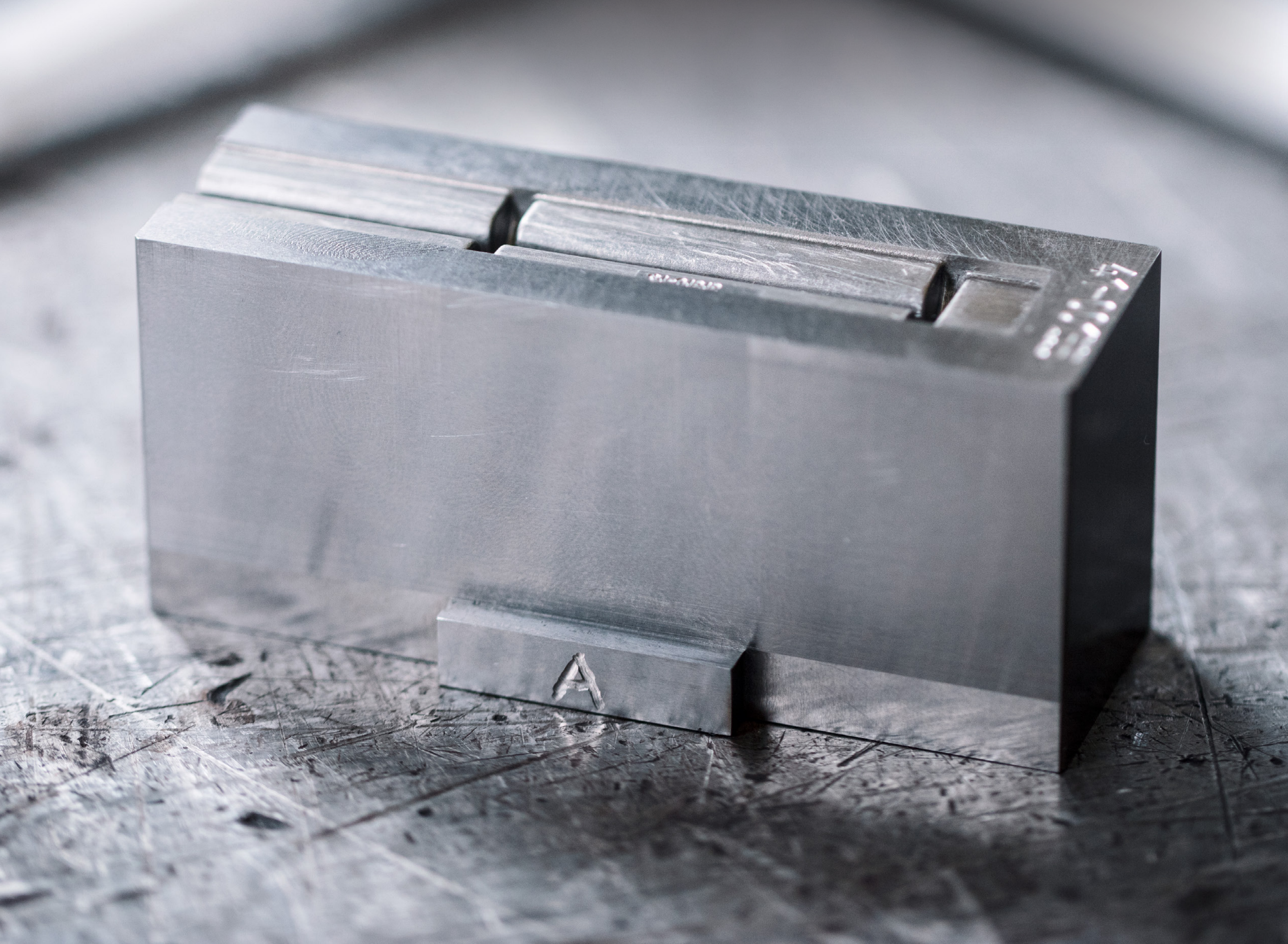
Desktop Metal

Built-Rite Tool & Die

Injection molding firm investigates quick-turn mold application, **identifies 90% cost savings.**



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Built-Rite cavity insert installed in the mold plate.

Overview

BUILT-RITE TOOL & DIE is a mold-making and design firm in Massachusetts with expertise in precision mold manufacturing. They specialize in the production of molds for plastic injection molding. These molds have complex designs, requiring extensive planning and precise execution.

The challenge

Small to mid-sized businesses like Built-Rite face increasing competitive pressure from international and domestic competitors. Overseas manufacturers can offer lower prices and domestic prototyping shops can offer quick turnaround times for small quantities of parts. 3D-printing gives Built-Rite an opportunity to realize shorter lead times and gain an edge against the domestic prototyping shops. This includes the ability to iterate quickly to win bids and meet strict deadlines.

For Built-Rite, the Studio System™ introduces the ability to make quick-turn mold assembly components with a process that is far less labor-intensive than other equipment in their machine shop and more cost competitive than a third-party prototyping firm. The Studio printer uses closed-cell infill to lightweight parts and minimize material without impacting the wear resistance required for tooling.

Application constraints

High tooling costs
Extended lead times
Complex part geometries

Studio System™ benefits

Reduced cost-per-part and material usage
Rapid iteration, in-house
Ability to print complex designs

Studio System™ printing the insert layer-by-layer in a process called Bound Metal Deposition™

Assessment of technology fit

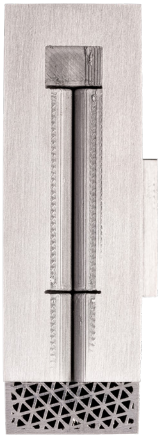
Plastic injection molding is a manufacturing process for producing parts in high volume. It works by injecting molten plastic material under high pressure into cavities within the mold to shape a part. For mass production, injection molding offers low cost-per-part, repeatable outcomes, and minimal waste of the injected material. About 32% of all processed plastics go through injection molding processes, making it a dominant manufacturing method.[1]

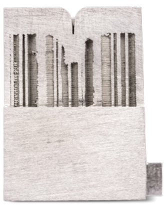
The mold-making process is extensive, requiring precise planning and execution while adhering to client deadlines, iteration, and expectations for part quality. A mold is made up of many complex cavities, inserts, and cooling channels. Mold tools must be able to withstand repeated impact and exposure to high-temperature polymers—making wear-resistance a critical feature. Challenges include high tooling costs and long lead times. Design changes can have a significant impact on time and cost, so the ability to iterate quickly is critical to overall process efficiency.

The Studio System uses a technology called Bound Metal Deposition™ where metal rods—metal powder and polymer binders—are heated and extruded onto the build plate, shaping a green part layer-by-layer. The part is immersed in proprietary debind fluid in the debinder, and then sintered in the office-friendly furnace. The three-part system is designed as an end-to-end solution for in-house metal 3D printing.

The role of infill

The mold cavity insert shown here has been cross-sectioned to show the infill printed throughout the part. The top view shows the triangular infill pattern used to lightweight parts. The end view demonstrates the ability to increase part thickness selectively, where needed. In this case, the mold-facing surface is thicker to allow for post-machining and to maintain durability.





[1] http://www.dc.engr.scu.edu/cmdoc/dg_doc/develop/process/molding/b2500001.htm

Part fabrication & comparison

Built-Rite identified an existing mold cavity insert for initial testing with the Studio System. Compared with an external prototyping shop, the Studio System achieved reduced cost and lead time, as well as a reduction in part weight and amount of material used.

COST SAVINGS	TIME SAVINGS	WEIGHT REDUCTION
90%	30%	41%

"An injection mold is a very complex assembly and must be built to withstand very high pressures. We immediately recognized advantages of using printed metal parts in our molds, including the ability to produce mold inserts quickly, the ability to design cooling channels in a way that we could not before—conforming to the cavity geometry, and also lightweighting parts to help reduce operator fatigue. What used to take two weeks with outside vendors now takes a couple of days. We can increase build capacity and diversify, and we can capture more business—especially in prototyping. We couldn't compete on turnaround time before."

Ron Caron
General Manager at Built-Rite

Part dimensions	**2.54 x 3.57 x 7.62 cm**

Studio System fabrication

Technology	**Bound Metal Deposition**
Material type	**AISI 4140** steel
Infill spacing	**2.8 mm**
Part mass	**320 g**
Fabrication time	**50 hours** print 14hrs \ debind 6hrs \ sinter 30hrs
Cost-per-part	**$47**

Third-party prototyping firm

Technology	**CNC machining** from solid metal block
Material type	**4140** steel
Part mass	**545 g**
Lead time	**3 days**
Cost-per-part	**$493**

Surface grinding the mold cavity insert

Evaluation

Injection molding tools require tight tolerances to fit the assembly, as well as a polished finish on surfaces that make contact with the injected plastic so that the part can be easily ejected from the mold. In its as-sintered state, part performance was evaluated based on two post-processing stages to observe variation on process parameters and material behavior, and then functional testing to observe the part in use.

1. Surface grinding

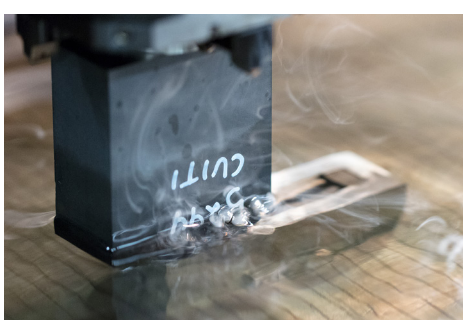
Built-Rite's machinists ground the surface of the 3D-printed mold inserts to achieve required tolerances and surface finish. They assessed whether any special handling was required and determined that the parts heated similarly to other tool steels and did not present any issue in sizing or fitting the inserts into the mold assembly.

2. Electric discharge (EDM)

Machinists used EDM to achieve the required surface finish on the cavity surfaces of the insert. They assessed the need for varying the parameter setup, electrode wear, and resulting surface finish. They determined that it was not necessary to vary the EDM parameters for the printed parts and the electrode wear was comparable to non-printed inserts. There were no notable differences in surface finish.

3. Functional testing

After post-machining, the insert was installed in the mold assembly and used to produce plastic parts made of acetal—a non-abrasive, low-friction plastic material. The temperature of the plastic when injected into the mold is about 205°C (401°F), and the mold itself is kept at approximately 82° to 121°C. A test run of about 100 cycles showed no flaw in the plastic parts produced and the 3D-printed insert showed no sign of wear.



Electric discharge machining (EDM)

Installing the insert

Summary

The success of the initial evaluation indicate the potential of the Studio System for injection molding applications. The system enables injection mold manufacturers to improve operations and realize the benefits of additive manufacturing without relying on third-party vendors. This includes reduced material usage and printing with closed-cell infill, resulting in reduced costs and the ability to lightweight parts while retaining the wear resistance required for tooling applications. In response to unexpected design changes or short turnaround times, the Studio System allows mold-makers to iterate on designs faster and at a lower cost than outsourcing to a third-party mold service.

Follow-up testing will include leveraging design flexibility of the Studio System to produce mold inserts with conformal cooling channels that follow the shape of the mold cavity. This allows for uniform cooling of the plastic part immediately after injection to reduce "hot spots" and optimize part quality beyond traditional manufacturing methods. Additional testing will also include printing with H13 tool steel, a material commonly used in this application.

About Desktop Metal™

Desktop Metal, Inc., based in Burlington, Massachusetts, is accelerating the transformation of manufacturing with end-to-end metal 3D printing solutions. Founded in 2015 by leaders in advanced manufacturing, metallurgy, and robotics, the company is addressing the unmet challenges of speed, cost, and quality to make metal 3D printing an essential tool for engineers and manufacturers around the world. In 2017, the company was selected as one of the world's 30 most promising Technology Pioneers by World Economic Forum, and was recently named to MIT Technology Review's list of 50 Smartest Companies. For more information, visit www.desktopmetal.com.

About Built-Rite Tool & Die

Built-Rite Tool & Die is a custom Mold Making and Design firm. Built-Rite is the corporate parent and driving force behind Reliance Engineering and the LSR Engineering Divisions. Built-Rite is staffed with highly skilled engineers, designers, and mold makers ready to execute your most demanding design challenge. Founded in 1984 Built-Rite is a leader in the manufacturing of precision molds for the Liquid Injection Molding of LSR, Liquid Silicone Rubber, Injection Molding of Thermoplastics and Thermosets and Compression and Transfer Molding of Thermoset plastic materials.