



# **Benefits and advantages of 3D printing**

# Benefits and advantages of 3D printing

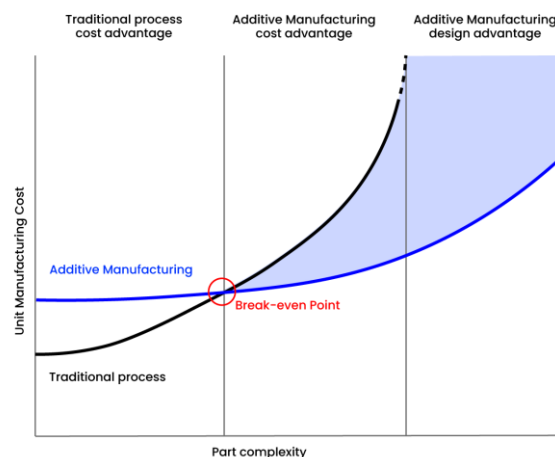


## What you should know about industrial 3D printing: advantages and disadvantages

Additive manufacturing (AM), also known as 3D printing, is one of the fastest developing manufacturing technologies in the world. It is a process of layer-by-layer material deposition to produce parts from 3D models. 3D printing has demonstrated its efficacy especially in low-volume, high-customization industries such as aerospace, and there are many reasons for this. In this article we will explore the ways in which 3D printing can benefit all industries, improve lead times, and reduce costs. The focus will be on Fused Filament Fabrication (FFF) printing, where a semi-molten filament of plastic is extruded through a nozzle, but these principles can be applied in general to all printing technologies.

The many advantages of 3D printing technology can lead to lighter parts, shorter lead times, and lower costs. This is all thanks to its main feature: a greatly enhanced design freedom, which allows the design of parts with highly customized and unusual geometries. Almost all 3D printing benefits stem from this and lead to many features such as rapid prototyping, on-demand and just-in-time manufacturing, digital warehouses, reduced part count, shorter assembly times, and easier maintenance. The design freedom and large variety of materials available for 3D printing make it a very flexible solution for industrial manufacturing.

The main limitations of additive manufacturing are typically linked to large volume productions, where the cost becomes particularly high compared to conventional methods. This limits the scope of 3D printing to small runs and complex parts, since for simple parts produced in large volumes, traditional manufacturing is sufficient.



# Benefits and advantages of 3D printing

## 3D printing and customization: how does 3D printing help in providing customization of products?

### Simpler design process

The benefits of 3D printing start with design freedom. When it comes to the designing process of parts, there is little cost [difference between 3D printing and traditional manufacturing](#) since they both use the same CAD programs. The two factors that in the end influence the costs are how complicated the designs are and the price of the materials. Traditional manufacturing methods, such as [injection molding](#) and CNC machining, offer no real shortcuts to faster or more complex parts, they must be made with all the limitations inherent to these technologies, such as appropriate draft angles, ensuring tool access, and designing generally uniform wall thicknesses. 3D printing, on the other hand, has few of these limitations. The design process for FFF printing is mainly focused on the reduction of supports and ensuring that they can be easily removed, beyond that there are only a small number of other considerations. This allows a much greater design freedom and therefore the possibility to use 3D printing for countless applications, even with designs that would be impossible traditionally; a single 3D printer can be used to make many different types of parts, from gaskets for chemical plants to satellite frames, from simple pins to spoilers for racing cars, from worm gears to compliant mechanisms, the only limitation is the designer's imagination.

### Easy manufacturing of complex geometries

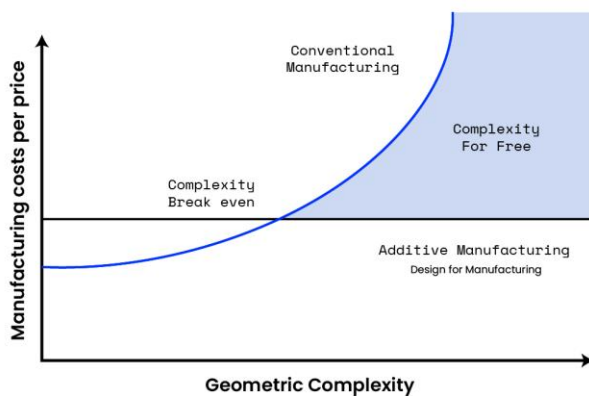
A lot of designing for traditional manufacturing is made using parametric designs and NURBS based software packages. These are appropriate for more regular shapes, such as rectangles, circles, and triangles, because every dimension and feature has been provided. This is the standard because components must fit together and are part of an assembly so more freeform design is not encouraged and is also often not practical in many CAD software packages.



Wind tunnel wings and flaps in Helios™ PEEK 2005

# Benefits and advantages of 3D printing

On the other hand, the few design limitations of 3D printing allow the creation of incredibly complex geometries that would otherwise be difficult, if not impossible, to make using traditional methods. 3D printing can work with meshes, which lend themselves much more to freeform and organic designs, which are inherently much more complex than regular shapes. Using AM, designers have much more freedom to change and manipulate geometries to better meet unique applications. This results in much more complex parts that have several advantages over more regular geometries including reduced mass, lower part count, and easier integration.



Manufacturing costs as a function of geometric complexity



Carbon PEEK duct with a complex geometry

# Benefits and advantages of 3D printing

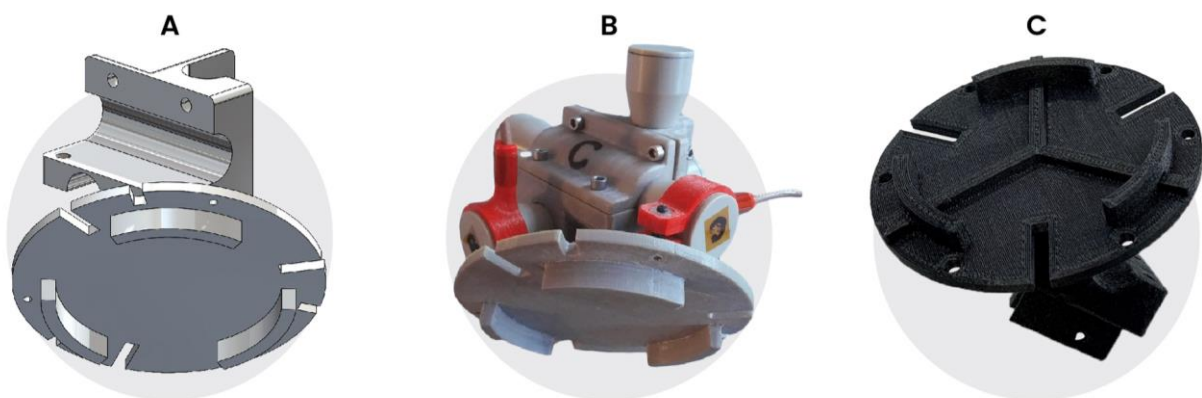


## Lead-time reduction and rapid prototyping

The first real use of 3D printing was as a method to produce prototypes, in fact an old name for AM is rapid prototyping. Thanks to the design freedom of 3D printing, modifying a prototype is easy to do and can be implemented at all stages of product development. This eliminates, for example, the need to produce a new mold every time a design is modified. Therefore, experimentation becomes viable, new designs and ideas can be readily tested and approved, leading to better and more innovative designs.

When the manufacturing process of a new product occupies a considerable portion of the project time (for example, for a one-year project the manufacturing time might take five months due to mold design and production), companies are forced to produce the final design several months before the end of the project. The issue is that the final design might be sub-optimal due to time restrictions and there is little room for improvements. Rapid 3D prototyping, instead, greatly accelerates the development phase, allowing several prototypes to be manufactured in rapid succession and changing the design paradigm.

On top of that, by leveraging the wide range of materials available for 3D printing, especially high-performance polymers that can survive difficult environments such as [space](#) and can [replace metals](#), advanced prototypes can be manufactured that are almost identical to the final product.



### Evolution of CubeSat part:

(A) Original design for traditional manufacturing.

(B) First redesign – minor changes made.

(C) Second redesign – more radical changes were made using the lessons learnt from the first redesign.



# Benefits and advantages of 3D printing



## On-demand and just-in-time manufacturing

There are many 3D printing benefits to businesses but one of the main ones is a dramatic shortening of lead times, done [through just-in-time \(JIT\) and on-demand manufacturing](#). Companies often use inventory systems that are specific to their needs, but none want an interruption in the supply chain that would lead to the missing of deadlines. Sometimes, though, unforeseen situations arise and so it is important to have a system in place that can compensate. Two of these systems are the aforementioned just-in-time and on-demand manufacturing. In JIT, a product (or products) is delivered directly from the supplier to the company without going through a warehouse. On-demand manufacturing involves ensuring that a customer has the right item in the right quantity and at the right time.

3D printing is very flexible and can provide both JIT and on-demand manufacturing of parts thanks to its speed and design freedom, either through the acquisition of printers or by leveraging services such as [Roboze 3D Parts](#). Using a database of already printed parts, new ones can be made in a short time and whenever necessary, compensating for interruptions in the [supply chain](#) and helping to maintain a good relationship with customers.

## Spare parts and digital warehouses with 3D printing

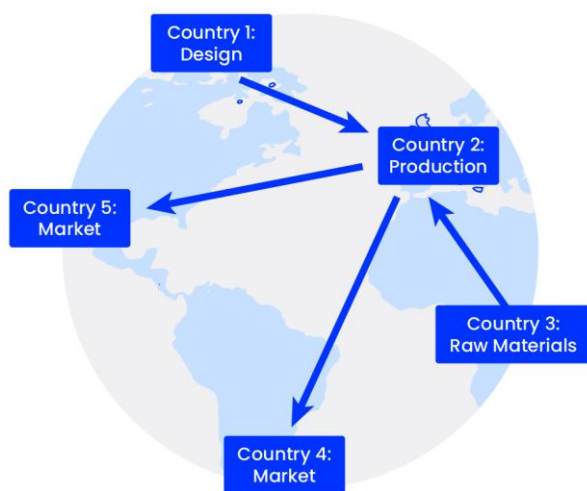
Spare parts are usually made using economies of scale, where more parts are manufactured than needed to stock spares for future need. The issue is that this need is often unpredictable and may or may not arise. Either way, the spares must be housed in a warehouse where they occupy space and increase inventory costs. By having an industrial 3D printer and leveraging 3D printing's ability to manufacture on-demand and JIT, it is possible to create a digital warehouse of already printed and verified parts instead, which is a much more flexible approach. The parts are stored digitally, occupying no physical space, and can then be printed when needed instead of needing to be ordered or stocked.



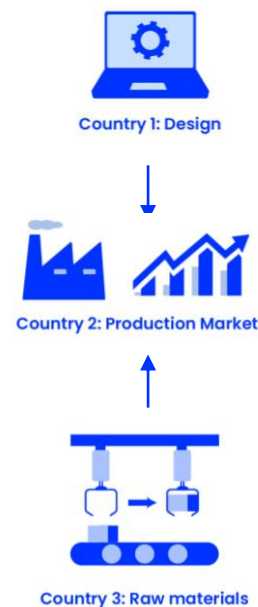


# Benefits and advantages of 3D printing

Costs can be further cut by having the best industrial 3D printers spread in several sites around the world that use digital warehousing. This not only eliminates the need for storage of spares, it also greatly reduces the delivery costs, especially if the parts are stored far from the place of need. This ability to produce parts locally and on demand is part of the movement called [distributed or decentralized manufacturing](#), a shift in manufacturing supply chains that has been taking place for a few years and of which 3D printing is a major enabler.



**Centralized Manufacturing**



**Local Manufacturing**

How the supply chain changes with local manufacturing

# Benefits and advantages of 3D printing

## Part integration with 3D printing

3D printing's design freedom not only allows more complex geometries to be manufactured, but it also allows the consolidation of several parts that would otherwise have to be made separately into one, considerably cutting the manufacturing time and cost. This also reduces the need for resources since fewer individual parts must be made, thus there is a reduction in material waste, such as that produced when using CNC machining.

Due to the limitations of conventional manufacturing, complex assemblies such as air-conditioning ducts for aircraft must be constructed out of several separate pipes since they follow very complex paths. By using 3D printing and high-performance thermopolymers such as [PEEK](#) (Poly Ether Ether Ketone) and ULTEM™ AM9085F, which have certifications for use on passenger aircraft, several sections can be printed together, lowering the manufacturing time and decreasing the costs.

Another example is the swinging arm and disc in swing check valves. Normally these are two separate components that are bolted together due to limitations in casting and CNC machining. Once again by employing 3D printing and a composite thermoplastic such as Carbon PEEK the two parts can be combined into one, simplifying manufacturing. As an added bonus, the lower mass of polymers makes the resulting assembly much safer to handle and easier to mount.



Example of traditional manufactured swinging element in swing check valves



Example of integrated swinging element  
Made with Carbon PEEK and AM



# Benefits and advantages of 3D printing

## Shorter assembly times

Integrating several parts together into one has the major advantage of greatly [reducing the assembly time](#), if not eliminating it entirely thanks to the design freedom of AM, which allows the easy manufacturing of complex geometries. By reducing the total number of parts, the time to use is also reduced. Use of AM for assembly time reductions can be applied to both manual and automated assembly and it is particularly useful for automated assembly systems since, in general, they are better at handling simpler geometries. In other words, having a single more complex part with a few attachment points is more efficient than several smaller components each with their own attachments.

Furthermore, the printing of assembly templates such as drilling jigs helps to standardize and speed up production because, thanks to AM's design freedom, ad-hoc jigs can be easily designed and manufactured for complex geometries. The designs can then be quickly changed, and a new jig made if variations are made to the part being drilled.



Autoclave case manufactured with traditional method – 15 parts, long assembly

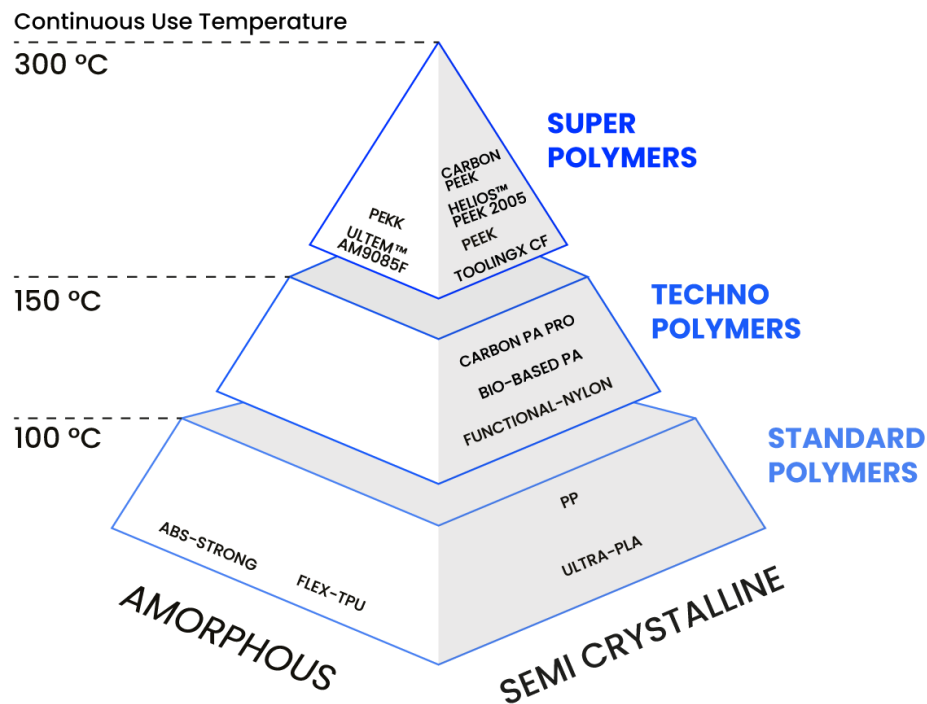


Case re-designed for AM – printed using Carbon PEEK in one monolithic piece, no assembly required

# Benefits and advantages of 3D printing

## Simplified maintenance of assemblies

The design freedom of 3D printing can also be used with an eye to simplifying maintenance. By reducing the number of parts, not only is assembly faster and easier, but this also naturally has the same effect on disassembly. Therefore, an assembly can be re-designed by integrating several parts together but keeping a component that requires frequent replacement separate. Using techniques such as this and combining them with a digital warehouse means that maintenance can be made much faster, less costly, and simpler.



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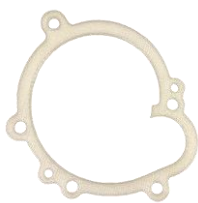


## Flexible solutions with standard, engineering, and high-performance polymers

Standard polymers are the most used around the world and include plastics such as PET, PVC, and PP. These plastics are characterized by low mechanical and thermal properties, but also a good chemical resistance and very low cost, making them particularly palatable for mass production of consumer goods such as plastic containers. With a few exceptions, most standard polymers can be 3D printed, ABS, and PA are commonly used to print prototypes and replacement parts with complex geometries.

The next class of polymers is engineering plastics, which are stronger than standard plastics and can be used to manufacture vehicle components, machine parts, and find applications in construction. These polymers are sometimes blended with other materials to produce composites with new properties. 3D printing of engineering plastics can be used for a variety of applications, for example to make durable and customized tooling using [FUNCTIONAL-NYLON](#). Engineering plastics and AM can also be used in the automotive industry, where increased design freedom and materials can be used for the production of interior trims, door panels, seat components, instruments panels and pillar covers.

High-performance plastics are differentiated from standard and engineering plastics mainly by a higher thermal resistance (higher continuous use temperature), as well as stronger mechanical characteristics. Materials such as Polyether ether ketone (PEEK) and Polyetherimide (PEI) are able to full fill much more stringent requirements compared the other thermopolymer classes, as such they can be used in challenging industries such as [aerospace](#), [energy](#), and [motorsport](#).



FLEX-TPU



PP



FUNCTIONAL-NYLON

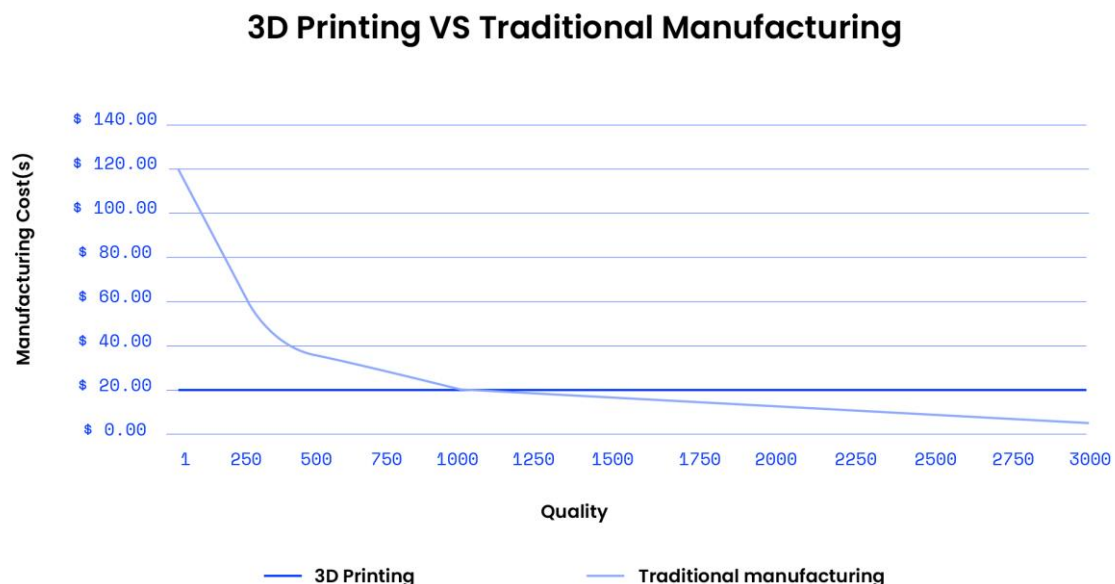
# Benefits and advantages of 3D printing



## 3D printing benefits in production: using additive manufacturing for small batches and internal production

It is a well-known fact that small production batches have a higher cost than high-volume ones, where economies of scale start to have an effect. This can be problematic when only a limited number of parts is required, for example in the case of spare parts or a pre-series (before going into full production). Typically, the mold is the most expensive part of the process, costing upwards of 10,000 USD, therefore companies will refrain from low volume runs.

There are many 3D printing advantages and one is that the cost for a single part does not change whether a batch of 10 or 1000 is printed. Because the cost stays the same irrespective of the volume, small batches are much cheaper to print than using traditional manufacturing. On top of this, thanks to the layered nature of 3D printing, complex geometries with features such as internal cavities, lattice structures, and functionalized surfaces don't impact the cost of the part. The break-even point can vary depending on the complexity, but in general can be said to be in the range of the hundreds of parts.



Comparison of manufacturing cost as a function of quantity for 3D printing and traditional manufacturing

# Benefits and advantages of 3D printing



## How can 3D printing help to internalize production?

Internalizing production is something that companies often do to reduce the costs of manufacturing and transportation, as well as to reduce time. Internal production means setting up a space that is dedicated to manufacturing parts that are needed often and often expensive to acquire, hence why the production is internalized. The acquisition of an industrial 3D printer can serve the same purposes as a whole machining shop with the added benefits of greater design freedom, flexibility, and low costs for small batches. Having an in-house 3D printing facility allows the creation of a digital warehouse and JIT and on-demand manufacturing, dramatically shortening the lead times and lowering costs, up to [-50% of costs and 80% of internalized production.](#)



Steel component  
produced with traditional manufacturing



Component in Carbon PA PRO  
produced with Roboze 3D printing

# Benefits and advantages of 3D printing



## Conclusion

Roboze's specialization in 3D printing for metal replacement is a valuable tool that complements traditional manufacturing by producing small customized batches and reducing costs and delivery times of finished products.

Increased competitiveness, corporate reputation, productivity and profits are the direct benefits experienced by companies that have adopted Roboze innovation in response to technological acceleration and competition on a global scale.

Find out how you can benefit from all these advantages by contacting one of our experts at [info@roboze.com](mailto:info@roboze.com).

Get ready to #PrintStrongLikeMetal





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