White Paper

Rapid Tooling Applications

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ABSTRACT

In today's competitive marketplace speed isn't everything - it's the only thing. Rapid Tooling (RT) can compress time to market while reducing tooling costs. In addition, RT techniques provide the ability to create parts from actual end-use production materials and run quantities up to production volumes, meaning more parts per mold.

In fact, RT techniques bridge the gap between Room Temperature Vulcanized (RTV) silicone rubber molds and machined aluminum tooling. With RT, you can create longer runs of functional prototypes and pre-production samples in a wider range of materials. Also, you can conduct manufacturing analyses and field trials with fully functional parts. This enables you to finalize the selection of production materials and to verify the tool prior to final mold making.

RT is becoming the new model for the industry. Today, it is used mainly for prototype tooling for low volume production. Depending on the part design and the choice of the materials being injected, numerous different parts can be developed. Many companies use Rapid Prototype Tooling services, which create precise molds faster and with high-speed milling capabilities.

RT is not about the process but about fast results and the success gained from employing a leading-edge technology. It is a combination of tools, methods, processes and people aimed at designing a rapid solution.

The term Rapid Tooling is used to describe a process which either uses a Rapid Prototyping(RP) technique as a medium to quickly create a mold or uses the Rapid Prototyping process to directly fabricate a tool for a limited volume of prototypes. RT takes less tooling time and costs less than conventional tooling. It can be used to make multiple parts out of alternative materials. A shorter lead time is the primary advantage of RT. Process Modeling, Rapid Product Development, Rapid Soft Tooling, Rapid Bridge Tooling, Rapid Production Tooling and the Express Tool Process are all part of RT technique list or processes related to making multiple parts out of alternative materials with shortened lead times.

This whitepaper provides an evaluation of how Objet PolyJet® Technology fits within the RT arena and framework. We expect the PolyJet technology, specifically the introduction of the process technology, to revolutionize RT production and to bring with it additional benefits, including labor-cost savings, a shortening of product development time and new design development possibilities.

Objet's family of 3-dimensional printing systems brings high-resolution RP solutions to RT environments. Objet's patented PolyJet Technology-based printing systems, which work with Objet FullCure® materials and Objet software, provide a complete 3-dimensional printing solution for virtually any RT application.

INTRODUCTION

The strong interest in RT stems from a more broad directional change in industry towards rapid product development. There are numerous reasons for wanting to develop products quickly and there is a great deal of pressure to do so. An example of an industry in which RT cycle time pressures are well known is the automotive industry; the time needed to develop a new car has been reduced dramatically in the past years. The shorter the development time, the more effectively the

developer can respond to current or recent customer trends. And, it is not enough to develop products rapidly. The products need to be attractive in terms of the market drivers and the manufacturing processes need to be both undependable and cost-effective.

Many engineers realize how vital it is to move new products to market quickly. A company able to launch a product ahead of the competitors can fully realize the market before rival products arrive and also tends to maintain a dominant position for a few years even after competing products have been released.

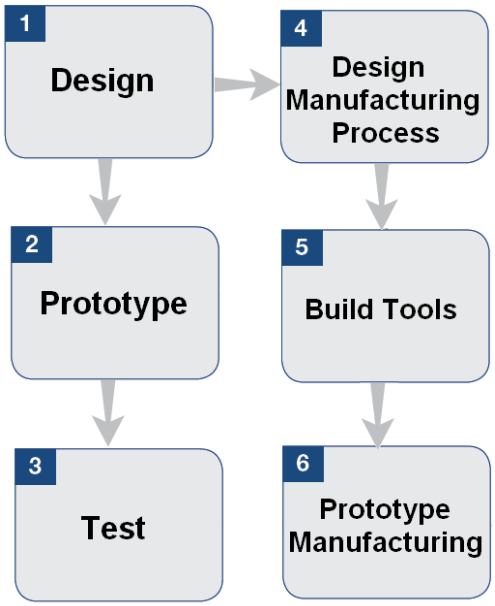

Figure 1: Typical Tooling Process

RAPID TOOLING ADVANATAGES

The term Rapid Tooling typically describes a process which either uses a Rapid Prototyping model as a pattern to create a mold quickly or uses the Rapid Prototyping process directly to fabricate a tool for a limited volume of prototypes. RT is distinguished from conventional tooling in four key ways. (1) Tooling time is much shorter, as time to first articles is typically less than one-fifth that of conventional tooling. (2) Tooling cost is much less; the cost can be less than five percent. (3) Tool life is considerably shorter. (4) Tolerances are wider.

Rapid Tooling holds value for many different industrials. For example, for the foundry industry, RT offers a fast, cost-effective alternative for producing multiple investment casting wax masters.
There is a wide variety of RT technologies available, including Prototype and Bridge Tooling and Short Run as Production Tooling.

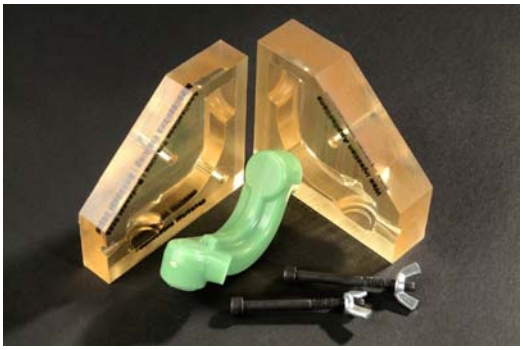

Figure 2: Printed PolyJet mold for wax injection

RT technology originally meant molds could be made much faster than with conventional machining. That is still true. But in the last few years, RT technology has evolved towards building molds that provide up to 40% faster cycles than is possible with conventional technology using proper mold design. This emphasis on productivity accompanies a shift in RT applications from prototype to full production tooling.

Newer RT approaches can minimize or eliminate warpage and internal stresses caused by uneven cooling. At the same time they can boost productivity by drawing heat more quickly from thick sections or other hard to cool features in the mold such as bosses or ribs. Tests of newer, high-conductivity tools by at least two sources reportedly found that cooling time in the molding cycle could be set to zero and the process would still yield acceptable parts.

The spectrum of RT technologies encompasses a few distinct approaches to producing a mold or insert. Some create an insert with a surface layer of tool steel and a core of conductive metal.

Figure 3: Printed mold for silicon injection

Common to all RT approaches is the creation of mold-cooling channels that conform to the contours of the part surface. This conformal cooling makes it possible to draw heat out from areas that would be hard to access with conventional cooling channels. Conformal cooling could lead to a reduction in the overall number of cooling lines needed, which would save in tool build time.

For RT molds to be successful, molders need to know how to use them properly. One has to be careful not to cool the tool too quickly or you may not get proper filling. Molders using enhanced cooling methods might have to adjust their molding process by increasing injection pressures and rates to ensure the material reaches the end of fill in the tool. They might also have to increase the temperature of the printed model. Optimizing the molding process for a thermally tool may entail changing the injection speed, ejection speed, mold-opening and closing speeds, mold temperature and cooling time.

A lack of understanding about how mold cooling works can lead molders to produce a lot of bad parts fast. This is because with more of the mold surface close to the cooling channel thinner sections cool too fast and then warp. A better approach is to move the cooling channel closer to the cavity where there is a hot spot and back it off a reasonable distance.

There may also be limitations on the minimum size of features that can be produced. Unsupported standing features need to have a minimum thickness. If possible, runners and gates should be machined in after the initial part build.

SUMMARY

The advantages of RT are: lowered tooling costs as compared to machining, and the possible usage of molds of patterns made from RP. The drawback of RT is that one can inject only basic part shapes and that the parts might require secondary work. Viewed in this light, RT offers the simplest medium for the production of non-ferrous parts and for the production of final parts with low tooling costs.

Taken as a whole, the RT process is often far less expensive than other techniques and it is one of the fastest methods available. It does suffer from some disadvantages as it produces a product that is limited in quantities per printed mold. However, the advantages of RT outweigh its drawbacks. It can achieve a wide range of shapes with a brief turnaround, especially when based on previously used molds or standard designs.

Objet's family of 3D printing systems brings high-speed Rapid Prototyping (RP) solutions to the RT environments described in this whitepaper. Its patented PolyJet Technology-based printing systems provide a complete 3D modeling solution for virtually any Rapid Tooling application.