AUTODESK UNIVERSITY

MP20597

3D Printing—Examining the Reality and Possibilities

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Learning Objectives

- Learn the process of rapid prototyping and its applications.
- Discover real-world applications of 3D printing and how you can make use of them.
- Discover tools available that can be used to create and deploy 3D-printable models.
- Discuss the future of 3D printing and its growing applications in the design industries.

Description

Whether it's being used in rapid prototyping and consumer products or small-run manufacturing, 3D printing has become an important part of the workflows of many hobbyists, artists, engineers, and fabrication companies. This course is a discussion of the landscape of the 3D-printing industry, and how to break through the hype that surrounds it. You will discover how 3D printing is being used in the real world for both personal and professional uses. From creating art to engineering prototypes, this course will also explore the expanding use of 3D printers and their place in an enhanced design workflow. Finally, we'll look at the practicality of how you can gain immediate returns from 3D printing your designs today.

Your AU Expert

Steven Schain is the postproduction supervisor for all CADLearning products from 4D Technologies, specializing in the development of Media & Entertainment CADLearning products for Autodesk, Inc., software, including 3ds Max software and Maya software. In 1998, Autodesk recognized Steven as one of only 16 Autodesk Training specialists worldwide. He has since contributed to Autodesk's certified courseware for 9 releases of 3ds Max software, was a co-developer of Autodesk's ACI Program and 3ds Max software's fundamental standards, and is currently an Autodesk Certified Instructor. As a premier Autodesk trainer, he has continued teaching end users, companies, and many others, including The Walt Disney Company, Guess, and the United States Army. As a 6-year veteran of Autodesk University, Schain has taught classes ranging from creating particle fountains in 3ds Max software, to classes on 3D printing and entrepreneurship.

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Contents

What is 3D Printing?

Definition

Rapid prototyping is a relatively new field in the design and manufacturing industries. By utilizing rapid prototyping, companies can create models of 3D designs using a number of prototyping techniques.

3D Print courtesy of Rapid Prototyping Services, LLC

There are several reasons a company would use rapid prototyping.

First, a company can quickly create an iteration of a new design, which allows them to test and retest a complete finished part without the expense of manufacturing. Using this process, a company or engineer can mock up a design, test features, evaluate form and function and perform other tests, like conducting a focus group, in order to evaluate the design of a new product. Having the ability to quickly alter the design and create a new version at a low cost makes it easier for companies to create better designs.

The second application of rapid prototyping is the creation of parts that will be used in the field. For many manufacturing companies, creating parts for a short run, say 25 to 200 pieces, can be costly. If it is a standard part, such as a connecting tube with flanges that would normally be molded from ABS plastic, rapid prototyping can save thousands of dollars. With materials capable of withstanding high pressure that are also strong and flexible, parts can be made that meet very rigorous standards.

A third application of rapid prototyping is the creation of fixtures that can be used during the manufacturing process. Take, for example, an assembly line where people are installing components into a small part. An engineer can spend the time to design a tool that holds the part properly, but it still has to be made. This is where rapid prototyping can be used to deliver low-cost, reusable fixtures for the assembly line. If the design of the fixture were to change, the fixture can be easily recreated and replaced with the new design.

Lastly, rapid prototyping is within the reach of nearly anyone with a computer and an idea. This opens the door to a future where you can just print a replacement part for a broken toy, create your own unique model, or even design your own custom chess set.

As a process, rapid prototyping has the ability to make the job of a designer a little easier by allowing him or her to focus on the design. It also provides a way for companies to save on manufacturing costs for low-quantity items, and it can increase productivity in many areas of the production industry.

What's the Hype?

Although the promise of 3D printing is extremely bright, there is still a lot of hype surrounding 3D printing and the use of it in various industries. 3D printing has been touted as the beginning of the end for manufacturing, the road to creating replacement organs, and the best thing since sliced bread! Be wary of the hype; there's a lot out there. Thankfully, over the past few years, the hype has simmered to a low rumble, but it's still there.

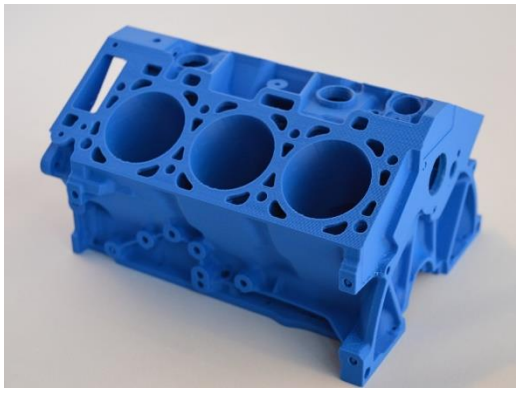
3D printing has been adopted by a large number of industries, with quite a thrilling outlook on the future. But that future has changed from even a year or two ago. In 2009, consumer 3D printing was relegated to the enthusiast, and it was years until truly consumer-useable 3D printers were available. Even today, that market is still just a tiny part of the overall 3D printing marketplace. Where there was once the promise of a 3D printer in every home, the reality is that the industry just isn't there yet.

However, with today's medical innovations and the experimental use of 3D printing in medicine, there's talk of printing new livers, even hearts! While that may be one possible future, it is far from the reality we see today. That's not to say that 3D printed knee replacements, 3D bioprinted human tissue, and windpipe stents are not amazing things, however, they are far from the hype in their current state.

3D printing is by far one of the most amazing technologies to come along in the 20th and 21st centuries. We need to look at the applications with one foot planted firmly in reality. And today's reality, while very cool and cutting-edge, still has a way to go to catch up to the hype.

Process of 3D Printing

The principle of rapid prototyping involves the idea that you can take a 3D model and build it using successive layers of a material. This is also known as 3D printing.



FDM PRINT FROM A FUSION 3 DESIGN, F306 3D PRINTER

First established in the early 1980s, neither the concept nor process of 3D printing has changed much over the years. What has changed, however, is both the price and the technology used for creating a 3D printed model.

The process begins with a designer, engineer or artist creating a 3D model in one of the many design programs on the market today. That model is then saved out to a format that will be used by the 3D printer, generally an STL file.

The printing process uses software specific to each printer, though they all do basically the same thing. The printing software takes the STL file data and slices it into layers that the printer is able to print.

Different printers use one of a handful of 3D printing processes. A majority of the 3D printers used in rapid manufacturing use a plastic filament that is laid down one layer at a time using a heated print head; others use ultraviolet light to cure layers of plastic resin; and some lay down a layer of fine material in an inkjet-like process that sprays a polymer to create the layer of the model. No matter which method you use, the process is generally the same.

What Can You Do with Your Model?

Printed parts can be used in a number of different applications. If you would like to test a concept or evaluate a design, a printed part is a great place to start. By creating a printed prototype, you can analyze many elements of the design and modify the part as necessary without the expense of traditional prototyping. A 3D printed part is also a great way to help you establish a new process.

With the high quality of available materials and the high degree of precision that many printers are capable of producing, printed parts can also be functional components. Using printed alternatives for pieces is particularly useful when you are designing a small-run of a part. Using a printer to create small parts can save design and engineering firms a great deal of money.

There's one thing about 3D printing that can't be overlooked, it is simply a fun way to create. When 3D printing, if you can think of an idea for an invention, a piece of art, or anything else that you can dream up, you can bring it to life.

Traditional Workflow

TRADITIONAL MOLDING PROCESS DIAGRAM

In the past, when you worked in design or product development, you went through a multi-stage process. After part development, you would have to create a part mold. The mold would then be used

to create your finished product. If the part wasn't produced accurately the first time, there was often a considerable amount of cost involved in both material and time to rework the concept.

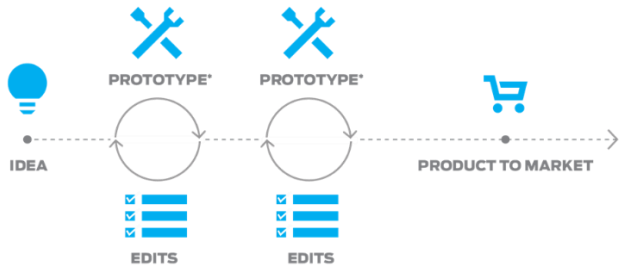
TRADITIONAL PROTOTYPE PROCESS. (IMAGE COURTESY OF MAKERBOT)

Traditional prototype creation can take days, even weeks to get a model built to specifications. Models were often made by hand from a variety of materials, like clay, paper, Styrofoam and a host of other options. Ones that were machined were made on lathes, or on more modern CNC machines.

The problem is the design process has to slow down to accommodate the prototype creation process, often leaving little time or money for redesigns and modifications. Cost is another issue that traditionally has limited the number of prototypes that can be created. Machining a part can cost hundreds, if not thousands of dollars.

Once the prototype is created, it can be tested and reviewed, then compared to the desired result. Edits and changes are then incorporated into the design, and the process starts all over again, taking more time and financial resources. With the traditional method of prototype development, many products get to market with flaws or design elements that are undesirable, or worse, cause the failure of a product after it has been brought to market and sold to customers.

Rapid Prototyping Workflow



REAL-TIME PROTOTYPE PROCESS. (IMAGE COURTESY OF MAKERBOT)

With the introduction of 3D printing into the design and engineering workplace, the prototyping process underwent a dramatic change. No longer would the prototyping process be the drag on the design of a part. Instead, it would greatly enhance the process and reduce the time it took to get a part from the idea stage to the production stage.

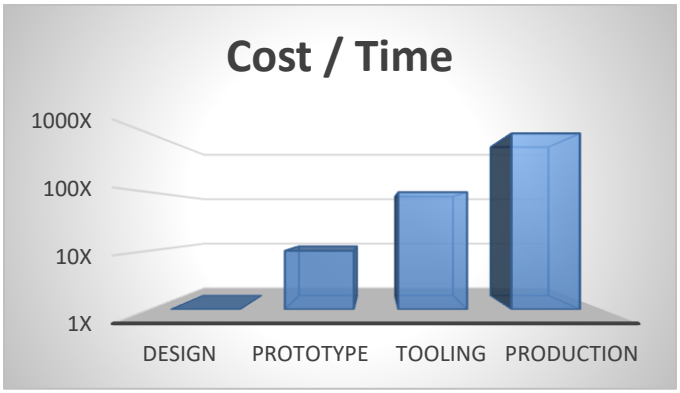
Instead of weeks to get a prototype back from being created, it now takes hours or days. Not only is the time reduced, but what once cost hundreds or thousands of dollars, now costs significantly less, even just a few dollars. The reduced time and cost allows designers and engineers to work in near real-time, with the design and prototyping functions happening at nearly the same time.

Real-time prototyping, with only a few hours separating the design from the prototype, is radically changing how designers and engineers work from day to day. With 3D printing, often at or near a work area, a product that in the past may have undergone two or three prototypes, can now have a dozen or more prototypes created.

The increase in the number of prototypes and the reduction in cost has given designers and engineers a new found freedom. Combined with the power of Autodesk Inventor, and its powerful features, you are freed to create better, more tested designs than ever before.

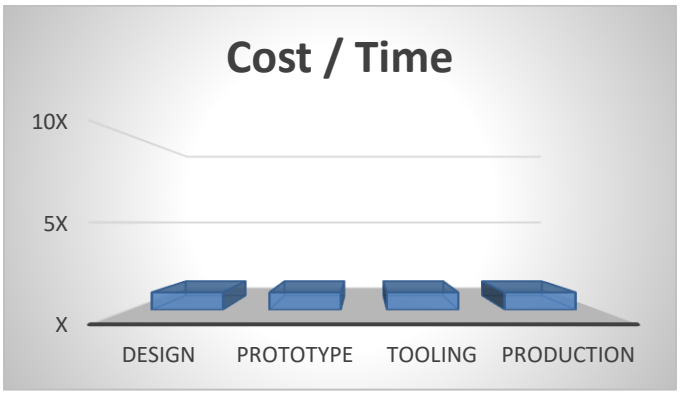
Enhanced Production Workflow

3D printing had a dramatic effect on the overall production workflow. The traditional production method is very similar to the traditional prototyping method in that it is a linear process. Once the design is complete, products are produced using a time-tested process. This process changes based on the type of process needed for manufacturing a particular part. However, the process limits the flexibility of the developer of the product. Once the production process begins, changes to the design become more and more expensive as the process moves through the various stages.



TIME VS. COST FOR TRADITIONAL MANUFACTURING CHANGES

The enhanced production workflow for manufacturing using 3D printing changes the equation when it comes to the cost of manufacturing and product design changes. While traditional manufacturing can allow for very low-per-part production costs, in comparison, the cost of changing a 3D printed manufactured part is a different story. The biggest advantage of 3D printing for manufacturing is that the cost of making changes at any step in the process is minimal or nonexistent. Unlike traditional manufacturing, without the need for tooling or molds, there is virtually no added cost for changing the design. At any step in the design process and at any time, you can simply use the newest model of the design and start production with it.



TIME VS. COST FOR 3D PRINTING CHANGES

Faster to Market

One other advantage 3D printing offers to product designers and engineers is the ability to move through the prototype stage with more iterations. Instead of taking days or weeks to get a prototype developed, it can be done in hours, allowing engineers and designers get their products to market faster than ever before.

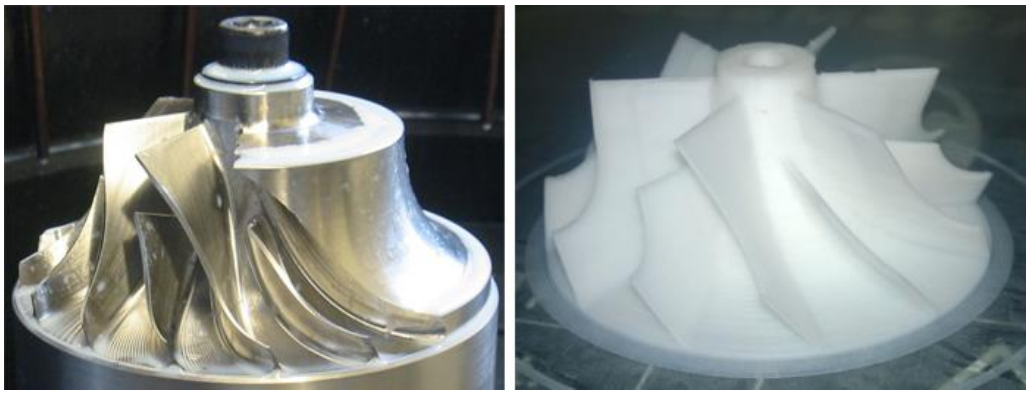
Better Products

3D printing allows designers to get their products to market faster than ever before. One of the added benefits of being able to create multiple prototypes and test them is the final product can be made better. Not only better, but the final product is also produced with fewer defects. Because designers have the ability to make more changes, they can add additional features and design elements that would not otherwise have been possible.

Lower Costs

The lower cost piece of the production equation is primarily based on prototype and low-run manufacturing of products. The cost savings for prototyping a part can be significant over traditional methods, like machining and CNC routing. Often, a machined part could cost hundreds to thousands of dollars to produce and take days to weeks to get back from the producer. Whereas a 3D printed version of the same model costs a fraction of the machined part, and can be printed in a matter of hours.

For low run production, 3D printing can save a considerable amount over traditional manufacturing techniques. Take a process like injection molding, normally this requires expensive tooling and molds in order to produce a large quantity of parts at a low cost. However, if only a limited number of parts are needed, say hundreds or just a thousand or so, 3D printing will cost considerably less than injection molding.



MACHINED VERSUS 3D PRINTED IMPELLER

Tools for Creation and Deployment of Designs

The basis of 3D printing is the reliance on software to produce the models that can be used to print a design. This is one element of design that is the same no matter what you plan to do with the final part. Design tools have been evolving at a steady pace since the early days of CAD, incorporating new features and adding new capabilities with every release.

Creation Tools

When it comes to creation tools, there are a broad range of options, from full-blown engineering product suites that do much more than create 3D models, to fun programs for beginners. These tools give users the ability to build models that can be used for 3D printing.

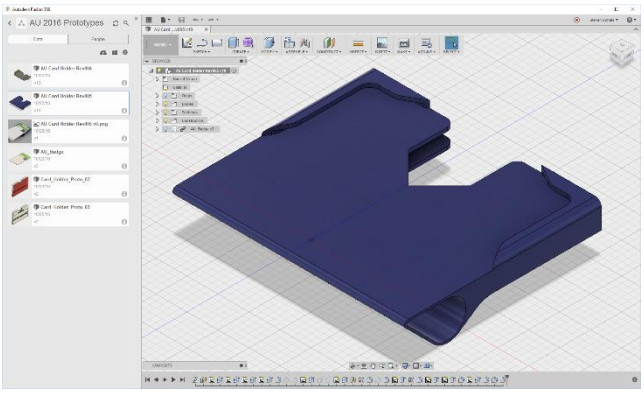
Another type of available program allows you to create 3D models from photographs. This is known as *photogrammetry*, and is a class of tool that is becoming more than capable of creating highly detailed models of real-world objects.

Autodesk Inventor

AUTODESK INVENTOR

For the advanced mechanical designer or engineer, Autodesk Inventor provides the level of flexibility professionals need to design with creative freedom. You can design parts using parametric modeling tools, freeform and direct editing. Inventor is incredibly powerful, with advanced tools like the incorporated shape generator, and its ability to use nearly any 3D CAD file format.

Autodesk Fusion 360

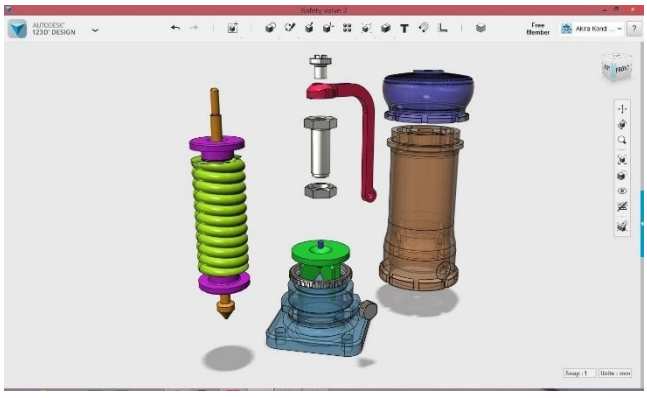


AUTODESK FUSION 360

Different from traditional desktop offerings, Fusion 360 is a hybrid between locally installed software and cloud-based internet components. As part of the ever-expanding Autodesk 360 cloud-based portfolio, Fusion is platform independent, allowing you to access your designs from a Mac, PC, or mobile smart device. With Fusion, you can download the program onto as many computers or devices as you wish. Since the program works on both Mac and PC operating systems, this enables you to effortlessly switch from one OS to another, maintaining your productivity, regardless of the type of computer you are working on.

Fusion 360 is direct 3D modeling software, providing you with the tools you need to create 3D components and assemblies. It also offers a host of modeling options that include parametric design and surface modeling.

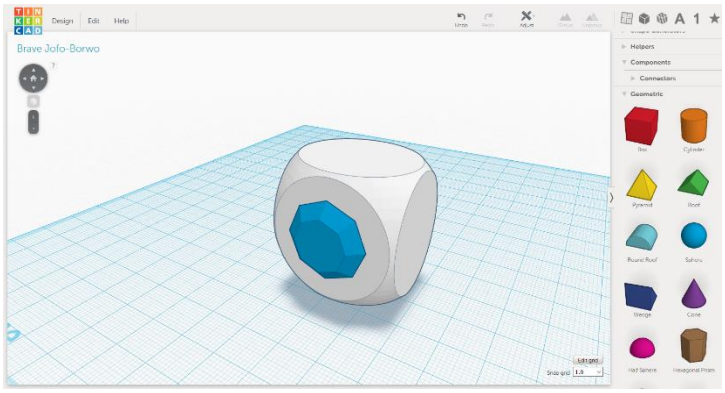
123D Design



123D DESIGN

123D Design is an interactive design program that combines ease of use with powerful design capabilities. With this 3D design software, you can create complex designs starting with basic shapes and sketches. The designs created with 123D Design can be 3D printed or manufactured using a variety of other techniques. Because you can begin from the basic shape, it is much easier to learn to use than more advanced programs like Autodesk Inventor.

TinkerCAD



TINKERCAD

TinkerCAD is an easy-to-use online application that provides fully functional 3D designing and modeling tools. With TinkerCAD, you work with 3D shapes and combine them to create more complex designs. Despite the fact that it is very simple to use and easy to learn, this program allows you to create very intricate and detailed designs that can be 3D printed.

Autodesk Remake

REMAKE

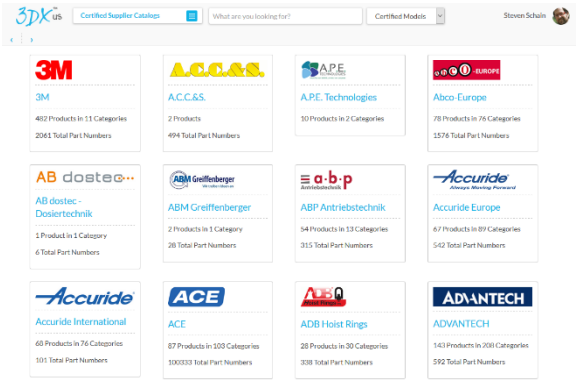
Autodesk Remake is a unique application that is not a design program, but a photogrammetry program. Photogrammetry, for this purpose, is the process of taking photographs and extracting three-dimensional objects from those photographs. Remake is a hybrid application that installs a desktop component and combines a cloud component into the workflow. With it, you can take photographs of objects and convert them to 3D printable models.

Another application that is similar to Autodesk Remake it is 123D Catch. This program is the consumer-level version of Remake and is available as an application for iPhone, Android and Windows phone.

Resources and Deployment

If you are prolific designer or a company that maintains a design part library, there are a number of websites available that can be used as resources. These websites and allow users to download components and predesigned models. Some also allowed designers to post their models either for free or for sale. These web sites have become an invaluable tool for designers around the world.

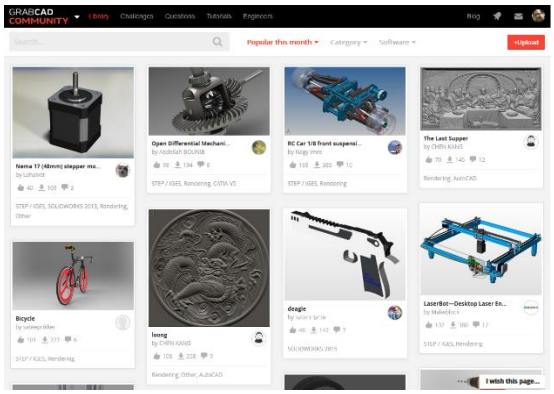
3Dx-us (https:// 3Dx-us.com/)



3DX-US

This site provides access to millions of certified supplier models that you can use in your everyday design work. The site also has a thriving community with individuals that post their designs for others to download and use.

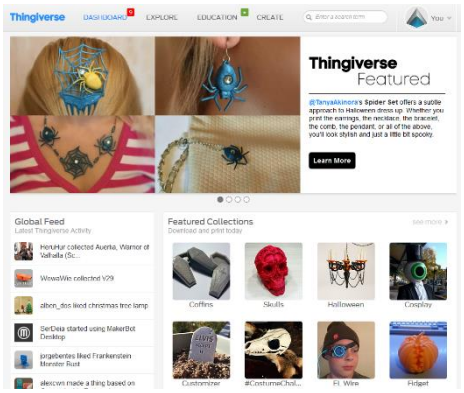
GrabCAD (https://grabcad.com/)



GRABCAD

GrabCAD is an online community that has been around for a long time and has a large user base. The website is not only an online repository where people can upload and download models of users' designs, but they have also begun creating their own tools. Tools like GrabCAD Workbench, which is a cab file management tool that is available for free. And, a 3D printing tool that currently works with a variety of Stratasys 3D printers.

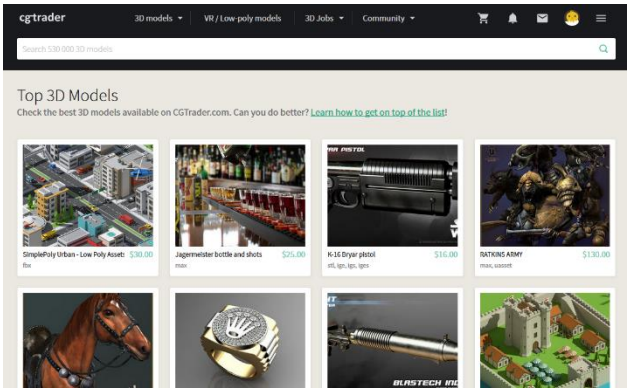
Thingiverse (http://www.thingiverse.com/)



THINGIVERSE

Thingiverse was created by MakerBot as a repository for users to post their designs. It has grown over the years to contain over 1 million 3D printable models. While this site is not specifically designed for CAD models, it does contain an amazing array of models.

CG Trader (https://www.cgtrader.com/)



CG TRADER

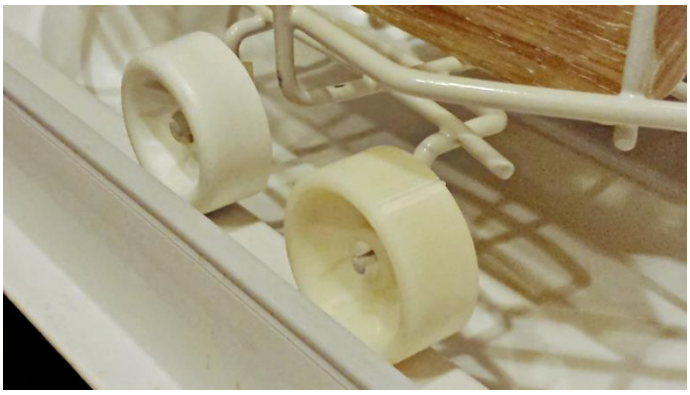
This website is one of the many web sites that allows users to sell their designs. This website also provides models for the media and entertainment, and design visualization specialties. It also has a repository of printable models.

Practical Applications

3D printing has gone through a number of changes over the years. In the early days, 3D printing was time-consuming and costly, and not very practical for applications outside of industry. However, with the advent of today's more flexible and cost-effective 3D printing methods, there are areas where 3D printing has become a practical tool.

Replacement Parts

One of the largest growth areas in 3D printing is the replacement parts industry. One of the reasons for this is that parts can be printed on demand without the need for storing them in a warehouse. Plus, if a part is no longer manufactured, the replacement can be designed and printed fairly easily, compared to other manufacturing processes. The replacement parts industry is undergoing tremendous change because of additive manufacturing. You are now able to simply download and print a replacement part on your home 3D printer.



DISHWASHER WHEEL REPLACEMENT (ORIGINAL ON LEFT, 3D PRINTED ON RIGHT)

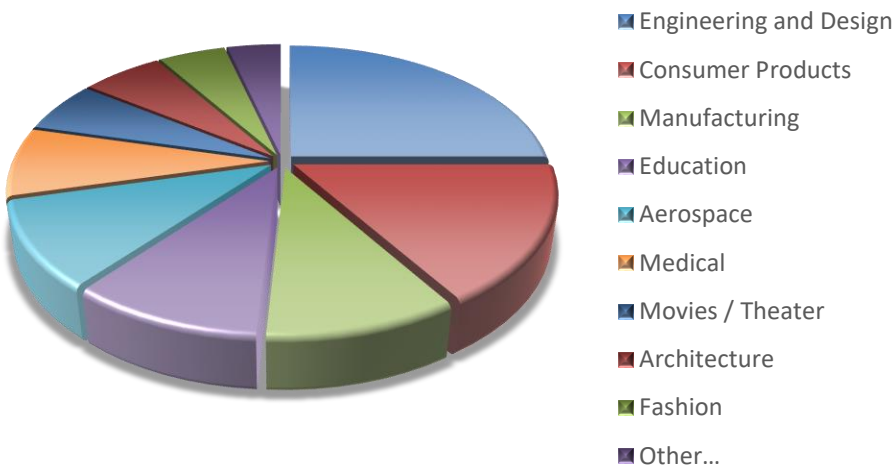
Useful Items

Sometimes a practical application doesn't necessarily need to be an industrial application for a consumer application; it can just be something that is functional. As a designer, you have the ability to create anything you need for nearly any purpose. With 3D printing, you're able to take that design and turn it into a working physical object.

Think about the things you do every day either in your home or in your office that could be made easier. Or, think about organization and where it would be useful to have something that's designed for specific purpose. For example, the part shown below is a very simple design of a wall-mounted bracket for hanging headphones near your computer.

3D PRINTED HEADPHONE MOUNT

Industry-Based Applications



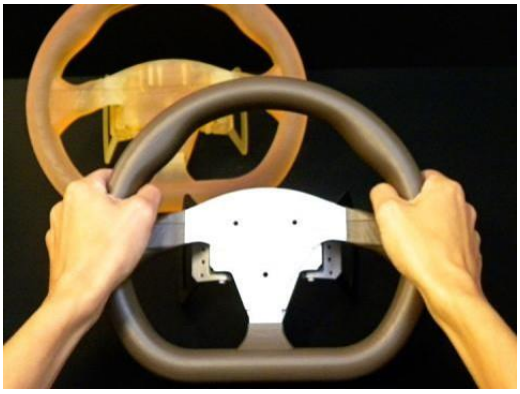
3D PRINTING IS SPREAD ACROSS A LARGE NUMBER OF INDUSTRIES

Professional

Professional applications are by far the largest category relating to the use of 3D printing today. While this category continues to grow, there are some key areas that have seen a wide adoption of additive manufacturing technologies.

Prototyping

The first and by far the largest application of 3D printing technology is prototype development. In the early days of 3D printing, designers and engineers realized they could save time and money by having their prototypes printed instead of machined. At first, the prototype had to be sent out to a service bureau, unless the company could afford one of the few very high-priced printers that were available at the time. In just the last few years, however, printer costs have come down dramatically, while output quality has increased to a level where even inexpensive printers can output parts good enough for prototyping.



PROTOTYPE MODEL, 3D SYSTEMS

Personal

With the advent of low-cost 3D printers in 2008 came a new form of expression as output became available. Immediately, people put their printers to use creating all types of 3D printed designs. Within the vast number of categories of things being 3D printed, some of the more popular models created can fall under three main categories: art and design, cosplay and toys and games.

Art / Design

IMAGE COURTESY OF VOXEL STUDIO

Cosplay

HAMMER OF SOL

Toys and Games

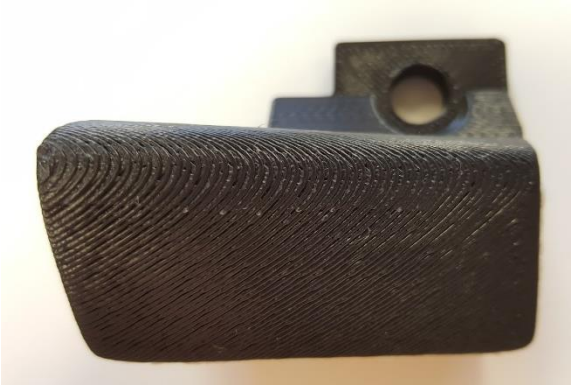
FULL SIZE TRADITIONAL STAUNTON CHESS SET DESIGNED BY 4DCADCAM.COM

Most active technologies

While there are a number of technologies in use today in the 3D printing world, a couple of them have become more predominant. This is for several reasons, but the primary reason is the end of patents on several key elements of each of these technologies. One common factor with all 3D printing technologies is the idea of creating a part using successive layers of material.

FFF / FDM

Fused Filament Fabrication (FFF) or *Fused Deposition Modeling* (FDM), is a 3D printing process that uses a strand of plastic filament that is extruded through the heated nozzle. This technology is the most popular of all of the 3D printing technologies due to the fact that it is simple to implement and can create very high-quality products. It is a technology that has been around since the early 1990s, and is a process that was developed by S. Scott Crump, and commercialized and marketed under the trademark abbreviation FDM by Stratasys Inc.



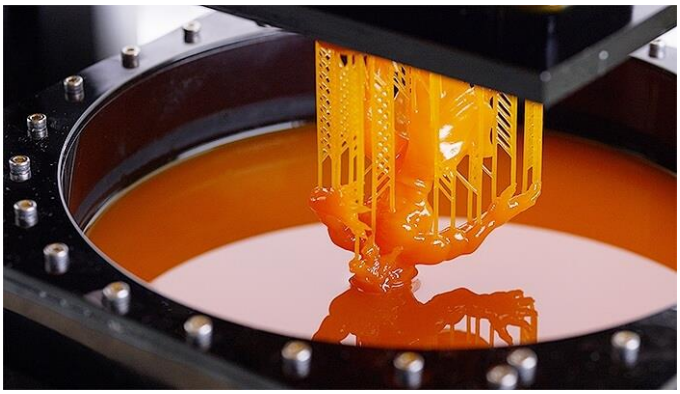
PART PRINTED ON A STRATASYS UPRINT SE PLUS FDM 3D PRINTER

With the expiration of the original patent, there was an increased interest, initially by hobbyists and enthusiasts, to develop the technology for both professionals and consumers. Today, there are hundreds of printers using this technology that range in price from only a few hundred dollars on up.

MAKERBOT REPLICATOR+

SLA

Stereolithography is a term coined by Chuck Hull in 1986, after he patented it as a method of creating 3D objects using UV light and a liquid photopolymer. The initial design used an ultraviolet laser that focused the beam at the bottom of a vat of resin. The laser would harden the resin for that layer, and the model would be lifted, and another layer created beneath the previous. This built a 3D object by adding successive layers.



A PART BEING MADE IN A MOONRAY SLA PRINTER

This technology was taken to market by 3D systems, who developed a range of SLA 3D printers that are still in use today. One of the major advantages of Stereolithography is the ability to create very high quality parts with minute surface detail. By using a laser or DLP projector, today's printers can resolve details as small as just a few microns across. This makes Stereolithography ideal for creating jewelry and other finely detailed objects. And like FDM, the patent for this technology has also expired, allowing for a large number of printers to be available on the market.

RING PROGRESS, PRINTED (LEFT) ON A KUDO3D TITAN 1

Important Issues

With the advent of the additive manufacturing, a number of issues have come to the forefront. Many of these issues have yet to be resolved, and may require the intervention of governments to solve them.

IP Protection

Intellectual property protection is by far the number one issue surrounding 3D printing and additive manufacturing today. Some have estimated global losses of intellectual property because of 3D printing to be over $100 billion per year. Additive manufacturing has undone in a few short years what manufacturing has taken decades to secure. It has upended traditional supply chains and allows users to bypass the manufacturer and 3D print a physical part that was created on a computer, or 3D scanned. This lets users print nearly anything, even patented and copyrighted designs. And this issue is going to continue to grow, along with the growth of the 3D printing industry.

Traditionally, a manufacturer had a tightly controlled supply chain, beginning with the initial design all the way through to the final delivered product. If a consumer wanted one of these products, they would need to purchase it either locally or online. This gave the manufacturer control over their products and their intellectual property.

With the introduction of 3D printing, that all changed. Now there are a large number of different types of supply chains that have been created. Each of these new supply chains creates potential risks for the theft of intellectual property, and if not outright theft, at least a loss of control over that property.

This is the reality of 3D printing today. Digital files of real things change hands with little or no control over who creates it or when it gets created. This is where the music industry was at the time of Napster. The difference today is how the major players are handling the loss of IP control. So far, the industries most affected by 3D printing have taken a step back and are looking at where everything is heading. That's not to say they are not going after IP theft; plenty of companies actively remove offending models from sites like Thingiverse and others. It is the smart companies that see the future and want to be a big part of it.

The protection of intellectual property has grown increasingly more complex an issue with the introduction of 3D printing. Many are looking to regulators and IP related organizations to craft rules that everyone can work with. This will not be an easy task.

Security and Hacking

Computer security is a top priority for every industry related to computers and cyberspace. It's only recently that cyber security and threats of hacking have come to the forefront of 3D printing. When it comes to security for additive manufacturing, it is not something the industry takes for granted. There are several issues related to security when it comes to 3D printing technology. The two most talked about are the purposeful introduction of print flaws, and the theft of data files for printing from the printer itself.

The introduction of a flaw in the print process may not affect a large number of parts. However, when it comes to the printing of critical components for aviation, automotive and other industries, the flaw in the print can have catastrophic consequences. Take, for example, the printing of a rocket nozzle. A perfect print will meet all the design specifications and be able to take the stresses and strains the part was designed for. When a flaw is purposely introduced for nefarious reasons, that part is no longer able to function properly and could potentially be the cause of part failure.

Hacking into a computer system and stealing data is nothing new to the world of cyberspace. Today, many 3D printers are connected directly to in-network systems. Because of that, they're vulnerable to outside intruders. Now, it is not likely that the average person will experience an issue with their 3D printer being hacked and their data stolen, but it remains an issue for large manufacturers, who are taking this very seriously.

Material Safety

One of the issues that has been part of manufacturing since the early days is the issue of material safety. The material safety issues that are related to 3D printing depend greatly on the process being used. Examining a few of the different material types reveals some of the problems with handling these materials and the safety measures that must be employed.

FDM or FFF printers use a variety of filaments for printing. Material safety for the vast variety of filaments range dramatically. PLA (poly lactic acid), and ABS (Acrylonitrile butadiene styrene) are two of the most often used materials for filament-based 3D printers. PLA is a thermoplastic polyester derived from things like cornstarch. It is generally considered to be a fairly safe material to work with and can be used in nearly all environments, keeping in mind that it is always good to have clean air circulating, no matter what material you're printing.

ABS, on the other hand, is made from Acrylonitrile, Butadiene and Styrene, and is a petroleum-based product. Gases and particulates from the printing of ABS filaments are released into the air and are potentially hazardous to human health. Therefore, when printing with ABS, it is important to not only have good ventilation, but it is also helpful to have filtration of the air coming out of the printer.

There are a variety of other filament types available for fused filament fabrication printing. Each manufacturer can have a different formulation and use different materials. Materials that can be added, like metals, wood, brick and more, change the makeup of the filament. To find out about the safety of these materials, look for the material safety data sheet from the manufacturer.

Stereolithography uses UV curable liquid resins to create 3D objects. Many of these resins are a mixture of acrylic acid investors mixed with a photoinitiator and can cause skin, respiratory and eye irritation. These are among some of the issues these resins can cause, which is why it is important to follow any instructions provided by the printer's manufacturer for safe material handling.

Selective laser sintering, binder jetting, and other power-based printing methods use extremely fine powers. These powers can be metals, plastics, or other materials, like gypsum. These materials can pose risks to human health if they are inhaled and handled improperly. Some also pose a risk of being

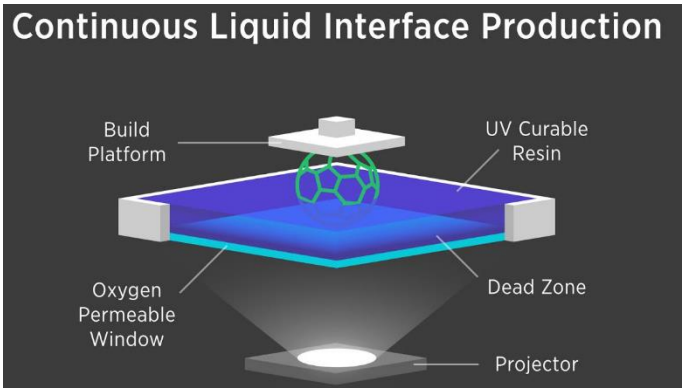
explosive if ignited by a spark or flame. Handling these materials in a safe manner can add additional cost to a printing setup.

The "Real" Future of 3D Printing

Faster Speed

Today, 3D printers can create a product in a matter of hours, or even minutes. This is already dramatically faster than the printers of the past. Manufacturers are constantly looking for ways to make printers faster and more capable. We have already seen dramatic improvements in the materials available for printing, from plastics to metals; now we're seeing improvements in speed and quality.

For example, in 2015, the company Carbon 3D introduced a continuous SLA 3D printing process known as CLIP (continuous liquid interface production). This technology has the ability to print 3D parts anywhere from 25 to 100 times faster than current SLA technology.



CLIP TECHNOLOGY, CARBON 3D, 2015

The quest for speed in the 3D printing industry is ongoing in all levels and all technologies. Many of the FDM printers have seen double digit increases in speed with the introduction of innovative technologies, such as the E3D volcano hot end. This hot end has the ability to process much more material per second than a standard printer, allowing printers to move faster and use larger nozzles. This combination brings a dramatic reduction in print time.

E3D VOLCANO HOT END

Quicker Turn Around

Increased speed in 3D printing is resulting in much faster turnaround of 3D printed parts. In the early days of 3D printing, getting a print back from a service bureau could take a week or more. This was primarily due to the speed of the process. Today's fast printers already allow for overnight printing and desktop printing that only takes hours instead of days.

Tomorrow's even faster printers will allow engineers and designers to get their parts produced within minutes of sending them to the printer. For service bureaus and in-house printing departments, this means higher throughput and the ability to serve more customers, as well as the ability to create prototypes at an unbelievable rate.

Mass Manufacturing

Mass production using additive manufacturing is currently in its infancy. With many of the large printer manufacturers focused on the manufacturing space, it's only a matter of time before 3D printing starts to compete with other methods of mass production.

Currently, companies like Stratasys are focused on different aspects of the manufacturing process. Today, it's possible to create molds for injection molding plastic parts at a fraction of the cost of traditional methods. And, companies like Optomec are already developing printers that can be used in the direct manufacture, high-volume production.

Tomorrow's manufacturing facilities will most certainly include a variety of the additive manufacturing technologies. Another benefit from the use of this technology is the ability to create customized mass produced parts. This capability will allow for more agile manufacturing, and the ability to distribute the manufacturing process to other points along the supply chain, even the end user.

Increased Productivity

With speed comes productivity. As a designer or engineer looking to prototype either an individual part or an entire assembly, faster printers will make a dramatic difference. When a part can be made in minutes rather than hours, a prototype can be iterated and tested in less time and at a greatly reduced cost. Productivity increases due to the increased speed of printers will be felt up and down the supply chain.

The increase in productivity will not only affect manufacturing, it will affect every industry that utilizes 3D printing. This includes medical practitioners as well. With the ability to 3D print from CT scans and MRI data, doctors can better plan complex surgeries. An example of this is the recent separation of twins joined at the head.

DOCTORS SHOW THE CONJOINED SKULL PRIOR TO SUCCESSFUL SEPARATION, CNN 2016

Better Materials

Material producers are constantly looking to improve the quality of the materials available for 3D printing. Today, a variety of materials are available, ranging from metals to plastics. Even bioprinting materials, like human cells is available. Of course, food printing is also part of this. Chocolate and cookie dough are among the many things users can print with today.

The future of printed materials will allow for unique material properties, since several printers on the market today can combine materials and make variations between them. This capability will continue to increase along with the variety of materials.

Take, for example, FDM printing materials. In the early days of filament-based printing, there were only a few options available, like ABS, PLA and some industrial materials like Ultem and polycarbonate. Today, manufacturers of filament are making stronger and better printing materials, like Colorfabb's nGen and Taulman 3D's Bridge Nylon. These and other filament manufacturers are continuing to push the envelope of what is possible with 3D printer filament.

Lower Cost

And finally, where does this all lead? Faster printing, better materials and the final ingredient, lower cost, is where the future lies. 3D printers and their materials started out with costs only large companies could afford. In the last 10 years, prices have come down on both printers and the materials for them. Prior to the ending of the FDM and SLA patents, 3D printers cost tens of thousands of dollars. Today, you can buy a 3D printer for under $500. As we move into the future, the costs will level out and become more stable. However, the quality of printers and the speed at which they print will continue to increase, providing an ever-growing value for the dollar.

Conclusion

Today, 3D printing is like the wild west, where new products shoot it out in an increasingly crowded marketplace. The beneficiaries of this marketplace are the end users of the technology. With the high point of 3D printing mostly behind us, industry leaders and new startup companies look towards the future. A future where both intellectual property rights and the rights of the user are in balance, where products are prototyped in minutes instead of hours or days, and, where a 3D printer in every household is a real possibility, not a pie-in-the-sky fantasy.