Roboze

Metal Replacement & Industrial 3D Printing

Roboze Report 2022

WHITE PAPER

Metal Replacement & Industrial 3D Printing - Roboze Report 2022

Introduction

Roboze designs and manufactures the world's most accurate 3D printers for producing parts with super polymers and composite materials to replace metals in industries with extreme working conditions.

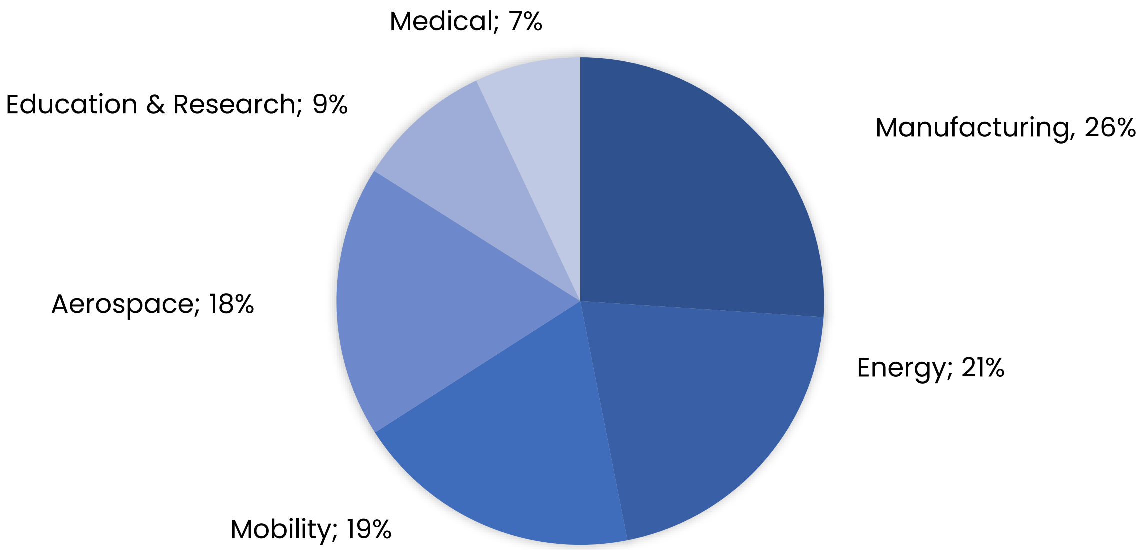
The main goal is to shape a new paradigm in digital manufacturing: Roboze Distributed Manufacturing that connects demand with supply, creating a distributed production model, which allows to produce avoiding waste, reducing shipments and CO_2 emissions, bringing production back to the point of use.

Consistent with our goal of expanding the adoption of 3D printing with innovative materials to accelerate the digital and sustainable transformation of companies, we have decided to gather our experience and put it at the service of those companies that want to explore the advantages and trends of the market in which they operate.

The future belongs to those who know how to anticipate it, today!

Objective of the analysis: The sample used for this paper includes 150 companies spread all over the world that use Roboze's Professional and Production series solutions for manufacturing of end use parts. The objective is to provide a snapshot of the current market and future trends in specific sectors.

Chapter 1: Adoption of Roboze 3D printing technology for vertical industries



Graph 1: Industries using Roboze 3D printing technology

3D printing offers a plethora of options in the production, design, and performance of novel parts and materials. It is more agile, faster, and innovative compared to more traditional manufacturing techniques, and this is reflected in the fact that the CAGR of the 3D printing sector is expected to be 24.3% by 2027.

The use of Roboze additive manufacturing (AM) solutions has spread to many sectors, as can be seen in the chart above. It shows the share of applications based on the main sectors of interest: Manufacturing, Energy, Mobility, Aerospace, Education, and Medical.

The greatest user of Roboze technology is the Manufacturing sector with 26% of the applications, where fast and cheap production of tooling and manufacturing of spares are the main drivers. This is followed by the Energy and Mobility sectors with roughly a fifth of applications each. In these sectors the focus is largely the same: optimisation of parts and reduced weight, as well as spare parts and tooling.

The Aerospace industry makes heavy use of 3D printing due to the ability to achieve significant mass reductions, thanks also to metal replacement, and optimisations. Another driver is the small production volumes which lead to high costs per part, whereas the cost per part in 3D printing remains unchanged regardless of the quantity. As with Energy and Mobility, tools and spare parts are also driving factors. These are the most used application areas currently by Roboze customers in these sectors. The growing trend is to validate new applications to manufacture end-use parts. Educational and research centres make heavy use of Roboze printing solutions both as a pedagogical tool and to manufacture experimental equipment quickly and at a low cost.

Biomedical adoption of 3D printing is still growing but more and more possibilities are being developed that make use of this technology, from surgical tools to aids and supports.

Featured application: Labelling cylinder

Application of labels on products is usually one of the last steps in production and can be done in a couple of ways. For products that are cylindrical such as bottles the most common technique is using cylinders to apply the labels.

These labelling cylinders can be configured to hold several labels by using suction to hold them in place while exposing the side with glue. The cylinder and container are then rotated one against the other to apply the label.

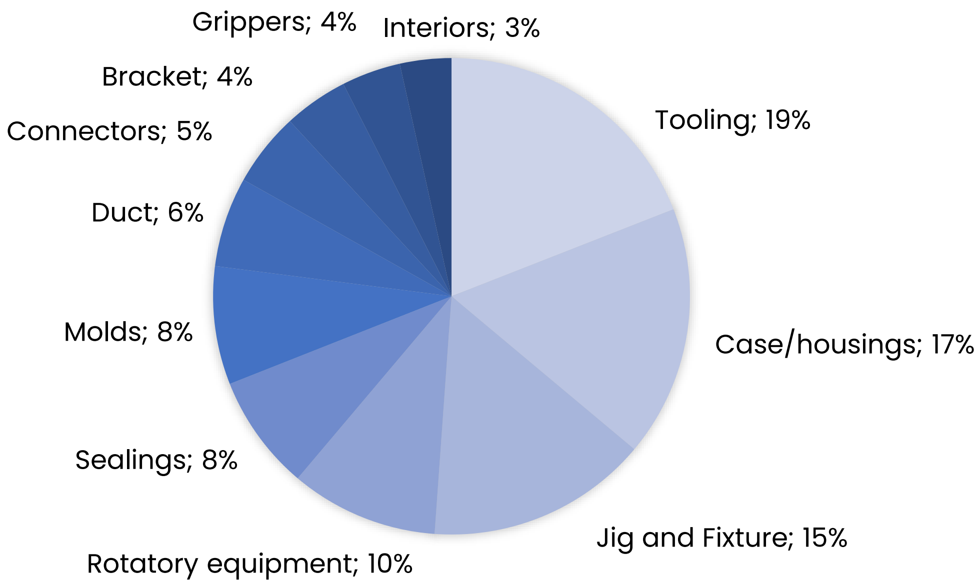
The use of Roboze's AM solutions allows great weight reductions through metal replacement and form optimisation. The configuration of the internal channels can be easily changed thanks to the design freedom of 3D printing to optimise the position of the holes, pump attachment points, and the pressure.

Advantages:

- Metal Replacement from metal to Carbon PA PRO
- Warehouse digitization to reduce lead times and parts to stock
- Design freedom for functional solutions and parts consolidation

Material	Carbon PA PRO
Weight	1.7 kg
Cost	€ 747 / $ 793
Printing Time	30 hours

Chapter 2: Adoption of Roboze 3D printing technology – Application Family



Graph 2: Adoption – Application Family

Graph 2 shows a breakdown of the applications by type, i.e., what kind of part was printed. In line with Graph 1, since Manufacturing, today, is the biggest user of Roboze solutions it follows that tooling takes the number one spot. This is followed by casings/housing, jigs and fixtures, and rotatory equipment, all applications which are commonly found in the Manufacturing sector.

Companies in general are still reluctant to manufacture parts, and this is particularly true for heavily regulated industries which are Roboze's main customers. As a first step companies prefer to use AM for parts that aid in production like tooling, cases, and jigs and fixtures but the trend is growing to employ this manufacturing technology for end-use parts.

Featured application: Tooling for thermo-forming of pipes and tubes

Plastic is used for a variety of parts in cars, including tubing that snakes around the vehicle, transporting fluids such as air, fuel, oils, and water. Thermoforming the tubes into the desired shape can be done by inserting them into tools called formers, then heating them in an oven at 180°C and finally cooling them in water. The formers can then be reused for new tubes.

Manufacturing formers is an artisanal process that takes days and therefore slows down the tube forming process. By employing ToolingX CF and the design freedom of additive manufacturing, formers can be produced quickly and with complex geometries, greatly speeding up the manufacturing process of tubing and cutting costs for former manufacturing. Successful designs can also be stored digitally and printed as needed without the need to stock spares.

Advantages:

- Warehouse digitalization and internalization of the manufacturing process
- Production on-demand and just-in-time
- Weight savings

Material	**ToolingX CF**
Production costs	€ 40 / $ 43
Time	3 hours
Weight	129 g

Furthermore, Graph 2 shows that sealings, which are used in the Energy sector, make up 8% of the applications, after rotatory equipment. Moulds are also at 8%, being a big part of manufacturing industries. Finally, there are more specialised applications such as ducts, connectors, and interiors, which are more common in industries such as Aerospace. They have a lower share of applications because these kinds of high-tech sectors tend to produce smaller volumes of parts when compared to manufacturing.

Featured application: PEKK fuel manifold for aircraft test bench

When using test benches, it is often necessary to manufacture custom components to ensure compatibility between the test subject and the test bench. These custom components can be anything from clamps to adapters to piping and need to be able to withstand the testing environment, otherwise they would be destroyed and invalidate the test results. Given the high requirements of the Aerospace industry, this means only the highest quality materials can be used, such as PEKK.

PEKK is known for its incredibly good resistance to hydrolysis in hot water and steam and a low FTS rating (flame, smoke, toxicity) of V0, making it an excellent option for use in extreme industries such as aviation, space, and oil and gas. When combined with Roboze AM, complex geometries become trivial to manufacture and since the price per part stays the same whether 1 or 10 or 100 components are made, it is ideal when needing to produce a small number of highly customised parts.

Advantages:

- Wide chemical and thermal resistance and strong mechanical properties
- Easy fabrication of a large variety of parts in a short time and at a low cost
- Design freedom leads to highly customised parts

Material	**PEKK**
Production costs	€ 450 / $ 478
Time	22 hours
Weight	350 g

Chapter 3: Metal Replacement

Metal Replacement means substituting metals with polymers: thanks to their mechanical, thermal and chemical properties, high performance polymers and composite materials can enable new extreme applications and replace metals such as bronze, brass, stainless steel and aluminum alloys. What happens when Metal Replacement meets innovative technology like Roboze 3D printing?

Advantages of Metal Replacement

- Thermal, electrical and acoustic insulation: Metals are electrically and thermally conductive, their volumetric resistivity is usually less than 10^{-5} Ohm-cm and their thermal conductivity can reach up to 400 W/(m*K) for copper. The volumetric resistivity of the polymers, on the other hand, is between 10^{12} and 10^{19} Ohm-cm, while the thermal conductivity is about 0.43 W/(m*K) for PEEK.

- Lower weight: Reducing the weight of parts mean savings and more efficient processes: in Manufacturing lighter tooling is easier to handle and requires smaller motors to move, for example in end-effectors. In the Aerospace and transport sectors, a reduced weight of the components leads to an increase in range and therefore reduced fuel consumption. The density of metals varies over a wide range: about 2.7 g/cm^3 for aluminium alloys, 8 g/cm^3 for stainless steel, and about 8.7 g/cm^3 for brass. In comparison the density of polymers is very low at between 0.9 and 1.5 g/cm^3. PEEK is 84% lighter than SS316 and 52% lighter than 6063 aluminium.

- Mechanical resistance: The development of new composites, mainly those reinforced with carbon fibers, significantly increases the material's tensile strength. Roboze Carbon PA PRO can have a tensile strength up to 171 MPa, even higher than that of some aluminium alloys such as Aluminum 6063 (breaking load of 130 MPa). This allows Carbon PA PRO, and Carbon PEEK, to replace aluminum in the manufacturing industry.

- Specific strength: Both metals, polymers and composites have high mechanical properties. Metals, however, have a high density unlike polymers and composites, a characteristic that results in a lower strength-to-weight ratio. Carbon PA PRO, for example, has a specific strength of 140 kPa * m^3/kg, which is about 1.2 times higher than aluminum 6061.

- Resistance to temperatures: Common industrial metals melt at very high temperatures, while standard polymers do not resist well at temperatures above 100 °C high-performance polymers and composites can reach 280 °C, allowing them to be used in a much wider temperature range.

- Chemical and corrosion resistance: Metals can be subject to corrosion, while polymers resist a wide range of chemicals, both acids and bases. PEEK and its composites, for example, are extremely resistant to a wide range of chemicals such as fuels, lubricants, hydrogen, chlorine, seawater, ammonium nitrate and many others.

Table 1: Why are polymer-based materials replacing metals?

Metals	**Polymers**
Subject to corrosion	Chemical and corrosion resistance
High density	Reduced weight
Thermal and electrical transmissibility	Thermal and electrical insulation
High energy consumption during manufacturing	Increased workability and lower manufacturing energy requirements
Mechanical performance	High-performance polymers are capable of very strong mechanical responses

Featured application: Carbon PEEK swing check valve system

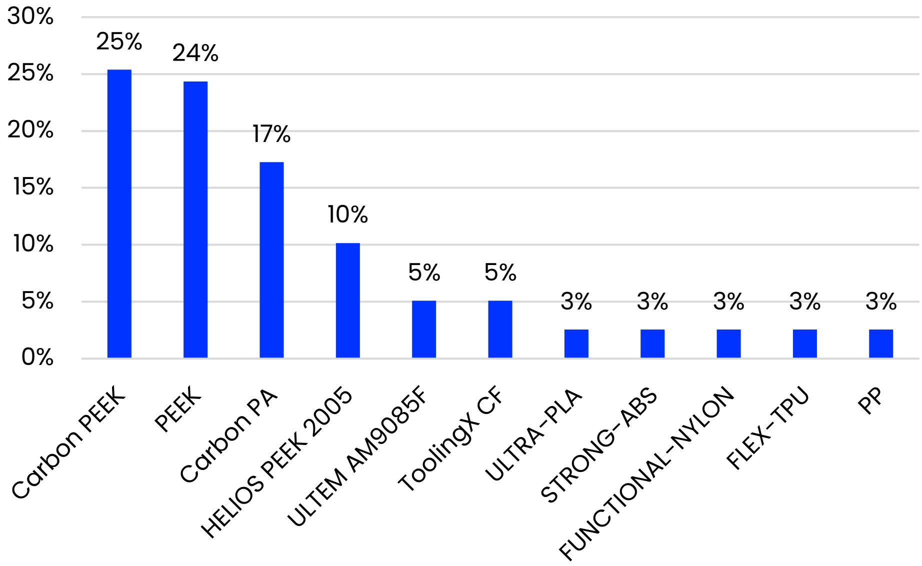
Swing check valves are designed to prevent fluid in a pipe from flowing back; as the fluid pressure reaches zero, the valve shuts fully to prevent backflow. Swing check valves belong a group of valves classified as automatic and are mostly employed in pipelines where a fluid needs to flow only in one direction to avoid accidents.

In this specific application the swing check valve was used in the Energy industry. It was originally manufactured in carbon steel but was subjected to heavy corrosion because of the presence of hydrocarbons in the flow. Super Duplex was considered as a replacement; however, this option would have been more expensive than manufacturing with carbon steel. Printing the parts out of Roboze's Carbon PEEK ensured an excellent chemical resistance and a very good sealing of the disk, reducing the leakage through the valve and reducing the maintenance costs.

Advantages:

- Reduced maintenance thanks to higher chemical resistance of Carbon PEEK
- No post processing required
- Lower mass means safer handling

Manufacturing	Traditional	Additive
Material	Carbon steel	Carbon PEEK
Weight	596 g	321 g
Cost	€ 1200 / $ 1274	€ 315 / $ 334
Printing time	3 weeks	15 h



Graph 3: Adoption – Most used polymers and composites

More and more companies are looking to 3D printing associated with these materials as a valuable tool for complementing traditional manufacturing, in order to produce small, custom batches that allow reduced costs and lead times for their customers.

As Graph 3 shows, the trend is towards the use of high performance thermopolymers over more traditional materials such as PLA and ABS. High-performance thermoplastics (also called super polymers) are a specialized and rapidly growing segment of the 3D printing plastics market that are employed in applications characterized by extreme temperatures, high mechanical loads, high doses of radiation, and exposure to chemical agents.

These higher properties allow them to be employed in much more demanding applications than engineering or standard polymers, for example for the manufacturing of spacecraft parts. Carbon PEEK and PEEK take the top spots because they are the most performing and well-known materials and are widely used for the thermal, mechanical, and chemical properties.

They are followed by Carbon PA PRO, which is another high-performance thermopolymer, greatly used in the manufacturing Industry. Helios™ PEEK 2005 is used in more specific applications, such as wind tunnel testing of aerodynamic components. It is then followed by ULTEM™ AM9085F, ToolingX CF, and the standard polymers having roughly equal shares. It should be noted that, although having been released only recently, ToolingX has already been employed in a number of applications equal to ULTEM™ AM9085F and is growing, demonstrating a marked interest in this material.

Interestingly, of the top five materials, three are composites. This is not a surprising result because the addition of reinforcement fibres in plastics greatly increases their properties and tailors them for specific applications, such as in the case of Helios™ PEEK 2005 having better thermal properties than PEEK and Carbon PEEK. Something else to note is that two of the top five composites are combinations of plastic with carbon fibres. This addition not only strengthens the original material but also changes its thermal and electrical properties, ensuring greater electrical conductivity, thermal conductivity and reducing its coefficient of linear thermal expansion. For example, Carbon PA PRO is much stronger than neat PA and therefore can be used in applications with mechanical loads that would crush regular nylon, thus greatly expanding the scope of this otherwise standard plastic.

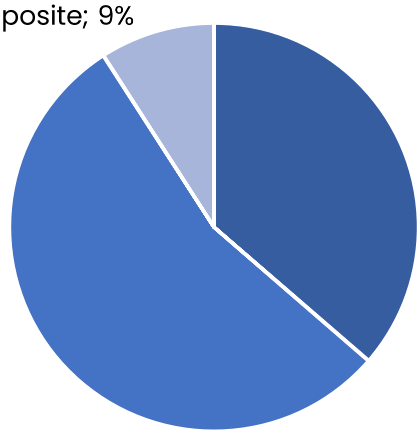
Featured application: CubeSat instrument holder in Carbon PEEK

CubeSats are a class of small satellites that are often employed by universities and research institutions due to their ease of construction and low cost. The university of Colorado Boulder is constructing a CubeSat called CANVAS to measure how the space environment in low Earth orbit is affected by lightning. Three magnetic field detectors and a PCB were held in the printed parts, whose unusual and complex geometries were uniquely suited for 3D printing. Originally the parts would have been manufactured using traditional materials and techniques, but this would have resulted in excessively long lead times, inability to make changes during design, high costs and a high mass, last point particularly detrimental for small satellites where every gram counts. Roboze's Carbon PEEK is a space-grade material that can withstand the rigors of the space environment including radiation, chemical attack, mechanical loads during launch, and temperature swings of up to 100 °C, making it ideal for this application. Combined with its low density and the design freedom of additive manufacturing, the lead times were greatly shortened, mass more than halved, and several design changes were implemented during development.

Advantages:

- Lower mass and therefore lower costs
- Design freedom for part count reduction
- Ability to produce several prototypes easily and cheaply during design stage

Material	Aluminium, CNC	Helios™ PEEK 2005
Production costs	€ 2884 / $ 3061	€ 300 / $ 318
Mass	390 g	143 g
Operating conditions	Resistance to radiation, atomic oxygen and temperature fluctuations (-40 °C ÷ 80 °C)	



Graph 4: Metal Replacement 3D Printing – Original material family

Graph 4 shows that more than half of the applications of 3D printed materials have the objective of replacing metal parts. As discussed in Chapter 3, plastics have several advantages compared to metals, which is why such a large share of applications is in this field.

The main driver for metal replacement is reducing the weight of the parts. This represents a huge advantage in many different industries where weight plays a key role in determining the efficiency. Some examples are Aerospace and transportation industries, where lower weights mean lower the Energy or fuel consumption and more efficient processes.

Metal replacement is a concept that can be utilized for every manufacturing technology. Regardless of the production method, as previously discussed, the advantages of utilizing polymers and composites instead of metals are multiple. However, when combined with the printing ecosystem developed by Roboze, plastics can enhance the flexibility and customization of parts, leading to even greater weight savings.

Polymer applications typically involve replacement of machined parts with 3D printed ones, cutting lead times and costs. Similarly, composites are expensive, and part manufactured with them take a long time, therefore replacing them with 3D printed high-performance thermopolymers is highly advantageous both in terms of cost and time.

Featured application: Carbon PEEK closed impeller

An impeller is a type of rotor that is used to increase the speed or pressure of a fluid. They are a key component of centrifugal pumps and are used in all sorts of applications, from chemical production facilities to water treatment plants to rocket engines. While open and semi-open impellers are relatively easily manufactured, closed impellers are difficult to produce because removal of material from inside the impeller is complicated. The impellers in this application were originally manufactured in cast steel, however showing a short lifespan and lead times up to 10 weeks.

The Carbon PEEK closed impellers printed in an ARGO 500 were mounted on centrifugal pumps and, thanks to the weight reduction from metal replacement, were less subjected to vibrations, resulting in a much longer lifespan. 3D printing also resulted in more balanced and quieter impellers, which increased the lifespan even longer.

Advantages:

- Weight reduction for increased lifespan
- Noise reduction with 3DP Carbon PEEK
- Traditionally unstable while instead fully balanced when manufactured with 3D printing

Material	**Carbon PEEK**
Production costs	€ 3000 / $ 3184
Time	70 hours
Weight	2 kg

Chapter 4: 3D Printing and Traditional methods

But when choose 3D printing over traditional methods?

Let's list the differences between traditional manufacturing and 3D printing. Here is a table showing the main differences between the technology families.

Table 2: 3D Printing and Traditional methods -Which one to choose?

Manufacturing	Traditional	3D Printing
Geometry	Limitations	No limitations, flexible and complex parts, infill options
N° of process needed to get to final shape	One or more	One
Stock needed	Yes	No
Profitability	Based on large batches	Independent of number of units
Goal	Mass production	Mass customization

3D Printing is the manufacturing method that is ideal for the quick production of parts when one or more of the following conditions are met:

- Production of small batches;
- Short lead time;
- Remote locations;
- Complex shapes or customized designs required: costs increase with complexity with traditional manufacturing;
- Reduction of stock parts, digital warehouse.

3D printing is the production technology for innovative companies: it helps to reduce the time to market by accelerating the prototyping phase, therefore it reduces the costs connected to the product development phase.

Our team of engineers here at Roboze will help you to evaluate the best options for your application according to your specific needs.

How to Select a Manufacturing Process for Your Product?

The choice on the production technology to implement for a product design, must consider several factors:

- Number of parts to manufacture
- Production speed and lead time
- Mechanical requirements and performance of the material and material family
- Surface finish needed
- Tolerances required
- Complexity of the shapes
- Customized shapes
- Cost (labor cost and waste material)

Table 3: Production methods comparison

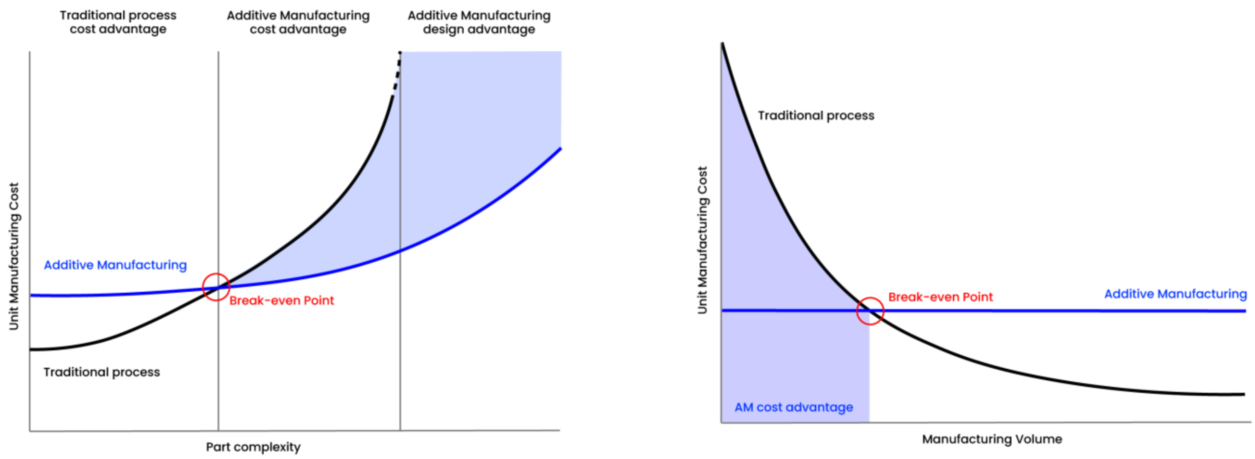
	FFF Roboze	CNC	Injection Molding	Forming	Joining
Cost-low volume	✓	–	X	X	X
Cost-high volume	X	X	✓	✓	–
Lead time	✓	✓	X	X	X
Material Selection	✓	✓	✓	✓	✓
Surface Finish	X	✓	✓	✓	✓
Integrated assembly	✓	X	X	X	X
Complexity	✓	–	–	X	X
Customizability	✓	✓	X	X	X

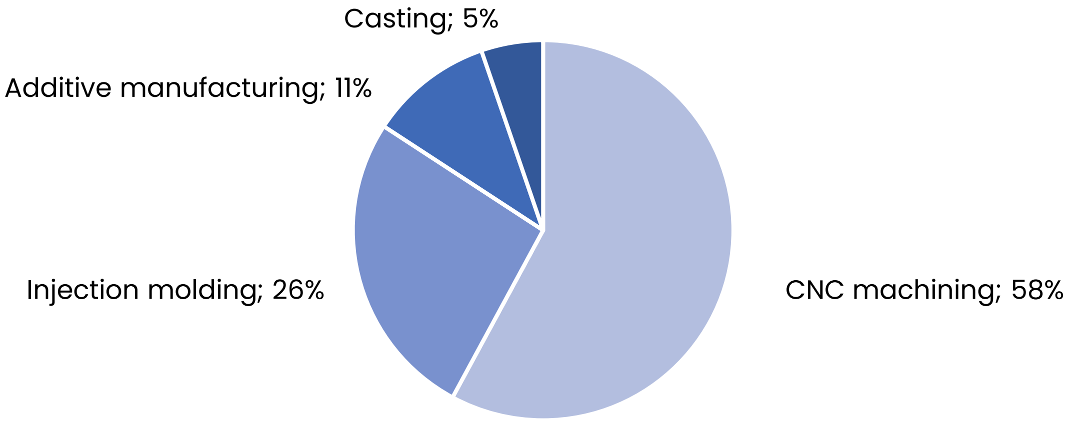
✓ is good – is fair X is poor

As can be seen in the table above and as the plots below help to illustrate, compared to traditional manufacturing additive manufacturing's greatest strength comes in its design flexibility. This is reflected in the ability integrate disparate parts into a single component and in the ability to manufacture complex and customised components quickly and cheaply.

Traditional manufacturing excels in producing high volume parts with a smooth surface. Where traditional techniques falter is in low volume runs and high complexity components. The cost of printed parts does not vary whether 1 or 1000 are made, which is significant when only a few dozen components must be manufactured.

Roboze's printing solutions really come into their own as the complexity of the geometry increases. Since the price per part does not vary and there is the possibility of creating highly customised parts, there is all the reason to make use of 3D printing either as the main manufacturing technique, such as for the production of brackets, or as an addition to traditional manufacturing, for example in the production of moulds and formers.





Graph 5: Original manufacturing techniques

Graph 5 shows the original manufacturing techniques that Roboze 3D printing went to substitute. Grabbing almost two thirds of the applications was CNC machining, which is not surprising since it is one of the most used manufacturing techniques in the world. There are two main problems with it, though: material waste and lead time.

Since machining is a subtractive manufacturing method, parts start from stock and removed material is lost and paid for by the customer, leading to parts being more expensive than they should. Long lead times are a consequence of the limited design freedom in machining, which typically needs to be combined with other techniques like joining to obtain finished parts. In other words, as the complexity of components increases so does the manufacturing time, thus causing slowdowns in production. As discussed in this paper, additive manufacturing does not suffer from the same limitations so is ideal for low volume, complex parts. Injection moulding is another popular form of manufacturing and is particularly suited for high-volume production and additive manufacturing is not appropriate in this situation. Yet, it is not always possible to obtain replacements for injection moulded parts, hence the possibility to 3D print them. At times the original supplier will have even stopped production, meaning that either spares have to be stored or a new production line has to be set up, which is very expensive. 3D printing can quickly and easily create spares for any part even if the supplier has stopped production thanks to its design freedom. Parts manufactured with additive manufacturing and casting are not very common and so have small shares. 3D printed parts can be further improved or substituted with higher quality materials. Like injection moulding, cast parts sometimes need to be replaced but spares cannot be found, hence the need for additive manufacturing.

Featured application: Carbon PA PRO frame for automotive assembly lines

The frame was used in robotic assembly lines in the automotive sector, several pneumatic actuators were mounted on the frame to manipulate components with a variety of end effectors.
The original was made from aluminum and assembled from several pieces using welding and bolts. The back and front plates were machined from stock and several pipes were used. Construction of the assembly was time consuming and did not allow easy modifications.

By leveraging high-performance thermo-polymers and the design freedom inherent in 3D printing, a new monolithic frame was designed printed that weighed less than half of the original frame while having the same mechanical properties. 3D printing also allows the easy implementation of design changes so new frames can be manufactured quickly.
The frames can even be made modular to allow them to be adapted to the application as needed. Successful models can be saved in internal databases and printed as needed without the need to store physical spares, saving storage space and reducing costs.

3D Printing is the manufacturing method that is ideal for the quick production of parts when one or more of the following conditions are met:

- Internalization of the manufacturing process and warehouse digitalization
- Design freedom for functional solutions and parts consolidation
- Weight savings on the end effector allow to pick a robotic arm with a lower load-lifting capability

Material	Aluminium, CNC	Carbon PA, 3D Printing
Production costs	€ 800 / $ 849	€ 300 / $ 318
Weight	3 kg	1.3 kg

Can 3D printing be combined with traditional manufacturing?

Subject to the type of materials, 3D printed parts can be combined with traditional technologies to achieve very smooth surfaces, to meet very low tolerances, or to assemble multiple large parts. High quality finishes can be obtained through mechanical and chemical polishing processes. Welding is a very good option for joining two or more parts.

Considerations

3D printing is a growing manufacturing technology that offers unparalleled design freedom and possibilities. Since it can simplify or eliminate manufacturing constraints such as the production of moulds, AM is fast, agile, and innovative and will keep growing in the future. In this paper an analysis was done of how Roboze printers and services were employed to provide a snapshot of the market and trends therein. The greatest users of Roboze 3D printing, see Graph 1, are the Industrial (26%) and Manufacturing (21%) sectors, followed by Energy (21%) and Mobility (19%), and then by more specialised sectors like Aerospace (18%) and Biomedical (7%).

This division is reflected in the application families, see Graph 2, with tooling, case/housings, jigs and fixtures, and rotatory equipment taking 61% of applications due to their use in the Industrial and Manufacturing sectors. The remaining 29% is divided amongst applications such as ducts, connectors, and interiors because they belong to more specialised sectors like Aerospace and Energy. One of the main uses of additive manufacturing is for metal replacement because high-performance plastics have several advantages such as low density, low electrical and thermal conduction, and corrosion and chemical resistance, summarised in Table 1. Graph 4 confirms this by showing that 55% of parts were originally made in metal, with the remainder being divided amongst polymers (36%) and composites (9%).

Being a specialist in high-performance thermopolymers, the most used materials shown in Graph 3 are Carbon PEEK (25%) and PEEK (24%), with Carbon PA PRO (17%) following not far behind. The first two are materials most representative of highly specialised sectors such as Biomedical, Aerospace, and Energy, which have very stringent requirements and therefore make large use of these materials. Carbon PA PRO finds its use mostly in Industry and manufacturing. Helios™ PEEK 2005 (17%) and ULTEM™ AM9085F (10%) are used in sectors like Mobility and Motorsport, whereas the rest of the materials find uses in a variety of applications so have roughly equal shares.

Chapter 4 explains where and when additive manufacturing is advantageous over traditional manufacturing: in low volume, highly customised applications. The price of 3D printed parts is the same regardless of quantity so large volumes are out of its scope, but it shines when complex parts must be produced in small volumes. Additive manufacturing also greatly shortens lead times and reduces need for the stocking of spare parts thanks to just-in-time and on-demand manufacturing and digital warehousing.

As shown by Graph 5, 58% of parts were originally made with CNC machining, with injection moulding (26%), additive manufacturing (11%), and casting (5%) following behind. Being one of the most widely used manufacturing methods, it is not surprising that CNC machining takes the first place. Injection moulding is also extremely popular for large volume production so follows second. Additive manufacturing and casting are less common and therefore get the smallest share of the application pie.

Conclusion

The trend of integrating traditional manufacturing methods and additive manufacturing is growing. The ARGO 500 platform allows the replacement of metals in numerous applications with enormous advantages in terms of lightness, mechanical strength, workability, and chemical resistance.

It provides repeatable, controlled, and traceable systems that allows customized production for each individual customer in every part of the world. Everything is designed to bring 3D printing into the new era of industrial production of customized medium batches, reducing time and costs for manufacturing companies.

This technological evolution allows the real application of the Manufacturing as a Service model, where additive manufacturing centers for goods close to the point of use, known as Roboze 3D Parts certified manufacturing partners, significantly affect the production and procurement costs of a company. Since the goods are produced locally, savings on logistics costs are immediate, thanks to the greater involvement of the end customer making it possible to reduce inventory costs.

By archiving a digital warehouse rather than having physical inventory warehouses, companies can significantly reduce their inventory costs by producing with Roboze industrial additive manufacturing systems, on-demand and just-in-time.
Roboze's specialization in Metal Replacement3D Printing is a valuable tool that complements traditional manufacturing by producing small custom batches and reducing costs and lead times of finished products.

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

Find out how you too can benefit from all these advantages by contacting one of our experts at info@roboze.com.

Get ready to #PrintStrongLikeMetal!

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