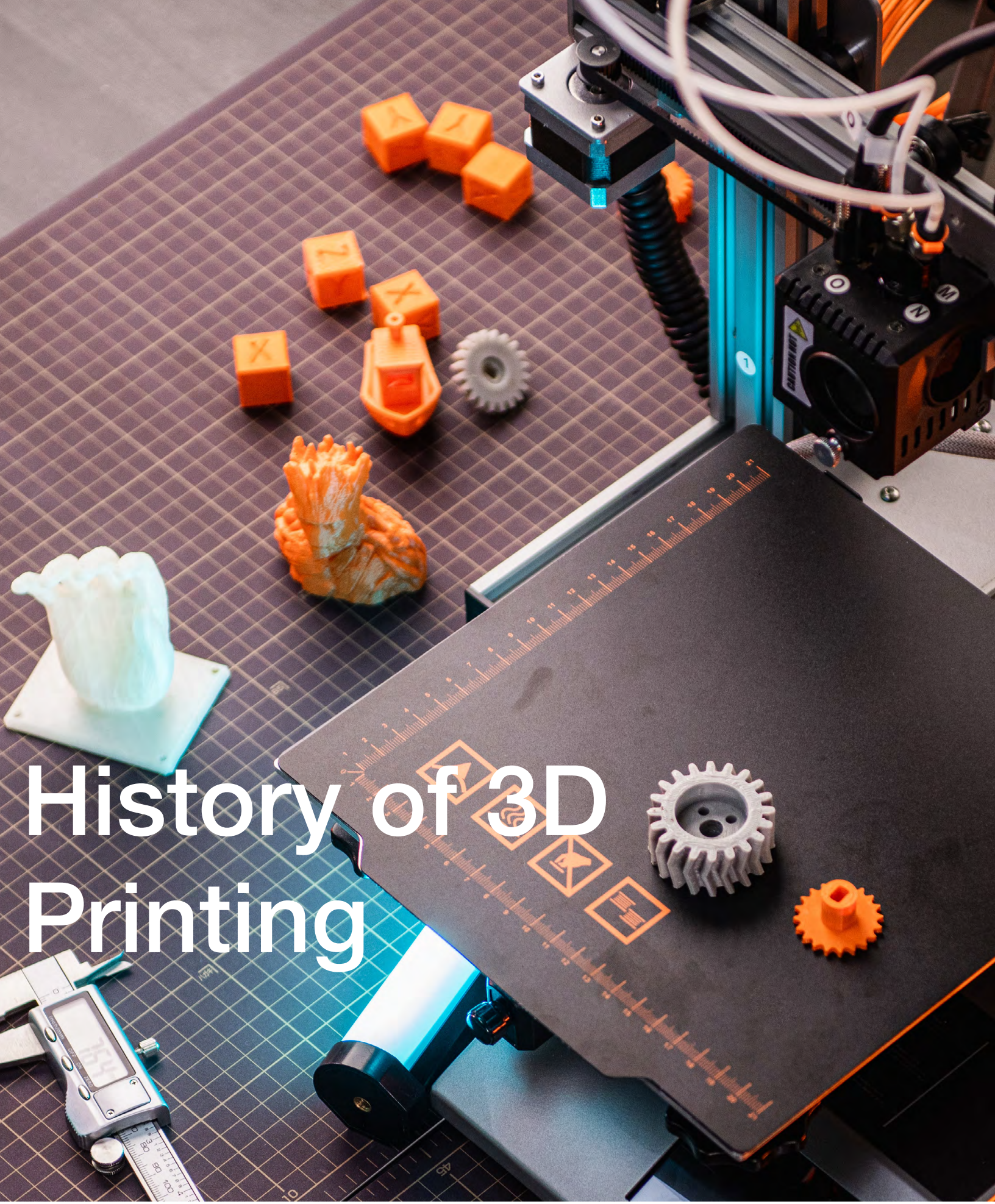

History of 3D Printing

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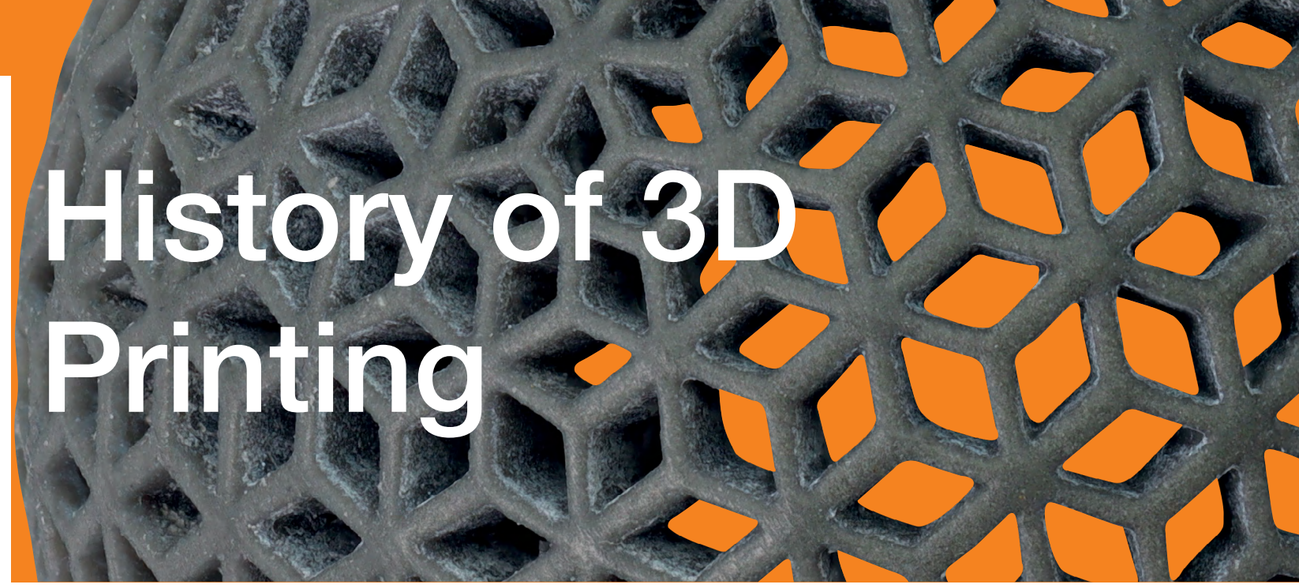


History of 3D Printing

Overview

While there's been a recent boom in the popularity of 3D printing over the last decade, it's actually been around for over 35 years. The technology started as an extremely expensive, niche method of manufacturing that held few advantages over more traditional methods, and over the course of its lifetime became much more advanced, seeing improvements to the materials and methods used that have paved the way for new applications, reduced costs, and widespread adoption.

The origins of 3D printing go all the way back to the 1980s. Dr. Hideo Kodama of the Nagoya Industrial Research Institute published research in 1981 on a technique very similar to what eventually would be called stereolithography (SLA). However, it wasn't until 1987 when a patent was first filed and the first SLA printer was created by Charles Hull, who is widely considered the true inventor of 3D printing[1, 2].

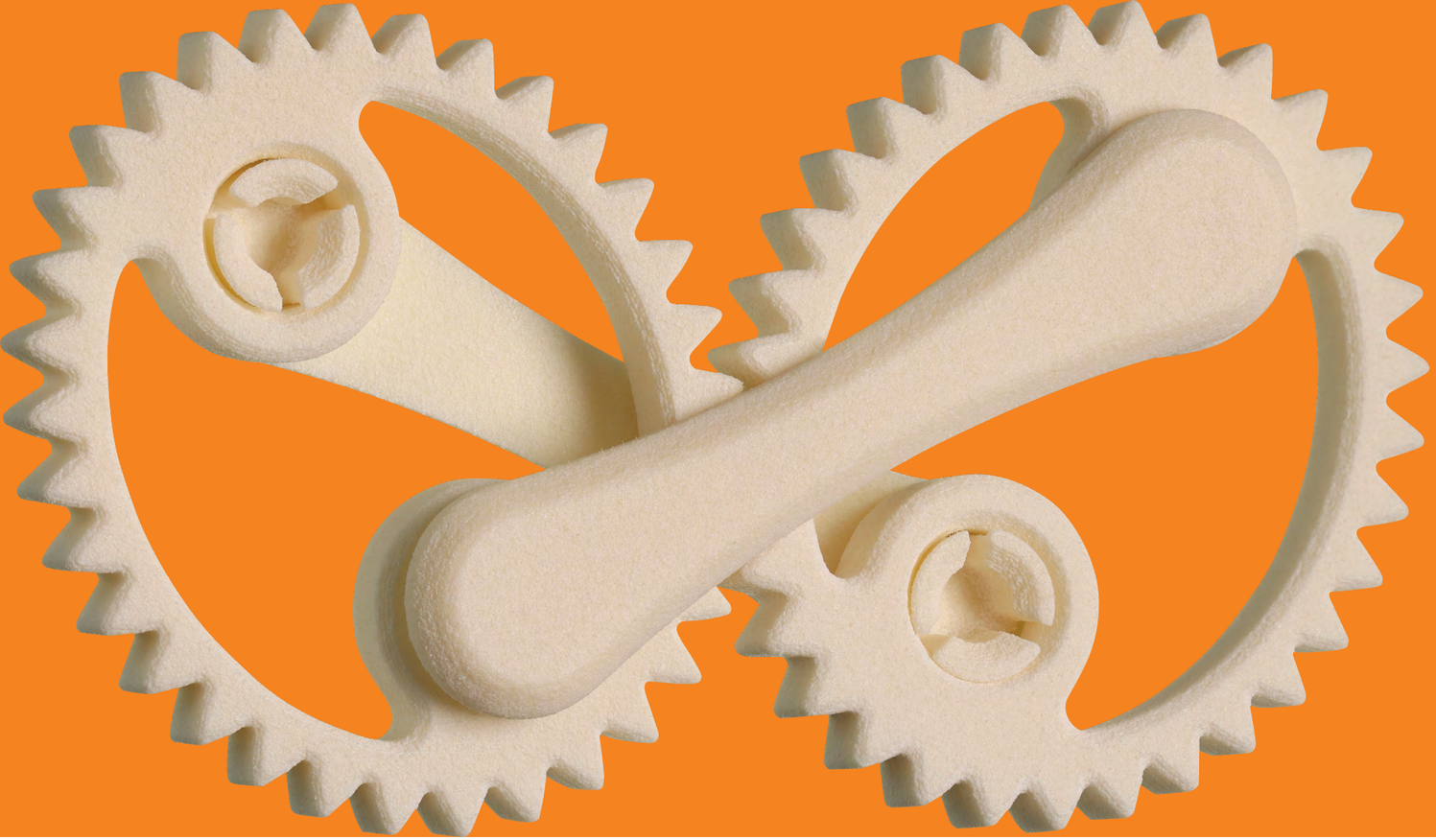
Over the next two years, Selective Laser Sintering (SLS) and Fused Deposition Modeling (FDM) printers were first developed, heating up the competition in the 3D printing space. No other major developments came along until the 90s, when Binder Jetting technology and 3D printers capable of making wax molds used for injection molding were invented[1, 2].

By the early 2000s, 3D printers had become capable of printing functional human organs, though these mostly existed more as prototypes and proofs of concept rather than organs worthy of transplanting[3]. However, there were some successful transplants of 3D printed organs – most notably 10 patients received bladder transplants using bladders printed from their existing bladder tissue[4]. Best of all, this method of organ transplant eliminates the risk of the body rejecting the transplanted organ since it's made of the patient's own tissue.

Around 2005, strides were being made towards more compact 3D printers. Dr. Adrian Bowyer set out to 3D print components to be used in other 3D printers – using what he dubbed as the "RepRap" open-source printer – making the technology significantly more affordable and compact[1, 2]. Over the next few years 3D printing would become much more widespread as more and more people got their own 3D printers and continued to print components for other people's printers.

By the 2010s, the concept of open-source 3D printing had grown and changed, becoming more focused on online 3D printing services where customers could purchase 3D printed components and have them delivered, rather than needing to print the parts themselves[2]. Numerous 3D printing marketplaces opened up around this time, driving further innovations as companies strove to differentiate themselves. Metal became much more commonly used as a printing material, leading to things like jewelry and components for cars being able to be 3D printed[2].

Amidst these new developments, three patents expired that would ultimately lead to a massive boom in 3D printing: patents for the FDM, SLA, and SLS printing methods[2]. Finally, 3D printing was on its way to becoming a household process that anyone could utilize without breaking the bank. With more and more people getting their hands on 3D printers, new innovations in materials and methods were soon to follow, alongside entirely new applications and services.



Complex Geometries

3D printing is widely known for being able to produce more complex parts than other manufacturing methods due to the layer-by-layer process of creating components. With machining, part complexity is limited by the machine tools and their inability to create overly complex geometries, such as a component with numerous cutouts or a hollow component. The freedom to create more complex geometries changes how engineers are able to approach a design problem, ultimately leading to superior solutions that can reduce weight, increase service life, improve performance, etc.

White Paper:
Breaking the (injection) mold

Better Materials

A common argument against 3D printing for a long time has been the quality of the materials being used. Often, 3D printed parts are seen as flimsy and only suitable for non-functional prototyping. However, this is far from the case. Many 3D printed parts can not only keep pace with, but even out-perform, injection molded parts in terms of wear rate. For example, iglide 3D printing materials from igus have been proven to wear at rates up to 50 times slower than other comparable 3D printing materials, as well as materials used for injection molding. Even the max permissible surface pressure of the iglide printing materials is superior to similar injection molding materials.

Innovations in 3D print materials haven't been limited to just plastics. Recently, MIT researchers developed a new method of heat treatment for 3D printed metal components, making the microstructure of the individual grains of the component more uniform, and therefore more structurally sound and better suited for use in the aviation industry, where creep is a concern[5]. 3D printed components also provide the additional benefit of more unique geometries, which can be utilized to reduce weight and improve fuel economy in aerospace vehicles.

Likely the most impactful new material that's been developed in recent years was an electrically conductive graphene-based material. In 2015, Graphene 3D Lab (now G6 Materials) unveiled the material, along with a prototype of – and plans to produce – 3D printed batteries using the material. Since 2015, various electrically conductive materials have been in development, with prototypes including circuit boards, thermometers, flex sensors, and more[6, 7, 8]. Ultimately, being able to combine these materials with a multi-material printing process could lead to more advanced technology being fit for 3D printing, like phones or computers.

New Methods

Not only have 3D printing materials undergone significant advancements, printers and printing methods themselves have also seen promising innovations. A new method of printing, developed by engineers from Stanford, is five to ten times faster than the next fastest high-resolution resin printer, and can even print objects out of multiple materials all at once. This is achieved with a new method of resin injection that uses syringe pumps to add more resin as the component is lifted from the print bed. Each syringe can be used to dispense a different resin, which is what allows components to be printed from multiple materials[9].

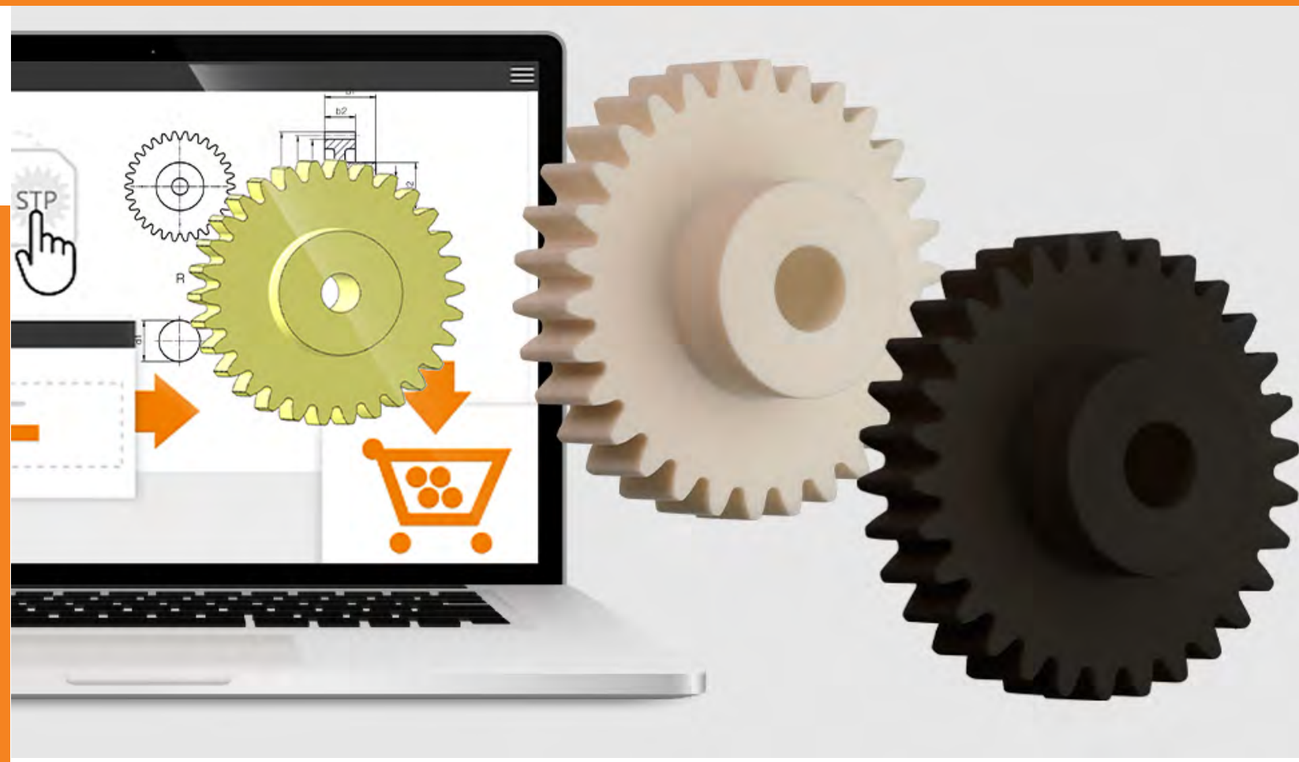
Another new method of printing was developed in 2019, which utilizes tomographic reconstruction (a process derived from imaging technology such as X-ray and ultrasound) to print an object from resin without the need for layering[10]. This way an entire component can be printed at once, greatly reducing the time needed to do so. The method also shows promise for multi-material printing and high-viscosity polymer printing, something almost no other printing methods offer.

Overcoming Supply Chain Shortages

A rarely talked about benefit of 3D printing is the ability to combat supply chain shortages and bring component production local, or even in-house. It's not at all uncommon for companies to outsource overseas. Up until recently, this was the smartest course of action financially. Now, however, with costs rising and the future remaining uncertain, 3D printing is becoming the simplest, most cost-effective manufacturing option for an increasing number of companies.

If a company stocks a low demand product, predictions need to be made about the amount of that product that will be purchased. If those estimates are too low, shipping delays are a certainty. If they're too high, the parts go to waste and the company loses money. With 3D printing, however, these low-demand components could be printed as needed in a matter of hours. This practice alone can eliminate more than 20% of the average company's unused inventory, while allowing short lead times to be maintained[11]. This doesn't even consider shipping costs, which can be reduced by as much as 85% across the board by adopting 3D printing according to a 2014 study[12].

International companies stand to benefit from 3D printing in other impactful ways. As new component designs are developed, CAD files of the designs could be easily distributed internally to all branches of the company. Those files would allow for easy printing of the new components while ensuring accuracy, keeping all branches in sync and speeding up the rollout process significantly.



Online 3D Printing Services

With the rise of 3D printing there's been a rise in online 3D printing services. Now, instead of needing to make a hefty investment into 3D printers and related components/ hardware, you can easily order 3D printed parts online, no hassle necessary. This is especially useful for ordering a single prototype or very small quantities of a part as a one-off purchase, where the investment into a printer wouldn't make financial sense.

Many 3D printing services are extremely simple to use as well. For example, the igus custom parts service allows users to upload a CAD, STL or STEP file directly to the configurator, choose a printing method and material, and order the part(s), all in one place. Services like this are growing in demand as more and more individuals are looking to create custom models or replacement parts, and companies try to prototype new components.

Learn how to use igus® online 3D print tool.

Try our online 3D Print Tool

3D Printed Houses & Buildings

One of the most important challenges that needed to be tackled in 3D printing was the creation of large components. For years, printers could only print small components in a scale of millimeters or inches, and materials like concrete couldn't be used for printing. Recent developments, however, have allowed for much larger pieces to be printed in a wider range of materials.

Gantry robots can be outfitted with a 3D print head and other necessary components to allow the entire space the gantry covers to be used as the print bed. The possibility of larger printed components has paved the way for 3D printed houses, bridges, and other large-scale components like boat rudders or rocket engines[13]. Back in 2016, a 3D printed pedestrian bridge made of concrete was installed in Spain, spanning roughly 40 feet[14]. Even today new ground is constantly being broken, with 3D printed houses being built across the world, with some being used as homeless shelters, low-income housing and emergency housing, as well as multi-story and multi-bedroom homes[15].

3D Printed Injection Molds

Even today, there's debate over which manufacturing method is "better", 3D printing or injection molding. There are advantages and disadvantages to each, of course, but there's a method to combine the two processes into one, reaping the benefits of both. Like previously mentioned, 3D printers that could create molds out of wax to be used for injection molding were developed in the 90s. Today the technique is much more refined, allowing for quick and easy printing of custom molds – though nowadays the process typically utilizes flexible plastics such as TPE. Online printing services, such as the igus® print2mold® tool, even provide cost calculations and service life estimates for parts made using the custom molds.

3D printed injection molds also open up opportunities to create custom parts with properties such as high temperature resistance, KTW conformity, and underwater use that would be difficult to process in 3D printers.

Conclusion

Even if 3D printing isn't "new", there have been so many groundbreaking advancements in recent years that it's nearly unrecognizable from its humble beginnings. Even at igus we've seen rapid growth in our 3D printing capabilities – we've expanded into printing methods beyond just FDM, now offering SLS, DLP and custom injection molded parts. Our online 3D print service and print2mold® service have both come a long way as well, making it easier than ever for customers to find the ideal material for their application and order their custom part.

As the industry gains more steam and more time and manpower is put into R&D, further innovations will arise and prove 3D printing is here to stay and can compete against the heavy hitters in the manufacturing world.

3D Printing Materials from igus®

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