CASE STUDY

3D Printing Quality Cores and Molds Provides Competitive Advantage

The first pattern shop in North America to operate its own sand 3D printer grows the entire business with binder jetting technology

HOOSIER PATTERN INC.

ExOne™

"We're known for our quality workmanship as well as our commitment to on-time delivery, which has helped us gain recognition as a premier pattern shop."

Keith Gerber, Owner and President of Hoosier Pattern

INDUSTRIES	Foundry molds and cores supporting automotive, aerospace, pump, consumer appliances, and agriculture
LOCATION	Decatur, IN
3D PRINTERS	Four ExOne S-Max® and One ExOne S-Max® Pro
MATERIAL	Silica sand, ceramic
BINDER	Furan
ALLOYS CAST	A variety of metals, from ferrous to aluminum, cast by their customers

STORY HIGHLIGHTS

- Consolidated, complex 3D printed core allows continuous iteration of a serial production design in value-adding ways
- High-quality monolithic core decreases post processing time 70% saving a customer almost $250,000 in production labor
- Design freedom enables part traceability that led to a Marine finding a personal connection to their military vehicle
- A decade of 3D printed projects, from historical restoration and industry applications to kickstarter campaigns, grows the business

Hoosier Pattern creates traditional patterns as well as 3D printed molds and cores for foundries

CUSTOMER
Hoosier Pattern Inc.

FOUNDED
1997

EMPLOYEES
70

WEBSITE
www.hoosierpattern.com

Binder jetting is just another tool in the Hoosier Pattern toolbox, complementary to its CNC machines, but it is the future of the foundry and pattern shop industry.

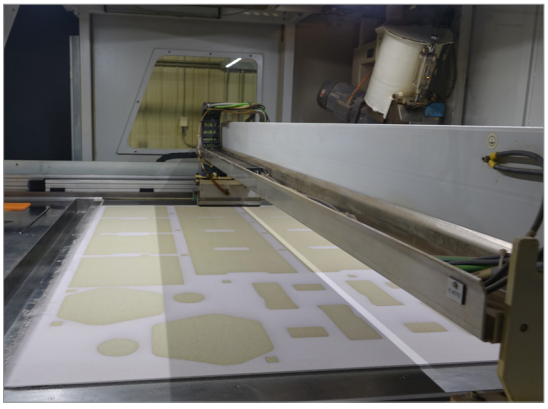
Hoosier Pattern Inc.

For 25 years, Hoosier Pattern has prided itself on being innovative and consistently raising the bar within the industry while maintaining the level of quality they have always been known for. Back in 2013, Hoosier was the first service center to own and operate a 3D sand printer in the United States. Currently, Hoosier Pattern now has five sand 3D printers in-house as well as over 25 machining centers.

Hoosier Pattern started in 1997 in a 3,500 square foot space with just a couple of machining centers. Today, Hoosier Pattern operates in a 90,000 square foot facility with state-of-the-art technology allowing them to take on jobs from various customers across multiple industries.

ExOne

ExOne is the pioneer and global leader in binder jet 3D printing technology. Since 1995, we've been on a mission to deliver powerful 3D printers that solve the toughest problems and enable world-changing innovations. Our 3D printing systems quickly transform powder materials — including metals, ceramics, composites, and sand — into precision parts, metalcasting molds and cores, and innovative tooling solutions. Industrial customers use our technology to save time and money, reduce waste, improve their manufacturing flexibility, and deliver designs and products that were once impossible.



With just one shift, Hoosier Pattern's fleet of printers run 24/7 to produce cores and molds for foundry customers all over the world

Pioneering Pattern Shop for 3D Printing

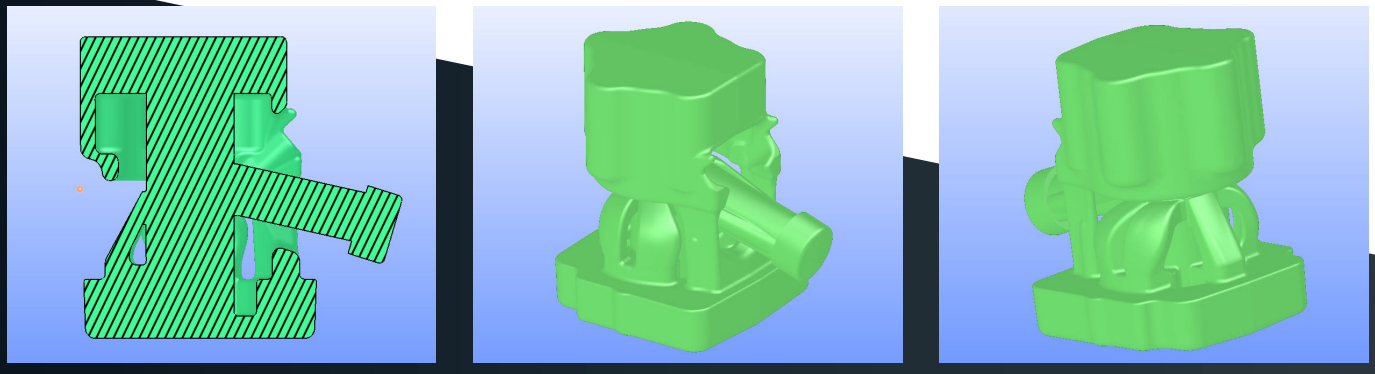
Hoosier Pattern, a CNC manufacturing and rapid prototype shop serving foundries with molds and cores for high-quality castings, prides itself on the combination of tradition and innovation in serving customers. Its 90,000 square foot facility in Decatur, Indiana houses a conventional machine shop with over 25 machining centers as well as lathes, mills, and shrink-in tooling.

Founded in 1997, the company embraced additive manufacturing by partnering with ExOne in 2013, making it the first pattern shop in North America to own and operate a sand 3D printer in-house. Today, Hoosier Pattern has three S-Max® and one S-Max® Pro binder jetting systems in its facility and uses their 3D printing capabilities to open new business opportunities, for both its additive and subtractive manufacturing operations.

The company's additive manufacturing and CNC capabilities allow it to tailor its solution to the needs of customers. The business is a pretty even mix of 3D printed projects and more traditional processes. Binder jetting is just another tool in the Hoosier Pattern toolbox complementary to our CNC machines, but it is the future of the foundry and pattern shop industry.

It's this combination of expertise across technologies - casting experience together with a deep knowledge of creating production tooling and assembling molds and cores - that allows Hoosier Pattern to help customers determine the best method of manufacturing suited to their projects' needs. 3D printing expertise allows Hoosier to execute unique designs and increase our production volumes.

This competitive advantage has led to continuous growth for the company since installing its first binder jetting system in 2013. By adopting binder jet additive manufacturing, Hoosier has increased its number of customers. "Our entire shop has expanded and grown with the 3D printing because of the doors it's opened," a company spokesperson said. They explained how new relationships that form over the freedom to create sand molds with binder jetting often leads to conventional machining projects as well. In fact, the company continues to expand its footprint and increase production capacity with new investments in both additive and subtractive equipment.



A complex dirt bike cylinder that ties together the water jacket, intake, and exhaust has been cast with 3D printed cores in production since 2015. Annual design changes are incorporated without hard tooling investments.

A traditionally produced impeller required 156 minutes to post process vs. 49 minutes per part from a 3D printed core. Using 3D printed cores helps Hoosier Pattern's customers be more efficient in overall production.

Helping Foundries and Products Improve

Being one of the pioneer users of ExOne sand binder jet technologies, Hoosier Pattern has also become an essential partner in helping foundries improve their overall production process. Examples of jobs at the company show how the advantages of 3D printing often stretch beyond the fast turnaround times its shop can deliver to enabling foundries to take advantage of cost-effective rapid prototyping or downstream process optimization.

One customer created a complex, 3D printed core for a dirt bike cylinder previously produced with a traditional pattern and core box. The complexity of the design – tying together the water jacket, intake, and exhaust - made it ideal for binder jet production. The customer made the switch to printed cores in 2015 and has used binder jetting for thousands of parts in production since. Each year, Hoosier receives a variety of prototype designs that they are able to quickly print and have cast so the customer can test for performance. Despite the complicated design bringing together multiple components, the company can test iterations without a tooling investment while designers can tweak the model to get exactly what they want.

Another customer noted the benefits of binder jetting cores not only affected the casting process itself but also that they saw direct cost savings during their post-processing. The 16" diameter impeller was previously produced with a pattern and core box with four core segments. By printing a single-piece core the company was able to improve their molding rates 30-40% and virtually eliminate any scrap not associated with short or interrupted pours.

But Hoosier's foundry customer also saw significant savings during post-processing of the finished cast components after making the switch to 3D printed cores. Because of the tight dimensional accuracy of the casting despite the complex monolithic core design, grinding and balancing the impellers was reduced from a two- to a one-operation process. A traditionally produced impeller required 2 hours 36 minutes to complete, while the printed core needed only 49 minutes per part, and time is money. Using 3D printed cores helps the customer be more efficient in overall production.

By eliminating nearly two hours of processing per part the foundry was able to save over $246,000 on labor over 1100 castings of the impeller. They also saw an improvement in machining time with less tool chatter and better tool life with more consistent cuts. With their fleet of ExOne systems, Hoosier pattern not only delivers cores on fast turnarounds but passes the process optimization along to its customers. because if they are able to mold, pour, and machine faster that improves their overall process – they're more efficient and faster.

Hoosier Team Guarantees Quality

The employees of Hoosier Pattern are uniquely dedicated to the shared vision of excellence and use their combined foundry and sand 3D printing knowledge to set the company apart. “We’re known for our quality workmanship as well as our commitment to on-time delivery, which has helped us gain recognition as a premier pattern shop,” said Keith Gerber, Owner and President of Hoosier Pattern. He explained how the team is the best at what they do and committed to exceeding expectations. In fact, the words, “The response to every task requested from our customer is a reflection of our quality,” are found throughout the building.

To ensure the team delivers the quality customers have come to expect, Hoosier has used the flexibility of binder jetting technology to create a unique quality control process. A typical day starts with the extraction of finished job boxes out of the ExOne 3D printers. Excess sand is removed from the build and test bars printed in every job box are verified for strength and durability to validate the build quality. Molds and cores are then sent to cleaning and inspection, where Hoosier begins an internal audit system with the use of a quality chart printed directly on each sand part, placed specifically in an area that won’t affect the final casting. Each square on the grid represents an employee who marks their respective section on the chart as they complete desanding and cleaning. The part is then audited for any erosion, scratches, or other imperfections that may affect the outcome of the casting. And while the accountability grid ensures no steps are missed, it also helps the company monitor its internal performance and identify areas for any necessary re-training to ensure consistent excellence for customers. Hoosier is dedicated to on-time delivery but ensures this doesn’t mean customers sacrifice quality.

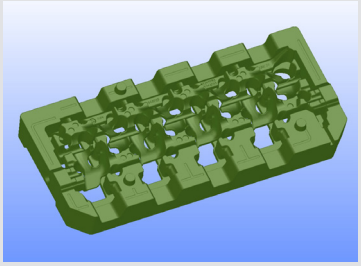
The digital workflow of the additive manufacturing process without hard tooling allows Hoosier Pattern to seamlessly integrate traceability into their production process through mass customization. For example, some jobs integrate printing the machine job box or other serial number identifier to be cast onto the final part to ensure a complete record of each component’s manufacturing process.

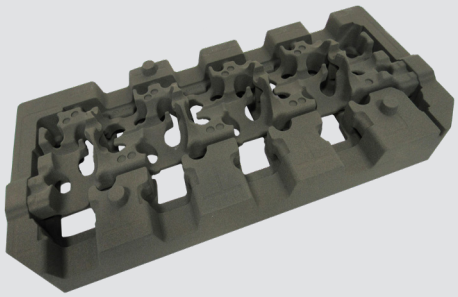
This all-around quality control lead to an unexpected level of part traceability that hit the Hoosier family close to home. Colin Rittmeyer, spent his summers during high school working in the pattern shop cleaning cores coming off the S-Max machines. At the time, the company was producing cylinder head cores for Coast Guard and military applications. Now serving as a Marine in the U.S. Military, Colin found one of the very cylinder heads produced with the sand 3D printers at Hoosier Pattern in his Assault Amphibious Vehicle.

With the flexibility of additive manufacturing design, Hoosier Pattern can print lift holes for part handling (left) or their quality audit grid and, when needed, assembly instructions, onto each part to help ensure all process steps have been completed before shipping a core to a customer (right).

After switching to the printed cores, Hoosier Pattern's customer found their castings three times more likely to hold tolerances and dimensions.

The casting used to be produced with tooling requiring multiple cores and complicated assembly. Because this often caused quality issues the company switched to a more complex, single-core design that they could produce with binder jetting. After switching to the printed cores, the customer found the castings three times more likely to hold tolerances and dimensions. Through the serial information printed in the core and then cast directly onto the part, the Hoosier Pattern team was able to trace the entire project – from the employee who cleaned the core after 3D printing to the pour at a foundry in Indiana in March 2018 to the discovery by Colin in-use in February 2021.





Colin Rittmeyer (right) stands in front of the AAV that features a cylinder head casting made from a core produced at Hoosier Pattern. Aided by the design flexibility of 3D printing, the inclusion of serial numbers on each part allowed it to be traced through the entire production process and back to the Hoosier, where he worked in the sand room cleaning cores.

Aside from aiding traceability, the design flexibility also enables the team to integrate features that help improve the manufacturing process and deliver on the 5S strategy of the company. Unique features such as lift holes to remove and handle finished components can be added to prints - of which seven different designs have already been implemented by the team to aid specific geometries and weights.

The Hoosier team has successfully incorporated and streamlined 3D printing operations – so much so that one customer chose to install their machine in Hoosier's facility, relying on the team to run and deliver jobs as a trusted supplier.

Watch the video

bit.ly/X1Hoosier

Lights-Out Mold and Core Production

Although Hoosier only runs one shift with labor, the 3D printers continue to build overnight with the reliability to provide lights-out manufacturing with very little downtime. To keep its machines running around the clock, the company uses over 150 tons of sand for production each month.

The ease of operation of the machines is also essential to the success of production. As a relatively new technology, Hoosier is only now starting to see some applicants come to the company with any 3D printing experience, making the user-friendliness of the machines essential since staff must be taught how to operate and maintain them.

The Hoosier team has successfully incorporated and streamlined 3D printing operations – so much so that one customer chose to install its machine in Hoosier's facility in 2014. That customer relies on the Hoosier to run and deliver jobs as a trusted supplier, speaking to the skill and dedication to quality of the Hoosier team.

Throughout the years the company has been involved in projects as varied as recreating a bell frame for a local historical society, restoring a 1923 Packard Indy race car, and even the production of molds for one of the most successful Kickstarter campaigns of all time. Binder jetting technology from ExOne aligns the company's 5S lean manufacturing methodology with its production practices, all while opening new opportunities and growing the business. Today Hoosier ships cores to five continents, capitalizing on the ability to offer a 10-day turnaround time with additively manufactured molds and cores.

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