USER STORY

Novus Applications Improves Injection Molding Process With Rigid 10K Resin

Injection molding is a common and versatile manufacturing process used to produce a high volume of parts. Look around you and chances are something in your vicinity was produced with injection molding: product parts and components, packaging, and bottle caps, to name a few. Used in manufacturing processes for home appliances, electronics, automotive, and more, many manufacturers turn to injection molding to achieve precise, repeatable parts. Mold fabrication can be expensive and time consuming—with high upfront equipment costs, machining molds can be cumbersome. However, there are alternatives to machining molds out of metal.

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Introduction

Novus Applications, a product development company focused on consumer goods, takes injection molding to the next level by incorporating 3D printing into the workflow to speed up the process, enabling an agile manufacturing approach. By 3D printing injection molds using Formlabs' Rigid 10K Resin, Novus was able to achieve their desired outcomes while saving costs and time by a few days.

Keep reading to learn the following:

- How to leverage 3D printing in the injection molding workflow.
- How Rigid 10K Resin enabled Novus to design faster.
- Best practices for injection molding with 3D printed molds.

Novus' Background

Novus has a far reach, serving the personal care, homecare, and oral care sectors and working with some of the largest brands. They complete designs for the manufacturer, conduct moldability studies, prototype and iterate quickly, 3D print parts and components, and produce small scale prototypes so that their customers can test their products. Novus focuses on injection molded plastics and the use of those plastic parts in consumer assemblies.

From medical companies to major brands like Colgate and Liquiglide, injection molded parts are in high demand. Novus honed their craft with years of experience.

> *"Injection molding is inherently demanding from a precision standpoint and an experience standpoint. So to be a good injection molder, you have to have a lot of experience in it. To walk in and mold well without much experience, there's a lot of trial by error and frustration and a lot of unknowns unless you understand what you're looking at,"*
>
> **Mark Bartlett,**
> president and founder of Novus.

> *"Likewise, in the tool building environment, in order to make the molds for injection molding, it requires a high degree of precision. A lot of experience to understand. How do you solve problems before they happen? And then what does it take in order to mold that part, flash-free, cosmetically appealing, filling appropriately just all the intricacies of this program?"*

With so many complexities for injection molding, Novus had to figure out how to be as efficient as possible.

How to Leverage 3D Printing in the Injection Molding Workflow

The initial stages of the injection molding process for Novus is as follows:

- Look at the part to understand the part's parameters and what material to use.
- Think about how to inject and demold the part in a way that the part comes out accurately and true to desire shape and form.
- Take the desired part model and render it in CAD software.
- Build solid models that'll represent different pieces of the mold.
- Make decisions about how to assemble the mold.

By 3D printing, Novus can eschew high end software, saving time on labor. As a result, the process is more automated. "The production of those parts is in an unattended fashion. I don't need a highly experienced individual, although I do need a person with experience and 3D printing. So the learning curve is faster. The production is far more unattended," Bartlett said.

Bartlett added that he was shocked at the simplicity of 3D printing, having come from a background in toolmaking and CNC programming. The cost effectiveness also floored Bartlett--he said that Formlabs 3D printers were well within his budget and they outshined FDM machines. He said that Formlabs provided high quality printing at a low cost, with a wide selection of materials. "A lot of people don't understand that there really is a middle ground between an exceptionally high priced 3D printer and the [quality] desktop version that people can buy at home. I felt like there was no middle ground on the market and I think Formlabs knocked it out of the park...[Formlabs] succeeded in...providing professional level results."

For example, Novus produces a lot of caps and closures. The company needed to produce a lot of small series of prototypes, requiring a fast method of production. Bartlett said that rapidly prototyping a cap in a 3D printed mold set helped streamline their workflow.

How Rigid 10K Resin Enabled Novus to Design Faster

There are many ways to elevate 3D printing, and selecting the perfect material is one of them. Bartlett specifically sought out Rigid 10K Resin because they wanted to study the longevity of a printed mold and they needed a material stiff enough to handle the pressure of this process, even with an intricate design. Rigid 10K's strength, stiffness, and thermal resistance make it ideal for short-run injection molds. Novus needed to quickly produce a lot of small series of prototypes. The cured resin parts served as an injection molding platform to build simple small scale molds, which over time evolved into increasingly complex parts. "The more complex that cap becomes, the more complex the packaging becomes, the more difficult it is to do [in] a 3D printed mold set," Bartlett said. "So we wanted to explore what the new highly filled resin offers. What did it accommodate? What did it allow us to do?"

Accuracy is key in injection molding, making part quality critical. "We need parts that not only can handle the temperatures and pressures, but are accurately located in the mold and are not going to bend, deflect, break. And, you know, they need to be able to handle those pressures. Then during the demolding process, I have to be able to exert forces on those same parts that will get the plastic out of the mold without destroying the printed pieces," Bartlett said.

Novus selected Rigid 10K Resin because it combines great strength, stiffness, and thermal resistance. They needed a material capable of bearing the high heat and pressure of this process while rendering small features. In particular, the threaded core was a delicate part. Thanks to this set of properties, they were able to inject hundreds of parts of polypropylene and polyethylene with one mold without breakage.

The following table displays some of the molding conditions applied to one mold without any visible damage. The mold showed some failure at a pressure of 11,500 PSI.

INJECTED MATERIAL	P5M6K-048 RED	PP1013H1 WHITE	MARLEX 9018 HDPE
Melt index	35	7.5	20
Nozzle temperature	390°F | 199°C	410°F | 210°C	400°F | 204°C
Injected pressure	6,800 PSI	9,500 PSI	7,200 PSI
Cycle time	48 sec	50 sec	68 sec
Number of injection cycles	30	30	30

The next table displays measurements on the final part injected in three different materials. For each, the team measured 20 diameters of the threaded parts to assess the repeatability of this process. We can observe an average deviation from the mean diameter of +-0.04mm over these 60 caps, reflecting a good dimensional stability.

MATERIAL	P5M6K-048 RED		PP1013H1 WHITE		MARLEX 9018 HDPE	
Mean	0.515 in	13.072mm	0.520 in	13.207 mm	0.517 in	13.134 mm
Cycle number	Deviation (in)	Deviation (mm)	Deviation (in)	Deviation (mm)	Deviation (in)	Deviation (mm)
1	0.000	0.009	0.002	0.052	0.000	-0.003
2	0.002	0.060	0.001	0.027	0.002	0.048
3	0.001	0.034	0.000	0.001	-0.002	-0.053
4	0.005	0.136	0.001	0.027	0.004	0.099
5	0.000	0.009	-0.001	-0.024	0.003	0.074
6	-0.001	-0.017	-0.001	-0.024	0.000	-0.003
7	-0.001	-0.017	-0.004	-0.100	-0.001	-0.028
8	-0.002	-0.042	0.002	0.052	-0.001	-0.028
9	-0.002	-0.042	-0.002	-0.050	0.000	-0.003
10	0.000	0.009	-0.003	-0.075	0.001	0.023
11	0.000	0.009	0.004	0.103	-0.001	-0.028
12	-0.003	-0.067	0.001	0.027	-0.001	-0.028
13	0.000	0.009	-0.001	-0.024	0.002	0.048
14	-0.002	-0.042	-0.001	-0.024	0.002	0.048
15	0.003	0.085	0.003	0.077	-0.002	-0.053
16	0.000	0.009	0.002	0.052	-0.001	-0.028
17	-0.002	-0.042	-0.002	-0.050	-0.002	-0.053
18	-0.003	-0.067	-0.003	-0.075	0.001	0.023
19	0.000	0.009	0.002	0.052	0.000	-0.003
20	-0.002	-0.042	-0.001	-0.024	-0.002	-0.053
Average from absolute deviation	0.001	0.038	0.002	0.047	0.001	0.036

Not only did Rigid 10K Resin exhibit good dimensional stability, but it was also faster and easier to print compared to milling aluminum and steel. “How does it handle the pressures and temperatures in the materials we were running? It performed excellent...it was performing at a level that we hadn't seen historically capable in the traditional [Rigid 4000] material,” Bartlett said.

Novus went though one iteration to reach the final design and was able to save on time. “I can print complex forms accurately, way faster than I'm going to machine them,” he said. Though Bartlett did not anticipate achieving completely perfect parts, Novus didn’t have to adjust molding surfaces, they only groomed the outside of the stacks. “Once we got at the mold, we ran it. And then we inspected the molded plastic parts and we were surprisingly accurate for not having done any iterations. We did one print, one run, and it worked great,” Bartlett said.

Upon seeing the consistent and stable dimensional parts Rigid 10K Resin yielded, Bartlett said that the resin became a go-to for small, intricate prints. “We've been using it in other internal components where accuracy and stability is a must.”

Best Practices for Injection Molding With 3D Printed Parts

While Novus is experienced in injection molding, they still had to work through the intricacies of molding caps. Adapting the design is critical, adding draft angles to facilitate demolding and opening the gates and adding venting to reduce pressure inside the cavity of the mold. It is recommended to print at the lowest layer height possible to facilitate demolding--the smooth surface finish of SLA 3D printing adds a great advantage to seamless demolding. Leaving some block allowance and grooming the outside of the mold results in better dimensional accuracy. The molding surfaces do not need to be touched but milling, hand sanding or grooming with a bridge port will help to fit both halves of the mold together and avoid flashing. When demolding, it is critical to not break the part or the printed mold--reducing injection pressure helps avoid breaking the mold. To reduce cooling time, Novus printed multiple cores to leave the ones that are not running to cool, using interchangeable stacks.

Overall, injection molding is an extremely accommodating technology for producing consumer packages, Bartlett said. Paired with 3D printing and the right materials, injection molding is a cost effective tool without sacrificing accuracy.