

### 3D Printing

A 3D printer is a device that enables you to create a three-dimensional object by creating it layer by layer. A layer is a thin cross-section of the object you are building. Each layer is attached seamlessly to the layer beneath it until the whole object is built. Even though there are different kinds of 3D printers, they all work the same way in that you need to begin with a computer-aided design (CAD) file, which provides the blueprint that the 3D printer uses to create the object. You can either create this CAD file using special 3D modeling software, or you can scan an actual object and create the CAD file that way. Then the software in the 3D printer “slices” the design into really thin horizontal layers, like a meat slicer does to a thick ham at the supermarket. There can be hundreds of these slices, or even thousands. Then the 3D printer “reads” the exact specifications of each slice and transforms the material into the exact specifications of the slice. The materials can be plastic, gold, other materials—even chocolate!

When a sculptor carves a statue, he is using what is called a subtractive process. This means he starts with a big block of stone or marble or wood and cuts away material until what is left looks like the thing he is carving, such as a bear. The industrial versions of this are cutting, milling, and machining. When a 3D printer is used, it is using an additive process. This means that the person starts with nothing, then adds layer after layer (using the instructions from the software) to build up the object you are creating.

If you don't own a 3D printer, you can still use one. There are several companies that let you upload your CAD file and they will “print” the object for you and send it back to you.

At Nike, they use 3D printing to “print” prototypes of new shoe designs using materials very much like the ones that will make it into the sneakers. If they don't like the way the prototype turns out, they can change the design in the software and print a new prototype. This way, they save thousands of dollars and many weeks of time. Other companies use 3D printing not to make prototypes but actual objects, such as jewelry and some kinds of clothing, that people buy. There is a company called RepRap which sells 3D printer kits that let you assemble your own 3D printer for around \$1,000. (One day, you might be able to buy a kit, assemble the 3D printer, then have it create more 3D printers!) Google has some freeware for creating CAD files so you don't even have to buy expensive commercial-grade software. One technology used in 3D printing is called stereolithography (SLA). The way it works is that a beam of UV light is concentrated on a vat of photopolymer resin, making it soft. When a bead of that resin is drawn out of the vat it hardens in the light, creating the slice. Another technology used is called Fused Deposition Modeling (FDM). FDM uses extrusion, pushing a beam of melted thermoplastics into a layer, then adding another layer. FDM is used in such products as LEGOs that are made of ABS plastic or biodegradable polymer. Another method is called Selective Laser Sintering (SLS). SLS is like SLA but instead of using liquid in a vat it uses powders such as glass, nylon, ceramics, or metals. The powder is fused (the technical term is “sintered”).

## Document 6.1 | Draft of the Description of 3D Printing

3D printing is now used in medicine, where researchers are starting to create human tissue and, eventually, entire organs. Pharmaceutical companies are also using it, as are architects who are creating 3D models of buildings without having to make them out of cardboard or other materials. Artists were among the first people to see the potential for 3D printing, turning CAD files into unique, beautiful objects out of all kinds of plastics and metals. Archaeologists are creating 3D models of priceless fossils for use in schools and museums. There is even a 3D replica of King Tut's tomb!