Richard Austin (1936-1990) was a metalsmith and author, with several hundred articles to his credit. After his death I was given custody of an extensive collection of manuscript material-mostly on the technical issues of metalworking.

This text represents the first effort to organize the material—an attempt merely to group the files by topic. None of this is finished, and the text makes reference to illustrations that were never done—illustrations which were stored separately in any case, making it extremely difficult to bring the parts together.

It is unlikely that I will ever be able to spend the time to sort this all out. But it seemed a shame to let these articles languish unread by those who might benefit from them in some small way. So I have decided to release them in their roughly sorted form in the hopes that someone may find them useful.

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There are several techniques which can be used to prepare blanks for carving ring models. To some extent, the technique used depends on the materials and on the specific set-up that you have in your shop. Let's begin by considering the blanking for hard carving wax models. There are two clear alternatives. You can start with a block of hard carving wax or a ring model tube. The use of a wax block is probably slightly less expensive in terms of material but slightly more labor intensive. To some extent, it's a matter of personal preference. For this reason, I'll present two clearly different techniques which you can use. Obviously, the work can be laboriously hand cut from the wax block. However, the method we're suggesting is much quicker.

Another approach to cutting the wax blanks can be used when smaller sizes or thinner sections are being produced. This is the use of a tapered drilling tool in the drill press. A rough (undersized) hole is cut in the blank and the drilling tool is used in the press. Since there is a significant taper, the tool has to enter the work from both sides. This will produce a cross-section similar to the one indicated in Figure 62. Actually, many people seem to prefer this radiused
interior for its comfort. However, if you need a crisp, straight hole, the drill blank approach is more satisfactory.
FLAME POLISHING

Most textbooks dealing with wax model making suggest the use of flame polishing for finishing. In cases where this works, it's an excellent technique. However, it's very sensitive to the melt viscosity of the wax which you are using, its melting point, and also the form of the model. If there is any fine detail, this will invariably be blunted by the use of flame polishing. Since my own personal work tends to be rather formal and architectural, I find relatively little use for flame polishing.

If you structure plastic parts from the models, the outside surfaces are relatively easy to buff or polish to a high finish. However, the inner areas will be difficult to deal with. Small rotary burrs leave a very rough surface on the plastic models which we tend to use for this application. A quick and relatively high quality finish can be achieved on the inside of plastic parts by flooding them with blue dental inlay wax applied with a very hot spatula. The wax will tend to collect in any small scratches or recesses and draw away from high spots. This has a quick leveling effect on the surface. A brief wiping with wax polishing solution will usually produce a surface which is satisfactory for the inside of most jewelry parts.
In the vast majority of cases, it's practical to stamp your hallmark, fineness mark or copyright mark in the finished jewelry. Generally speaking, this is somewhat easier if you have a small hand press rather than simply using punches. The punches are a little more difficult to control, and they often distort the finished work. In some castings, it turns out to be quite difficult to place these marks no matter what system you use. This is particularly true on highly finished work where the distortion and grain boundary disruption will tend to show through after the work is stamped. There are two easy solutions to this problem.

If you only need to have special stamping occasionally, you can apply a small spot of soft wax to some area on the model and simply use your stamps to impress the marks into the soft wax before casting. This can be done in loc.................. It may also be useful to provide a small tab to locate the stamps. One way to achieve this is to cut a very small tab from polystyrene plastic, locate it in place, coat it lightly with soft wax and make your impressions. This approach provides a very finished, professional look.
Even better control can be achieved by applying small plastic elements containing the hallmarks. The appropriate marks are stamped in a fairly thick piece of sterling silver which is then cut into a small tapered block, as indicated in the drawing. This impression is used to prepare a silicone rubber mold by the techniques illustrated elsewhere. Dental acrylic can then be placed in these molds to prepare small castings which contain the impressions. These can be very neat and trim. The impressions are applied with sticky wax, and then blue inlay wax can be fluttered around to provide a smooth radius connection. This approach is particularly good on projects where you are going to use solvent polishing, since the polishes will tend not to erode away the letters.
Most modeling wax suppliers provide special wax wires which are intended for spruing. Generally speaking, these wax wires have a slightly lower melting point than the waxed used to construct the models. The theoretical reason for using the sprue waxes is that these will melt quickly and allow the wax to flow out of the cavity unimpeded. In certain cases, this can be important. However, it should be noted that there is certainly no requirement that this be the case. In order to prove this point, I've had my students sprue models on wooden dolls or plastic networks. In this case, it is guaranteed that the sprue system will be the last rather than the first pattern to be eliminated. In order to evaluate the need for sprue wires, it is important to look at why this might actually make a difference.

A good deal of the literature stressing the use of low-melting sprue wires has been derived from commercial investment casting processes. In this case, ceramic or high-temperature investments are used, and the models are placed directly in very high-temperature furnaces. The wax is instantly softened and eliminated from the mold. Obviously, in this case you would want to clear the sprue network as quickly as possible.
In commercial jewelry practice, some manufacturers prefer to melt (dewax) the wax from their systems at low temperature before the burnout cycle. Basically, the model is put in an oven at about 300° or less, and the wax is simply melted out. Although in theory you could catch this wax and reuse it, the main reason is to provide a clean, rapid burnout. The wax which is collected as a liquid doesn't have to be burned. If there are large volumes of wax present in a relatively small furnace, this can be a much cleaner, tidier operation. As a matter of fact, if you eliminate the wax quite carefully, you need very little in the way of venting for the burnout. If you're going to melt the wax out in this fashion, having the sprue system clear first is an obvious advantage.

More recent studies have suggested another reason for the use of low-melting sprue wax. During the early stages of burnout, a portion of the wax is absorbed into the investment. Excessive absorption seems to create a somewhat lower surface quality in the casting surface.
A comprehensive understanding of the requirements of sprue design must be based on two fundamental elements:

. Metal Solidification Shrinkage
. Viscosity/Flow Properties Of Molten Metal

In the metallurgical section of this book, we described the solidification process in precious metal alloys. An understanding of this process will be used to develop specific spruing rules. However, some comments concerning the viscosity and flow properties of the molten metal are appropriate at this point in the discussion.

If you wish to study the flow of liquids or gases through piping systems, you soon discover that there are two fundamentally different situations, depending on whether or not the material flowing through the system is compressible or incompressible.

Air and other gases are examples of compressible materials. That is, the volume which a given weight of the material occupies depends on the pressure applied. When a compressible material flows through a complex piping network of varying cross-sectional area, the pressure changes from point to
point. Obviously, this pressure will not exceed the incoming pressure of the system but, for example, if 10psi air is introduced into a pipe that gradually expands, the volumetric flow will be maintained but pressure will fall. If the air flow suddenly encounters a significant constriction, there will usually be an increase in air pressure.

Incompressible fluids do not behave in the same way. The hydrostatic pressure remains essentially the same throughout the plumbing system at various rates of flow. This behavior is like the brake fluid in your automobile. Some literature on investment casting has based the flow and spruing requirements on the concept of a compressible fluid. This is incorrect. All of the design of the sprue system must be based on the characteristics of an incompressible fluid.

The proper design of spruing networks is inseparable from the basic casting design. Variations in material location and shell thickness determine the required sprue pattern. No reasonable amount of sprue design will overcome the inherent faults of a badly designed casting pattern. On the other hand, proper spruing can ensure success with relatively complex forms containing considerable variation in cross-sectional area.
Some of the confusion in the literature concerning proper sprue design can be explained in terms of the differences between commercial/industrial practice and the artist/craftsman. Since each sprue connection requires subsequent smoothing and polishing, commercial practice indicates that an absolute minimum of sprues should be used. Since most commercial casting models are prepared in multiples from rubber molds, the commercial operator has the opportunity to develop the optimum (minimum) spruing system by trial and error.

The artist/craftsman faces a different situation. Since there is a high labor content in the model, it's extremely important that the casting be successful the first time every time. In this case, the uncertainties of a one-of-a-kind casting mean that extra sprues may be necessary to increase the probability of successful casting. Obviously, both the artist and the commercial caster would like to have the minimum number of sprues in order to simplify clean-up. However, the safety margin required by the artist-craftsman may suggest more sprues and/or a more complex sprue network.

Sprues which are too short or too large in diameter can cause significant casting defects. At first glance, it would appear that the larger the sprue opening the better. However, too
large an opening or too large a sprue allows flux contaminated surface metal to pour into the mold cavity. This effect is illustrated in the attached drawing. The flux and slag are less dense than the metal; therefore, they tend to gravitate to the low pressure side of the casting (towards the center of the spindle). This means that the defects will generally be found near the sprue opening, even though it's likely that the flux and slag entered the cavity first. If flux is carried into the opening, you will typically see small, bright colored depressions in the casting when it is removed from the investment. These depressions, created by the presence of flux, are not only flaws in their own right but they also are centers of crystallization which are porous and difficult to polish, even after the basic surface depression has been removed. In practice, the sprue opening should be just large enough to allow the flow of metal into the cavity while exceeding the cross-sectional area of the location which it feeds. By restricting the flow, the metal has time enough to fill the sprue opening, and the model is filled by it with molten metal from the bottom of the melt. Use of a longer sprue network tends to have the effect of moving the flux defects out of the jewelry and into the spruing system.

Modern casting practice has probably increased the number of flux defects observed. Historical practice was to use a
crucible liner, which was replaced after each casting. This crucible liner tended to absorb excess casting flux and, to a lesser extent, trap any particulate matter present. Because of the hazards of asbestos, current methodology recommends the use of a crucible which has been glazed with flux. Unfortunately, over a period of time this glaze tends to build up and a significant amount of the flux usually travels with the metal. Thus, the use of unlined crucibles demands a somewhat higher quality of sprue system design.

There is considerable controversy over the issue of flow-back in sprue systems. Flow-back is the situation where the configuration of the model and sprue system require that some part of the metal flow back toward the center of the centrifuge, or the center of the sprue. In theory, the hydrostatic pressure provided by the model should allow flow-back all the way back to the level of the molten metal in the sprue. However, given the speed of solidification and the elimination of air, only a limited amount of flow-back can reasonably be expected. Factors which relate to the amount of flow-back which will occur are:

. The diameter of the opening or part which must accept the metal
. Flow-back resistance
. The depth of molten metal above the flow-back area (the
hydrostatic head

The following specific issues must be considered:

I. EQUAL AREAS OF BRANCHING

II. CROSS-SECTIONALS RULES
   A. Sprue greater than section area
   B. Constantly diminishing area

III. RADIUS EFFECT
   A. Cut in or undercut
   B. Excessive fillet

IV. COMMERCIAL VERSUS ARTISTS/CRAFTSMAN APPLICATIONS

V. FLUX CARRY-OVER
   A. Sprue size limitations
   B. Use of a reservoir

VI. SPECIAL SPRUING SITUATIONS
   A. Massive sections
   B. Remote mass
   C. Flow-back
   D. Thin sections

VII. DIFFERENCES IN SPRUING FOR DIFFERENT CASTING METHODS

VIII. INTENTIONAL POSITIONING OF DEFECTS
   A. Degree of final finish
   B. Crystal size
Sprue are the wax wires used to support the wax pattern in the desired position. During burnout, these wax sprues are lost, leaving passageways through which the melting wax escapes from the mold. During the casting process, this sprue system provides passageways for the molten metal to flow into the mold. The spruing process is very important for the production of a sound, dense casting. In industrial practice, a number of waxes will be sprued into a complex tree so that multiples can be cast.

Production of a sound casting requires even and progressive cooling from the farthest point in the model to the sprue button. Many texts on casting give various rules of thumb concerning how close the model should be to the flask wall and/or the end of the flask. Obviously, the model cannot be placed too close to the end since breakout will be a hazard. However, in most cases these rules relate more directly to even cooling. If one edge of the model is placed too near the flask wall, it will tend to cool at a different temperature than other areas. If heavy wax models are clustered together on the sprue tree, this can also encourage uneven cooling.

The requirements for the spruing of individual models versus
the large industrial trees are somewhat different. First of all, if you're casting a one-of-a-kind hand-made wax, you need to be certain that you will get an adequate casting. This must work the first time every time. If you were working with multiple waxes, a certain amount of empirical experimentation will teach you the best arrangement. Since the cost of the individual waxes is relatively small, a certain degree of scrap in the early stages of the development are not excessively expensive. Other factors come into play with regard to the two different systems. First of all, in the single system the net length of the sprue system is relatively short. This means that it's much more likely that flux contamination or oxides will be swept into the cavity. The long length of the complex sprue systems usually insures adequate time for the segregation of the metal and its flux so that an effective bottom pour is achieved and the flux remains on the sprue button.

The flask is the container which holds the mold material. It provides structural strength and maintains uniform dimensions. Stainless steel flasks are recommended since they are rust and corrosion resistant in the oven and ultimate water emersion. There are two basic types of flasks. The standard flask has a solid cylindrical wall and is used for centrifugal casting and vacuum-assisted casting. The perforated flasks have a number
of holes in the wall and are used for vacuum-chamber casting. All flasks are available in various heights and diameters. The flask size is determined by the size of your wax pattern. When placed inside the flask, the pattern should be centered so as to have a minimum of 3/8 of an inch from the sides and 1/2 inch from the top. Somewhat closer spacing may be used when casting single items in a small flask. Certainly these dimensions are appropriate for large trees.
MODEL, MAKING
FREE, HAND, TURNING

Although the basic concept of lathe turning is not unique, the
freehand method described here is not widely used. There are
few literature references to the method, and I rarely
encounter it in commercial shops. Within the last few years,
some specialized equipment has become available. This is
unfortunate since it is a versatile technique which uses
equipment commonly available in most shops. The basic
technique is skill oriented rather than equipment oriented.

I have demonstrated this technique to a number of students.
Since it is skill oriented, I have found that it takes some
practice. This means that there will be a frustrating
learning period where you must invest a little time to make
some progress. However, in my experience, the technique is
easy to grasp and is certainly much simpler to master than a
skill such as freehanding engraving. Our discussion will
focus on the use of the technique for making basic components
for model building for investment casting. However, there are
a wide range of possible applications in model building.

For any of you who have done any turning, you know that tools'
chatter can be a real problem. This is probably one of the
most serious difficulties in this technique. First of all, the material which you are turning is relatively flexible and can actually bounce or flex under the tool. Second, the material is quite soft and, therefore, it's easy to gouge the tool into the work or simply to take too deep a cut. Finally, the fact that both the tool and the work are not held rigidly means that it's easy to set up a vibration pattern. There are a few basic points which will minimize your difficulty. First of all, the basic blank which you're working from should not be much more than about three times as long as it is thick. As you develop very long thin shapes, they tend to whip. You can turn very thin parts if they're made from a thicker blank and you work down from the tip. You could turn an 1/8" diameter rod an inch long, but you'd have to start with a blank that was fairly thick and cut from the tip toward the base. The second technique which will help is to be sure that you work with the cylindrical blank before you begin to develop your form. I normally cut out a rectangular blank, fuse it to the turning plate and knock the corners off with a file freehand. Then I begin the turn. However, I roughly turn the full length into a round form. This means that it will be well balanced and the tool less likely to gouge or dig in on the corner. Finally, the location of the cutting tool is important. In order to prevent grabbing or chattering, the cutting piece of the tool should be behind the center line of
the work. This relationship is illustrated in Figure 2.

Although it's not absolutely necessary, it's been my policy to reserve a set of stone setting burrs and rotary files just for working in wax. If you do this, they will last for many years, since the wax is so soft it has little tendency to dull the tools. Conversely, this means that the tools are quite sharp and remain so. This makes for a much smoother cut and less clogging. If you're going to use this technique, I would strongly suggest reserving a new set of tools for this purpose. The conventional cutting tools designed for jewelry are adequate if you use very light cuts in delicate work. For more aggressive cutting, larger coarse-tooth equipment is better. The Dremel line of rotary files is very good for gross cutting and carving in wax. The three flute wax cutting berths are also very useful. However, for carving the inside of pearl seats and the development of bearings for faceted stones, conventional metal working tools seem to work out the best.
MODELING

WOOD

Many kinds of wood can be used to make jewelry models but my favorite is balsa wood. It's easy to work, available in a wide range of small forms and it burns out relatively well. Wood can be used as a modeling material in its own right or it can form the substrate for a wax or polymer emulsion build up. I have also used larger balsa wood strips to construct the sprues for large, hand poured lost wax castings done in pewter.

Wood must be sealed or waterproofed to insure a good cast. Any of the techniques described previously will work well. If you wish to preserve the wood texture the clear model paint works well. You can enhance the texture by brushing the material lightly with a small wire brush. Work the brush parallel to the wood grain. If you wish to bend the wood, a brief soaking in hot water with a little ammonia added will render it quite flexible. The wooden parts can be pinned into various shapes while they dry.
MODELING

PAPER

The most common technique for making casting models of large thin shapes is to fabricate the forms from sheet wax. This material is available in a wide range of thicknesses and various melting points and hardmesses. However, most sheet wax has a relatively low melting point. This can lead to several problems. First the material is fragile and hard to work with. When warm the thin shapes may not even support their own weight and when chilled they are fragile. Crisp outlines are hard to hold and joining the shapes to other wax components can be difficult. Finally, these waxes are difficult to texture if you want a detailed crisp surface. There are at least two good alternate solutions to the problem:

. Paper
. Plastic
MODELING

ORGANIC MATERIALS—PREPARATION

The use of organic materials in jewelry modeling offers a diverse range of texture and form. The organics include wood, leaves, flowers, paper, cloth and even banana peels. As a practical matter there are certain characteristics which are generic to most of these materials.

The first is porosity. If you try to invest a material which is porous or water absorbent you'll have more difficulty getting an accurate reproduction of the surface. For this reason, some type of surface treatment is often required. Depending on convenience, the materials involved and the desired effect I have used:

- Lacquer
- White Glue
- Wax

**Lacquer or model airplane dope** - Most of the clear, fast drying spray or brushable lacquers used in the model or craft fields work well. If the materials are to be brushed on, you may wish to dilute them so they don't build up and obscure surface detail.

**White Glues** - Water soluble white glues work well for some purposes. Generally, they must be diluted extensively
with water to provide a thin enough material to prevent obscuring the detail. This material works well with large or massive parts. On thin, fragile piece of organic material, the water may soften it and actually change its shape.

Waxes - The use of white glue or lacquer requires that the material dry after the finish is applied. If the material is sturdy (such as wood or acorns) I flow on melted dental inlay wax and brush off the excess with a toothbrush. This way the model building process can proceed without delay.

The second generic problem is that nature didn't plan most of these materials for casting models so they may contain shapes or configurations which will not cast properly. Small holes, deep recesses, or thin sections must be built up or reinforced.
MODEL BUILDING

The modeling building process presents a wide range of alternate tools, materials and techniques. For practical reasons this chapter will be limited to a brief overview of the alternate processes.

Tools And Materials

Many specific wax working tools are produced commercially. Additionally, many other common workshop tools may also be used for wax modeling.

Spatula - Various manufacturers offer a variety of wax spatulas. However, most of these will have one of three basic forms: Spatula, needle point and ball shaped.

The spatula is the most versatile. Because of its relatively large surface area it can be used to add, or remove wax from the model. It is especially useful for building of materials such as Kerr Inlay Wax or Perfect Purple Wax. The needle shape is useful for "welding" small parts together and for applying some types of texture. The ball tipped tool is something of a compromise. It has somewhat more surface area and mass. It can be used for welding or texture where more heat is required.

One problem with the commercial spatulas is their mass. Many are too heavy for the delicate work required in jewelry modeling. Simple wax tools can be formed from piano wire and dowel handles. There is a practical limit to the size of the smaller tools. As the mass decreases they hold less and less heat. At some point they cool so quickly that they have little practical use.
At this point the electric spatula becomes very useful. The Kerr Miniwax welder can be adapted for very small points. Since heat is added continuously, small size is not a problem. The welder also provides improved speed and control. Electric welders are especially useful in repetitive production operations such as assembling sprue trees.

Lubricants And Release Agents. - Melted wax sticks to metal work surfaces. A number of release agents may be used to minimize sticking. A film of glycerin or fine machine oil may be sufficient to coat metal surfaces and prevent adhesion. Kerr Microfilm is a specially formulated release agent. A coat of microfilm applied to a ring mandrel (or rubber mold) assures easy removal of the wax pattern with minimum distortion or breakage.

Special release agents are available in the dental trade. These may be referred to as dip lubricants. The most effective release agents are the silicone compounds which are found in high temperature lubricants and water proofing compounds. If you want to use silicones, they are available in two forms which are useful for shop application. The first would be the aerosol cans of silicone spray lubricant available in hardware stores or automotive shops. These can be sprayed onto the surface and the excess wiped off. If you want concentrated material, silicone laboratory grease is the best. This is available in tooth paste size tubes. Although it's relatively expensive, a small tube of the grease is a lifetime supply. Jewelry trade shops also offer silicone grease in syringe applicators. If you use silicone release, care should be taken to confine the material to the work area. Surfaces which have been contaminated are difficult to bond with paint or adhesives. Also the use of silicones produces models which are extremely hydrophobic.
Solvents And Polishing Agents - For practical purposes, wax solvents and polishing agents are the same material. The solvent is used to smooth the surface by rubbing with a soft cloth and the solvent. The solvents are also useful for cleaning up shop tools. Commercial material such as Kerr's Laboratory Solution work very well. One popular material is eucalyptol. It has a very pleasant odor and works well as a wax or polish. Xyline is also an effective wax solvent. Although no major hazard is present, you should remember that many wax solvents are flammable and may also be toxic in quantity. They should be used in a well-ventilated area, and careful hygiene is appropriate. Kerr Laboratory Solitine is an excellent and safe product for wax cleanup and polishing.

Model Building

The key element to successful modeling is to use the appropriate materials and techniques for each operation. Keep in mind that a simple model may be constructed from several different materials. Each material is chosen to provide the optimum result. For purposes of this discussion we will consider three different modeling techniques and then consider how they might be merged.

- Buildup
- Carving
- Wax Turning
- Plastics

Buildup - Carving waxes are easily cared by a scraping action. This can be observed in the use of two or three flute wax burrs or by cutting the material with an engraver. However, the low
melting point of the wax means that the material will soften or melt and clog the teeth of conventional files or rotary burrs. The wax data illustrated in chapter 7 indicates that a considerable softening occurs even before the material actually melts.

If you intend to use conventional cutting tools, they must be extremely sharp. There are three principle factors to consider when you machine plastics or waxes:

1. The Cut Of The Tools
2. Sharpness
3. Cutting Speed

The Cut of the Tools - The pattern and size of the teeth both influence the way in which the tools cut the material. Generally speaking, plastics require a finer tooth pattern and waxes a larger, more open pattern.

Sharpness - Because these materials have low melting points, tools must be extremely sharp to lift chips of the cut material rather than melt the surface. As soon as the tools become clogged, the friction between the two wax surfaces aggravates this problem considerably. In effect, clogging the tool destroys its cutting action.

Cutting Speed - The velocity of the surface of the cutting tool is directly related to the rotational speed of the tool and its diameter. Obviously, a large diameter tool will have higher surface speed at any given rpm.

Small tungsten carbide burrs work extremely well on plastic. Because they usually have a
double-cut surface, they tend to minimize chatter. Because they are carbide, they remain very sharp for a long period of time, and the tendency to melt the plastic is minimized.

Wax Turning - In recent years there has been an increased interest in turning techniques for the production of precise rotational forms. Some specialized equipment is available but many small parts can be turned freehand. The technique is simple:

- A block of hard carving wax is fused to a turning place.
- The assembly is chucked in the handpiece of a flexible shaft machine.
- Parts are turned freehand, using gravers and other conventional jewelry tools.

The turning plates used are illustrated in Figure 26. They were made by soldering nails to a variety of washers. The nails should be cut to about 3/4" in length.

Kerr Master Pattern Wax in blue (medium) or green (hard) work well for this application. The wax should be blanked by sawing out a cube of sufficient size to accommodate the part to be carved. This blank and the turning plate are both heated with an alcohol lamp and fused together. This bond may be reinforced by applying Kerr Inlay Casting Wax to the joint.

The turning plate and wax blank are chucked in the handpiece. The first step is to dress the blank into a slightly tapered cylinder. See Figure 26. Ball burrs, stone seating-tools and files may also be used to develop the desired form.

Tool chatter may be a problem with this technique. Since the tool and the work are not held very firmly a rhythmic vibration may develop. Several factors may contribute to the problem.
Because the wax is quite flexible, long thin shapes will tend to deflect. Keep the blank as short as practical. Making a deep cut may also aggravate this problem. Finally it's important that your tools be sharp.
CONSTRUCTION

All of the construction involved can be accomplished with ordinary jewelry-making tools. The plastic should be cut with a 2/0 jeweler's saw blade. Lubrication will help keep it from sticking. Just as a general suggestion, when you are cutting plastic, your tools must be very sharp and you must cut slowly. I would also suggest that you use a tungsten-carbide cylinder-shaped burr like the one illustrated in the figure. These are very good for forming the insides of the model shanks, and also they are very handy for cleaning up finished castings. Although they're a little expensive, they last for years if they're taken care of, and they're a good addition to your shop.

1 - Layout - This technique can be used to structure all kinds of shapes and forms. However, it provides the greatest benefits in shapes which have deep recesses or recesses which are pointed and difficult to reach. The form indicated here is a typical style which I use in my work. The outline may be adjusted to suit your own needs. The general shape of the ring has parallel sides. Obviously, this can be tapered in either direction as indicated in Figure 2. This can be done by tapering the core section before assembly. In any event, your first step is to determine the size and the outline of the ring. Note that sizing should be done very carefully,
since you will find that this kind of style can only be stretched a limited amount after it's cast.

2 - Core Section - The total thickness of the ring will be built up from this core section in two facing sheets. The first thing you need to do is determine how thick the core should be. This determines the width of the inside recessed area. In the case illustrated, I began with an acrylic sheet about three-and-a-half millimeters thick. The first carving step was to pierce the acrylic with a hole that matches the final ring size. In this case, I was working with a size 6. Begin by drilling a small hole in the sheet, inserting a No. 2 saw blade and sawing a hole about five-eighths of an inch in diameter. This hole should be gradually enlarged using hand or powered files until it matches the size of the ring. Note that careful measurement eliminates the need for any adjustment in the casting process. The ring blank should be precisely the size which you wish to achieve in the final ring. After the hole has been sized, the outside profile can also be sawed away and refined with small files. In this case, a smooth mil file is very effective. Again, remember that this file should be sharp and uncontaminated with wax or metal particles. Having gone to all this trouble to make what appears to be a very fine ring shank, the next step is to cut away the inside material, as indicated in Section D in
the photograph. This is sawn away from the inside until you have a strip of plastic roughly one millimeter thick corresponding to the outside profile of the ring. The next step is to laminate this strip between two sheets of thin plastic. Krazy glue provides a good bond and sets fast enough to keep the work moving. The lamination can be done with oversized sheets, the next step being to saw away the excess on the outside and pierce the hold on the inside. Be careful not to use an excessive amount of cement, since this will tend to form a line on the inside juncture of the model. This tends to deteriorate the appearance of the part. One way to avoid this is to hold the laminations lightly together and apply the cement from the outside, allowing capillary action to draw it into the joint.

3 - Model Refinement - Finally the model is fully detailed, working slowly and carefully to bring it back to the desired ring size and to smooth the outer surfaces. You may continue to smooth the plastic with a succession of sandpaper. However, this form is very easy to polish, and you may wish to simply cast it with a filed surface and finish out the metal later. If there seem to be any imperfections on the inside, you may flow in a fillet of Kerr blue inlay wax inside the form to cover any imperfections. Scrape away the excess with a round spatula and polish the inside with or other wax polishing agents. This will result in a slight radius in
all the corners; however, if you've done a good model-making job, this shouldn't be necessary.

4 - Head - This project was set with a six millimeter round brilliant amethyst. The head was cast to match the ring. Modeling was done by the free-hand turning process on the Fordham flex shaft. However, it can be carved by any technique that fits your skills or it can be fabricated in the conventional way. Alternately, you may simply wish to purchase a commercial head and apply it to the casting.

5 - Casting - Casting should be straightforward since there are no unusual sections involved. The part was sprued in four locations as indicated in the photograph. The horizontal layout will avoid bubbles in the core if you use a vacuum system. However, if you do not use a vacuum, some care should be exercised during investment to eliminate bubbles. If the hollow core is limited to one side of the ring (that is, if the back of the shank is curved), you may wish to change the geometry to insure the bubbles are not trapped. Spruing was accomplished with four twelve-gauge wax wires.

6 - Finishing - During casting, a small stub was in a cast in the center of the head. This formed the sprue and a short piece of this material was left in place when it was removed from the sprue former. This gives you something to work
with during finishing and also provides a locating pin during the soldering operation. In order to clean up the heads, I normally lock this stub in a small pair of vice-grip pliers which allows me to have a good firm grip while I clean them up. Using this technique, the head can be finished quickly. The shank should also be polished at this point.

7 - Joining - After both parts of the casting have been cleaned up and given a preliminary polishing, the stub on the bottom of the head can be filed to a small pin shape. This is cut off perhaps an eighth of an inch long. A corresponding hole is drilled in the center top of the shank and the pieces can be joined with medium gold solder. The pin keeps the head from moving about and insures a nice symmetrical casting assembly. Finally, after soldering a hole is drilled through the center of the bottom of the seat and out into the ring shank. This opens up the bottom of the seat and insures that the wearer will be able to clean and maintain the article. Please note that the pin may totally disappear and the shoulder contact area may be all the solder joint required.

This plastic assembly technique can be applied to a very wide range of modeling situations. In our next article, we will consider another application of plastic materials which can be used to form shell structures which are more organic or free in their forms.
CONSTRUCTION

No. 1 - Design And Layout - Obviously, the process indicated here can be accomplished in a freehand manner. However, I generally prepare a pattern if I think there is the slightest chance of producing more than one version of a specific design. The use of simple templates is particularly beneficial for limited production since it bridges the gap between one-of-a-kind designs and multiples made by rubber molds or other reproduction techniques. Once the design is complete, I prepare a scribing template such as the one shown in the figure. Basically, this is a flat metal plate carrying the outline of the design with a locating tube attached. I would generally prepare several patterns in different ring sizes. The outside of the tube can be adjusted in about one-half ring size steps. The simplest way to do this is to purchase brass tubing from a model shop. Tubes of 5/8 of an inch or slightly larger generally bring you into the right range of sizes. Slice off a piece about 1/8 inch long and stretch it on the mandrel until the outside diameter equals the ring size you wish to reproduce. I usually file a slight taper to the cylinder and then soft-solder it to a brass or copper base. The outline of the model is sawn and filed from the blank template. Because it will be used more than once, it is well worth the extra time and care to do a very careful job at this point. Remember that scribing will enlarge the
pattern slightly, so it's usually useful to make the template a little under sized. Also, you should polish the edges since it makes it much easier to control the scribing if they're very smooth.

No. 2 - Blanking - Once a sheet of core material has been selected in the proper thickness, the next step is to pierce it with a hole of the proper ring size. I usually do this by a combination of sawing, filing with a rotary file and sand paper. Again, it's very useful if you can mark a circle on the blank to work from. For many years, I used ordinary plastic draftsmen templates. However, these don't last too long under the pressure of marking with a steel scribe. For this reason, I prepared a series of metal templates pre-measured to provide standard ring sizes. This template is shown in use in Figure 2. The blank is pierced with a small drill and a #2 jeweler's saw is used to saw off the disc. I find that a large diameter tungsten carbide rotary file works very well for bringing the shank to size. I generally file to within about 1/8 of ring size. You can end up by using 220 or 400 wet or dry sand paper on a ring mandrel to adjust the size precisely. If the blank is going to remain on the inside of the ring, considerable care should be used. However, if you're going to form a hollow model, no great precision or fine finish on the inside cut is required at this time.
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PART 1

MODEL MAKING - MATERIALS FOR INVESTMENT CASTING

By: Richard D. Austin

The lost wax casting process has been used for thousands of years. However, until recently there were only a few waxes available for model making. Early goldsmiths were limited to materials such as bee's wax and bayberry wax. When the petroleum industry began to refine natural crude oil, a number of new materials became available. Paraffin is probably the most obvious example. Subsequently, the development of the petrochemical industry added synthetic waxlike substances (plastics) to the list of materials which might be suitable for "wax" model making.

At the present time, there are hundreds of different types and forms of wax available for jewelry making. These are various combinations of natural organic waxes, refined petroleum based materials and synthetic materials based on polymer chemistry. A growing market has encouraged the introduction of materials with a wide range of properties. This has expanded to the point where it is sometimes confusing to select from the alternates available.

What I intend to do in this series of articles is to present a non-technical discussion of various materials, their properties and application. However, I would like to remind you that there is no "right way". Within the parameters of the process, whatever works is all right. I have seen craftsmen produce beautiful results with unlikely materials. What works for you is what you should use.
When I started out to prepare this article, I thought it might be interesting to segment the commercial waxes by their constituents. This turned out to be difficult for two reasons. First, commercial manufacturers are not willing to disclose what materials they use in various wax blends. Second, knowing that a wax blend contains a particular ingredient isn’t much help. I concluded that the best way to discuss the waxes is to talk in terms of their physical properties and intended applications.
PART 3

MODEL MAKING - MATERIAL FOR INVESTMENT CASTING

ACCESSORY MATERIALS AND TOOLS

By: Richard D. Austin

To date we have discussed wax properties and specific wax formulations. In addition to the waxes there are a number of other accessory materials and tools which are useful in the model building process.

Lubricants and Release Agents - Melted wax may stick tenaciously to metal work surfaces. A number of release agents may be used to minimize sticking. In some cases a film of glycerin or fine machine oil may be sufficient to coat metal surfaces and prevent adhesion. Special materials such as Kerr’s Microfilm are also available for this application. The most effective release agents are the silicone compounds which are found in high temperature lubricants and water proofing compounds. If you want to use silicones, they are available in two forms which are useful for shop application. The first would be the aerosol cans of silicone spray lubricant which can be found in a hardware store or automotive shop. These can be sprayed onto the surface and the excess wiped off. If you want concentrated material, silicone laboratory grease is the best. This is available in tooth paste size tubes. Although it’s relatively expensive, a $5 or $10 tube of the grease is a lifetime supply. Jewelry trade shops also offer silicone grease in syringe applicators.
Some cautions about the silicone are in order. They work so well that they can be annoying. If other surfaces in your shop become contaminated, they can cause problems. It's difficult to paint over the surfaces which have been contaminated with silicone grease and it can cause poor adhesion on components which are assembled with glue. If you do use silicone, use it sparingly, keep it under control and clean up well when you are done.

**Solvents and Polishing Agents** - For practical purposes wax solvents and polishing agents are the same material. The solvent property is used to smooth the surface by rubbing with a soft cloth and the solvent. The solvents are also useful for cleaning up shop tools. Commercial material such as Kerr's Laboratory Soluteine work very well. One popular material is eucalyptol. It has a very pleasant ordor and works well as a wax or polish. Xylene is also an effective wax solvent. Although no major hazard is present you should remember that many wax solvents are flammable and may also be toxic in quantity. They should be used in a well ventilated area and careful hygiene is appropriate.

**Mold Releases** - There is a different class of release materials which may be used in vulcanized rubber molds. Not all combinations waxes and mold materials require a release agent. I would recommend that you follow the manufacturer's direction with regard to wax releases for rubber molds. It should be noted that the release properties of the injection waxes vary widely from compound to compound.
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<td>Cabela's</td>
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<tr>
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<td>Craftsman Wood Service Company</td>
<td>Multi-Drills, Misc. Tools &amp; Wood</td>
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<td>660 Grant Street</td>
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<td>Buffalo, New York 14213</td>
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<tr>
<td>Plastic Technics</td>
<td>Injection-Molded Plastic Jewelry Components</td>
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<tr>
<td>13000 Saticoy St.</td>
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<tr>
<td>North Hollywood, CA 91605</td>
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<tr>
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Company
United States Plastic Corp.
1390 Neubrech Road
Lima, Ohio 45801
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Material
Sheet, Tubes, Spheres
Bottles, Containers
Adhesives
MOUNTINGS

By: Richard D. Austin

In the first article of this series we discussed a freehand turning method for preparing ringtops and stone seats for round gemstones. In the second segment we discussed the application of plastics to the process of making ring shanks. In this article I will discuss the application of plastics to the preparation of casting models for stone seats, bezels, and prongs. Since I have already discussed the basics of plastic applications I would like to go directly to the construction methods.

Before proceeding with detailed instructions, this is a good point to consider some practical issues. When you're making one of a kind jewelry items the finishing problem may be different than production work. In production or commercial work it's vital that the pieces come out of the casting investment with the best possible finish. Since a single highly finished master can be made and duplicated quite precisely, it's worth the investment in time in the original model. However, in the preparation of one of a kind items some compromises may be appropriate. If it's very easy to come back and polish a portion of the finished jewelry, it may not be economical to spend too much time trying to refine the model. In most cases, I concentrate my labor on making sure that the stones will be a good fit and that portions of the jewelry,
which will be difficult to reach during polishing are well finished. Easily polished outside surface areas receive less attention during model building.

I have arbitrarily divided this subject into three major areas; bezels, stoneseats, and prongs. In reality a jewelry component may combine more than one of these. However, let's begin by talking about the problem of preparing bezels. When bezels are used for faceted stones a more elaborate seat is required. For this situation, let's use the example of a cabochon. Consider the problem of mounting an oval cabochon a cast mounting.

In traditional practice the bezel is often applied to the finished casting. This allows for a precise adjustment of the bezel size, the use of malleable materials and a minimum of model building time. However, it has the distinct disadvantage of potential color variations in the finished jewelry as well as the visual problem of solder seams unless they're well done or hidden in the design. Whenever practical I use a cast bezel.

The problem of creating a cast in place bezel is one of fabricating a very thin wall in the model which conforms precisely to the stone. A traditional way to accomplish this is to use sheetwax. However, most sheetwax is soft and it requires considerable skill to develop a good fit and a
precise crisp shape. This is exactly the kind of application where plastics can provide a clear advantage.

The steps in the construction of a simple bezel from plastic are straightforward. Begin with a piece of acrylic sheet somewhat thicker than wall height of the bezel required. The next step is to mark the outline of stone on the sheet. The best way to do this is to sand the plastic lightly with 400 grit wet-or-dry sandpaper and mark around the stone with a hard pencil. The mark will remain more legible if it is covered with a piece of clear plastic tape. Drill a small hole in the middle of the bezel area and use a #2 jewelers saw blade to saw slightly inside the line. Work slowly and use a blade lubricant. Next use hand files or rotary files to enlarge the inside of the oval shape until the stone fits snugly in place. The trick of achieving a good fit is to make sure there are no high spots on the inside and that the stone fits closely. It must not snap into place. When you turn the sheet upside down the stone should fall out. With this amount of clearance you should be able to compensate for the very slight shrinkage which occurs during casting. When the inside of the hole is neatly shaped to fit the stone, the next step is to develope the thin sectional area. This is done by sawing around the hole leaving approximately 1/16 inch wall thickness. Use a small mill file to gradually cut down the wall thickness and form a slightly tappered
section. If you observe carefully you will find that no
matter how carefully you work the shape develops rounded
corners. This radiusing effect is illustrated in the sections
in Figure 1. This is the reason you start with extra thick-
ness. An improved section can be formed by removing a little
of the bezel height from both sides before applying it to a
base. I normally file one side of the bezel (the thicker
base) at this point. Then I glue the oval to a sheet of plastic.
Normally, I do this on a large scrap and don't worry too much
about neatness or precision. This can be done with any of the
so-called instant glues. You can apply the glue liberally
and simply drop the bezel in place. Although it won't dry
instantly you will find that within a few minutes it will
bond the bezel down. The next step is to remove the outside
material from the bezel base plate and bring it to the pro-
file of the bezel itself. Finally, as much of the inside is
cut away as appropriate for your design. The last step is
to cut the bezel down to the proper height and tapper before
incorporating it in your model.
CUTTING PATTERN

Even with the best tool selection, proper speed and careful handling, there are certain limitations to the shapes or forms which can be cut freehand. Machining down the edge of a plastic sheet is a classic example. Without the assistance of a milling machine, it's essentially impossible to machine a flat plane on the edge of a plastic sheet. To varying degrees, depending on your skill, the edge will tend to be somewhat radiused as indicated in the attached figure. Understanding the nature of the problem can help you minimize the difficulties which you will encounter. First of all, you will notice that the profile of the edge cut tends to be somewhat oliiptical in nature; that is, the radius or curvature is a little quicker near the edge. This means that if crispness is required in the form, you might think of starting with a thicker sheet, developing the outline, and then lapping the face down to eliminate some of the worst curvature on the edge. A second alternative is to use a slightly tilted edge whenever practical. Except for the inside of bezels, there is relatively little reason to try for a sharp edge except in specialized design situations. Also, in many cases, you may use a little inlay wax to dress up or cover the effects of this problem. For example, a bezel section as indicated in figure 26 might be slightly undercut on the bottom edge. This is a particularly bad
situation, since you will tend to cut or polish through the bezel at the level of the stone seat. To prevent this, you may flood the inside of the bezel with blue inlay wax and then quickly cut away all but a small radius at the bottom. This should not cause any interference if the bottom of your (cabashants?) are properly beveled. Lacking a proper bevel, it may be useful to cut one on the stone with a small diamond file or conventional lapidary equipment.
The fabrication of jewelry from pre-finished components has two particularly useful applications in limited production jewelry manufacturing.

First, the assembly of commercial components provides an enormous range of design opportunities which allows the custom jeweler to create a relatively unique pieces of jewelry with a minimum investment in time, materials and facilities. Simply put, there are an almost infinite variety of options available with the existing components.

The other particular application is in the assembly of prefinished individual components during the fabrication of one-of-a-kind jewelry pieces. In large production runs, it is practical to prepare masters to produce one piece castings of any reasonable design. However, if a single piece or a very limited run is required, it may be more economical to prepare and finish a series of individual castings and assemble these through conventional soldering processes. This second option may provide a simpler and more economical approach to both the model building and finishing processes. It also allows the creation of certain crisp forms and detail which would be difficult to finish in a one piece casting.

Inherent in both of these applications is the need to locate the parts accurately in place during the soldering process. There are a number of specific techniques which can be used depending on the number of components, size, configuration, etc.
One of my favorite techniques for locating parts during the soldering process is the use of embedment in investment. I'm always surprised that this technique is not more widely used in commercial shops. It allows very accurate positioning and provides the ability to assemble a large or complex in groups of components at one time. On the other hand, it does require some special preparation and the investment has to be allowed to sit (usually overnight) before the soldering can proceed. Although this breaks the orderly work flow on a single project, I find that it doesn't cause much problem. If you have a number of pieces going simultaneously. It's also more effective or efficient if you are able to invest a number of objects at the same time.

The basic concept of the system is very straightforward. The components to be joined are assembled with wax. Wax is also used to protect the material in any area where you wish to hold the investment back. It is, however, necessary that enough of the metal be exposed to interlock all the components after the wax is removed. The assembly is embedded in investment with the soldered area exposed; after the investment is set the wax is removed by warming and and/or solvents and the soldering proceeds in a conventional manner.

The first illustration, which we will use, is the assembly of a prefinished head and shank which were cast to a specific design. Before going into the details, you should note that this is a relatively large piece and that the process is somewhat unique, in that the welding will occur in two steps.
Number 1. Wax Joining - The principle advantage of this process is the fact that the use of wax allows you to position or move the parts very carefully. In this case, the objective was to join to prepared shank to the head. I usually use a little Kerr utility wax or any other brand of sticky wax for this process. Although a little extra wax can be used to build up or reinforce the joint, you should avoid using too much so that the investment can develop a good grip on the model. In this case, once the parts are accurately aligned or joined, the ring shank is laid on its side in a shallow plastic cup and investment is poured in until the head and shank are locked in place. You will note in the photograph that this buries one joint in the investment but leaves the other exposed.

Number 2. Preparation - I typically let the investment set overnight and then warm it gently to remove the wax. A typical approach is to softly heat the wax joint with a torch and then use a q-tip or cotton swab to remove the excess wax. After the wax has been thoroughly removed, you may wish to preheat the investment block. In this particular case, no preheating was required since the joint was well above the investment; however, if you are going to use a very flat layout where the parts are very close to the surface of the investment some preheating may be beneficial. Typically, I would do this bringing the parts to the temperature of about 350°. At this point I usually paint the part with a boric acid and alcohol solution and flux the joint.
Number 3. Soldering - The first joint is soldered placing the solder snippet on the inside of the ring shank. This location for the solder generally helps minimize cleanup. The insides corner of the juncture will have a slight radius due to the surface tension of the solder. This makes it relatively easy to polish and yet provides a sharp corner. Any surface irregularities will tend to be on the inside of the shank which will require extra finishing in any event. After the solder joint is complete and the parts have cooled, the investment is simply broken away by gentle tapping. At this point I would typically wash the part carefully, scrubbing all the investment away with a tooth brush, and if necessary, pickle the components. At this stage, the objective is to complete the second solder joint without damaging the first one. I would typically coat the ring with a boric acid and alcohol solution and then paint the completed joint with a yellow ochre coating to help prevent melting. In many cases I use the same grade of solder for both sides if I feel that I can control the heat. As the components become smaller and heat control less localized I might use two different grades of solder on the two sides of the ring. This has the disadvantage of sometimes providing different radii in the intersection due to small differences in the viscosity of the molten solder between grades.
MODEL MAKING
FOR
INVESTMENT CASTING

PROGRAM NOTES

Richard D. Austin
Bezels, Stone, Saws & Pougs

I. Oval
   Cab.
   Section Dec.
   \[ \begin{array}{c}
   \text{I} \\
   \text{II} \\
   \text{III}
   \end{array} \]

II. Rectangular
   \[ \begin{array}{c}
   \text{I} \\
   \text{II} \\
   \text{III}
   \end{array} \]

Cut Corner, Begins With a Slot

III.
   \[ \begin{array}{c}
   \text{I} \\
   \text{II} \\
   \text{III}
   \end{array} \]

   A. Good Carving
   B. Wax Flooding
   C. Oval or Rectangular

Shrinkage,
   Cab's Must Fall Out. No Snap Fits. Facetted Need Some Relief or they climb.
FIGURE IN THE ROUND

The figure in the round is a challenge to the artistic and practical skills of the advanced silver and gold worker. The size of full figure representations for the amateur are limited by very practical considerations: the cost of material, the size of casting flasks and the equipment available to melt the required metal. The use of the techniques discussed here are of some historical interest since many very ancient items were cast in the same way. In general, the type of equipment available to the amateur dictates that the figures be rather small. The authors have successfully prepared figures in the range of 30 to 60 millimeters in height, the height being limited by the shape and mass of the figure. It is of some interest that 54 millimeters is one of several "standard" heights for miniature military figures. These figures, which are often rather fine, are typically cast in pewter type alloys. An examination of such figures would yield some insight into the problem of preparing a suitable model.

Although it is not the purpose of this book to teach art, some basic anatomy is helpful in structuring a figure. Figures and illustrate the basic proportions of the human head and body. The human figure may be fatter or thinner in one or all areas, but the proportions of the lengths of the body elements are remarkably uniform. The body may be thought of as fairly constant framework (proportionally) covered by varying amounts of flesh. At this point you should consider a general design for your project. You can work from sketches, photographs, or a simple mental image but you must have some idea of what your final composition will be like. Next, a size should be selected for the figure. This leads us to a selection of the material and casting method. The figure described
here is a solid figure small enough to be cast in a centrifugal casting machine. Before a final selection can be made on the subject matter, a general understanding of the various construction alternates is required. One of the first questions is whether the figure should be hollow or solid. As figures grow larger the simple mechanics of the system suggest that a hollow figure is in order. For example, if we wish to construct a but, the figure is of massive shape with a large flat base. One classic way to cast such a figure was to prepare a clay base slightly smaller in every dimension than the final figure. Wax was then built up over the base to the final dimensions of the desired figure. The various sprues and runners are attached and the prepared model was packed completely in clay. At this point the wax was burned out and metal cast. This technique has been used historically to cast a wide range of items including larger than life size human figures. This basic technique has one weakness. If a figure has little contact area the core can break and shift. This can be corrected by holding the core in place with metal pins of the same material to be used in the actual casting. With this technique the core may be partially or completely enclosed in metal. A number of ancient bronze statues have been found which were cast around fully enclosed cores. In many cases this has lead to deterioration of the work. In general it is recommended that cores be provided with some opening to the outside of the work. In theory the pins which hold the core will fully weld to the cast metal. Unfortunately this welding does not always occur in practice. For this reason it is good practice to locate the pins in an inconspicuous spot. Large smooth open areas are particularly avoided as locations for the pins.
If the object is to be cast in a centrifugal caster the size is restricted by the largest flask which can be accomodated. If the casting can be poured then the restriction is the maximum melt of metal which can be made by casting the desired metal.

In the case of lead or pewter it is relatively easy to make a pour of 10 lbs. or more in the home shop. In general the pewter type alloys are more permanent since lead is prone to the formation of a soft white oxide. However lead is inexpensive and with minimum care decorative objects made from lead will last for many years.

As an aside to our basic project here I would like to suggest that the reader consider a life size casting of a human head. The model for such a casting is easier than might be expected. For a base I would recommend buying a polystyrene foam wig stand in the form of a head. Using this as a base the features can be built up in wax. When the model is complete the core (styrene foam) can be dissolved in acetone to provide a hollow model. This may be invested and poured in lead for a very unusual original piece of work.

The model shown in the illustrations is built up starting with the basic proportions described earlier. This stick figure may be constructed from wax wire but figures made in small sizes from wax can be frustratingly fragile. In practice all or any part of the figure may be constructed from any material which will burn away cleanly. As we have seen earlier both wood and plastic can be used under certain circumstances. The stick figure illustrated was constructed from medical applicator sticks (match sticks are fine) assembled with epoxy adhesive. If you wish to avoid the problems of carving a face you might try guying some plastic toy figures (cowboys and soldiers are popular) in the right scale. Remove the head from the figure and carve away the excess material until you have what looks
like a shaved head. Simply use this head on your stick figure and proceed. In any case the next step is to build up the figure with wax and a spatula or wax pen. The hard blue dental inlay wax is very satisfactory for this buildup. It is easy to carve and polish this material because of its room temperature hardness. Proceed with the buildup as illustrated and cast as we have done previously.
CAST IN PLACE BEZEL

By: Richard D. Austin

When I teach a casting class or hold a seminar, I find that most people learn basic wax carving or fabrication very quickly. However, many people become frustrated when fine detail is required. A good example of this kind of problem is the modeling of a bezel. It's somewhat difficult to hold the thin sections in wax. In this article, I'll present a technique for modeling a bezel in plastic.

You will need some plastic sheet about 1/16" thick. There are two convenient sources for the material. Most clear, ridged plastic boxes are made from styrene. See Figure I. If you don't have an old box in your shop, most variety stores will carry storage boxes which are suitable. Alternately, most building supply stores carry acrylic sheet for glazing applications. This material is usually available in two thicknesses. You want the thinner material, $5.00 - $10.00 worth of plastic should be a lifetime supply for most shops.

This technique can be used for cabochons or faceted stones. The faceted mounting is slightly more complex so I will use it to illustrate the technique. The ring illustrated here is a mens' gypsy ring set with a 14x10mm oval amethyst.
CAST IN PLACE BEZEL

By: Richard D. Austin

(Addition to text 11/3/86)

As we stated in the general introduction to this series of articles, the preparation of cast in place bezels can be somewhat frustrating. However, the use of acrylic or polystyrene plastic makes this process much easier. The following instructions detail the construction of a model for a men's ring with a 16 x 12 millimeter oval faceted amethyst. The steps indicated can be used to prepare a wide range of mountings for faceted or cabochon stones. If you wish to practice this technique, I would suggest that you begin with a larger stone, such as the one illustrated in this article. I have successfully cast bezels for stones as small as three millimeters square. However, this requires some practice and experience. Begin with something easy and develop your skills.

The following directions detail how this model was prepared.

Construction - The following steps can be used to construct a model from styrene or acrylic plastic, depending on which material you have available.
When I teach a casting class or hold a seminar, I find that most people learn basic wax carving or fabrication very quickly. However, many people become frustrated when fine detail is required. A good example of this kind of problem is the modeling of a bezel. It's somewhat difficult to hold the thin sections in wax. In this article, I'll present a technique for modeling a bezel in plastic.

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This technique can be used for cabochons or faceted stones. The faceted mounting is slightly more complex so I will use it to illustrate the technique. The ring illustrated here is a mens' gypsy ring set with a 14x10mm oval amethyst.
1. **Preparation** - If you begin with a plastic box, saw out a flat section from a lid or side. Note that the side sections may taper to provide a draft or release from the mold. If you begin with glazing sheet, you will need to reduce the material to workable sized pieces. The objective is to have sheets which are small enough to maneuver within the throat of your jeweler's saw. 3" to 4" square is about right. Use 400 grit sandpaper to "frost" an area of the sheet about twice the size of the stone.

2. **Seat Preparation** - Place the stone, table down in the frosted area of the sheet and mark around it with a sharp, hard pencil. If the stone tends to slide, a spot of sticky wax can be used to hold the stone in place. Drill a small hole in the middle of the oval and insert a jeweler's saw blade (#2). Saw out an oval section about 1mm inside the marking. File the opening until the stone fits evenly but above the surface of the sheet. Use hand or rotary files to bevel the seat until the stone fits as indicated in the figure. Note that the girdle is slightly above the level of the sheet. You will find that this
will make it easier to close the bezel later.

3. **Bezel Construction** - The bezel is simply a hole in the sheet which neatly fits the stone. The carving proceeds in the same general way as the seat. However, no bevel is needed. You should make it a careful fit but not snap tight. The finished casting will shrink and the metal is unyielding. You may be able to force the stone into the model but not the final casting.

4. **Joining & Finishing** - The next step is to glue the two parts together. The fastest way to do this is with an "instant" adhesive. There is one problem. If the parts are not properly located, you seldom get a chance to reposition. I've found a simple way around this difficulty. I cut the ovals at the ends of strips several inches long. I locate the parts and lock them together with vise grip pliers at the far end of the strips. I use a straight pin or toothpick to wedge the sheets slightly apart. Apply the glue, remove the wedge and press gently. Even instant glues require a few minutes to develop their full strength. Set the parts aside for a few minutes to allow the bond to develop fully. A spray catalyst may speed the process. A wide range of adhesives are usually available at any hobby shop that sells plastic models.
5. **Forming** - Saw the bezel form from the combined sheet, leaving a wall thickness of about 1mm. Use hand or rotary files to cut down the walls to the taper indicated in Figure 3D. I find that the best combination is to begin the cut down with a large tungsten carbide rotary file and finish with a smooth mill file. If you want a better finish, use an emery board or stick with 400 grit paper. No matter how carefully you prepare the parts and align them, there may be some undercutting, as indicated in Figure 4. If this is the case, you may have a thin section in your bezel which will collapse or wrinkle during stone setting. Usually at this stage I flood the inside of the bezel with blue inlay wax, which will adhere very well to the plastic. After the wax is fully cooled, I use a round-tipped spatula to scrape the material away. This provides a slight radius at the base of the bezel and fills any undercuts which may have developed. You will note in the drawing that I've indicated a curve at the top of the bezel. This tends to form a knife edge during finishing. The solution to this is to make the bezel a little deep at this stage and cut it down slightly during the finishing operation in the cast part.

6. **Shank** - The ring carving was cut from Kerr hard carving
wax. The bezel was joined to the shank with a bead of Kerr inlay wax applied to the joint from the inside. A slight opening of the joint from the inside will allow the wax to flow freely. The objective is to minimize the amount of inlay wax on the outside of the joint. The ring was textured with a heated spatula. The presence of inlay wax on the outside will noticeably change the texture.

7. Casting & Finishing - With a 6.7 dwt cast weight, this was a fairly massive ring. Four, 10 gauge sprue wires were attached as indicated in the photograph. Note the heavy but rather long tapered section between the sprue former and the actual sprue wires. I find that this configuration provides a couple of advantages. First of all, it moves the ring as near to the top of the flask as practical. This increases the hydrostatic pressure during the casting process. Second, the relatively long taper tends to encourage segregation and make sure that any flux or contaminants are not carried into the mold cavity during the casting process. The finished casting may be finished by hand or conventional automatic finishing techniques. However, some final hand work on the bezel will be required. Generally speaking, I completely polish the ring form and then cut down the bezel. I work with a fine rubber-bonded wheel on the flux shaft machine and
alternately cut down the wall and the height of the bezel. A couple or three quick cuttings will bring the bezel to the final form, and a very light polishing will bring it to its final finish. The height of the bezel and thickness are a matter of the size and strength of the stone and your personal setting technique.
Most parts of a jewelry model do not have to be made with any great precision but there are two things that need to be right. If it's a ring it must fit and if there are stones to be set they must go in place neatly and securely. The whole issue of getting stones to fit neatly is worth further discussion. Most of the jewelry illustrated up to now has had the prongs or bezel applied by soldering to the final casting. In many cases such as a men's gypsy style ring with a bezel set stone this is as quick and finished as any method. However, you should develop the basic skills needed to cast prongs or a bezel in place.

In teaching my jewelry classes I've always tried to present a full range of jewelry making techniques. I think that specialization should come after a good understanding of general metal-working. My class sequence generally starts with fabrication, followed by chasing and finally casting. This means that the casting student generally has his fabrication skills in good order. I still approve of this sequence but occasionally it worked to my disadvantage as a teacher. When my students were confronted with a wax modeling problem with fine detail they often would say "I'll just solder that on after I've done my casting". In the short run that is actually the best solution but it doesn't develop more advanced modeling skills. Although I will still use soldered parts on my work I try to minimize the amount of fabrication after casting. The most common reason for soldering or fabrication in my own work is to allow pre-polishing of parts which would otherwise be impossible. The ring in Figure ____ is a good example. There is no practical way to put a good polish on the flower after it is assembled.
Even if you are going to solder your bezel or prongs in place you still need a good stone seat.

**Stone Seat** - Preparing a seat in a wax model is always a challenge. This is particularly true in the case of faceted stones, baroques, cameos, or cabochons with domed backs. In commercial jewelry this problem is often solved by sticking to standard, calibrated stones, by reducing the material around the stone to four contact points for prong mounted rings, or by just hiding everything with a bezel. However, it's always best to have a well fitted seat all around the stone. This is dictated by the jewelry design and the mechanics of protecting a stone.

The process for preparing a stone seat is simple and straightforward. The outline of the stone is scribed on an appropriate block of hard carving wax. Using a small rotary file or hand carving tools a rough seat is cut into the block. No special care is used at this stage and a rough cavity is actually better than a smooth one. The carving proceeds till the stone will drop into the depression with it's girdle approximately level with the surface of the block. When this stage is reached, a small hole (approximately 1/8") is drilled completely through the center of the model. The hole through the block is enlarged until it is one or two mm smaller than the stone. Next, the stone is coated with oil or commercial wax release and placed in the depression in the desired location. A small spatula is used to flow melted dental inlay wax to the space between the carving wax and the stone. The wax is applied quite hot. This will produce a low viscosity and carry the wax well into the space between