The Power of Print

3D printing continues to evolve in exciting ways aimed at improving our health.

March 3, 2016 By Kate Ferguson

When Dr. Anthony Atala, director of the Wake Forest Institute for Regenerative Medicine in Winston-Salem, North Carolina, showed a 3D-printed, life-sized kidney structure several years ago at a TED Talks conference, the audience was awestruck. Even though the organ wasn't ready to be implanted into a live person, the demonstration proved that a 3D printer could produce a human organ.

The kidney was made of human cells and looked pink, a little like a raw chicken cutlet. Dr. Atala said the 3D printer created the organ in about seven hours, but that the kidney wasn't functional, because, like tissues and other complex organs, the 3D-printed kidney would have required an extensive network of blood vessels to keep the organ's cells alive.

To date, although researchers have had limited success creating 3D-printed blood vessel networks, they're still unable to print functional complex organs because they can't print both components together.

As scientists perfect 3D-printing technology, each advancement is like a signpost leading to the ultimate goal of printing a fully functional organ ready for transplant. But most scientists agree that this breakthrough is still many years in the future.

Closely related to 3D-printing organs for transplant into the human body is using handheld 3D printers to repair organs that are damaged, diseased or functioning improperly. At Wake Forest, teams of scientists in the first phase of the Armed Forces Institute of Regenerative Medicine (AFIRM) study designed a 3D printer to print skin cells on top of burn wounds. These researchers used a bioink created from different kinds of skin cells. After a scanner determined the size and depth of the burn wound, the printer applied layers of the correct type of cells found at different levels of the injury.

Although the research is being conducted for the military, this 3D-printing technology would also benefit civilian burn patients. The patient would lie on a bed with his wound underneath a flatbed scanner. Then, printheads on the 3D printer would print layers of skin cells at their correct level in the wound directly onto the patient's body.

In the second phase of the AFIRM study, Wake Forest researchers will work on using 3D printing to

develop tissues to replace bone, nerve, blood vessels, fat and muscle to help soldiers—and sometimes civilians in war zones—suffering from head and face injuries caused by high velocity weapons.

Researchers are also studying how to repair organs inside the body by using 3D printers and bioink composed of cells to create patches of healthy new tissue to place on damaged areas. “The promise for tissue therapies that cure disease, with reduced risk of immune rejection, made on demand from cellular building blocks rather than waiting for a limited supply of donor tissues, is a vision we are passionate in pursuing,” says Organovo, a biotech company based in San Diego, California, and one of the leaders in the field of 3D-printed human tissues.

Last year, Organovo partnered with L’Oreal, a beauty industry leader, to develop skin tissue for testing product safety and performance. “Organovo has broken new ground with 3D bioprinting, an area that complements L’Oreal’s pioneering work in the research and application of reconstructed skin for the past 30 years,” says Guive Balooch, global vice president of L’Oreal’s technology incubator.

3D printing will also make advancements in cosmetic surgery possible. According to one science site, researchers are working on face printers that could scan our faces at a young age and save the image for reapplication every few years so people could look ageless.

But Organovo’s scientific founder Gabor Forgacs, PhD, the George H. Vineyard Professor of Biological Physics at the University of Missouri-Columbia believes scientists may never create 3D-printed complex organs. Instead of trying to copy natural organs as they are, Dr. Forgacs thinks scientists should pour their energy into improving the functionality of complex organs, such as the heart or liver. “We are fantastic engineers,” he says.

One speculative researcher, Agatha Haines, agrees. Speculative research considers ideas that are theoretically possible but regarded as unusual or strange by scientists in the mainstream research community. “A lot of my work is about the weird and wonderful things that exist inside our bodies and the potential for design around those things,” Haines says.

In 2014 at the Design Indaba Conference, Haines presented a number of speculative designs to improve functionality of the human body, some of which included unique organs created via 3D printing. Her designs combined properties from different body parts and even different species to create fantasy organs meant to address various health issues. One of Haines’ designs was for an organ she named the “electrostabilis cardium,” which would use parts from an electric eel to discharge an electric current to the heart to stop a rapid or irregular heartbeat. “I was imagining things we have in nature that we could put together to create new functions,” she says.

Haines views herself as a modern-day Dr. Frankenstein and believes 3D printing could allow scientists to create body parts for human beings that are better than the ones we currently inherit when we’re born.