

Additive Manufacturing 101 for the Metal Casting Industry



Bringing products to market - faster!

AM for Metal Casting

From Concept to Product

Metal casting aka foundry, is a process by which molten metal is poured into holds in order to make metal parts. The parts can be for manufacturing components for applications in Automotive, Farm Equipment, Railways, Machine tools, Sanitary ware, Pipe Fittings, Defence, Aerospace, Earth Moving, Textile, Cement, Electrical, Power machinery, Pumps / Valves, Wind turbine generators etc.

While metal casting is a traditional process that has been in use for a few thousand years, the modern foundry business has evolved into a major supplier of countless number of metal parts. The impact of the foundry industry in a modern society is huge. It is estimated that in India alone, there are about 5000 foundries, churning out an annual business of about \$20 billion and providing employment to about half a million people.

Enter additive manufacturing. Additive manufacturing is a serious alternative to metal casting since it is now possible

to actually print a part directly from a design instead of going the route of pattern, core, foundry process.

Metal Additive Manufacturing

Metal additive manufacturing has been attracting serious attention amongst metal component makers, as an alternative to metal casting. However, not much progress has been made owing a few factors:

1. Metal 3D printing is an expensive process. Large amounts of printing material is needed to produce the parts.
2. Time involved: Metal additive printing is not a fast process. Some designs could take several hundred hours for printing a single part. As such it is not a replacement for volume manufacturing, but could still be considered for making patterns. However, the initial cost of investment for a metal 3D printer and the eventual cost of the patterns made with metal 3D printing have made metal casting units shy away from using metal 3D printing. Also making patterns using metal additive manufacturing invite their own set of issues.
3. Risk of pattern distortion during the printing process. This means the job has to be started all the way again.

4. Difficulty of repairing or modifying a 3D printed metal pattern.

Polymer additive manufacturing

Polymer additive manufacturing, on the other hand removes several of the limitations that metal 3D printing has and in its turn offers several advantages to the foundry process for making patterns and core boxes.

Additive manufacturing does not just replace the existing processes of pattern making such as wood working or CNC machining. In order to successfully deploy additive manufacturing, one should be conscious of the fact that new pattern shapes not possible with conventional processes is now possible.

This means one needs to start thinking right from the stage of design of not just the pattern but even the part design. It is possible in some cases to actually make patterns that can include two or more existing parts such that subsequent assembly processes can be reduced for end customer. Additive manufacturing thus can redefine existing processes and collapse multiple process steps into a single, neat and elegant process step. Established manufacturing rules may have to be examined and restructured if necessary in order to take advantage of additive manufacturing.

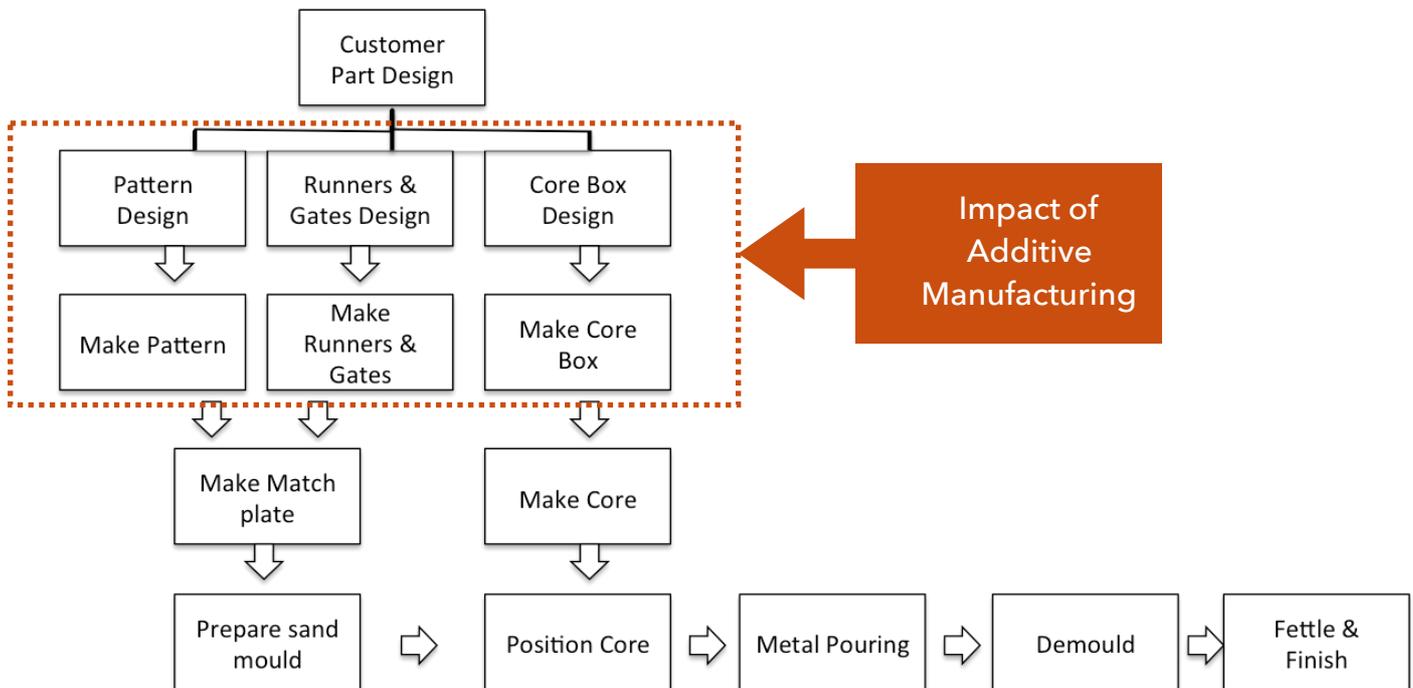
1. An additive manufacturing flow would imply that the changes that one seeks to implement, would start at the design stage. Due to its ability to handle complexity, additive manufacturing design should take into consideration issues such as introducing more complexity into its design for the end product as well as for the pattern that it seeks to make.

2. Due to the fact that near-final parts can now be made with relative ease in a very short time with lower costs, prototyping takes on added significance. Engineers can now play with their designs and revision changes do not always have to be nightmares.

3. This iterative process is not just true for the patterns but also for components such as runners, risers and gates. Creative experimentation leads to much improved design, functionality as well as efficient production processes, leading to overall economies in costs.

4. Foundries can now experiment with polymer patterns that can be used for making metal patterns. Where once long lead times and costly machining charges were daunting, it now becomes relatively simple for these companies to print polymer master patterns from which metal patterns can be made.

Metal Casting Process Flow



Traditional metal casting process makes use of either wood or metal to make patterns, runners & gates and core boxes. These processes imply that the inherent limitations of the materials used to make these items restrict the ability of the foundry to manufacture these parts.

We will discuss some of the limitations. The following tables will throw some light on how the limitations of the traditional process can be overcome with additive manufacturing.

Traditional Manufacturing		
Part to be made	Material Used	Limitations
Patterns and Core boxes	Wood or Machined Metal	<p>Lead times: Carving wooden patterns or machining down metal involves long lead times which typically run into a few weeks at least.</p> <p>Cost: Making wooden patterns requires using an experienced wooden pattern maker. Making metal patterns involves lot of machining time. Both are expensive.</p> <p>Limited Prototypes: Wooden or metal patterns means each prototype involves more lead time and more cost. So experimentation will be limited.</p> <p>Dimension control: In any metal working process, dimension control is always a bug bear. If patterns and cores are not correctly sized, the finished product will require further post processing for dimensional control</p> <p>Limited Complexity: Both wood and metal machining mean having limited capability to address complex designs. Complexities are usually addressed by making different parts and assembling them instead of casting them as a single part.</p>
		<p>All of the above reasons apply to these parts too. However, the most significant would be the difficulty to make changes to the design iteratively in order to come up with an optimized design.</p>
Runners, risers and gates	Wood or Machined Metal	

Additive Manufacturing		
Part to be made	Material Used	Advantages
Patterns and Core boxes	Polymer - typically ABS or PLA	<p>Lead times: One of the greatest advantages of additive manufacturing. Patterns can be printed within a day or two.</p> <p>Cost: The cost of patterns and coreboxes printed with plastic would be a fraction of the cost of typical metal or wooden counterparts</p> <p>Unlimited prototypes: Due to the speed with which additive manufacturing can churn out parts, it is possible to have a few different iterations before coming up with an optimised part.</p> <p>Dimensional Control: 3D printed patterns and coreboxes have comparatively better dimensional control compared to their wooden counterparts, and will be comparable to the dimensions achievable with machined metal.</p> <p>Unlimited Complexity: This is one of the biggest advantages of additive manufacturing. 3D printed parts can be made with any complex shape such that it is possible to combine multiple patterns into a single pattern.</p> <p>Patterns to make patterns: Additive Manufacturing can also be used to make patterns that can then be used to make metal cast patterns for longevity, These patterns will then be the negatives of metal cast patterns and the positives of the original product.</p> <p>Address variable shrinkage: Shrinkage can be addressed at print level separately for X, Y & Z without having to change the design.</p>
		<p>Iterative design possible: Due to its inherent advantages in cost and lead time, additive manufacturing can be successfully deployed to run multiple iterations of runners, risers and gates in order to evolve an optimal casting run.</p>
Runners, risers and gates	Polymer - typically ABS or PLA	

About Stratnel Technologies

Based in Indira Nagar, Bangalore, Stratnel Technologies LLP provides engineering solutions to their customer using additive manufacturing strategies. The promoters have several decades of experience in mechanical engineering, metal working and process control.

We provide additive manufacturing solutions to our customers to resolve their complex engineering challenges. We have customers in machine building, aerospace, foundry and general engineering.

Our solutions include providing additive manufacturing services to meet specific customer requirements, as well as supplying additive manufacturing tools such as 3D printers, training, maintenance and support.

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