hall, president and CEO of ActivArmor, which patented the design and sold 10,000 masks in a year.

The company has since returned to its core business of custom-printed waterproof casts, which Hall views as another pandemic innovation because they allow wearers to wash their hands.

The masks were time-consuming for the small company, which custom-made about half the masks it sold. For those, the engineers had people scan their faces with an iPhone app and made 3D-printed molds in their lab in Maryland. Then, at ActivArmor, a kind of clear, flexible plastic was heated and formed on the molds to make the actual masks.

The other half of the masks sold were ordered from six preselected sizes, a range that meant just about everyone found one that fit.

Hall wants to hand off the project to a large-scale manufacturer and distributor. She believes other firms could use the heat-forming technology, the kind used to mold Solo plastic cups, to make masks for a couple of dollars each.

The six sizes can still be ordered through a company called HMD Technology in Canada, but Hall said they are expensive at $65 and up in U.S. dollars. Even that price is a discount from her initial in-house, money-losing pricing of $99 for the off-the-shelf masks and $149 for

the custom masks.

The products themselves look a bit like clear gas masks, with places on each side of the mouth for small replaceable filters or adapters to attach existing respirator-style disks for the most protection.

Hall said the biggest complaint from users was about a bit of moisture buildup inside the mask, which can be wiped off with a cloth.

"Their real value is they are transparent, so you can see what the doctor or EMT coming to rescue you is saying. They are the correct shape for most every face. And they are fit tested for their protective seal," she said.

"They don't bruise your face," she said. "You can run them under the faucet to clean them."

But that won't matter to the masses until the cost comes down, she said.

Government and industry officials hope some new thinking could increase uptake and reduce costs for when masks are again recommended or required.

"In the future, we need more effective and well-fitting masks," said Dr. Eric Toner, a senior scholar at Johns Hopkins Center for Health Security, during a recent webinar hosted by the center and the Steering Committee on Pandemic Preparedness and Health Security, a nonpartisan educational forum for federal lawmakers and regulators.

"Widespread public use of masks could save thousands of lives in the next pandemic," he said.

Toner said it would likely take government funding or reliable markets

to incentivize industry to take up the development process and the supply chain to deliver enough of them.

The N95 and KN95 masks most effective in filtering the coronavirus were in such low supply early in the pandemic that state and hospital officials got into bidding wars. That was among the reasons they weren't initially recommended to nonmedical consumers, who were directed to less-protective cloth masks, some of which were homemade.

The administration of President Joe Biden only recently was able to buy and mail more than 240 million of the best masks to the public and stock pharmacies and other outlets.

The country wasn't ready with masks for the pandemic, said Stephen Redd, a former deputy director for public health service and implementation science at the U.S. Centers for Disease Control and Prevention.

The Strategic National Stockpile once had supplies, but many were not replaced after the H1N1 flu pandemic in 2009 and other batches expired, he said during the webinar. Even now, some N95 and KN95 masks cropping up for sale online do not meet government specifications.

Also, those specifications were largely created for industrial use, rather than pandemics, so there are no rules for kids' masks.

"There's not been much focus on where innovation could take us," Redd said. "How do you stimulate innovation in the absence of commercial demand?"

Ellen White, global business director for respiratory products for the manufacturing giant 3M, told the panel the government needs to start

with new regulations to guide the innovation. They should focus on better fit and reusability, in addition to protection, for both adults and children.

"They need to be comfortable for users," she said. "But we also need to look at the overall supply chain and how they can be brought to scale."

Government officials are thinking about those things, said Sandeep Patel, director of the Biomedical Advanced Research and Development Authority, the federal health department agency responsible for mask stockpiles.

"We're trying to get away from single-use masks," he said. "The other piece we're thinking about is comfort and design, so people feel more comfortable wearing masks for a long time."

That was a goal when the University of Maryland engineers first called ActivArmor.

The engineers say the work isn't done.

"Cost remains the biggest barrier," said Kevin Aroom, a Maryland institute engineer whose face served as one of the initial models for the 3D-printed molds used in making the ActivArmor masks.

These days, he spends more time testing, in batches of 20, off-the-shelf N95 and KN95 masks on behalf of government and industry consumers to see how well they filter. Salt particles are substituted for aerosolized coronavirus in their high-tech machinery. Such testing is crucial in the time of internet forgeries, he said.

But testing, too, could use some innovation. For instance, they eventually could integrate testing equipment into the machines that manufacture

masks and other devices.

Aroom, Bentley and others in the institute are eager to turn more ideas and research into commercial products, if someone is willing to fund the research and development.

"We created the masks in record time," he said. "And people in hospitals are wearing them right now."



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