

The Free Beginner's Guide

07 : BENEFITS
& VALUE

3D Printing Applications :

The origins of 3D printing in 'Rapid Prototyping' were founded on the principles of industrial prototyping as a means of speeding up the earliest stages of product development with a quick and straightforward way of producing prototypes that allows for multiple iterations of a product to arrive more quickly and efficiently at an optimum solution. This saves time and money at the outset of the entire product development process and ensures confidence ahead of production tooling.

Prototyping is still probably the largest, even though sometimes overlooked, application of 3D printing today.

The developments and improvements of the process and the materials, since the emergence of 3D printing for prototyping, saw the processes being taken up for applications further down the product development process chain. Tooling and casting applications were developed utilizing the advantages of the different processes. Again, these applications are increasingly being used and adopted across industrial sectors.

Similarly for final manufacturing operations, the improvements are continuing to facilitate uptake.

In terms of the industrial vertical markets that are benefitting greatly from industrial 3D printing across all of these broad spectrum applications, the following is a basic breakdown:

Medical and Dental



The [medical sector](#) is viewed as being one that was an early adopter of 3D printing, but also a sector with huge potential for growth, due to the customization and personalization capabilities of the technologies and the ability to improve people's lives as the processes improve and materials are developed that meet medical grade standards.

3D printing technologies are being used for a host of different applications. In addition to making prototypes to support new product development for the medical and dental industries, the technologies are also utilized to make patterns for the downstream metal casting of dental crowns and in the manufacture of tools over which plastic is being vacuum formed to make dental aligners. The technology is also taken advantage of directly to manufacture both stock items, such as hip and knee implants, and bespoke patient-specific products, such as hearing aids, orthotic insoles for shoes, personalised prosthetics and one-off implants for patients suffering from diseases such as osteoarthritis, osteoporosis and cancer, along with accident and trauma victims. 3D printed surgical guides for specific operations are also an emerging application that is aiding surgeons in their work and patients in their recovery. Technology is also being developed for the 3D printing of skin, bone, tissue, pharmaceuticals and even human organs. However, these technologies remain largely decades away from commercialisation.

Aerospace



Like the medical sector, the aerospace sector was an early adopter of 3D printing technologies in their earliest forms for product development and prototyping. These companies, typically working in partnership with academic

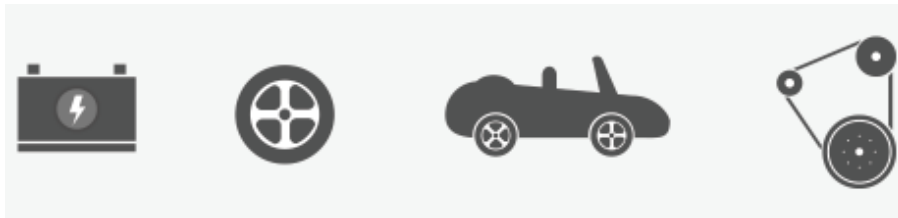
and research institutes, have been at the sharp end in terms of pushing the boundaries of the technologies for manufacturing applications.

Because of the critical nature of aircraft development, the R&D is demanding and strenuous, standards are critical and industrial grade 3D printing systems are put through their paces. Process and materials development have seen a number of key applications developed for the aerospace sector – and some non-critical parts are all-ready flying on aircraft.

High profile users include GE / Morris Technologies, Airbus / EADS, Rolls-Royce, BAE Systems and Boeing. While most of these companies do take a realistic approach in terms of what they are doing now with the technologies, and most of it is R&D, some do get quite bullish about the future.

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Automotive



Another general early adopter of Rapid Prototyping technologies – the earliest incarnation of 3D printing – was the automotive sector. Many automotive companies – particularly at the cutting edge of motor sport and F1 – have followed a similar trajectory to the aerospace companies. First (and still) using the technologies for prototyping applications, but developing and adapting their manufacturing processes to incorporate the benefits of improved materials and end results for automotive parts.

Many automotive companies are now also looking at the potential of 3D printing to fulfill after sales functions in terms of production of spare/replacement parts, on demand, rather than holding huge inventories.

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Jewellery



Traditionally, the design and manufacturing process for jewellery has always required high levels of expertise and knowledge involving specific disciplines that include fabrication, mould-making, casting, electroplating, forging, silver/gold smithing, stone-cutting, engraving and polishing. Each of these disciplines has evolved over many years and each requires technical knowledge when applied to jewellery manufacture. Just one example is investment casting – the origins of which can be traced back more than 4000 years.

For the jewellery sector, 3D printing has proved to be particularly disruptive. There is a great deal of interest – and uptake – based on how 3D printing can, and will, contribute to the further development of this industry. From new design freedoms enabled by 3D CAD and 3D printing, through improving traditional processes for jewellery production all the way to direct 3D printed production eliminating many of the traditional steps, 3D printing has had – and continues to have – a tremendous impact in this sector.

Art / Design / Sculpture



Artists and Sculptors are engaging with 3D printing in myriad of different ways to explore form and function in ways previously impossible. Whether purely to find new original expression or to learn from old masters this is a highly charged sector that is increasingly finding new ways of working with 3D printing and introducing the results to the world. There are numerous artists that have now made a name for themselves by working specifically with 3D modelling, 3D scanning and 3D printing technologies.

- Joshua Harker
- Dizingof
- Jessica Rosenkrantz at Nervous System

- Pia Hinze
- Nick Ervinck
- Lionel Dean
- And many others.

The discipline of 3D scanning in conjunction with 3D printing also brings a new dimension to the art world, however, in that artists and students now have a proven methodology of reproducing the work of past masters and creating exact replicas of ancient (and more recent) sculptures for close study - works of art that they would otherwise never have been able to interact with in person. The work of Cosmo Wenman is particularly enlightening in this field.

Architecture



Architectural models have long been a staple application of 3D printing processes, for producing accurate demonstration models of an architect's vision. 3D printing offers a relatively fast, easy and economically viable method of producing detailed models directly from 3D CAD, BIM or other digital data that architects use. Many successful architectural firms, now commonly use 3D printing (in house or as a service) as a critical part of their workflow for increased innovation and improved communication.

More recently some visionary architects are looking to 3D printing as a direct construction method. Research is being conducted at a number of organizations on this front, most notably Loughborough University, Contour Crafting and Universe Architecture.

Fashion



As 3D printing processes have improved in terms of resolution and more flexible materials, one industry, renowned for experimentation and outrageous statements, has come to the fore. We are of course talking about fashion!

3D printed accessories including shoes, head-pieces, hats and bags have all made their way on to global catwalks. And some even more visionary fashion designers have demonstrated the capabilities of the tech for haute couture – dresses, capes, full-length gowns and even some under wear have debuted at different fashion venues around the world.

Iris van Herpen should get a special mention as the leading pioneer in this vein. She has produced a number of collections – modelled on the catwalks of Paris and Milan – that incorporate 3D printing to blow up the ‘normal rules’ that no longer apply to fashion design. Many have followed, and continue to follow, in her footsteps, often with wholly original results.

Food



Although a late-comer to the 3D printing party, food is one emerging application (and/or 3D printing material) that is getting people very excited and has the potential to truly take the technology into the mainstream. After all, we will all, always, need to eat! 3D printing is emerging as a new way of preparing and presenting food.

Initial forays into 3D printing food were with chocolate and sugar, and these developments have continued apace with specific 3D printers hitting the market. Some other early experiments with food including the 3D printing of “meat” at the cellular protein level. More recently pasta is another food group that is being researched for 3D printing food.

Looking to the future 3D printing is also being considered as a complete food preparation method and a way of balancing nutrients in a comprehensive and healthy way.

Consumers

The holy grail for 3D printing vendors is consumer 3D printing. There is a widespread debate as to whether this is a feasible future. Currently, consumer uptake is low due to the accessibility issues that exist with entry level (consumer machines). There is headway being made in this direction by the larger 3D printing companies such as 3D Systems and Makerbot, as a subsidiary of Stratasys as they try to make the 3D printing process and the ancillary components (software, digital content etc) more accessible and user-friendly. There are currently three main ways that the person on the street can interact with 3D printing tech for consumer products:

- design + print
- choose + print
- choose + 3D printing service fulfillment