the evolution of plastics in education: 3D printing

by Dan Trent

back to contents

One of my favorite toys as a child was called a Thing Maker. It was great for making plastic insects, fishing lures, troll dolls, and many other "squishy" objects called Creepy Crawlers. The idea was to squeeze different colors of liquid "Plasti-goop," probably a plastisol plastic, into a metal mold. You then "cooked" the lizard, or spider, or troll head on what was essentially a hot plate until it became a solid rubbery mass. The mold was then cooled in a water bath before removing the properly "cured" item. I made dozens of the Creepy Crawlers and used them to frighten my friends, my parents, and of course, my teachers. It really was a lot of fun!

Figure 1. http://www.ebay.com/itm/Vintage-Working-1964-MATTEL-THINGMAKER-CREEPY-CRAWLERS-Original-Packaging-/282207494637?rmvSB=true

In February of 2016 the Mattel Corporation announced that it was reintroducing the Thing Maker, some 50 years after the original. The "new" Thing Maker is a 3D printer! As reported in *USA Today* (2016), Mattel has partnered with Autodesk (the computer-aided drafting software folks) to produce a 3D printer and interface that will sell for about $300. My favorite "old" technology has evolved. Three-dimensional objects may now be "printed" rather than "cooked!"

3D printers are quickly becoming common fixtures in classrooms and laboratories at schools around the world. There has been an explosion of 3D printing in the past five or six years in the United States. If you have visited a professional conference or education trade show recently, you have no doubt seen many models on display. They come in a variety of sizes, configurations, and price ranges. They are an invaluable asset in teaching almost every subject—well, at least that is what the vendors tell us.

Most of us have a conceptual idea of how the 3D printing process works. According to 3D Printing.com (n.d.), 3D printing is the additive manufacturing process of making three-dimensional solid objects from a digital file. Essentially, a 3D printer is a machine that prints a three-dimensional object rather than a two-dimensional image. Imagine the toner that a traditional printer or copier deposits on paper as a thin layer of plastic. Imagine, further, that the copier makes multiple passes over the same sheet of paper building up layers of plastic, one on top of the others, until an object is formed. Another way to think of 3D printing is to envision a medical MRI in reverse. An MRI makes an imaginary "slice" through an object creating a visual image of a very thin section of the body part or object being examined. If each of these "sliced" images were cut from the paper and stacked atop one another, in order, a 3D model of the part would emerge.

This technology has been around for quite some time. Additive manufacturing has been used in industry for over 30 years, and 3D printers have been marketed to educators for nearly two decades. The BIG question remains: Is there a place for 3D printing in the classroom? It is a neat idea and looks like fun. But does it serve a useful purpose for our students? I admit that I am a late adopter and was dubious for many years. Early versions used liquid-based systems that were very expensive, agonizingly slow, and produced objects that were fragile and not very durable.

The technology has improved, and the cost has come down over time. But I still questioned the return on investment. My tipping point came at an ITEEA Conference in Milwaukee in 2015. I went on an educational tour of Joy Global, manufacturer of giant surface mining shovels (think Mike Mulligan's steam shovel on a massive scale). They used 3D printers to quickly build parts for their scale models before prototype construction. The engineer who led the tour showed us a spool used to hold the cable that raised and lowered the shovel. The spool was "printed" in just a few hours at a cost of less than five dollars. The same part would require hours of machining and cost several hundred dollars if made from metal. When questioned about the durability of 3D printed parts, the tour

Figure 2. https://www.makerbot.com/products/3d-printers/

guide told us that if a plastic part broke, they would just spend another five dollars and possibly use a more robust plastic filament. I finally got it! If a major manufacturer like Joy Global thinks 3D printing is practical, so do I!

I still find it astonishing to be able to draw or design a part with CAD software and then, almost instantly, actually produce a physical model in my lab. I can build the model from a number of different materials. The "filament" used to create these models comes in a variety of different materials and colors and looks like replacement string from a string trimmer. The most common and widely available filament materials are polylactic acid (PLA) and acrylonitrile butadiene styrene (ABS) plastic. Both will produce good quality plastic models. Other specialty filaments include nylon, polyethylene terephthalate (PET), thermoplastic elastomer (TPE)—a more rubbery plastic, wood-impregnated plastic, electrically conductive ABS plastic, ceramic (clay engineered for 3D printing), carbon-fiber reinforced PLA, magnetic iron, steel-infused PLA, and more. You can probably find a filament to match almost any application.

Most 3D printers require stereolithography (STL) files in order to print models. These files can be generated (or exported) using most commercial drawing software packages (SolidWorks, Autodesk AutoCAD Inventor, etc.). Several free and open-source design tools also generate STL files (Sketchup, Blender, Wings3D, TinkerCAD, etc.). Many of these drawing applications are intuitive and simple to learn. You will likely be able to create your own models in no time! Autodesk 123D (www.123dapp.com/) offers a host of design options, including 123D Catch that allows you to generate 3D models from photographs, 123D Circuits to aid you in electronic projects, 123 Sculpt+ to create 3D sculptures on iPad, and more.

But you do not need to be able to draw or design your own 3D parts. There are thousands of free files available on the web encompassing almost every subject imaginable. Fossils are very popular STL downloads. A vast collection of free, searchable fossils may be downloaded from GB3D Type Fossils (www.3d-fossils.ac.uk/). The models originate from British science museums and provide students everywhere the opportunity to examine fossils without fear of damaging them and reducing the "ick" factor of handling dead critters. The Makerbot Academy (www.makerbot.com/) is another terrific resource for teachers. They offer some great downloads, including a saber tooth tiger skull, the great pyramids of Giza, a frog dissection kit, and more. Makerbot Education (www.makerbot.com/education/) publishes a guide to integrating 3D printing and design into the classroom and into assorted curricula.

Thingiverse.com (an "offshoot" of Makerbot) claims to be the world's largest 3D printing community. They have over 1.6 million 3D models that can be printed "as-is" or modified using Thingiverse apps (www.makerbot.com/thingiverse/). NASA has a site where you can download printable asteroids, the Hubble space telescope, the lunar rover, space ships, Apollo moon landing sites, and much more (https://nasa3d.arc.nasa.gov/models). Other sites with free STL file downloads include Grabcad (Grabcad.com), Autodesk123d (www.123dapp.com/), NIH 3D Print Exchange (http://3dprint.nih.gov/), and many more. Do a Google search for "free STL file downloads," and you will be amazed at the results!

You do not need to own a 3D printer to make 3D models! There are 3D printing services available online that will print objects on your behalf. The most popular are Shapeways (www.shapeways.com/), i.materialise (https://i.materialise.com/) and Sculpteo (www.sculpteo.com/en/). The UPS Store (www.theupsstore.com/print/3d-printing) offers 3D printing services at more than 60 locations. You can design your model using one of the design packages mentioned above or select from a wide range of available models. What are the benefits of using a printing service? You have the capability to print objects in a wider array of materials and/or colors. You can send scans, photographs, STL files or even physical objects to the printer service for reproduction. The service takes care of all quality control issues for you. A 3D printing service may be a convenient option to consider before "taking the plunge" into purchasing your own printer.

back to contents

conclusion

It takes some effort to keep up with technology. Remaining technologically literate is a lifelong process. Sometimes we mistakenly believe that we have "kept up" only to find that we were wrong. That was my experience with 3D printing. I did not think that my old Thing Maker was still state of the art. But I certainly didn't realize that it had been replaced by 3D printing! I also was surprised to find that I could produce 3D models without owning a 3D printer by using an online printing service. The popularity of 3D printing has led to the proliferation of STL files available at no cost on the web.

If you are in need of a three-dimensional model as a teaching aid, there are solutions to almost every conceivable need available with a few clicks of the mouse—even if you do not have access to a 3D printer! Even though I was a bit "late to the party" when it comes to 3D printing, I encourage everyone to look into the options available. Download an app or some free software, design or search for a 3D model, print it yourself or have it done for you at a UPS Store or other online service. Once you give it a try, you may be "hooked" and wonder how you ever taught without utilizing this amazing technology!

references

3D Printing.com. (n.d.). *What is 3d printing?* Retreived from http://3dprinting.com/what-is-3d-printing/

USA TODAY. (2016). *Mattel resurrects ThingMaker as a 3D printer.* Retrieved from www.usatoday.com/story/tech/columnist/baig/2016/02/12/mattel-resurrects-thingmaker-3d-printer/80236104/

Dan Trent, Ph.D., *is the CAD Program Leader in the Department of Engineering Technology at Mississippi Valley State University. He can be reached at Dan.Trent@mvsu.edu.*

Children's Technology and Engineering Peer-Review Option

The *Children's Technology and Engineering* journal now offers a peer-review option for publication. At the time of submission, contributing authors will have the option to request that manuscripts undergo peer review prior to publication. Before submitting, potential authors should consult the themes and subthemes for specific issues and indicate interest in covering a particular topic by emailing kdelapaz@iteea.org.

children's technology and engineering
A Journal for Elementary School Technology and Engineering Education

The theme for Volume 21 (2016-17 school year) is:
A Focus on *Standards for Technological Literacy*,
with the following subthemes for future issues:

21-3: Design and Abilities for a Technological World
21-4: The Designed World