The revolution will be printed in 3-D

May 16 2014, by Dan Gordon

Three graduate students in architecture and urban design created a prototype of a 3-D-printed wrist splint, which could be used for quick, inexpensive and customized medical relief.

Three-dimensional printing is an increasingly important tool for industry and research, and the terminology as well as the technology is creeping into the consumer market. But what is it? And how are UCLA faculty and students using it to create everything from bone splints to stunning fashion?

The digital revolution has given us 24/7 access to every conceivable piece of information we might need (and much that we don't). You say you want a new revolution? Some believe we may be on the verge of one that's analogous: the ability to print anything, any time—not on paper, but in three dimensions. Shoes. Toys. Jewelry. Prosthetics. Pizzas. Apartments.

That's right, apartments. Last fall, in the Munich-based 3M futureLAB run by Peter Ebner, visiting professor in UCLA Architecture and Urban Design (A.UD), a group that included UCLA architecture students produced what they billed as the world's first apartment using only 3-D technology—fully furnished and complete with bedroom, bathroom, kitchen and living space, if a bit cramped at about 37 square feet. Ebner predicts that over the next two decades, 3-D printing will overtake construction in architecture as part of "the next industrial revolution."

You need something to wear for the revolution? Julia Koerner, an A.UD architect and lecturer, has broken new ground in a collaboration with Amsterdam-based fashion designer Iris Van Herpen and the Belgium-based 3-D printing company Materialise. Employing 3-D modeling to execute Van Herpen's two-dimensional designs—otherworldly creations by a woman whose pieces have been worn by Björk and Lady Gaga—Koerner has printed two dresses that have been modeled on the runways at the prestigious Paris Haute Couture show before going on display at major museums. "There are no limitations in terms of seams and cutting patterns, which gives you a lot more freedom to experiment," Koerner explains of the advantages brought by the 3-D technology, which she used to execute Van Herpen's design on a dress that gave the appearance of being created "of liquid honey," one critic observed.

Closer to home, three graduate students in A.UD used 3-D to print and then cruise around campus on a skateboard more intricately designed than traditional manufacturing could produce. The black, lightweight

plastic was shaped in the complex mineral skeleton of the radiolarian organism. "The skateboarding world is very interested in variety and customization," says Jac Currie, who designed the board along with fellow students Mo Harmon and Tas Oszkay. "This would also be easily replaceable, so if in the future 3-D printing is something that's done at home, people could print their own boards every time they broke one."

It's far from clear that any of the aforementioned applications will ever become routine, or that 3-D printers will one day be as indispensable as the Internet. But as the technology advances and prices drop, it no longer seems a matter of if, but how, 3-D printing will change our world. It's already got legislators on their toes: In January, a California state senator proposed a bill requiring background checks and registration for individuals who use 3-D printers to assemble firearms. The technology may offer the promise of replacing body parts—a Belgian company having provided a hint by printing a jawbone that was implanted into a patient in 2011—but it's already caused a stir for its ability to churn out a gun for someone who isn't supposed to own one.

How it works

Known more formally as additive manufacturing, 3-D printing uses computer-generated digital models to create three-dimensional solid objects—the printer following the shape of the model as it spews out the selected materials, layer upon layer. "If you can imagine a coffee cup that's sliced into one-millimeter sections, a 3-D printer, using a laser to heat resin, can 'print' each of those sections in 3-D," explains Koerner. "They would come out layer by layer, building out that shape." Among the technology's many advantages: By printing only the materials needed for the structure, it is greener than traditional manufacturing, where ample material is left on the factory floor.

The Voltage Dress designed by Iris van Herpen in collaboration with UCLA architect Julia Koerner

With 3-D printing, the geometric complexity of the object is no longer a barrier, or even an added expense. "The qualities germane to digital design—complexity, flexibility and variation—are difficult and expensive to realize using conventional industrial methods of production, but effortless and economical using 3-D printing," says Kivi Sotamaa, an architect and A.UD faculty member whose technology seminar and research studio focusing on 3-D printing resulted in the skateboard, as well as a host of other novel products.

Sotamaa believes that digital modeling, 3-D printing and tailored material technologies are precipitating a seismic shift in design and manufacturing. "Complexity, uniqueness and customization can potentially happen at high speed and industrial scale, enabling new, more complex and individualized products," he says. In this new paradigm, businesses that rely on materials transportation will increasingly be replaced by manufacturing based on digital transfer of files and local production. The ability to 3-D-print replacement parts on demand, as the U.S. military is already doing, provides a glimpse at a future in which

there will be far less use of the traditional factory, or need to hold inventory.

To your health

The technology is ideal for so-called rapid prototyping—allowing researchers to quickly create, test and refine their products. "It gives you flexibility in testing out new things and then creating something in a matter of minutes or hours that would otherwise take months," says Aydogan Ozcan, a UCLA professor of electrical engineering and bioengineering. Ozcan has used 3-D printing to create microscopes, sensors and diagnostic tools that are integrated onto a cell phone, bringing the testing capabilities of an advanced medical laboratory into field settings through compact, inexpensive and lightweight instruments. "Almost any engineering project starts with a simple design, then you encounter things you hadn't considered that you need to change," Ozcan explains. "That aspect of iteration and design is what makes 3-D printing so convenient—the feedback between design, testing and redesign is much faster and more cost-effective."

In the laboratory of Bioengineering Professor Benjamin Wu, senior Shannon Wongvibulsin is involved in developing techniques to create molds for tissue-engineering purposes such as bone and cartilage repair, capitalizing on 3-D printing's ability to accommodate the micro-architectures specific to each patient's injury and regeneration needs. Her project seeks to use sucrose—sugar that is cheap, nontoxic and easily dissolved with water—to print scaffolds that facilitate bone and cartilage regeneration. (In the future, she hopes to directly match the patient's injury as visualized in a CT or MRI scan.) The scaffolds act as a sacrificial template used to mold the biomaterials into "tissue-engineering scaffolds," prior to dissolving the sucrose.

In Sotamaa's technology seminar, three architecture graduate students

teamed to develop the prototype of a 3-D-printed wrist splint, which they hope will ultimately help to meet the needs of developing countries and disaster zones for quick, inexpensive and customized medical relief. The students—Derek Buell, Peter Nguyen and Nicholas Solakian—were inspired by a conversation with a disaster-relief physician who explained how prevalent and debilitating wrist and joint injuries are in poor and disaster-stricken areas. Their hope is that as 3-D printing becomes more feasible in these regions, it could one day reduce the time and expense of shipping the splints to areas that are in many cases remote. Their prototype—lightweight and intricate—considers both aesthetics and function.

A printer in every home?

Credit: UCLA Architecture and Urban Design

To be sure, 3-D has plenty of limits—in the materials that can be used, in the resolution of the prints and, most of all, in the cost. But as befits the pattern of other technologies, things are changing—fast. In addition to greater processing power and bandwidth, the printers are increasingly

expanding beyond the original focus on plastics to include nylons, metals, resins, silvers, polymers and other materials. With costs coming down, it's beginning to make economic sense to have a 3-D printer and use it on an as-needed basis, rather than holding inventory.

For the most part, the excitement of 3-D remains confined to commercial purposes. It's true that desktop 3-D printers in the home are beginning to become a reality—you can now get one for not much more than $1,000. But most of us won't be printing our own shoes or coffee mugs any time soon, if ever. That requires a high-end printer, and it doesn't make economic sense when companies can do it better and more efficiently. If you're looking to customize your shoes, Nike will do that for you, with a lower cost and better outcome. "For simple things that don't have to be super-high quality, I could see [homemade products] happening," Ozcan says. "If it's anything more complex, you go to a vendor."

But don't be surprised when you begin to encounter businesses selling replacement parts that can be printed, rather than shipped. Or to find companies using 3-D printing to provide you with the ability to customize your products. "With 3-D printing, unlike with other manufacturing, there's no massive cost increase when you change the design," says Andrew Raffel M.Arch. '13, an architecture graduate student in Sotamaa's technology seminar. "Rather than changing all of the tooling and processes, you just adjust the digital file and resend it to the printer." Raffel and fellow student Ryan Hong M.Arch. '13 used 3-D printing to develop a flexible, nylon-polymer motorcycle glove—designed for optimal grip, comfort and protection, and easily customizable for a market that has known little variety.

Make no mistake: Traditional mass production techniques will continue to have their place. "3-D printing is never going to be as efficient as an assembly line at building large batches of a standardized product," says

Guillaume Roels, who teaches operations and technology management at the UCLA Anderson School of Management. "But it opens the door to mass innovation, where the competition is less about manufacturing ability and process management and more about intellectual assets—imagining and creating new products."

Roels draws parallels between the digital revolution and the changes likely to come through 3-D printing. "As soon as you had the Internet, that became a platform for a huge increase in innovation, and innovation nurtures growth," he says. "Who knows—there may be a second Silicon Valley coming out of this."

With the declining cost continuing to put 3-D into more hands, Roels believes we may have come to a tipping point. "So far, this has just been for the early adopters," he says. "But as the price drops and more people begin to use it, you start to have a proliferation of new ideas and approaches. 3-D printing was a dream five years ago, it's a reality today, and it will be a widespread reality very soon."

Provided by University of California, Los Angeles