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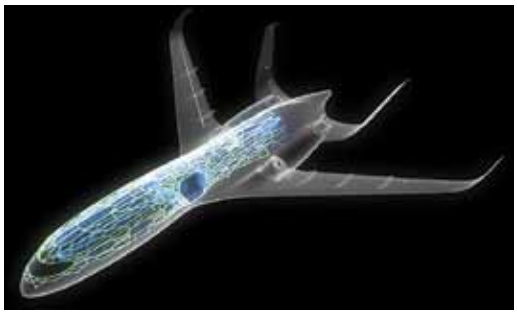
3D Printing Primed to Change the Future

Throughout history there have been technological developments that have had significant world-changing impacts their inventors never envisioned. A technology that has only existed for 36 years is now changing manufacturing, construction, biotechnology, medical technology, nanotechnology, and even our future source of food.



Airbus APWORKS

Photo 1 (above)—The Airbus bionic partition is the world's largest airplane cabin component to be 3D printed. It is 45% lighter and made of a new high-strength metal alloy.

Boeing

Photo 2 (left)—This Boeing air nozzle was manufactured by a 3D printer.

3D printing is impacting all the above while staying true to its simple definition of creating three-dimensional objects from digital files, one thin layer at a time. It has gone from a new way of building models and prototypes to a new way of building anything. This metamorphous occurred when 3D printing expanded from printing plastic to printing metals, concrete, biological cells, organs, and even food.

The most obvious way that 3D printing changed manufacturing was by simplifying the way new designs are created and modeled. Once it became possible to quickly go from a design to a prototype for testing and evaluation, it became possible to quicken the pace of bringing new products to market. This shortened the time between product updates, and allowed manufacturers to quickly bring new and updated models to market.

Since the newest 3D printers can now print metals, including titanium, they are able to create parts that are lighter than but just as strong as the original (Photo 1). In many technology areas 3D printing is becoming the manufacturing process. This change to additive manufacturing is accelerating in the areas of health care, aerospace, automotive, energy, and even consumer goods.

At this very moment rocket engine parts, molds for industrial injection processes, turbines, airplane assemblies, and thousands of other parts and objects are being fabricated by 3D printers (Photo 2). The method of fabrication is now determined by performing a cost analysis to determine the cheapest way of producing what is needed. One day soon many replacement parts will no longer be inventoried, they will be printed on demand when they are needed.

Most new homes and buildings start out as a set of architectural drawings on a computer. A new breed of 3D printers can turn these drawings, one layer at a time, into buildings. It only took a 3D printer 47 hours to build the small house shown in Photo 3. Figure 1 shows how the 3D printer could move from plot to plot and build an entire street full of houses in a matter of weeks. This CBS *This Morning* video report (youtu.be/zIq58e6phPQ) shows the 3D printer in action.

The construction of buildings by 3D printing is the perfect way of building inexpensive small homes quickly where they are needed; one can expect this form of 3D printing to mature quickly. In short order we can expect the 3D printers to grow in size, and the physical size of the

ICON

Photo 3 (above)—It only took 47 hours for a 3D house construction printer to build this house.

ICON

Fig. 1 (left)—The construction 3D printer builds the home by laying down one thin layer of concrete at a time at the location indicated in the architectural build file.

Photo 4 (right)—The astronaut holds the first tool created by a 3D printer in zero gravity.

Photo 5 (below)—In zero gravity, this Russian Cosmonaut used a bioprinter to print living human cartilage tissue. Astronauts and Cosmonauts are determining the feasibility of using 3D printers to produce what is needed to fix the craft and crew during deep space missions.

NASA

Roscosmos

building that they construct to have no limits. This technology also allows for much more architectural freedom when it comes to designing structures that appear to defy gravity or blend in with nature.

It is impossible to pack a rocket with all the replacement parts that might be needed on a deep space mission. NASA and other nations plan on using 3D printing to allow astronauts to build replacement parts when they are needed. Photo 4 shows an astronaut with a wrench which was the first tool printed in space.

Photo 5 shows a Cosmonaut removing living human cartilage tissue from a bioprinter. Deep space missions will rely on 3D printing to meet all kinds of replacement part needs and eventually also produce the materials needed to fix injured astronauts. The goal is to also have a special 3D printer on board that can combine food ingredients and print out more enticing and less boring food for astronauts to eat.

Alan Pierce, Ed.D., CSIT, is a technology education consultant. Visit www.technologytoday.us for past columns and teacher resources.

Watch youtube.com/watch?v=CNwqetNPED0 to see how food is already being printed here on earth. NASA has awarded a research grant to Systems and Material Research Consultancy to develop the feasibility study of using 3D printing to make food for astronauts to eat in space.

To create medical 3D-printed implants, digital CT and MRI scans are converted into the build files that are sliced up into thin layers, so a medical 3D printer can print the body part. Since it was created from the scans of the recipient, it is a perfect match ready for surgical implanting.

The bio 3D printers that have been developed build living tissue by laying down layers of different living cells that are found in organs, vessels, and skin. When the cells are put together, in a temporary dissolving lattice, they start to work together as they would in a living organism. With funding from the US Army, Wake Forest School of Medicine researchers have built a bio 3D printer that can print skin which could be used to help burn victims and wounded soldiers.

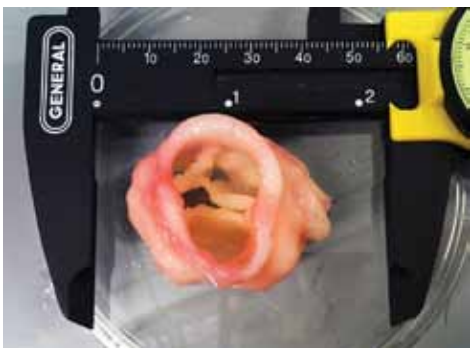
Bio-medical researchers at Harvard University have successfully printed blood vessels. At Cornell University researchers have printed a working heart valve (Photo 6), and at Princeton University researchers have used 3D printing to create a human ear. A February 2019 Pharmaphorum report discusses many breakthroughs including the printing of human heart tissue. Printing full human organs is still at least ten years away but companies like Organova are already bioprinting living human tissue that can be used to test the safety of new medications (youtu.be/s3CiJ26YS_U).

Printing living organisms is much harder than printing food. Industrial bioprinters can create vertically grown t-bone steaks by printing, in their proper location, the different types of lab grown cow, pig, or chicken cells. Even if it tastes the same as real beef, it is not clear how many people will purchase it. However, a UN prediction estimated that the population of the Earth will reach 9.6 billion by 2050. I imagine that the only way to place steak on peoples' tables in 2050 will be by bioprinting it on an industrial scale.

Taking It a Step Further

1. Select a small toy or simple, non-electrical mechanical device that has multiple parts. Using 3D printing software such as *Tinkercad*, design a part that can replace one its parts. Download *Tinkercad here:* https://www.tinkercad.com.

2. Working in teams of two or three, look at the impact 3D printing is having on a particular technology category, such as engineering, agriculture, communications, construction, manufacturing, transportation, or energy and power. The final report can be written, a video, or a PowerPoint presentation.



Cornell University

Photo 6—The 3D-printed sheep heart valve created at Cornell University is a giant step toward one day being able to bioprint replacement organs.