

Future of Die-casting Industry Considering the 3D-Printing Boom in India

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Abstract—The die casting industry plays a vital role in the manufacturing sector and imagining our life without die casting sector is now next to impossible. In the last 2 decades, one more such technology is revolutionizing manufacturing and prototyping, that is 3D printing. 3D printing is much easier and involves fewer processes in comparison to die casting. This can make it a potential alternative to die casting in the future. Die casting and 3D printing, both in their own way, are unique and have different use cases. It is important to see what both of these technologies will look like in future and how they will revolutionize the manufacturing sector. Feasibility, Industry size, productivity and accuracy of both of these processes will also play a very important role in influencing the market. This paper compares both the technologies with help of a case study of producing 100000 “Frying pans” using both of them and analyzes Feasibility, Industry size, productivity and accuracy to prove monopolized supremacy of die casting over 3D printing. There are various ways in which 3D printing can evolve as a competition to Die casting industry. This paper at the end suggests some solutions to counter the challenges faced by 3D printing technology in order to evolve in Indian Markets.

Index Terms— Die casting, prototyping, 3D printing, manufacturing.

I. INTRODUCTION

A. Die-casting

Die casting is a type of manufacturing process that is capable of producing geometrically complex metal components by using a type of molds, called dies. A non-ferrous alloy such as aluminum, zinc, etc. is melted in the furnace and then injected into the dies in the die casting machine, this process is called die casting.

B. 3 Dimensional Printing

As the name suggests in this process a 3D component is printed by a 3D printer using computer aided design (CAD). With evolving technology, 3D printing is now possible in Plastic filament, Carbon Fiber Filaments, Conductive Filaments, Flexible Filaments, Metal Filament and Wood Filament, etc. This technology is mainly used for rapid prototyping.

II. DIE CASTING

Die casting is a complex process and involves several levels in it. This process can mainly be divided into 3 parts

i.e. designing, die manufacturing and component manufacturing.

Designing- designing can mainly be divided into two parts i.e. component design and die design. Component design is basically designing the desired final part and die design is designing of the special mold – die according to the desired component. These designs are primarily 2D and are then further designed in 3D (CAD). Then this design is simulated to check its die casting accuracy before manufacturing of die.

Die manufacturing – Once the die design is complete, the manufacturing of special kind of mold i.e. die starts. A preferred die material is chosen according to the type of component, type of alloy used, type of foundry process (i.e. GDC, HPDC, LPDC etc.) Also to sustain the continuous thermal changes involved in die casting process the die is manufactured using special grade and heat treated hot work steel and then the manufacturing of die starts. In die manufacturing process mainly used advanced machines are VMC, Sinking EDM, and Wire cut EDM etc. Along with other conventional machines. Different parts of a die are separately manufactured using specialized machines and different types of materials are used to manufacture die inserts and mold base and then assembled together. Once the die is ready for manufacturing then it goes to foundry for production.

Component Manufacturing – Die casting machines are used for manufacturing of components. Molten metals are injected at selective pressure in the die and get shaped according to final component. This pressure depends on the type of manufacturing process (i.e. GDC, HPDC, LPDC etc.) and machines. Then final finishing process takes place.

III. 3 DIMENSIONAL PRINTING

3D Printing is a relatively new technology and involves fewer processes. 3D Printer can mainly be divided in 2 parts- Designing, processing and printing.

Designing- Designing in 3D printing is also very much similar to designing in die casting. But the main difference is that no special mold is needed and this also reduces time and expense involved in die designing. Only component design is necessary for 3D printing. This design is a CAD.

Processing- Processing is also a major process involved in 3D Printing. In this process slicing of CAD design is done using slicing software. Slicing is the process which makes layers of design and sends this to printer for ease of printing. Slicing also optimizes use of manufacturing materials and estimates weight of component and time needed for its manufacturing.

Printing- this is the most important part of 3D printing, a 3D printer is used for printing 3D objects. A 3D printer has 3 axis X,Y and Z and travels all over the platform and lays down layers of material in succession according to the sliced object. Nozzle present in the printer melts and lays down thin layers of filament material. Once the printing is complete, final finishing takes place.

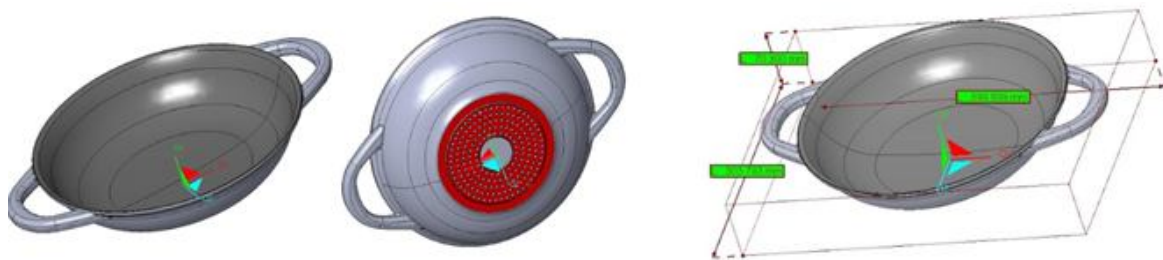


Figure 1.

IV. COMPARISON

Considering that Die casting is a century old manufacturing technique and 3D printing being a relatively new technique comparing them may not be fair but is necessary to know how much both of them have to evolve to compete with each other.

The rubrics for this comparison of technology is as follows- Feasibility, industry size, productivity and accuracy. Industry size of both the technologies is calculated by facts whereas the other three aspects will be compared on the basis of a case study.

V. CASE STUDY

This is a model of a metallic frying pan (figure 1) and we will be seeing how feasible, accurate and productive is manufacturing of such 100000 castings using both technologies considering the loop holes of both techniques.

Technical Specifications-

- Length- 39.9899 CM
- Height- 7.03 CM
- Width- 30.3793 CM
- Weight- 1.206 KG
- Material used – ALSi10Mg

VI. FEASIBILITY

Die casting- In die casting the biggest chunk of money has to be invested in raw material and production of model. Cost composition of manufacturing of 100000 can be seen in fig. 2. Total cost of production of 100000 pieces is 31900000 INR.

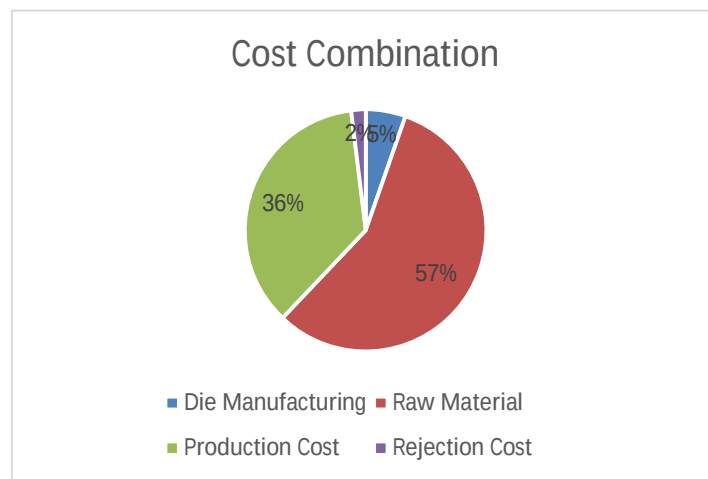


Fig. 2

3D Printing- 3D Printing as mentioned earlier is a prototyping technology. In 3D Printing also raw material is the major cost consumer. Below is the approximate financial data of 3D Printing 100000 such components. The total cost 3D printing 100000 such components is 3968000000 INR.

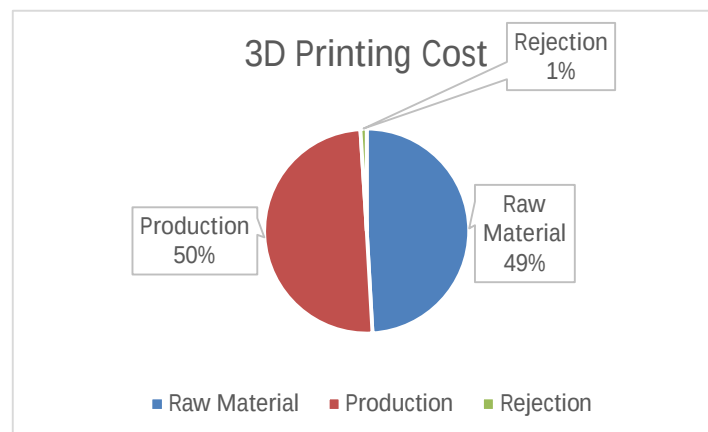


Fig. 3

VII. ACCURACY

1. *Die Casting*- Rejection cost in Die casting is somewhere near 2% of total project cost. The main reasons for rejection are mechanical inaccuracy of machines, over utilization of dies and unfavorable production conditions. Other than this, negligible manual finishing is required to remove the extra material from castings.
2. *3D Printing*- Rejection cost in this technique is 1% of total project cost and alike die casting, finishing 3D printed components also involve negligible manual finishing.

VIII. PRODUCTIVITY

1. *Die casting*- Components manufactured by die casting techniques are time tested and highly productive and efficient in use case. Today majority of plastic, rubber, metal parts used around world are produced using die casting technique and there is absolutely no room for doubt about productivity of parts manufactured.
2. *3D Printing*- 3D printing is a fine manufacturing techniques and fulfills all dimensional accuracies of a part just like die casting, and as 3D printing is also one of the rapid prototyping techniques, productivity of parts manufactured with this technique stands at par with parts manufactured by any other technique.

IX. INDUSTRY SIZE

1. *Die casting*- Die casting industry is a fat-cash industry in India. India being a leading producer in aluminium die casting parts, the industry as a whole contributes 1.09 Billion USD in 2020 and is expected to grow till 1.81 Billion USD by 2026. The Indian Automobile Aluminum Die Casting Market is anticipated to grow at a CAGR of over 8.8 % during the forecast period of 2021 - 2026.
2. *3D printing*- 3D printing at this point of time has negligible contribution in metallic automobile parts production in India, so we will be considering total industry size and dividing it by global contribution trends. 3d printing market will jump from \$12.6 billion (in 2020) to \$37.2 billion in 2026 but the contribution of automobile sector is around 20% out of which approx. 50% is metallic parts production which fairly contributes same as die casting industry.

X. CONCLUSION

	Die Casting	3D Printing
Feasibility	+	-
Accuracy	-	+
Productivity	=	=
Industry Size	+	-

The above table gives us the result of comparison of 3D Printing and Die casting process. The table indicates that Die casting is more feasible and is a bigger industry in comparison to 3D printing where 3D printing has an upper hand in delivering better accuracy. We conclude that both these technological processes are equally productive. Die casting has an edge over 3D Printing at least in Indian context.

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