

**RAPID RESPONSE, LOW-VOLUME MANUFACTURING**

# **SPEEDY DELIVERY**

**BY J. TYLER TEAGUE**



**T**he exportation of jobs out of the U.S. is old news for the American jewelry industry. Most large factories have either moved their production offshore completely or have downsized their domestic factories and outsourced much of their manufacturing operations. Independent retail stores are no longer competing with each other; they are competing with QVC, Wal-Mart, and other major jewelry retailers. Labor can get only so cheap and merchandisers can scrape only so much metal out from under their designs before they collapse. Fortunately, there are still customers out there who want and appreciate good quality and design—and it's up to manufacturers to produce it for them, while at the same time turning a profit.

So how do you produce innovative, high quality jewelry and stay competitive in the shrinking American jewelry manufacturing marketplace? One answer is rapid response, low-volume manufacturing.

This new style of production is based on CAD/CAM technology. Manufacturers can move from concept to finished pieces in 24 to 48 hours. With this system, it is no longer necessary to make metal models. The design goes directly from CAD file to wax or resin model to mold to casting.

My goal in this article is to introduce you to the rapid response, low-volume manufacturing system. If the system or components of it can help you save money, reduce headaches, and provide new domestic options for your business, I can die a happy man.

## FAST BREAK

In traditional styles of jewelry manufacturing, a customer submits a design sketched on paper, a model maker interprets the design into a 3-D wax or silver model, and the customer approves the model or requests changes. If an order is placed for only a few pieces, it is often not cost-effective for the manufacturer to take the job. Since an order for a few pieces would require the same time frame and expense to make a model as an order for 10,000 pieces, the manufacturer may decide that the order isn't worth the effort

for the volume. On the other hand, from the customer's perspective, the time required to make the model, molds, possibly samples, and finished pieces may be longer than he or she is willing to wait. This is a lose/lose situation.

In rapid response, low-volume manufacturing, small orders such as the request described above are welcome. The design comes in as a CAD file or is con-



CAD files can produce complex details...

## THE RELATIVE SPEED OF THIS PROCESS TRANSLATES INTO EXTRA MARGIN.

verted into one by the staff CAD operator, it is e-mailed to the customer for approval or changes, a model is built in wax or resin, a mold is taken, and waxes are injected, invested, and cast. The relative speed of this process translates into extra margin for the manufacturer and quick turnaround for the customer. It's a win-win situation.

The following is a summary of the production steps involved in a successful rapid response, low-volume manufacturing system.

**MODEL MAKING.** With the introduction of CAD/CAM technology, you can mill or print a wax or resin model of most basic jewelry pieces in just a few hours. The mill or rapid prototyping machine (in-house or via a service bureau) takes the place of a staff model maker, and the ideal factory employs a CAD jewelry operator/designer who has experience making models by hand. However, if finding someone with these skills is not possible, you can still succeed with the right software and processes. (For a listing of CAD/CAM equipment and service providers, visit *AJM Online*, [www.ajm-magazine.com](http://www.ajm-magazine.com).)

8:00  
AM

*Paper design arrives. Use CAD software to render and convert it into an STL file ready for output. E-mail the design to the customer for approval.*

10:15  
AM

*The customer responds favorably to the design. Send it to the rapid prototyping machine for modeling.*

12:30  
PM

*Place the completed model into pre-mixed and vacuumed RTV compound. After a quick final vacuum, let the mold sit for 15 minutes to allow the bubbles to settle. Place the mold into a hot water bath for two hours.*

2:15  
PM

*Place the mold in cold water for 10 minutes, then cut. Proceed to shoot 10 waxes.*



...as well as simple designs.

There are CAD software packages available that allow you to cast a design in virtual space with your metal of choice to check for turbulence or hot spots that lead to porosity in castings. Most jewelry-related CAD programs also have the capability to project the metal weight of a CAD file. The file can then be modified easily to meet the customer's weight requirements.

Once the design is complete, you have multiple machining options. I prefer two types of models: those milled from hard carving wax and those generated in high-resolution resin by rapid prototyping machines. Both types of models have excellent surface finishes, which are ideal for taking a mold.

Although it is possible to cast directly from resin or carved wax models, I have found the surface of the castings to be less

than ideal. For this reason, I make a mold and shoot waxes. Any casting failures in the system would require additional carving or prototyping time, which goes against the goals of rapid response manufacturing.

**MOLDING.** Making natural rubber molds is not essential in rapid-response, low-volume manufacturing. Instead, RTV

(room-temperature vulcanizing) or LTV (low-temperature vulcanizing) molds can be taken quickly to speed up the process. Since RTV molds start as liquids, they can be used for a range of pieces, from a bulky charm to delicate filigree. On the other hand, LTV molds, which start as putty, should be used only for more durable pieces, such as simple rings and pendants, that can handle the pressure required to form the mold. (To learn how to speed up the curing process for RTV molds, see "Molds in a Jiffy," page 47.)

As in traditional manufacturing, it is necessary to have access to a trained mold cutter, whether in-house or

via a local service bureau. For time efficiency, it is best to have a mold cutter on staff who is also cross-trained in other areas, such as shooting waxes or building trees.

Cutting a good mold takes some training and practice. I've found it helpful to use transparent RTV or silicone molding compounds instead of the colored variety; you can see the orientation of the model better and therefore reduce your chances of damaging it during the molding process. Silicone rubber compounds cut differently than natural rubbers, so you'll have to cut a few trials first to get the hang of it.

Keep the following key points in mind when working with silicone rubber molds:

- It is best to build a proper sprue onto the model when you are designing it in



RTV or LTV molds speed up the process.

**2:45 PM**

*Sprue and tree the waxes, five per tree. Surround the trees with wax-coated paper tubes that serve as flasks.*

**3:00 PM**

*Place the prepared binder solution and high-speed investment into the vacuum mixer and mix for 1.5 minutes. Pour the mixture into the two flasks, vacuum for one minute, and let stand.*

**3:15 PM**

*After standing for 10 minutes, the flasks are at 180°F (82°C). Pop off the bases and let the flasks self de-wax.*

**3:45 PM**

*Place the flasks into a 1,600°F (871°C) preheated oven for one hour. The wax practically blows out of the bottom of the flasks at this temperature. When the cloud of smoke stops coming out of the oven port, flip the flasks over for the remainder of the hour.*

CAD. If there is no sprue on the model, you can use Super Glue to adhere a resin or metal sprue to it.

- If during the molding process you damage or break the model, try not to worry about it. Since you are doing small production runs, you should focus on getting a good mold, not saving the model. However, in most cases the damage is minimal and the model can be repaired with Super Glue or, in the case of wax models, a wax pen.

- When using silicone rubber compounds other than RTV, it's essential to gently hand-pack the rubber. Start in the recesses of the model and work your way below, beside, and above the model, until all gaps

are filled. To prevent deforming or breaking the model, apply gentle pressure slowly.

In addition, do not use mold frames that have holes in them for these rubber compounds; they will create uneven pressures that can damage the model.

**INVESTING AND CASTING.** Once you've shot the number of waxes needed for the task and treed them as you would normally, the next step in the rapid response system is investing. This is an area where speed and accuracy are key.

Traditionally, you would invest the waxes in conventional gypsum-bonded investment, burn out overnight, and cast the next day. But that's far too long for this

new system, so you need to rev up the investment process. Fortunately, there are investments available that fit the bill.

By using high-speed investments, you can invest, burn out, and cast in as little as two hours. (I use a three-hour burnout to ensure complete carbon elimination and proper casting temperatures at the end of burnout.) The surface achieved with these new investment materials is fairly good, and most can

be used for gold, silver, platinum, and stainless steel casting.

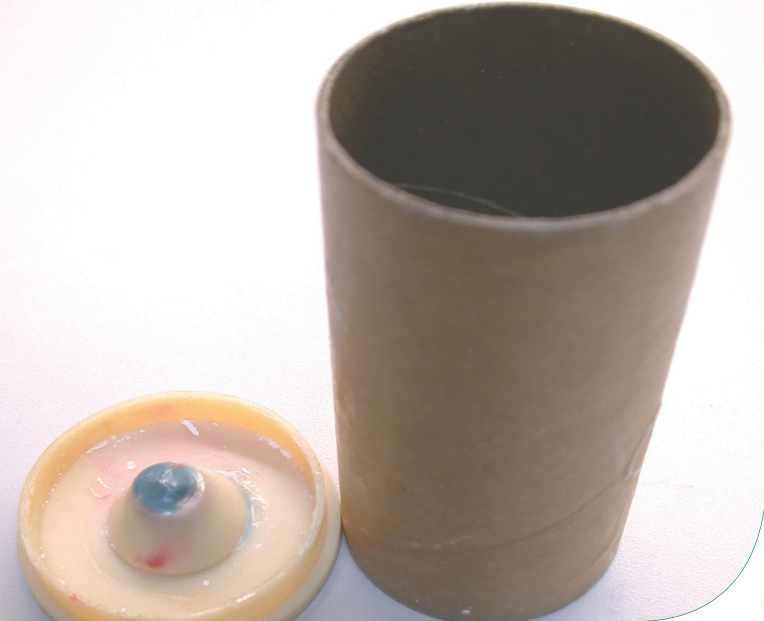
Once the flasks are burned out, you can proceed to casting the order as you normally would.

**PAYOFF.** The faster you can turn around the order, the happier your customer is, and the more you can charge. If a customer asked you how fast you could make 10 pieces of style X, you could offer them a price of 1X for a five-day turnaround, 1.5X for a three-day turnaround, and 2X for a one- to two-day turnaround. All are possible and relatively painless with this system. This is the kind of customized, quick service that sets these rapid response factories apart in the market.

Think of the ramifications for large jewelry companies that require multiple samples of new styles in time for shows or to meet the delivery demands of their customers. This is an entire market unto itself. If these companies are using overseas factories, two weeks is considered very fast to turn around new samples. What if you could get the samples out in two to three days—without the need for in-house model makers? It's a new way of doing business—and a new hope for the future of American jewelry manufacturing.

Visit AJM Online, [www.ajm-magazine.com](http://www.ajm-magazine.com), for a list of CAD/CAM equipment suppliers and service providers.

A high-speed investment system ensures timeliness.



**4:45**  
PM

*Remove the flasks from the oven and set them, hole up, on a safe surface, such as a firebrick. Reset the oven to casting temperature and crack the door.*

**5:05**  
PM

*Use an optical thermometer to check the temperature down the pour holes of the flasks. They should be close to temperature. Place the flasks back into the oven and prepare to cast.*

**5:15**  
PM

*If you prepared the metal while the flasks were cooking, it should take only 10 or 15 minutes to cast these two flasks.*

**5:45**  
PM

*Break out and de-vest castings. Proceed to finishing, setting, and polishing, or place in mass finisher and complete the order the next day.*

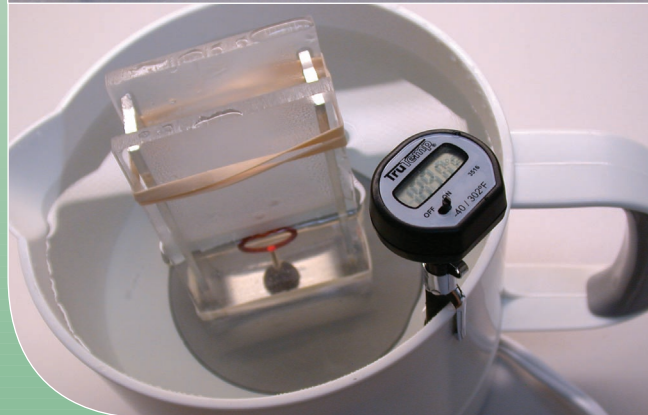
## MOLDS IN A JIFFY

The instructions that come with all RTV molding compounds that I have used suggest an 18- to 24-hour cure time. In a rapid response manufacturing system, this day of waiting just won't cut it. Fortunately, there is a mold curing shortcut that can be used with most models made of hard carving wax or rapid prototype resin. Bill Mull, owner of Zero-D Products in Willoughby, Ohio, showed me a trick for making and fully curing a two-part RTV mold in two hours. Now that's more like it.

To make an RTV mold in a jiffy, start by following the manufacturer's instructions for mixing the compound and removing the bubbles from the mix. When the bubbles are eliminated, pour the liquid RTV into the frame and place it into a 185°F (90°C) hot water bath for two hours. Keep the water at the same level as the rubber in the mold frame to ensure homogenous curing, and keep an eye on it for the duration. Also, it's important to keep the water at 185°F (90°C). This temperature poses no problem for resin rapid prototype patterns or models made from hard carving wax. Most hard carving waxes don't get soft until about 225°F (105°C), and the resins can withstand even more heat.

If you've kept the water temperature stable and the mold frame submerged, the mold should be fully cured and ready to cut in two hours.

If you're in an extreme time crunch and two hours is too long to wait for the mold to cure, you can use a no-heat, two-part silicone rubber mold such as Bellicone. This material can be used on more durable pieces (I wouldn't recommend it for filigree) to make a quick 30-minute mold. Take note that the mold will last for only about a day; it's a good quick mold for a few shots. ♦



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