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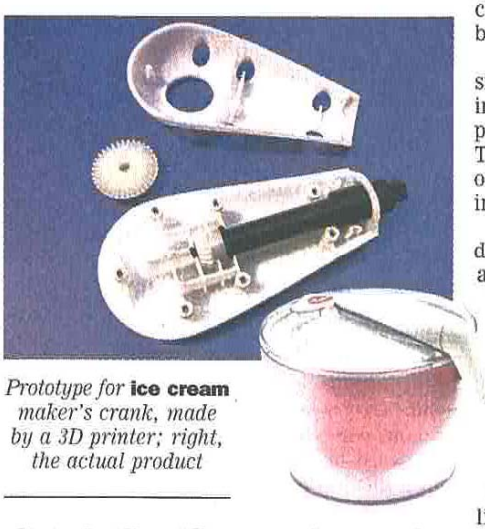
3D Printers Reshape World of Copying

By William M. Bulkeley

Toby Ringdahl, a computer-aided-design specialist at shoemaker **Timberland** Co., recently bought a color 3D printer from **Z Corp.** that allows footwear designers to see their constructions overnight rather than waiting a week for model-makers to carve them. The printer cost $50,000, but he says it was worth it. "People get pretty amazed when they see a full-color, prototype shoe on the table," Mr. Ringdahl says.

Computer printing is going three-dimensional. In the past four years, designers of a variety of products, including shoes and cellphones, have been buying specialized office printers costing $20,000 to $50,000 that can quickly produce a plastic model using computer-aided-design, or CAD, software.



Prototype for **ice cream** *maker's crank, made by a 3D printer; right, the actual product*

Though they resemble typical office copiers on the outside, these are not ink-on-paper printers. Rapid prototyping machines were pioneered by **3D Systems** Corp., of Valencia, Calif., nearly 20 years ago. They work by taking computer-aided-design data and using it to build a device layer by layer. Inside a 3D printer, either a print head shoots out plastic particles and glue, or an ultraviolet or laser beam passes over a liquid resin bath, hardening a layer of plastic, 3/100ths of an inch thick, in a computer-generated shape. Then the machine builds layer upon layer until the full model is completed, one to four hours later.

Now the technology is reaching ordinary consumers—even young ones. Later this summer, SolidWorks, a U.S. unit of **Dassault Systemes** SA, a French maker of design software, plans to start up a new business called Cosmic Modelz that will allow kids to use the technology to create their own customized action-figures.

Children can design a figure using SolidWorks' Cosmic Blob software on their home PCs, then go to a Web site run by 3D printer-maker Z Corp. and order their figures to be "printed" for $25 to $50. It will be kind of an electronic version of the Build-a-Bear Workshop concept where children create customized teddy-bears.

Making consumer toys is just the latest expansion of the rapidly growing 3D printing business. Rapid-prototyping machines used to cost well over $100,000, but some models are now under $20,000, prompting small businesses and high-school and college shop classes to buy them.

"Our technology mission is to make 3D printing as fast and easy as printing on paper," says Tom Clay, chief executive of Z Corp., based in Burlington, Mass.

Terry Wohlers, president of **Wohlers Associates**, a Fort Collins, Colo., market research firm, says 3D printing is the fastest growing part of the rapid-prototyping industry, which had revenue of $809 million in 2005, up from an estimated $705 million in 2004. Revenues come from services, materials and the machines themselves, which make models and specialized parts.

Some experts say within a few years hobbyists will have their own low-cost machines, many created by other 3D printers. Adrian Bowyer, a mechanical engineering lecturer at the University of Bath in England, says he is developing a 3D printer that, when connected to a PC, will be capable of recreating most of its own parts—allowing individuals to build new 3D printers for little more than the cost of the plastic resin.

3D printers can't replicate semiconductors

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New Copiers Create 3D Plastic Models on Demand

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or metal screws and bolts. But products made by printers should be as sturdy as the originals once they're assembled. Mr. Boyer predicts this could aid cottage industries making jewelry or home furnishings like hooks and vases, or even lead to homemade cellphones or digital cameras. He expects a 3D printer that can print itself might be ready in a few years. As the self-replicating machine spreads, "It will evolve," he says, with the most successful changes being widely adopted.

Large 3D printers can build models 20 in. high and 24 in. wide. To make bigger parts—for example, engine blocks—users can produce two halves and glue them together.

Industry leader 3D Systems, and No. 2 **Stratasys** Inc., of Eden Prairie, Minn., make some systems that are designed for rapid manufacturing of specialized parts. One system uses metal powder that is fused by a laser, layer by layer, to make parts with strength comparable to metal castings. The Army is studying using such systems in war zones to create replacements for broken parts of planes and tanks.

Timberland Co. ***shoe sole*** *designs produced by a 3D printer from Z Corp.*

Some designers use 3D printing as a communications tool. Eric Freitag, director of engineering services at **Smart Design**, a New York-based design firm that bought one of Stratasys's Dimension 3D printers, says "you like to think the client sees what you see" but that a drawing on a piece of paper doesn't always fully communicate a design concept. With a 3D model, "there's always a 'Wow' moment when they really get it," he says.

A number of U.S. companies say they use "3D faxing" to send designs to 3D printers at factories in Asia so manufacturing engineers have a clearer idea of what they're supposed to build.

Cheaper, simpler 3D printers are spawning new applications. Architects often design in two-dimensions, but model-makers like **Alchemy Models** Inc. in Phoenix are using 3D printers to make models to show architectural review boards what new buildings will look like. 3D printing companies say brain surgeons are using the machines to create models of patients' skulls to design protective metal plates.

At **Walt Disney** Co.'s Pixar Animation Studios, animators used a Z Corp. machine to make 250 models of "Toy Story" characters for a museum display. Warren Trezevant, an animator at Pixar, says his colleagues were so excited by the figures that the 3D printers produced that "We printed more for people's desks."