ADDITIVE MANUFACTURING IN METAL CASTING

TRIDENT ALLOYS, INC

INTRODUCTION

When it comes to the foundry industry and the technology that has been used to create prototypes and production castings, there have been minimal changes. The technology of the foundry industry is one of the most researched areas within the respective engineering discipline and therefore it beckons the phrase "If it isn't broke don't fix it." 3D printing is beginning to change that line of thought by introducing new ways to manufacture a casting. The first being the use of 3D printed sand, which requires no hard tooling and can be easily changed to accommodate product design changes throughout the life cycle of the part. The second is the use of 3D printed plastic for hard tooling versus expensive wooden tooling. Both 3D printing methods are bringing new advantages to the foundry industry which are passed on to the parts buyers to take advantage of to reduce their costs and shorten lead times.

Figure 1: Trident Alloys' Neptune

3D SAND PRINTING

Many people are still unsure of what 3D sand printing is and how it relates to molding. The Viridis3D robotic sand printer, as seen in Figure 1, uses binder jetting technology in which furan binder is deposited in specific patterns to bond individual layers together to create the mold. This mold is comparable to existing no-bake technology in strength and surface finish – all without the need for an expensive wooden/metal/polymer pattern.

The process flow for 3D printed sand is very similar to traditional mold making, therefore any large production orders can be transitioned flawlessly if the need arises. The part begins as a 3D model or 2D drawing provided by the customer, once a satisfactory casting model is achieved (i.e. machine stock added, fillets added) solidification analysis can be used to design an efficient rigging system. The major advantage to this is that when the part goes to the foundry floor there is a high confidence that the casting will be sound as the solidification software has predicted/shown where risering was needed and a proper gating system calculated based on established formulas.

With 3D modeling the foundry engineer can create what works best for that particular casting by cutting the mold into several sections to allow for easier cleaning and handling or even removing mold material in areas that are unneeded to reduce cost and weight on the final mold. This can be seen in Figure 2, which shows a partially assembled mold that was printed in 4 separate sections.

The 3D printer can run autonomously with very limited outside action needed by an operator. With Viridis3D's current printer technology the rate of printing is 2.25 inches per hour on average and a curing time of 2 hours depending on the size of the mold printed, it is typical to print a mold and pour it the next day. One of the largest complaints with 3D printed sand

Figure 2: Partially assembled 3D printed mold

molds is the surface finish, this is due to the layer by layer print creating horizontal lines on all surfaces. There is a solution that involves careful sanding of mold wash and reapplication to get a much smoother finish that is more aligned to traditional sand casting.

3D PRINTED PLASTIC TOOLING

We recently acquired a Stacker S2 3D printer, as seen in Figure 3, to allow us to print temporary and long term production tooling for our customers. Printed plastic is a technology that has been around for many years but is now becoming more mainstream in the foundry industry because of more economical machine pricing. With 3D printed plastic the foundry is able to rapidly develop first article tooling without the labor and costs associated with wooden tooling. Plastic patterns can be designed for replacement parts as well as the extended production runs. Because the plastic costs fractions of what wooden tooling costs the patterns are effectively disposable meaning no storage costs for customers and when the job comes around again

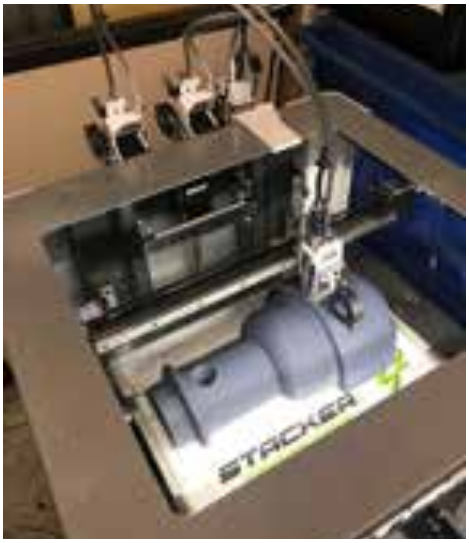

Figure 3: Trident Alloys' Stacker S2

a new pattern is printed and attached to existing cope/drag boards.

The 3D printed plastic process we use is known as Fused Filament Fabrication (FFF). This entails a heated extruder that extrudes the plastic in the desired geometry line by line from start to finish. The 3D printer is capable of printing very fine layer heights, less than 0.1mm in height, giving tooling equal to that of wood. All manner of pattern equipment can be printed from the pattern itself to individual pieces to be assembled into a much larger pattern or coreboxes, an example of which can be seen in Figure 4.

ADVANTAGES

These technologies in regards to sand casting provides several advantages to the foundry that are passed along to the customer. The biggest advantage to 3D printing is reduced lead times. When using 3D capabilities the customer can expect to see a 2-4 week lead time from order placement to delivery. The

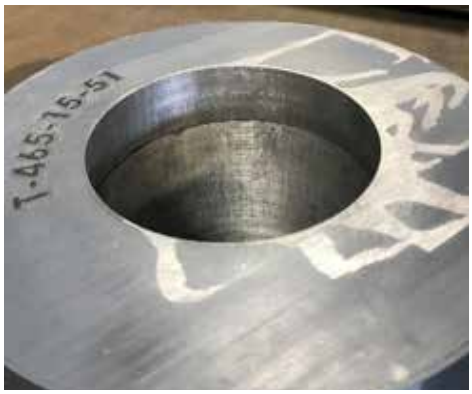

Figure 4: 3D printed plastic core box, showing interior cavity

foundry can use 3D printing to produce a casting in the time it would take to even receive the pattern from a pattern shop. The rapid prototyping nature of 3D printing allows quick modification to any design or casting material changes with no downtime since there is no pattern that needs to be modified. All that needs to occur are the changes made to the 3D model and a new sand mold or plastic pattern can be printed in the same day. The modifications can be implemented within minutes of the results from the first casting being seen.

Lastly, there is an abundance of cost savings for the customer as there is no hard tooling, no need for storage, and no repair/upkeep. Everything can be stored on a flash drive to be used again in short notice if that particular casting is needed within a couple weeks.

Contact:
JIM GALASKA
jimgalaska@tridentalloysinc.com

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GLOBAL PERFORMANCE
MAKES A WORLD OF DIFFERENCE

Trident was the first in the world with a Robotic 3D Printer for metalcasting because global markets require global thinking. If your production requirements are taking you to new points on the globe, consider the benefits of a leading-edge, digital foundry in the USA.

Trident Alloys leads in metalcasting Additive Manufacturing to give you the best options for your pumps, valves, propellers, and other critical part. Benefits to Robotic 3D printing of molds/cores:

- **Reduced Lead Times**
  Castings poured in days not weeks.
- **Reduced Costs**
  No expensive hard tooling or pattern rework, as modifications are made quickly to digital CAD files.

Trident Alloys, Inc.
181 Abbe Avenue, Springfield, MA 01107
413.737.1477 info@tridentalloysinc.com

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