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# Rapid Injection Molding Brings New Possibilities

*By Brad Cleveland, president and CEO, The Protomold Company, Inc.*

**Brad Cleveland, president and CEO of The Protomold Company, Inc. (All images courtesy of Protomold).**

Now more than ever, technological advancements drive the product design process. Increasingly powerful CAD programs allow more complex product designs, which in turn drive the demand for more complex prototypes. At the same time, fast-moving competitive markets require frequent design changes, shorter lead-times, and tighter budgets. In short, prototyping must be faster, better, and less expensive.

While traditional rapid prototyping is still widely used, a growing number of design engineers are turning to rapid injection molding for prototype development. Pioneered by The Protomold Company of Maple Plain MN, rapid injection molding is based on the use of proprietary software technology that automates the process of designing injection molds and a streamlined mold manufacturing process, resulting in fully functional parts while dramatically reducing the time and cost normally associated with conventional injection molding. As acceptance grows, rapid injection molding is changing the way designers think about prototyping in industries like aerospace, appliances, automobiles, electronics, and medical devices.

## Different Processes for Different Needs

While rapid prototyping and rapid injection molding both start with a 3-D CAD part model, the actual processes and end results are very different. Rapid prototyping, which includes technologies like stereolithography, selective laser sintering, fused deposition modeling, laminated object manufacturing and three dimensional printing, creates a prototype layer-by-layer to form the end product.(1) Rapid injection molding, on the other hand, uses the familiar process of injecting heated thermoplastics into a metal mold, where the material cools into the desired shape.(2) Unlike rapid prototyping, rapid injection molding produces a fully functional, injection-molded part. The resulting quality difference is so significant that many design engineers who test form and fit using rapid prototyping will still check the functionality of their prototypes using rapid injection molding. Also, while conventional mold-making is very labor intensive, rapid injection molding fully automates this step, typically reducing tooling cost and lead time by two-thirds.

## Quantity and Quality Considerations

Rapid prototyping may be an acceptable choice for creating small numbers of prototypes in very short lead times – typically fewer than 10 parts in one to five days. But rapid injection molding can economically deliver 25 to 1,000 production-quality prototypes in 3 to 15 days. When production-quality surface finishes are not required, rapid prototyping may be an acceptable choice, but the “stairstep” surface it leaves on parts is a significant disadvantage, as it keeps parts from fully reproducing the intended design. Rapid injection molding, on the other hand, uses a CNC-machined metal mold to create the part shape, so it can replicate the intended shape much more accurately, just as with conventional injection molded parts. This can greatly increase the value of the prototype to the design engineer.

Furthermore, rapid prototyping is very limited with respect to materials that can be used and often creates prototypes too fragile for rigorous physical testing. Rapid injection molding can utilize a wide range of production-grade resins to manufacture fully functional parts, allowing the design engineer to consider both mechanical properties (e.g. strength, temperature resistance, etc.) and cost when ordering the prototypes. At Protomold, customers can select from hundreds of in-stock resins or provide the material themselves.

## Rapid Injection Molding for Design, Testing and Production

Rapid injection molding can be utilized from the earliest stages of product development through bridge tooling and ongoing production. After rapid injection molding is used to create prototypes, it can support the manufacture of 1,000, even 10,000 parts for pilot production or market testing at no additional tooling cost. If high production volumes do justify production steel tooling, rapid injection molding can be used as bridge tooling, to produce fully functional production parts until the steel tool is available. And when production volumes are moderate, rapid injection molding can be a complete, cost-effective production solution.

## How Rapid Injection Molding Works

Rapid injection molding is a unique, highly automated method of producing injection molded parts from a 3-D CAD part model. The core technology is proprietary software that automatically converts the part model into toolpaths for CNC milling machines. These in turn produce the mold components that, when assembled and mounted on an injection molding press, produce the desired part. (See Figures 1 and 2. Open the image window above and click on the Forward button to scroll through images).

Although a vast array of geometries can be produced, some limitations in part size and complexity exist due to the highly automated nature of the mold making process. For example, CNC milling results in rounded external part corners. Some high-aspect ratio features, e.g. thin ribs, may not be machinable. And the ability to produce “undercut” part geometry features is limited.

However, adapting part designs to be compatible with rapid injection molding can be very simple. After submitting a 3-D CAD part design via Protomold’s Web site, design engineers receive feedback on part geometry and pricing via ProtoQuote®, Protomold’s Web-based interactive software. ProtoQuote allows designers to change parameters such as the number of cavities, A- and B-side finish levels, and resin, as well as the desired delivery schedule. These changes automatically update the price quote.

The software also provides a rapid injection molding compatibility review, often suggesting changes that will improve moldability or reduce tooling cost. This automatic analysis highlights undercuts, wall thicknesses that could cause fill or sink problems, and areas where draft is required. The system also provides color-coded indications of radii resulting from the mold-milling process and areas where a minimum thickness might be required. If design modifications are indicated, design engineers can consult Protomold’s online design guide or contact the company’s engineering professionals for assistance.

When the order is finalized, the Protomold software automatically generates the mold design, including core and cavity geometries, shutoff surface generation, gate-design layout, and ejector-pin placement. The software then outputs toolpaths to CNC machine cells to manufacture the required mold components.

### Discovering the Benefits of Rapid Injection Molding

Trapeze Networks™, a wireless local area networking (WLAN) startup company based in Pleasanton, Calif., recently collaborated with its design firm and Protomold to manufacture a wide range of parts used in the company’s new WLAN Mobility System™ product line. This suite of products shares a system-wide control plane and data plane that delivers secure user mobility, seamless wired and wireless integration, and tools to plan and manage large enterprises — before and after deployment.

The company’s initial plan was to consider a two-step approach to product development. In the first step, the company intended to use “rapid prototypes” to verify form and fit. In the second phase, once the design had been refined and stabilized, it would use a conventional injection-molding process to get working parts and premium-quality prototypes to test functionality. But, on advice of its design-engineering firm, Santa Ana, Calif.-based designsUNLIMITED, Trapeze Networks decided to try an alternative process, using the relatively new technology of rapid injection molding.

Because Trapeze received its rapid injection molded parts in just five days, the company was able to skip the rapid prototyping step of new product design for its Mobility Points™ product and move directly to functional testing and production ramp-up — faster and more cost-effectively than they originally believed possible.

Once the initial testing was completed, Trapeze proceeded with placing a high-volume production tooling order from a current supplier and was quoted an eight-week lead time. After showing this supplier what Protomold accomplished in one week, the company was able to renegotiate the production-tooling lead time to four weeks. During the interim from low-volume to high production, Trapeze was able to use parts made from Protomold to support its production ramp-up while the high-volume tooling was manufactured.

With the ability to obtain accurate, rapid injection molded parts, Trapeze has radically changed its product development cycle.

### New Possibilities

Before rapid injection molding, design engineers faced a large gap between the capabilities of rapid prototyping and conventional injection molding. Rapid prototyping parts were fast and relatively cheap, but weren’t “real”. Injection molded prototypes were real parts, but neither cheap nor fast. With rapid injection molding it is now possible to get real parts, real fast and at a real savings. To find out more about rapid injection molding, visit The Protomold Company’s Web site at www.protomold.com.

**References**

1. Worldwide Guide to Rapid Prototyping, http://home.att.net/~castleisland.

2. Injection Plastic Molding Design Guide, www.engineersedge.com/injection_molding.htm.

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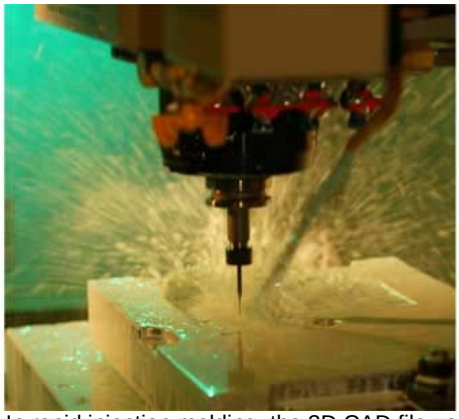

Fig. 1 - In rapid injection molding, the 3D CAD file used to generate the mold design is downloaded to Protomold's advanced software system, which automatically outputs tool paths for the high-speed HAAS CNC machine centers to manufacture the molds.

Fig. 2 - Using Protomold's rapid injection molding process, Trapeze skipped rapid prototyping and went directly to functional testing and production ramp-up of its Mobility Point housing. The Trapeze Networks™ Mobility Point is a system device that augmen