Professor creates self-folding, origami robots

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Sam Felton envisions a world in which temporary housing would autonomously constructed, and origami robots would fold themselves into 3-D machines for space exploration. Based on the research he's done—and the origami robots he's already built—his vision might not be as far-fetched as it would seem.

Felton joined Northeastern this fall as an assistant professor in the College of Engineering, after earning his doctorate in mechanical engineering from Harvard University. There, he worked with a research team focused on creating printable, foldable robots, with an eye toward getting them to fold themselves.

"We were able to make things that could walk on their own, but we weren't just interested in building a single self-folding item," Felton said. "The idea is to push the boundaries of what's possible in self-folding structures."

Now, the challenge is to build them so they can unfold as well.

Felton was the lead author on a paper published in the journal *Science*, which explored the method he and his collaborators established for building self-folding machines. The idea is based on origami, the Japanese art of paper folding.

Appropriately, his robots are made of paper—though the paper is sandwiched between layers of pre-stretched polystyrene. Any toy aficionado might recognize the pre-stretched polystyrene, as it's the same

material that makes up the popular Shrinky Dinks toy.

With the toy, children draw on large pieces of flexible sheets that are then placed into the oven to shrink down and harden into trinkets.

The self-folding robots use a similar heat-contracting mechanism. Strips of copper are placed along the fold lines of the robot. Microchips installed on the robot send electric current through the copper, making them heat up. When that happens, the polystyrene material contracts, causing the joint to buckle and fold.

Felton's newest challenge is finding a way to "scale up" the robots, which means getting away from using heat as the catalyst for folding.

"Now we're looking at hydraulics, pneumatics, and chemical reactions," Felton said.

The robots, he explained, could be used in a number of different ways.

"There are a lot of different options for them—the current research seems to be pushing for doing stuff at the micro scale, so getting the robot to fold itself is the only way to form these shapes," Felton said.

"But I'm really interested in expanding it to the very large scale, where it could be useful both for architecture and buildings that could assemble themselves as well as for space exploration, where it's very difficult to transport stuff up into orbit. So if you could compact the robot down by folding it up and then having it assemble itself, you could save a lot in cost and manpower."

Felton envisions the buildings being used as temporary shelter in places recovering from disaster. It's a futuristic idea, he said, but that's exactly the point.

"Purely from a research standpoint, a lot of it is this pie in the sky stuff—if it were possible right now, in the short term, there would be a company already doing it," Felton said. "So you have to pick these huge goals and work backward and figure out what the first step is."

More information: S. Felton et al. A method for building self-folding machines, *Science* (2014). DOI: 10.1126/science.1252610

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