



JC Steele's Efficient Sand Casting Strategy with Large-Format Additive Manufacturing

How a 130-year-old company reduced expenses by 75% and increased their annual production by over 50% with BigRep additive manufacturing

Manufacturing industrial machinery requires some of the most demanding production methods used. Outsourcing is difficult and expensive when dealing with the amount of raw metal that is required to produce massive augers capable of chewing hard materials, and the process to melt those materials is incredibly time consuming with no margin for error – lest the process be restarted, costing an egregious sum.

For many industrial machine manufacturers, the associated development and production expenses mean it's far more beneficial to bring processes in house.

By means of proprietary foundries, production methods like sand casting are used to create the strong components needed for demanding industrial applications. More recently, industrial manufacturers have discovered that large-format additive manufacturing can create a plethora of efficiencies in developing and creating the patterns that sand casting depends on.



For over 130 years J.C. Steele & Sons, Inc., a global leader in the design and manufacturing of stiff extrusion equipment for brick making machinery, has operated out of Statesville, North Carolina.

The company originated with a focus on the brick industry where it's become a United States institution able to tout that 90% of US bricks are created with one of their machines. By maintaining a keen sense of what modern tools can expand their capabilities, JC Steele has thrived and expanded.

In house, JC Steele maintains a foundry, pattern shop, and machine shop to create their massive heavy machinery. The foundry and pattern shop work closely for a process called sand casting, a casting method where positive patterns are created from a variety of materials – traditionally by hand with hard woods like mahogany and maple, but also pressure cast aluminum - to form a negative cavity in sand. The molds are used to create large, durable parts from metals like ductile iron to use in stiff extrusion equipment.

As advanced as JC Steele's facilities are, they found the high time and fiscal costs associated with the traditional pattern making process restricted the company's ability to invest in research and development. For a company that knows first-hand the importance of innovation and growth, that was a problem. Amid growing competition, JC Steele was missing opportunities to continuously improve their casting wear life and efficiency.

To find a solution, JC Steele turned to large-format additive to quickly produce the massive patterns their business is centered around.

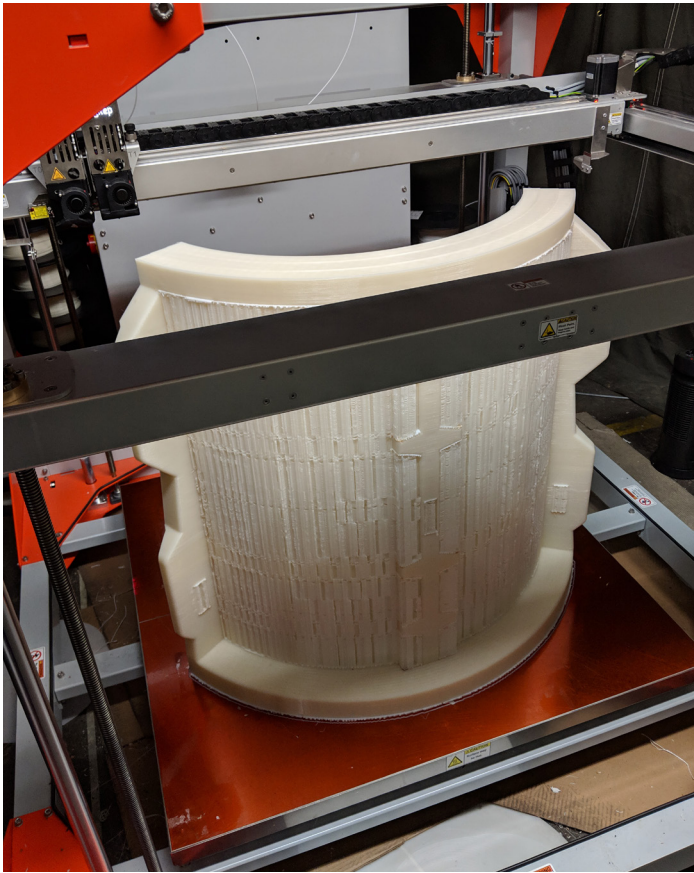


Final sand casted part from a 3D printed pattern

"Pattern making is pretty much a lost art," said JC Steele's Pattern Shop Supervisor, Chris Watts. "With 3D printing we can just design our parts in CAD and go straight from that to a pattern." Though the company was already very experienced in additive manufacturing before acquiring a BigRep ONE, they knew their next 3D printer had to have a huge build volume.



Top, bottom, and mid-section of a stiff extrusion auger sand mold before pouring

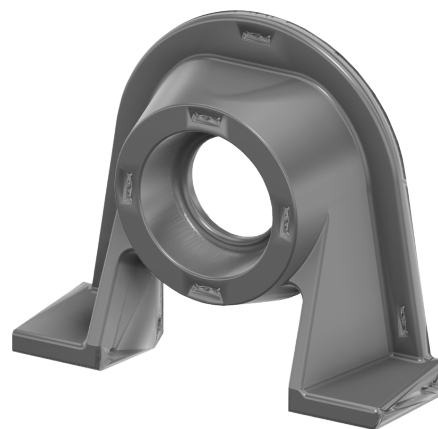


The company's stiff extrusion technology is dependent on augers – huge columns that work like a drill bit to compact and move material forward through an extrusion chamber. Piecing parts together from smaller printers didn't save enough time after slicing and adhering, so large-format was already important, but the capacity of the BigRep ONE to build on the existing capabilities of their other printers made large-format an absolute necessity.

“We make a whole range of parts, from something that can fit in your hands to something bigger than your car,” said Jeremy Kauffman, JC Steele's Engineering Manager, as he explained why a large-format printer meets a variety of their needs rather than being a niche machine for massive parts. “If we need a large quantity of a smaller part, I can nest 100 parts on the BigRep ONE that I can only fit a few of on another printer.”

Bearing Mount

Dimensions: 96 cm x 84 cm x 32 cm
Nozzle: 1 mm
Layer Height: 0.6 mm
Plastic Weight: 6.5 kg
Filament: ProHT, Black
Printing time: 173 hours



Patterning

By implementing additive manufacturing into their patterning workflows, JC Steele reported an 75% cost reduction and a 50% faster time-to-production on their geometrically complicated patterns.

When you compare pattern making's traditional and additive workflows, the reason why is clear. Previously, the workflow to create a pattern was complex and expensive.

1

Design
pattern

2

Send
drawings to
the pattern
shop

3

Interpret
the
drawing

4

Reductively
build a
pattern by
hand

5

Dispose
of wasted
material

6

Post-
process
pattern

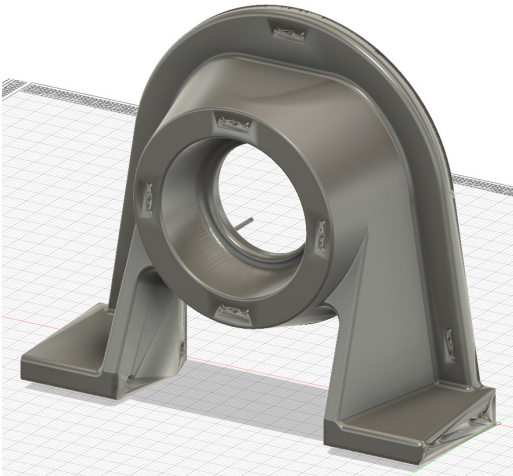
7

Send to
casting

Now, their additive workflow is drastically reduced to four steps:

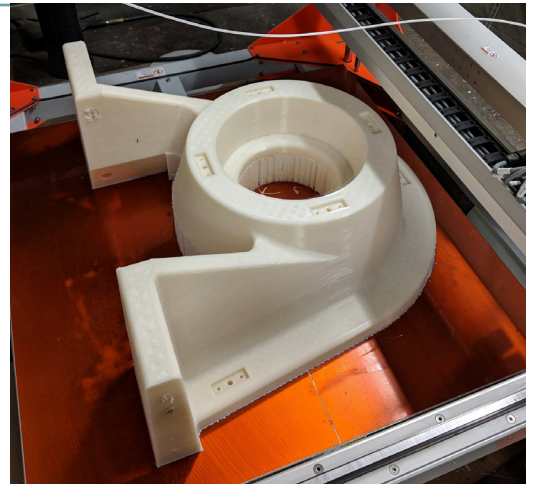
1

Design
pattern
in CAD



2

3D Print
CAD file



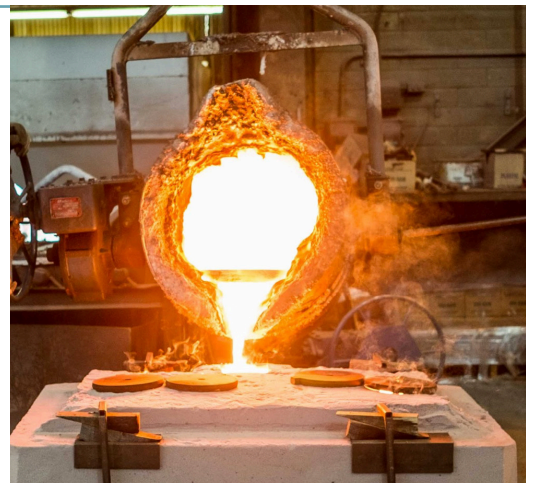
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Send to
Molding



4

Casting



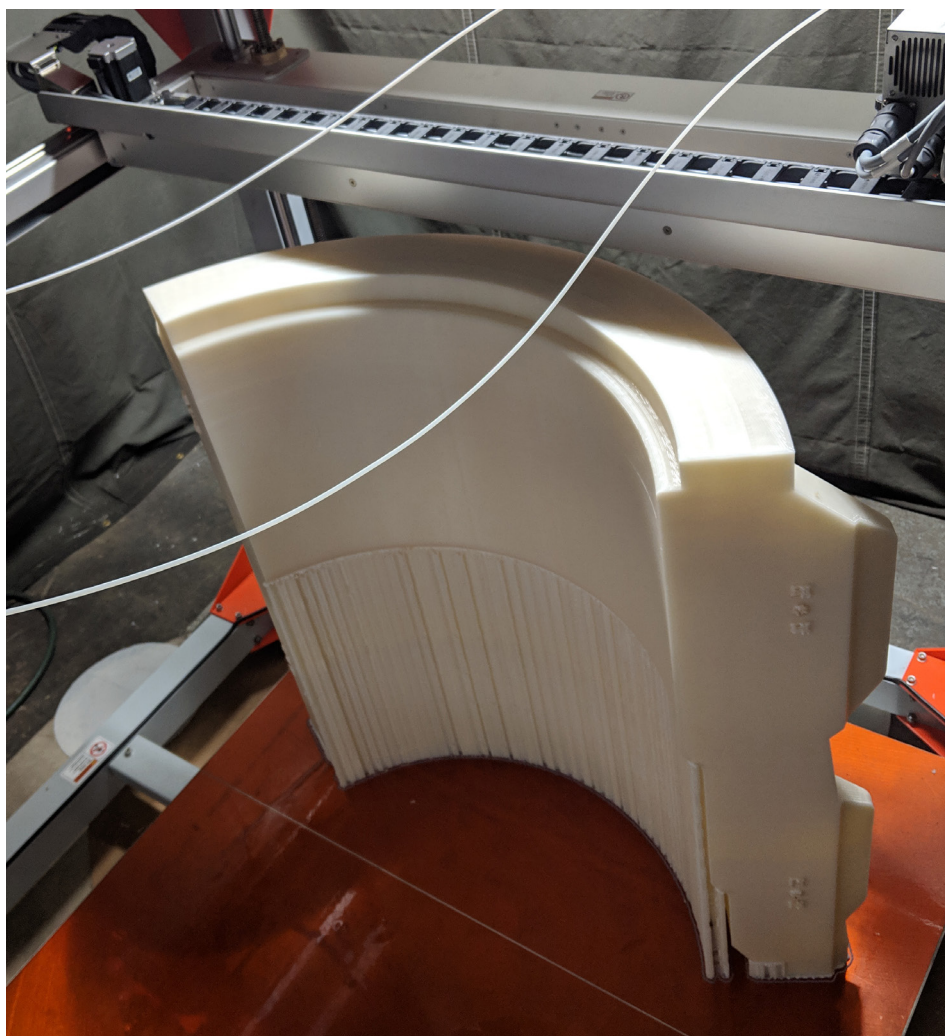
By streamlining the workflow, JC Steele has eliminated the longest (designing a pattern by hand), most prone to human error (interpreting design drawings), and expensive (managing reductive waste) parts of the design process.

As a result, they managed to create 60 new patterns in just a year. An unprecedented increase in production and an accomplishment that's required their BigRep ONE to be running 24/7 with rotating operators checking in on weekends to verify progress and change filament.

As a bonus, environmentally friendly materials like PETG have the necessary strength resistance for sand casting applications, eliminating the need for wasteful reductive materials without a large environmental footprint.

"With traditional methods, I think we would have been lucky to get half of that in the time we did," Watts said. "Maybe not even that."

With 3D printing creating such efficiency in the pattern shop, the company's valuable pattern makers can now focus on other projects, repairing parts, and especially on post-processing, where they've found ways to improve beyond typical 3D printing workflows.



In sand casting, patterns absolutely must have perfectly fine finishes. If not, they risk ruining the sand cavity while being pulled out. Because of this, wood grain or even microscopic rigidity created by a layered extrusion process can be disastrous.

So, JC Steele's pattern makers devised a solution by applying traditional techniques used in patterning with mahogany to 3D printed plastic parts. Realizing that layer lines aren't unlike the grooves in a wooden pattern, parts are finalized with a coating of wood filler that smooths the printed pattern's exterior surface, ensuring that parts are easily removed from sand cavities without compromising a design's geometry.

"As far as comparing plastic to wood, I think it's just as durable in sand casting and our other applications." Watts said.

"The possibilities are really endless as to what you can achieve with a plastic part."

Testing and Reiterations

In the past it was paramount that patterns be designed and created perfectly the first time, otherwise excessive costs and lead times would drastically delay time to market and stretch costs excessively. There was little room for mishaps or human error as traditionally produced patterns could take up to a month to recreate by hand. After introducing 3D printing to their production process, creating multiple options to test for best-fit solutions became viable. Using their BigRep ONE, JC Steele designs test parts that can be easily installed and removed, printing multiple designs of complex parts that vary in crucial differences

– like thickness – to test and truly understand their choices before expensive patterning and foundry processes are necessary.

“We’ve had issues where things were missed in the design or they didn’t turn out the way we wanted them,” Watts explained as he discussed the flexibility that additive manufacturing introduces to their process, even after the testing phase.

“With 3D printing, we’re able to quickly go back and reprint that part with the new design. We’re able to get a new part into our production process very quickly that way.”

Degrading Patterns and Unavailable Parts

For a company as old as JC Steele, 3D printing presented some especially novel solutions. After 130 years they’ve built up a large product portfolio and, considering the cost of their heavy machinery, their customers expect them to service equipment for the foreseeable future. That means they’re still servicing equipment that pre-dates modern design software. As these old wooden patterns deteriorate, it’s vital they can be recreated with perfect accuracy. There’s no margin for change in interpreting the paper designs.

If a part deteriorates beyond use old machines may no longer be serviceable, but creating archived patterns with traditional methods is a large investment for relatively small gain. After investing in additive manufacturing, the company spotted a solution and invested further into 3D scanning to expand their additive capabilities. “We can scan a part before it’s too far gone and print it instead of trying to rebuild it,” Watts said.

Now JC Steele keeps a digital archive of old patterns, ensuring their customers can always be serviced with the quality they’ve come to expect.

But JC Steele isn’t the only company with archived parts, and not being able to order parts they need has created problems in regular operations. Parts that are no longer made by their manufacturers or carried by their suppliers can create serious roadblocks for the company. JC Steele has overcome the issue by printing these unavailable end-use parts in-house, eliminating lead times to find new suppliers, to wait for shipping, or to plan complicated solutions. After seeing how effective these parts could be they applied the same method to tooling, producing jigs and fixtures on site.

“We have some new machines we’ve built where we didn’t want to invest in hard tools upfront,” Kauffman explained. “We printed jigs and fixtures to accurately drill holes or to assemble parts without having to outsource expensive tooling.”

Worker Safety

These kinds of end-use learnings have been taken a step further and used to increase safety around JC Steele's various facilities. With exposed, rotating gears and shafts, it's important that such dangerous machinery have redundant guarding to prevent worker injury. Since their in-house 3D printer is so easily accessible it's become a simple matter for JC Steele to create custom replacement, or additional, guards and other preventative solutions for the wealth of heavy equipment in all their production facilities and ensure their workers are protected.

Applying their additive technology to end-use parts demonstrates how opportunities present themselves when a highly skilled team is introduced to 3D printing with the freedom of large-format build volumes.

"It's cheap, it's fast, it's right here," Kauffman said. "Anything that comes up, we always have that now if we think it's a good tool."



Conclusion

To unlock this kind of success, it's important for a business to implement processes effectively. That means properly introducing employees to the evolved process of additive manufacturing and helping them to understand how it facilitates and expedites traditional processes rather than entirely replacing them.

Demonstrating how to implement 3D printing into traditional workflows is an important part of the additive adoption process. At JC Steele, some employees had been using traditional methods exclusively for over 40 years and they were sometimes intimidated by the idea of new workflows. "It took some time to get that buy in, but ever since we have people realize the advantage to additive and are coming up with new ways to use it as often as we can," Watts said.

They've noticed the quality of the German-engineered BigRep ONE too, running the large-format workhorse "24 hours a day, seven days a week for almost a year," Watts said.

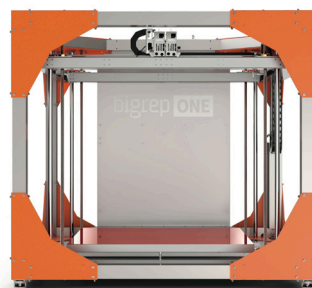
Where some of their smaller 3D printers have had issues with delamination – print layers becoming separated after printing – Watts said they've experienced no issues like that with their BigRep ONE despite running the machine so constantly.

For JC Steele, large-format was a must have to create their large foundry parts and produce at scale. By buying into BigRep 3D Printers they've remarkably increased pattern production, reduced time to market by 50% and cut costs by 75%. This level of efficiency is only furthered by the benefits they experience in a wealth of other applications to save money, eliminate lead times and improve working conditions around their facilities. These rewards experienced by JC Steele and innovative companies like them show why businesses must have access to large-format additive manufacturing as an ever-increasingly relevant technology.

Find out more about BigRep's additive manufacturing systems:



bigrep **STUDIO G2**



bigrep **ONE**



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