From ventriloquist's dummies to turkey dinners, 3-D printing is heading home

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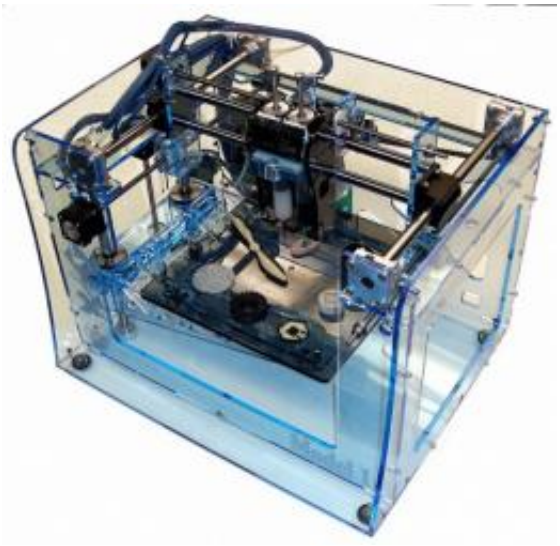

The Model 1 (above) is the first Fab@Home system. It includes everything necessary for basic, multimaterial desktop fabrication. It makes use of a basic "syringe pump"" material dispensing tool, with disposable syringes to enable dispensing of a wide variety of materials. Credit: Image courtesy of Fab@Home

When the ventriloquist Jeff Dunham wanted to make a new dummy for his show, he designed the character's head on his home computer and then printed it out in his workshop.

Using a rising technology known as 3-D printing, Dunham's printer laid down layer after layer of colored plastic until it formed the dummy's head.

Scientists at Cornell are printing out turkey dinners the same way. Several manufacturers are creating customized dental crowns, and others individualized artificial hips.

3-D printing has already begun to revolutionize manufacturing and now is on the verge of spreading out into home and office. And just as desktop computers created a revolution by moving computing from huge corporate-owned mainframes to everyone's desktop, 3-D printing is poised to do the same.

Those in the field call 3-D printing "additive manufacturing,", because it makes stuff by adding things together, with nothing left over. Whatever the name, the machines are getting smaller, the software more available, and the machines -- nicknamed fabbers -- cheaper, some under $1,000.

"In just a few hours, these mini-factory machines can produce a simple object like a toothbrush or make complex machine components, artisan-style jewelry or household goods," wrote Hod Lipson of Cornell University and Melba Kerman, a consultant at Triple Helix Innovation, in a report called Factory@Home for the U.S. Office of Science and Technology Policy.

The printers work like ink-jet printers except they spray plastics, metals, or almost any substance that can flow, onto platforms in very thin sheets. The layer hardens, the platform moves down slightly, and another layer is added. Like color printers with four or five different inks, the 3-D printers can have more than one substance.

A large industry is burgeoning around the technology, said Terry Wohlers, a Colorado consultant who specializes in the industry. Everything from small-startups to huge corporations is using 3-D printing to build prototypes, finished parts, or complete items, or to provide a printing service.

Nike designs running shoes on a computer and prints out prototypes, he said. Boeing has 3-D printed parts in ten of its aircraft. Thousands of printed devices serve as implants in human bodies, modified to each individual by simply adjusting the software, Wohlers said. The machines can turn out laboratory equipment, electronic devices and customized medicines.

Now some of the attention is turning to individuals and the home.

In Lipson's lab at Cornell, researchers are putting 3-D machines to work in the kitchen. With the help of New York chef Dave Arnold, they are constructing food. They can make it look like any design desired, write with it, or write on it.

The devices, about the size of large microwave ovens, work something like the "replicators" in Star Trek, where Capt. Jean-Luc Picard regularly ordered "Earl Grey tea, hot" and the hot tea and cup appeared instantly. The difference, according to Jeff Lipton, a graduate student in Lipson's lab, is that the fictional replicator made food from basic atomic elements, while the devices at Cornell need tubes of more complex liquid or paste ingredients, to put the food together. What goes in, comes out.

Not everything works, Lipton said. They worked with cheese, Nutella, hummus and, peanut butter. It didn't come out well. They tried using artificial ingredients. Ditto.

"Some people can accept a little artificiality and you can cross this valley where it is no longer food: it's gunk," Lipton said. In the early experiments, "we crossed that valley and came running back."

They tried some of the recipes Arnold helped design with the chefs at Cornell's esteemed School of Hotel Administration.

"They judged us harshly," Lipton said. But, he said, they are getting closer.

In the case of turkey, the tubes contained ground turkey and an emulsifier, Lipton said, the kind of "meat glue" used to make sausages. The turkey substance hardens after printing and looks, tastes, and smells like turkey, he said.

Lipton said that the biggest difficulty with replicating food is calibration.

"Two batches of cookie dough can have wildly different cooking properties." Getting the temperature right proved difficult. Even changing temperatures in the kitchen or lab could throw off the process.

Lipton said they are working on a feedback system that will allow the printers to calibrate themselves.

Getting temperatures right also was a problem at England's Exeter University, which prints chocolate. Chocolate is difficult to work with because the temperature has to be just right and the flow rate perfect. Using control systems designed at Exeter, users can design their own desserts.

There is little waste with any of these uses.

Not everyone is convinced all this will lead to 3-D printers in every home. It may, however, be a new way of doing business, bringing in an age of what economists call a "long-tail economy," in which companies deliver huge volumes of goods, but with small quantities of many items for its customers, something like the Amazon and Netflix models.

"The homeowner or the consumer will go on the web, will punch in the part number, it will available in digital form somewhere, or there will be

a service and it will be printed. That's how I believe it will unfold," said Wohlers.

Or, you go to the printer and order up "turkey, dressing, mashed sweet potatoes and Earl Grey Tea.

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