

*Welcome to the insight of
the next Revolution in
Manufacturing
ADDITIVE
MANUFACTURING!!!!*

***Next in GEARING- ADDITIVE
MANUFACTURING***

ADDITIVE MANUFACTURING

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Additive manufacturing (AM) is evolving rapidly, today the reputation of the 3d printing is a maker dominated space full among the hobbyists, armatures and also given away to today's industrial additives. The additive manufacturing incorporated to industries today is the new generation of the hardware and software designed for delivering the production parts and model representing prototype at the competitive cost.

Metal 3d printing is now beginning not only to challenge centuries old fabrication methods such as casting and forging but also the modern-day metal injection moulding and 5-axis machining.

We can imagine the benefits of the 3d printing of the complicated structure as a single part, where the parts manufactured using other method might lead to multiple small components and have to be put together using various connectors which might as well affect the strength of the assembled structure [1].

What about gear object. Leaving out the important parts in the gear assembly like the shafts, bearing and motors, gear itself is a single part, and is successfully being manufactured using the injection moulding and subtractive manufacturing. So why choose 3d printed gears ?

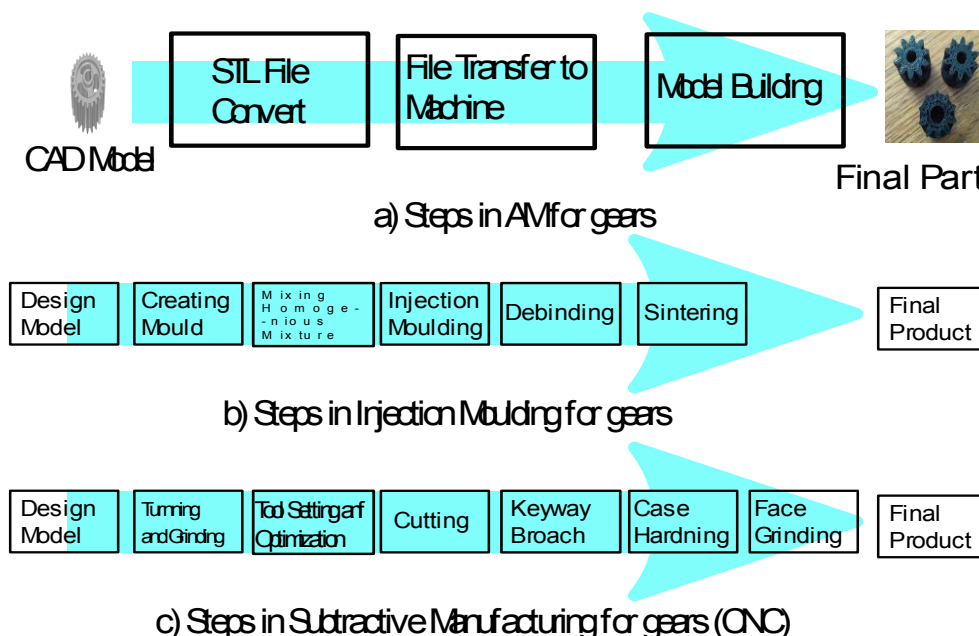


Figure 1 – Step for different Manufacturing process for gear production

For the rookie readers like me can tell from the figure1 that the number of processing step is reduced, and also could be seen that AM process does not require any additional extrusion dies or to have setup different tools and fixtures like in other manufacturing processes. This does not mean that AM process do not have any disadvantages. There are many drawbacks to AM considering its current state of development.

The Figure1 is just to present an idea on how many steps of processing are involved in the different manufacturing methods. Ofcourse there are multiple methods are available for every manufacturing process and it changes in various combinations to optimize based on the applications and the required product. Also, every product has different post processing to be done for obtaining the required final product.

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Additive Manufacturing in Gearing –

Advantages:

In the upgrowing field of AM the gears manufacturing could be considered to be little higher fruit, considering the aerospace and space industries applications where the light weight and high strength go hand in hand, whose results are promising using AM technology [2].

AM is expected to revolutionize manufacturing with its capability of modelling complex shapes, better structural strength and huge reduction in metal scraps compared to subtractive manufacturing. Gearing in AM is more popular among experimental and prototypes projects, for which the advantages could be interpreted as follows:

- 1) Printed gears made of plastics are cheap, quick and customizable.
- 2) The best advantage of the printing gears is that data sharing capabilities where the set of STL files could be shared between the systems. This cloud based inventory access also reduces the obligations of having hands-on inventory like the large scale manufactures, and considering the rate of development in this technology the entire gear research which has been around for century could be virtually informed throughout its product lifecycle and could be put to printing on demand.
- 3) Due to the virtual inventory, the all the research on gears made could be revisited and is could be improved to its micro point data.
- 4) Complicated and variant in model could be obtained.

The dominated 3d printers do not have the strength or the resolution to print high precision gear teeth. This is where metal 3d printers are getting popular. The metal 3d printers could handle metal variants of stainless and tool steels.

The Markforged Metal X provides the better solution for reducing the overhead costs such as keyway broaches, extrusion dies, special tooling etc., for prototyping and production. On the topic of the virtual inventory and data processing Markforge extended its research to the AI-powered software named Blacksmith focused on making the manufacturing machines intelligent. They also developed a compatible tools to 3d scan the parts and the all the data points information is reverted back to the AI to to make them self-train and adjust the machine to produce the next parts with higher precision [5].

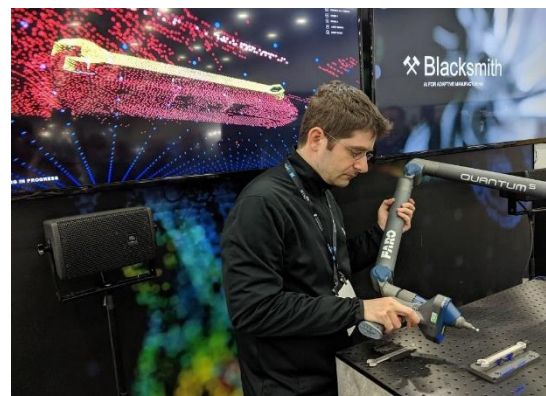
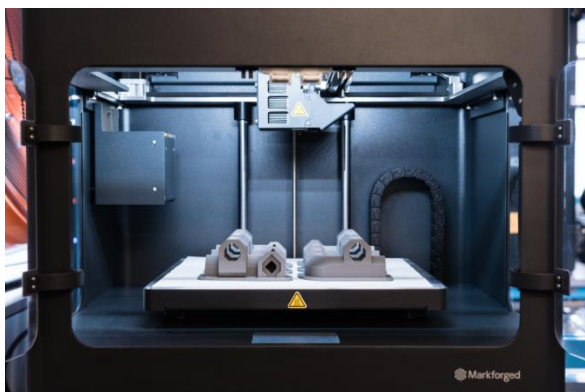


Figure 2 – Here shown is the Metal X machine and the Blacksmith interface with the scanning device [5].

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Challenges:

Gearing in AM is very complicated due to its research and demand on components and also due to its tight tolerance. The major challenges of gearing in AM can be of two folds: one being the high precision requirements to minimize the gear teeth backlash and to obtain material which could withstand higher torques.

Beyond the above two manifolds the gearing in AM has its own unique limitations. Some of the industrial challenges could be interpreted in the form of cost and size, along with that is the lack of quality control in the industries, due to its current usage in prototype stages alone. Another discussed challenge is that in current development stage for every next material used requires a new process of AM to be developed in programming level and along with that post-processing and its integration to the AM adds additional challenges as well as the surface inconsistencies [2].

Lets now discuss few problems for printed plastic gears popular in the forums among the small scale experimentalists and people creating prototypes in few points below [3]:

- 1) Most discussed is the slicing software challenge where different program tends to different spots for the holes and sometimes modelled as a polygons. Sometimes heat generated and cooling and also the misalignment between layers could also tend to tighter holes. The solution for this could be perceived by giving tolerance or to ream them out later.
- 2) The other challenge is the solid infills for obtaining the small gear teeth. The small gaps generated between the teeth are common thought the slicer is programmed for 100% fill. One manual way of solving is by increasing the layer overlap. The documentation of Richrap offers a good range of hand-on solution from his blog.[4]



Figure 3– Gaps in gear teeth – Solid infill Challenges [4].

- 3) The strength is the huge challenge among the plastic gears for transmitting the torques a good rule of thickness to be 3-5 times that of the circular pitch of the gear is suggested.

One major challenge I could personally realise is to be educated by various research undergoing currently. Introduction to the new ways of manufacturing is going to take time to understand the process and how it could be leveraged to included and change one's business.

Conclusion - One of the interesting integrations in the world of technology where AM technology proves that its is not trivial to shift from rapid prototyping to production. Through its complicated the progress towards AM to its way in series production could be realized. One of the challenges is that there is no standardise method of production. But in the world of todays technology where there is a need the demand is provided.

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