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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ADHESIVES

In most applications, I'm torn between using instant glue and solvent cement. Generally speaking, the choice is a compromise between neatness and speed. In most cases, solvent cements are easier to control, but they require much longer setting times. To achieve full strength, the solvent must migrate along the joint and evaporate. If the migration path is too long, the solvent stays in place and bonding is weak. If the depth of the joint is small and you can wait a day or two, I would recommend solvent cements. If you are in a hurry, use instant cement.
PLASTIC

INTRODUCTION

The use of natural and synthetic wax for model building places certain constraints on the artist craftsman. These limitations are directly related to the physical properties of the wax materials: low melting point, low physical strength and flexibility. Because of these characteristics, wax lends itself very well to the preparation of soft organic forms.

The substitution of plastics for model building can help minimize these limitations. In this regard, plastics are more suitable for the construction of crisp, well defined architectural forms. This technique bridges the gap between the controlled forms of European style fabricated jewelry and the organic nature of much contemporary casting.

The use of plastics in the model building process provides three specific benefits:

1. **Unique Shapes** - Plastic allows the model building process to construct shapes or forms which would be very difficult and time consuming to construct in wax. This is particularly true when preparing crisp, well defined forms or thin sections.

2. **Speed** - The use of plastics allows the model builder to
execute this design quickly.

3. **Quality** - Better control of dimensional tolerances and section thicknesses can improve the finished casting quality. The finish quality of the model can materially decrease finishing time on the final casting.

It should be remembered that the best solutions to most modeling problems will be achieved by a combination. In many cases, a model might use several different plastics and as many different waxes. Each element of the model should be constructed from the material most suited for that application.
PLASTIC

CONVENTIONAL WISDOM

At the present time, plastics are not widely used for the construction of investment casting models. The limited literature and popular folklore is full of misinformation. Before we consider any details, I would like to dispell several of the most popular misconceptions:

1. **Health Hazards** - The pyrolytic decomposition of some plastics can generate toxic fumes. As a practical matter, the materials most suitable for this application tend to be those which represent the least hazard. With the exception of a few plastics which contain significant amounts of the halogens or nitrogen, the hazard is minimal. Burnout should be conducted in a ventilated fume hood no matter what model building material is used. Given that caution, the hazard appears to be less than that associated with many other art materials.

2. **Difficult Burnout** - Burnout problems are almost nonexistent if the proper materials are used. As a practical matter, most of the popular carving waxes already contain plastics (polyethylene). In my own observation, many cases of difficult burnout relate to the
use of filled plastics. Calcium carbonate filler won't burn out in 100 years.

3. **Mold Damage** - It is sometimes stated that the higher physical strength and melting point of the plastics places undue strain on the surface of the mold during burnout. This strain is alleged to erode the surface of the cavity or to crack the mold and cause fins or webs. There do appear to be cases where the plastic decomposition products chemically attack the investment but, again, proper material selection will eliminate the problem.

Obviously, some commercial practices such as dewaxing the flasks at low temperature are not suitable for plastic molds.
PLASTIC

MATERIALS

Plastics surround us in an almost infinite variety of colors, forms, finishes and compounds. Only a limited number are suitable for jewelry modeling. Although it is not necessary for the jewelry maker to be an expert in plastics, some basic information will help you avoid the most common problems.

There are two basic classes of plastics: thermosetting and thermoplastic plastics. In simplest terms, the thermoplastic materials behave like wax when heated to moderate temperatures. They will soften and melt. On cooling, they reharden with their properties essentially unchanged. Thermosetting materials do not have the same kind of reversible response. Once these materials have reacted and set, they can't be melted. Heat simply destroys them. The decomposition of thermo-setting materials often yields a char or residue which is very heat resistant. The differences in properties can be related to the basic physical structure of the plastic. Thermosetting plastics are cross-linked while thermoplastics are composed of long coiled molecules.
Typical examples of both classes of material include:

**THERMOPLASTIC PLASTICS**
Acetal
Acrylic (methyl methacrylate)
Acrylonitrile-butadiene-styrene (ABS)
Cellulose plastics
Polyamide (nylon)
Polycarbonate
Polyethylene
Polypropylene
Polystyrene
Polyvinylchloride

**THERMOSETTING PLASTICS**
Epoxy
Melamine
Phenolic
Polyester
Urethane

Thermoplastic materials are used in jewelry modeling. In most cases they will burn away cleanly. Conversely, the thermosetting materials seldom burn well.
If you are accustomed to conventional wax fabrication, it is important to open your mind to the array of alternates that plastic modeling offers. Before considering specific applications, it will be helpful to review the materials and forms available.

The processing of plastic materials yields complex mixtures of compounds. They vary with regard to molecular weight, cross linking, molecular size and so on. Variations in processing yield a range of properties within any given generic class. A generic class of polymeric material may be available under a wide range of trade names. For example, Acrylite, Lucite and Plexiglas are all registered trade names for acrylic plastic. Although all three materials are acrylics, their properties will vary between manufacturers. Even with a single manufacturer and trade name, there may be a number of different grades of material with different properties. Because of these variations, it is perfectly possible that any one of you can find an exception to any descriptive statement I make about plastic materials. The lesson: always run test samples.
Three thermoplastic materials work especially well in the model building process:

Acrylic
Polyethylene
Polystyrene

Because of their unique properties, each material is particularly suitable for some part of the model building process. Because they are widely available and inexpensive, they are very convenient for the metalsmith. The properties of the individual materials determine their application.

Acrylic plastics are characterized by transparency combined with excellent resistance to ultraviolet light. They are reasonably strong and have moderate impact strength. Because of these properties, they find wide application in glazing. Acrylics machine and polish well, and solvent bonding is satisfactory if the appropriate solvents are used. Of all the plastics you might wish to consider using for model building, acrylics are the most widely available in a variety of physical forms. They are also the most forgiving to process. Acrylic glazing is carried by most hardware or home supply stores in thicknesses of 0.075 to 0.095 inch. Sheet size varies, but the typical cost is about $1.00 per square foot. Since the sheets are too big to store or to work with jewelry tools, I generally cut the sheets down to a more manageable
size which can be cut with a jewelry saw. Plastics
distributors carry a wide range of thickness of acrylic, and
you can often buy the material as scrap or in one-square-foot
sheets.

Polyethylene is extremely tough and flexible, which makes it:
an ideal choice for many types of bottles and containers.
These same properties make it very difficult to machine by
conventional means. Polyethylene is almost impervious to all
the common solvents, so solvent bonding is not practical.
Polyethylene is also an excellent release agent, which makes
it difficult to glue. The commonest commercial forms of
polyethylene are bottles and plastic bags. Polyethylene is
also used in laboratory wear, where a number of interesting
forms are available. Machineability is dramatically improved
by the addition of natural or synthetic waxes. Low molecular
weight polyethylene is a major constituent in most commercial
hard carving jewelry waxes.

Polyethylene is especially suitable for prongs and as a base
for wax build-up. I have settled on using polyethylene milk
bottles for most applications. If you measure the material,
you'll find that the thickness varies because of the way the
bottles are manufactured. You'll end up with a variety of
thicknesses which can be used in different applications. For
thicker sheet, plastic can lids will provide stock. Laboratory ware and bottles are also a good source of material.

Polystyrene has the same kind of transparency associated with acrylic, but it has much lower resistance to ultraviolet light and weather. Polystyrene is a rigid material, but it is appreciably more brittle than acrylic. This characteristic combined with a low heat distortion point means that polystyrene is difficult to machine. It tends to gum the tools and also to crack easily. However, it is very easy to injection mold. These properties and its low cost make it an excellent material for rigid packaging and various novelties.

Polystyrene is attacked by a wide range of organic solvents, so solvent bonding is excellent. The same general characteristics mean that it's easy to glue with many of the solvent-based cements. Rigid packaging is probably the most common application where you would see polystyrene in day-to-day use. In addition, small beverage glasses, toys and model kits are commonly made from polystyrene.

Occasionally, you can purchase polystyrene sheet or rod from a plastic supply house or hobby distributor. However, packaging materials are a convenient source. If it is inexpensive,
clear and rigid, it is probably polystyrene. Figure 96 illustrates a number of polystyrene packages. In a typical box, the plastic is roughly 1/16 inch thick and useful for a wide range of modeling applications.

You will note that all of the materials that we have talked about thus far are either clear or translucent. Many plastic objects are opaque or brightly colored. Plastics are often modified by the addition of dye, pigment, fillers or reinforcing agents. These may range from dyes that will burn away cleanly to glass fibers which will never burn out. If you want to try materials that are obviously pigmented or reinforced, begin by doing a burnout test.
PLASTIC LAMINATION

One of the more vexing problems in constructing casting models is to insure that wall thicknesses are uniform and that the cross section is appropriate. There are two factors which make this an important issue. First, casting quality will be dramatically improved if you can avoid thick sections or sudden changes in cross section. Second, if you are working in gold, the use of thin, hollow sections can considerably decrease the cost of materials. Other considerations may also be involved. The techniques which we will be discussing speed up the process and in most cases improve the appearance of the interior of your work.

Two completely separate techniques will be presented which may be used in different situations. The first will be a plastic lamination technique which is best suited for structured architectural forms. Second, we will discuss a method which can be used to structure hollow shells into organic forms incorporating compound curves.

This first example will be constructed from a combination of plastics. The model illustrated here was constructed from a thick sheet of commercial acrylic plastic and some thin
polystyrene salvaged from a small plastic box. Acrylic sheet can be purchased from a number of suppliers, but the simplest way may be to go to a hardware store and purchase a small piece of the acrylic used for glazing. Alternately, you can go to a plastics distributor and ask to purchase some scrap. Most plastics companies end up with a large supply of acrylic scrap in various thicknesses. They often sell this material by the pound at very modest prices. Note that you do not need to feel constrained by the thicknesses available; you can always laminate the plastic into thicker or thinner pieces to build the core of the model. Thus, you have a great deal of flexibility. The model can be constructed completely from polystyrene by laminating enough sheets together to achieve the desired thickness. In this case, all you have to do is salvage some small plastic boxes from around the house or go to a discount store and pick up a box or two. The photos indicate some typical kinds of plastic products which you can use.

There are a wide range of adhesives available which are suitable for this kind of work. However, for this project my favorite candidate would be the krazy glue or instant glue which you can purchase in almost any variety store or hardware store. This allows the fastest assembly. Alternately, you may wish to use solvent cements, although these tend to dry
very slowly in large, thick sheets. Although they are not my favorites, epoxies can also be used for this application as long as they are applied sparingly.
PLASTIC BEZELS

In my own work, I find there is kind of a trade-off between the time spend in buffing or polishing the model and the time you spend finishing the casting. In areas that are large, smooth and open, it seems to be quicker to spend most of your time polishing the metal than to lavish a great deal of attention on the model. No matter how carefully the model is prepared, the finishing of the metal will be almost the same. In cases where it's more difficult to polish the model, such as textures or recesses, considerably more care is appropriate in the model building process.

As we stated previously, the plastic can be polished to a high gloss. However, there is another technique which provides fairly good results with a little less work. This is simply to lacquer the model after it's been sanded. Most hobby shops sell various types of spray lacquer which are specifically formulated to be applied to plastic models. Since the models are styrene, the paints are specifically formulated to not attack the plastic. It should be noted that many of the craft sprays and conventional lacquers will attack the plastic. In any event, if you can locate a plastic-compatible spray, this can be used on the parts to enhance their gloss. It is
important, however, to note that any spraying needs to be done before wax parts are used for touch-up or to develop any radii since the lacquer will tend to break up in areas which have been touched by plastic. Also note that any contamination from silicone, molds, mold releases or sprays will also render this technique useless.

The principle shortcomings of wax modeling relate directly to the inherent nature of the materials. Basically, there are two problems. First, it's difficult to hold close dimensional tolerances working in wax. The material is flexible and often softens with handling. Even when reasonable dimensional standards can be established at one point, the material may stretch or bend during subsequent work. Second, the material has relatively little structural strength. This means that certain kinds of thin sections are difficult to achieve. If you are producing traditional organic forms which are common to wax modeling, this presents relatively little problem. However, if you wish to produce precise crisp forms with thin cross sections, the problem becomes much more serious. Since most fine jewelry would utilize these crisp forms and thin sections (because of gold economics), it's important to find ways to use plastic materials to circumvent these inherent problems.
Although it's practical to make models completely out of plastic, this may require special materials, skills and processes. A hybrid model combining plastic and wax is much simpler and more practical. Since the thin sections and precise tolerances usually relate to stone seating, this is probably the best area for plastics application. Additionally, plastics can be added to some models to achieve thin cross sections or deeply recessed areas. The best way to treat these is to examine some processes individually below:

**Bezels** - A cast bezel requires both good dimensional control and thin cross sections. This makes it an excellent candidate for modeling of plastic. The following material will outline one way of constructing a plastic bezel which can be cast separately or added to a wax model as required. Commercial acrylic sheet is probably the best material for this application since it is available in a wide range of thicknesses. Ultimately the thickness will correspond approximately to the bezel height. Begin by selecting an acrylic sheet of a thickness equivalent to the bezel height which you wish to achieve. You may wish to use a slightly thicker sheet and cut down the bezel after the model is formed. Also, many cabochons are not uniformly beveled, and you may wish to change the bezel height at different locations or curves. The first step is simply to cut a hole in the
acrylic sheet which corresponds to the inside of the bezel. In most cases, begin by selecting an engineer's templet which most closely corresponds to the shape desired. Normally, you can find an oval quite close to the one you need. If the oval of your stone is truly unusual or the shape is other than oval, it may be necessary to mark the plastic in some other way. In any event, the basic shape is scribed on the plastic. This can be done with a stylus or a hard, sharp pencil. Typically, I sand the plastic surface with 400 grit sandpaper and mark the bezel with a hard drafting pencil. You can keep the mark from rubbing off during handling by placing a piece of clear adhesive tape over the marks. Next, drill the hole through the plastic, inserting number two jeweler's saw, and saw out the basic form. This should generally be kept about one-half millimeter smaller than the size of the stone. At this point, some irregularity is tolerable. The next step is to use various rotary files to enlarge the hole to provide a good pit fit for the stone. I normally use a series of tungsten carbide rotary files for this operation. I work with care, insuring that the sides of the opening are as square as possible. Avoid unnecessary development of a radius. As you approach the final size for the opening, you can hold the stone over the hole and look into a bright light. This will disclose any contact points which should be relieved. As the final size is approached, I often use number four jeweler's
files and/or 200 grit sandpaper for the final fitting.

Remember that a snap in place fit is not satisfactory. The plastic will yield somewhat more than the ultimate metal, so even though you can snap the stone into the plastic, it will fit tightly in the metal. There should be a free fit which will not bind the stone in any point.

The next step is to remove the basic bezel form from the sheet. Saw around the opening, leaving a wall thickness of roughly two millimeters. The outside of this cut can be relatively crude. The next step is to glue this oval form to a sheet of acrylic or polystyrene plastic. This will form the seat of the bezel. The material used for the seat can be in the range of one-half to one millimeter in thickness. The oval may be glued in place with instant cement or solvent cement. The next step is to saw the base sheet to match the outer side of the bezel. When the glue is fully dried, tungsten carbide tools are used to work the bezel wall thickness down to an appropriate dimension. This should be done with a very slight taper, leaving the top of the bezel slightly thinner than the bottom. Because of the natural radius of the plastic, you may find that the cross section which is developing at this point will be similar to that indicated in Figure 6. This can be corrected by flowing a
bead of blue dental inlay wax into the depressed area next to the stone seat. After the wax is hardened, a small spatula can be used to form a radius. Normally, this radius will not interfere with a properly beveled cabochon. When the bezel wall section is properly developed, the inside of the seat can be removed, leaving a narrow shelf to accommodate the stone. The reason for leaving this operation until last is to provide structural strength during the process of cutting down the bezel wall. At this point, you may wish to make the seat a little thinner by lapping on 220 grit wet or dry sandpaper. The height of the bezel wall may also be cut down at this point. If you're inexperienced in this technique, it may be best to begin with a bezel which is too deep since they tend to develop a knife-edge section until you have any good level of skill. This doesn't cause a problem if you have enough material to allow you to cut down the bezel at the end of the process.
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PLASTIC PRONGS
By: Richard D. Austin

In this series of articles, we will be discussing the application of plastics in the model-building process for lost wax casting. We will present a series of projects using the materials in different ways. Generally, the approach will be to present more and more complicated techniques so that you can begin with the simplest applications and end with the use of complete plastic models. In this first article, we will discuss the use of plastics for constructing prongs to be applied to conventional models. I'm certain that any of you who have made lost wax masters for prong set stones have at one time or another experienced a certain amount of frustration in applying the prongs. I hope that this specific technique will make this operation easier for you. In addition to the application of plastic prongs, we will mention some other techniques which may help you in the preparation of wax models. First of all, let's begin by discussing some of the materials which you might want to use.

Materials - Depending on the size of the model and the general appearance which I'm trying to achieve, I use one of about three materials for preparing the prongs. Let's consider each of these before beginning the article. If you go to the
grocery store and look at plastic milk bottles, you will note that there are two kinds. One of these is an opaque white and the other is a translucent material. This translucent material is an unfulled polyethylene. This material is very similar to the waxes used to blend most hard carving waxes. It burns out and it's a very suitable form for preparing prongs. The next time you finish a gallon of milk, rinse the carton out and cut away all of the more or less flat areas. If you measure the thickness of the plastic which you have removed, you will find that it varies widely. This is due to the particular molding process, but it's also very useful for you. You can have a range of material thicknesses for different scales of operation. The second choice for prongs would be clear plastic packaging material such as styrene. Suitable material can be cut from most rigid jewelry boxes or plastic packaging materials such as those shown on the photograph. Finally, a third source of material is very handy. If you purchase a plastic Rubber Maid scrub brush such as the one shown in the photograph, you will discover that the bristles are actually triangular sections of plastic which taper from the base to the end. These seem to burn out rather well and provide a wide range of material for prong preparation.

Application - The polyethylene sheet is excellent for
constructing wide, flat prongs like those shown on the small brooch in Photograph 3. The triangular forms are excellent for longer prongs where a certain amount of bulk is required. The hard plastic can be used to construct even more massive prongs for very large mountings. Unless the prongs in the finished casting are completely inaccessible, I generally make them a little long and plan on cutting them down just before setting the stone. Also, my general experience with the casting process suggests that a slight taper to the prongs usually makes them somewhat more substantial and less prone to various kinds of crystallization or casting porosity which might cause the prongs to break. In this regard, the polyethylene can be used as a base to build up prong sections.

Generally speaking, I find the polyethylene milk bottle stock to be the most versatile of the materials, so let's consider making a model using this material for prongs.

**Construction - Number 1.** The cut-corner stone used was selected because it also provides an opportunity to illustrate another useful technique in model building. The first stage was simply to construct a conventional wax model without prongs. **Number 1 stone seat** - Begin with a block of hard carving wax slightly thicker than the distance between the girdle and the culet of the stone. Drill a hole through the
wax block and begin to carve a stone seat with a small shop knife, engraving tools or whatever process you would normally use. However, in this case, the model can be quite crude. Both the taper and the fit can be loose as long as the stone is supported with the girdle slightly above the surface of the block. Also, you need not make any accommodation for the corners in the model. When the block is fully prepared, the stone should be coated with the release material. The best material I've found is silicone grease, which is available as silicone stop track grease (?) from most laboratory supply houses. A very thin coating of this material provides an excellent release agent. Note that good shop practices demand that this material be kept fairly well contained. If you contaminate surfaces which are to be enameled or glued at some later time, this can cause a real problem. In any event, add a very small amount of the grease to the surface of the stone, wipe it down with a paper towel and set it in place in the block. Next, use a heated spatula to apply Kerr inlay wax to the gap around the stone. The wax should be applied extremely hot so that the viscosity will be low and it will flow into all of the crevices. When the top is completed flooded, turn over the wax and flood the joint from the back. Next, cut away the excess wax from the top and pop the stone free. If the stone is not unduly sensitive to heat, please it in a refrigerator or freezer and this will usually cause the stone
to simply pop out. If not, it may be gently pushed out. If all has proceeded properly, you should have an almost perfect case of the back of the stone in the wax. If there are any small flaws, these can be touched up. You will notice that the wax has flowed into the area where the corners of the stone were cut away. The final step is to carve down both the inside and the outside of the model until a suitable head has been formed.
PLASTIC FRAMES

The use of the corners from plastic boxes or other components such as plastic model railroad parts allows you to build rectangular frames very quickly and very accurately. Because two corners are well established at right angles, the process is much easier and faster than working with four loose pieces of material. Basically, what you need to do is prepare two L-shaped segments with legs of the proper length. This can be done by filing the edges to the proper length at the same time. This procedure is illustrated in Figure 54.
PLASTICS/DRILLING

The stress of drilling the more brittle plastics tends to form a star crack pattern on the exit side of the hole; several things can be done to prevent this. There are special fluted plastic drills available which have a long narrow point such as we see illustrated in this slide. The second solution is to regrind convention twist drills to a more pointed configuration. The third alternative is to simply drill slowly and be particularly careful as the drill emerges from the backside of the hole. Several other things will help prevent cracking. The problem is most severe in thin plastic sheet. These should be supported from the back against a smooth scrap of wood. This keeps the material from deflecting as the drill exits. Working freehand, it is a little difficult to drill slowly and smoothly so if you have access to a drill press, you should use it whenever possible.

The drill press is also useful for another function. No matter how carefully you work freehand with rotary files, the surface tends to have a crown or radius across the section of the plastic. This can be minimized by using the straight sided tool in a drill press. Fundamentally you use the drill press like a router. Although it is a little unhandy, you can lock the head down and simply move the material on the table. This not only eliminates the
radiusing, but ensures that the hole is perpendicular to the sheet.

The drill press is also particularly useful for the preparation of ring shanks for limited production work. The next slide illustrates what is known as a multi-drill. These are essentially a tapered reamer designed to work in a drill chuck. The resources list shows two places where these can be purchased. Basically, you can use these drills to blank out ring shanks from plastic sheet. Begin by scribing a 5/8" diameter circle on a sheet of plastic. The material shown here is approximately 1/8" thick. This can be done with a 1" jewelers file. The circle can be cut quite crudely and should remain just inside the scribed line. The material is then placed in the drill press and the multi drill is entered from both sides to bring the blank to a round shape and a proper size. You will note that doing this will provide a slightly radiused interior. This is actually quite comfortable for a ring shank and this is the approach which I presently use. The drill press can be used to do these in multiples quite quickly. If you set the stop on the drill press and penetrate the sheet from both sides, it will be absolutely symmetrical. I normally cut out strips of plastic about 1" wide and pierce them with six or eight holes per strip. The length is determined by the depth of the jewelers saw. Then I set the stop for a standard ring size and blank the whole strip. A half an
hour spent doing this will prepare a large supply of blanks in incremental sizes for your orders.

If you're going to do a very large number of ring snanks, I would suggest that you regrind the drills to sizes corresponding to specific ring sizes. This will be somewhat more expensive since you will have to dedicate a drill to each size, but it makes the blanking even quicker since it is not necessary to adjust the drill press.
BEZELS

Because of their superior physical properties acrylic or polycarbonate plastics are preferred for the preparation of bezels. Acrylics have the advantage of being readily available in a wide range of sheet thicknesses. Polycarbonate is more difficult to purchase, but it is an extremely tough material. This toughness helps prevent breakage during the carving of delicate thin sections. Start with a sheet of plastic slightly thicker than the finished height of the bezel. One eight inch sheet would be typical for smaller stones and 3/16 is usually adequate for larger pieces. Carving proceeds in the following steps:

1 Marking - I usually mark the plastic with a number 3 pencil. First, sand one surface of the plastic lightly with number 400 sand paper. After sanding you can draw on the plastic with a hard pencil. If you make an error, sand it away and begin again. You can draw around the stone to mark the sheet. If the stone is large or unusually shaped this is the best approach. If it tends to slide while you're trying to mark the sheet a little sticky wax on the back of the stone will help hold it in place. For small ovals it may be difficult to hold the stone steady. I keep an assortment of small oval graphing templets in my shop. I select the oval that best fits the stone and use that to mark the sheet. After the sheet is marketed place a piece of transparent tape over the pencil
marks to keep them from rubbing off.

2 Drill and Saw - Drill a small inside the bezel shape to accommodate a jewelers saw. Saw out the form staying slightly inside the marketed line. A number 2/0 jewelers saw blade is a good size for this application. Saw much more slowly than you would in metal to keep from melting the plastic and binding the blade. It helps to use a brand new blade and some form of lubricant.

3 Inside Carving - The next step is to carve out the inside to match the stone. I generally begin with the straight sided rotary file in the flexible shaft machine, and finish with a number 2 cut jewelers file. There are 2 key objectives. The first is to carve straight, vertical sides in the opening. The second is to provide a good fit for the stone. Do not create a "snap fit". The final metal will not be as flexible as the plastic and there will be a slight shrinkage during casting. The stone should fall free from the opening in the plastic.

4 Outside Carving - After the inside is complete saw around the outside of the opening leaving a wall thickness of about 1/16" or a little less. Work slowly so that you don't crack the plastic and keep the wall thicknesses uniform as you can to minimize filing. After the blank is sawed out use a smooth mill file to work the part to the desired thickness. The same judgment factors apply in this application that are used in fabrication. A thicker bezel is needed in silver,
for large stones, or when the stone has almost vertical sides. If the stone is small, thin, or the work is in hard or metal, then thinner section is preferred. At this point, you should file and sand the bezel down to the desired height. The reason for starting with a thicker sheet should become apparent at this point. No matter how carefully you've been working, the bezel edges will be rough. Removing a little material will result in a crisp more usable form. This sequence is illustrated in Figure number 1.

5 Base - Stones may or may not be a part of the ornamental form. Let's consider a simple bezel. At this point, you may wish to use styrene rather than acrylic plastic. However, either material is satisfactory, but styrene may be more widely available in thin sheets. Start with a piece of plastic about 1/16" thick or a little less. Sand one side lightly with number 400 sandpaper and glue the bezel in place on the sheet with instant glue.

6 Finishing - When the glue has set, drill a hole in the area to be removed inside the bezel. Use a number 2/0 jeweler saw to trim the inside leaving roughly a 1/16" shelf. File the inside to a uniform width to support the stone. Finally, saw just outside the bezel and use the smooth mill file to develop the final form. The carving steps in Figure 2, illustrate the way the final form should develop. Notice that a slight taper in the bezel section is developed at this point.
This would usually provide a little better casting quality and improve the likelihood of good fill. Also, if the bezel is placed on a large flat area it makes it a little easier to get at it in the final polishing steps.

7 Polishing - Depending on the application and the other aspects of the model you may or may not wish to actually polish the bezel at this point. If you are going to polish it it's probably best to work in acrylic plastic. The acrylic can readily be polished if it is first sanded with 400 water-dry sandpaper, followed by a sanding with 600 paper and a buffing on a soft, unstitched wheel using ZAM or one of the commercial plastic polishing compounds. You may have difficulty with the reveal of the scene between the two pieces of plastic. This can be minimized by using acrylic for both parts. However, if a very high finish is required the best bet is to use a bezel fabricated from a slightly thicker sheet of plastic, and place the step inside so that any seam of is on the bottom rather than the side of the form. This takes a little more time to fit the second piece of plastic inside the bezel. But if a very finish and a very high original casting quality is required this may be the better procedure. This alternate is illustrated in the cross-section in Figure 3.
Polyethylene represents a general class of plastic polymers. As is the case with many other polymers it is available as a solid or foam type material. Many transluscent or opaque white plastic bottles are made of this material. It is characterized by being a relatively soft and flexible. This is in contrast to materials such as polystyrene which is a much more rigid. Like polystyrene, polyethylene can be prepared as a foam as well as a solid material. In the case of Polyethylene foam, it's flexible nature makes it quite commonly used as a packaging material. You will typically encounter it either as thin sheets of foam which are characterized as being soft and flexible like fabric, or as very long thin noodles of extruded foam. Either of these materials can be used as the basis for some interesting free form jewelry masters.

Basically the technique is the application of heat to cause the foam to shrivel and twist and then the selection of suitable parts of the pattern for reinforcement with wax in casting. There is relatively little information available or literature on how to best deal with polyethylene in the casting process. However, the literature does suggest as my experience also indicates that the material is a little bit hard to burn out. Generally you will need to go to the top of the burn out range (1200-1300 degrees F.) and use a little bit longer period of time to get a clean burnout. In many cases, this approach will lend itself to forms which are essentially large crinkled sheets. As I mentioned elsewhere, the casting of these type of forms requires good spruing since the flow of metal tends to chill rather rapidly and you may often encounter fill problems in this type of work.
Obtaining the correct plastic materials for jewelry modeling application can be a problem. Acrylic plastics are probably the easiest to obtain in commercial quantities. Acrylic sheet is widely used as a substitute for glass in various glazing applications. This means that acrylic sheet in the range of 1/16" to 1/4" is widely available through hardware stores and mass merchants. Generally speaking, it is available in sheets which are quite large relative to the requirements for jewelry. One trip to the hardware store and about $50 will probably provide a lifetime supply of sheet for most small shops. Laboratory supply houses and plastics specialty houses also carry polyethylene sheet and polycarbonate sheet. Polycarbonate is also used in glazing applications, while the polyethylene finds many other industrial uses where chemical and moisture resistance is valuable.
PLASTIC MODELING

FLAT OBJECTS

Thin flat forms such as monograms are an ideal application for plastic modeling. Small letters are very difficult to cut even working with hard wax. Thin acrylic or styrene sheet is an almost ideal material for modeling these forms. A simple example can be used to demonstrate two convenient techniques. For commercial work I often simply use standard fonts rub on or transfer type to layout monograms. An appropriate type font is selected in the size desired for the final letters. The plastic sheet is roughened with 400 grit sandpaper and the letters are rubbed on in place. The next step is to simply cut them out with a #2/0, 3/0 or 4/0 jewelers saw blade. You may have some trouble with the letters rubbing off during cutting. This can be prevented by putting scotch tape over the letter before cutting. Scotch tape is also useful in protecting penciled on outlines. It is also worth noting that the plastic cuts a little more smoothly and there is less burring if you cut through plastic tape. The plastic tape can be put on both sides of the sheet for the best quality. The sequence that the letters are cut in can be used to make the job a little easier. If you are doing a series of letters all in one size try to lay them out in a row as though they were being prepared for typography. However, you should leave a little extra space between them.
The strip of letters can be cut on both sides trued up parallel with a file. This gives a nice, uniform, overall height. Beginning at one end of the strip cut the letters out. This means you always have a good piece to hold on to while you are working.
PLASTICS FOR CASTING MODELS

Before starting the presentation I would like to position the discussion. My education and work experience has been technical, and commercially oriented. I have specialized on model making and casting technology, not on jewelry design. The examples of finished jewelry which I will use to illustrate the various points in my presentation are simple exercises constructed to illustrate specific techniques.

The use of natural and synthetic wax for model building places certain constraints on the artist craftsman. The substitution of plastics for model building can help minimize these limitations.

The use of plastics in the model building process can provide three principal benefits:

1. **Unique Shapes** - Plastics allows the model builder to construct shapes or forms which would be very difficult and time consuming to construct in wax. This is particularly true when preparing crisp, well defined forms, or thin sections for casting in gold.

2. **Speed** - The use of plastics allows the model builder to execute this design quickly.

3. **Quality** - Better control of dimensional tolerances and

Number 1
section thicknesses can improve the finished casting quality. The finish quality of the model can materially decrease finishing time on the final casting.

This technique bridges the gap between the controlled styles of European style fabricated jewelry and the organic nature of much contemporary casting.

Although I've been using plastics in model making for a number of years, I didn't realize the complexity of this topic until I began to prepare this presentation. A great deal of work remains to be done. I would like you to consider this as an intermediate report on the subject. I began this project enthusiastically. I am even more impressed by the possibilities now that I've had time to study the problem.
PROGRAM OUTLINE

The presentation outline will discuss:

I. Conventional Wisdom
II. Plastics Materials
III. Forms and Sources
IV. Adhesives and Bonding Agents
V. Fabrication
VI. Examples

In the course of this presentation, I'm going to reference specific materials. The sources for these will be listed in a handout available after this program. By giving you these notes, I hope that I can proceed more rapidly with the presentation. There will be time for questions and I will be available to discuss any details during the next couple of days.
CONVENTIONAL WISDOM

The use of plastics in the model making process is poorly understood. The limited literature, and the popular folklore is full of misinformation. Before we consider any details, I would like to dispell two of the most popular misconceptions:

1. **Difficult Burnout** - Burnout problems are almost non-existent if the proper materials are used. As a practical matter, some carving waxes already contain plastics. There do appear to be cases where the plastic decomposition products chemically attack the investment, but again, proper material selection will eliminate the problem.

2. **Health Hazards** - The pyrolytic decomposition of some plastics can generate toxic fumes. However, with the exception of a few plastics which contain significant amounts of the halogens or nitrogen, the hazard is minimal. As a practical matter, the materials most suitable for this application tend to be those which represent the least hazard. Burnout should be conducted in a ventilated fume hood no matter what model building material is used. Given that caution, the hazard appears to be less than that associated with many other art materials.

Number 4
PLASTICS MATERIALS

There are two basic classes of plastics: thermosetting and thermoplastic plastics. In simplest terms the thermoplastic materials behave like wax when heated to moderate temperatures. They will first soften and finally melt. On cooling they reharden with their properties essentially unchanged. Thermosetting materials do not have the same kind of reversible response. Once these materials have reacted and set, they can't be melted. Heat simply destroys them. The decomposition of thermo-setting materials sometimes yields a char or residue which is very heat-resistant.

The differences in properties can be related to the basic physical structure of the plastic. Thermosetting plastics are cross-linked while thermoplastics are composed of very long coiled molecules.

Typical examples of both classes of material include:

THERMOPLASTIC PLASTICS

Acetal
Acrylic (methyl methacrylate)
Acrylonitrile-butadiene-styrene (ABS)
Cellulose plastics
Polyamide (nylon)
Polycarbonate
Polyethylene
Polyp propane
Polystyrene
Polyvinyl chloride

THERMOSETTING PLASTICS

Number 5
Epoxy
Melamine
Phenolic
Polyester
Urethane

Thermoplastic materials are used in jewelry modeling. In most cases they will burn away cleanly. Conversely, the thermosetting materials seldom burn well.

**MATERIALS, FORMS AND SOURCES**

If you are accustomed to working with conventional wax fabrication it is important to open your mind to the array of alternates that plastic modeling offers. Before we look at specific applications it will be helpful to review the materials and forms available.

Any generic class of polymeric material may be available in a wide range of trade names. For example, Acrilite, Lucite and Plexiglas are all registered trade names for acrylic plastic. The processing of plastic materials yields complex mixtures of compounds. They vary with regard to molecular weight, cross linking, molecular size and so on. Variations in processing yield a range of properties within any given generic class. Solvent resistance is often a variable. Because of these variations, it is perfectly possible that any one of you could find an exception to any descriptive statement I make about plastic materials. The lesson: always run test samples.

Number 6
Three thermoplastic materials work especially well in the model building process:

Acrylic
Polyethylene
Polystyrene

Acrylic plastics are characterized by transparency combined with excellent resistance to ultraviolet light. They are reasonably strong and have moderate impact strength. Acrylics machine and polish very well and solvent bonding works well if the appropriate solvents are used. However, solvent bonding proceeds more slowly with acrylics than with polystyrene. Acrylics are easy to glue and their properties make them suitable for a number of applications. Of all the plastics you might wish to consider using for model building, acrylics are the most widely available in a variety of physical forms. They are also the most forgiving to process.

Acrylic glazing is carried by most hardware and home supply stores in thicknesses of 0.075 to 0.095 inch. Sheet size varies, but you can pick up eight to ten square feet of material for a few dollars. Since the sheets are too big to work with jewelry tools, I suggest you purchase a cutter. Use it to scribe a line in the plastic and break it like glass. If you can't find a cutter, scribe the plastic with an awl and break it on the score. I generally cut the sheets down to a size which is easy to store (perhaps 4 x 6" sizes) and which can be cut with a jewelry saw. Plastics
and it is appreciably more brittle than acrylic. This characteristic combined with a low heat distortion point means that polystyrene is difficult to machine. It tends to gum the tools and also to crack easily. However, it is very easy to injection mold. These properties and its low cost make it an excellent material for packaging and various novelties.

Polystyrene is attacked by a wide range of organic solvents, so solvent bonding is excellent. The same general characteristics mean that it's easy to glue with many of the solvent-based cements. Rigid packaging is probably the most common application where you would see polystyrene in day-to-day use. In addition, small beverage glasses, toys and model kits are commonly made from polystyrene.

Occasionally, you can purchase polystyrene sheet or rod from a plastic supply house or hobby distributor. However, I usually use packaging materials. If it is inexpensive, clear and rigid, it is probably polystyrene. In a typical box, the plastic is roughly 1/16 inch thick and useful for a wide range of modeling applications.

You will note that all of the materials that we have talked about thus far are either clear or translucent. Many plastic objects are opaque or brightly colored. Plastics are often modified with additions of dye, pigment, fillers or reinforcing agents. These may range from dyes that will
distributors carry a wide range of thickness of acrylic and you can often buy the material in one square foot sheets.

Polyethylene in its unpigmented state is translucent rather than transparent. It is extremely tough and flexible. These same properties make it very difficult to machine by conventional means. Polyethylene is almost impervious to all the common solvents, so solvent bonding is not practical. Polyethylene is also an excellent release agent, which makes it difficult to glue. The commonest commercial forms of polyethylene are bottles and plastic bags. Polyethylene is also used in laboratory wear, where a number of interesting forms are available.

The most consistent use I've had for polyethylene is to make prongs for models. I have settled on using polyethylene milk bottles for this material. If you measure the material, you'll find that the thickness varies because of the way the bottles are manufactured. You'll end up with a variety of thicknesses which can be used in different applications. For thicker sheet, plastic lids will provide stock. Laboratory ware and bottles are also a good source. Later, I'll show you some "ready made" polyethylene prongs that I located recently.

Polystyrene has the same kind of transparency associated with acrylic, but it has much lower resistance to ultraviolet and weather. Polystyrene is a rigid material.
burn away cleanly to glass fibers which will never burn out. If you want to try materials that are obviously pigmented or reinforced, begin by doing a burnout test.

FORMS

In addition to being available in a wide range of sheet sizes and thicknesses and a more limited variety of tubes and rods, plastic is also available in a number of "special forms" that have potential applications in model making. Although none of these forms would be impossible to structure by conventional means, the presence of a pre-finished shape may save time.

Spheres - Plastic spheres are manufactured for a number of applications ranging from fluid metering to toys. Materials include acrylic, nylon, polypropylene and polystyrene. Spheres are manufactured in diameters from approximately 2 millimeters to an inch or more in diameter. These spheres are useful for a number of modeling applications. Plastic spheres are also available in a surprising number of consumer products. The ball and cup type hinges seen on many plastic boxes each contain small spheres. Even hair care products such as this hairbrush may contain spherical forms.

Screw Closures - One task which practically defeats many beginning silver students is the exercise of making a screw

Number 10
closure. There are a variety of closures available ranging in size from minute to larger than any of your casting machines will accommodate. Many or these can be incorporated in structures to create screw closures. It should also be noted that they can be used for various kinds of cold assembly. This will allow you to accommodate more complex systems of mixed media since the method of joining does not tarnish or burn the base metal. I have had the best success casting the threaded parts separately and then fabricating them into large objects. Low profile threads usually make the thinnest sections and the best quality castings.

Close Tolerance Fits - A wide range of plastics products are designed with snap fits. These parts can be used for various decorative or functional purposes. One of the most useful is to provide a method of joining or aligning parts.

Filaments - Plastic filaments are precisely analogous to wax wires in the model building process, but they are more rigid and able to withstand handling. They can be cut to precise dimensions and joined by adhesive or solvent bonding processes. The easiest plastic filaments to obtain are made of nylon. Nylon fishing line is available in tensile strengths up to about 300 pounds. A 300 pound test nylon fishing line is about 14 gauge.

Styrene is available in rigid, straight lengths. It is easy
to bond by solvent bonding. The illustration shows a ladder form which I've developed to test the burn out and filling characteristic of the wires. This gives you a good idea of what you can expect during the casting process. You will notice that the longer wires do have the benefit of more pressure during the centrifugal casting process. If you are centrifugal casting wire forms, it is a good idea to sprue your models in such a way that any fine detail is at the maximum depth under the metal.

**Foam** - Both polystyrene and polyethylene are available as foams. The polystyrene foam is generally found as a packaging material for meats, eggs, or as an insulating material. Polyethylene foam is generally used as a packing material for high-impact applications. You'll find polyethylene foam blocks packed around computers and typewriters. The foams generally have the characteristics of their base resins. Polystyrene foam is brittle and attacked by a wide range of solvents, while polyethylene foam is much tougher, flexible, and virtually impervious to most common solvents. Although I'm not a fan of random events, both of these materials can be used to structure free-form models of various kinds. They can be heated with an alcohol lamp or small torch to melt and distort them into various organic shapes. If the plastic blocks are first blanked out in the shape you want to develop, a limited degree of control can be achieved. From what I've seen, polyethylene foam would be the preferred material. It has a

Number 12
higher melting point and it's a little easier to control during the forming process. Note that melted plastics stick to the skin and cause painful burns.

Cylindrical Forms - There are a number of places where cylindrical forms are useful. In wax they can be made by various lathe or freenand machining techniques. However, the plastics industry has supplied a broad range of circular forms. Everything from ballpoint pen couies to plastic wine glasses are made in round shapes.

Casting Resin - One of the more frustrating aspects of my examination of the plastic materials has been the search for a good casting resin. Unfortunately, finding the ideal material for jewelry parts is difficult. First of all, we need to consider the criteria of such a material.

The ideal casting resin would have a low viscosity so that it would fill the molds easily, it would mix bubble-free so the castings would be high quality, it would be hard and machinable after it was cast so that additional operations could be performed and it would burn out cleanly in the casting process. Unfortunately, all the materials which I have experimented with to date, are some compromise among these properties. Materials which may cast very well don't burn out well and vice versa.

To date, the best casting resin I've found is dental

Number 13
acrylic. Some of you teach your students to use casting acrylics, but in my experience, they get mixed reviews.

When I find people having trouble with casting acrylic, it often turns out that they are using the colored material. However, most of the companies that provide dental acrylics offer some of their formulations in clear. For my own use, I've settled on Kerr's Fastcure. This is a very rapid setting dental acrylic which I've found useful for at least one process.

Part of the trick to using these materials is to get a smooth bubble-free casting. Mixing tends to introduce air and the Fastcure sets so rapidly that it's not always possible to get the mold filled in time. I've made dozens of castings by filling the mold about 2/3 full of monomer and then dusting in the powder. The end result is a slightly flexible material with fair, though not excellent, surface gloss.

**Emulsions** - Many polymers can be processed into water based emulsions for use as paints or adhesives. Basically, these are finely divided plastic materials dispersed or suspended in water. As the water evaporates, the polymer forms a tough adhesive bond with itself or the substrate it is applied to. This process is irreversible. Once the material has dried it does not readily redissolve in water. To date, my experiments with emulsions have produced

Number 14
inconsistent results. There are a number of potential applications for polymer emulsion in the model building process, so my testing will continue.

Colored Materials - I've had excellent luck using some types of colored plastics in the casting process. One material which generally works quite well are the various plastic Easter eggs. These come in a wide range of sizes and colors. Although you may find that not all of the colors cast equally well, I've had good success casting these to form various kinds of curved forms and snells. You can make everything from a pen-wa ball to a cane head working with the plastic Easter eggs as a core.

Most white plastics either burn out poorly or react with the investment material. However, occasionally even white materials burn out well. As you can see from this photograph, materials which burn out quite well may not always be suitable for casting. You should note that the various copyright and trademark laws do affect your use of certain objects, however interesting and useful they may seem to be.

ADHESIVES AND BONDING AGENTS

One of the advantages of plastic model building is the fact that parts can be assembled using adhesives.

Number 15
The choice of an adhesive depends on the material being bonded, curing or drying time, bond strength, positionability and a host of other factors. Bond strength is not always the primary requisite for model making. All that is required is that the bond be sufficient to withstand the investment process. In my selection of adhesives, I am more concerned with the properties of application (positioning and speed of setting) than I am with bond strength.

First of all, we should begin by segmenting the bonding agents into two types, solvent adhesives and the materials which contain solid material.

A solvent adhesive works by softening the surface of the parts to be joined. In a sense, they turn the surface to glue. After this bonding occurs, the solvent migrates out of the system and the parts are one unit. Solvent bonding generally works best where you bond very narrow lines. If you bond large flat sheets with solvent adhesives, it may take years for all the solvent to migrate out of the joint. Since the solvent dissolves the plastics involved, any traces of the solvent which get out on the surface will tend to affect the finish. The degree of surface texturing or deterioration from the solvent may be quite extreme when it is spread over a wide area. Solvents can also be used to create surface texture.

Number 16
Depending on the materials to be joined, solvent cements can be prepared from a number of materials including:

- acetone
- methyl "cellosolve"
- methylene dichloride
- chloroform
- methyl ethyl ketone
- ethylene dichloride
- methylene chloride

Achieving high bond strength with solvent cements demands that the parts fit together well. Fortunately for jewelry applications, only nominal bond strength is required, and you can assemble quite a sloppy joint using solvent cement. However, any gaps must be filled with wax.

The solvent can be introduced to the joint by a drafting pen or artist's brush.

Rather than work with the bulk solvents, I generally purchase blended solvent cements from a plastics distributor or a hobby shop. I keep a selection around and test them on whatever model building plastic I am using.

There are literally hundreds of different kinds of glues. The best way to segment them is to consider whether they are one or two-part systems. The most useful one-part systems are the various plastic model cements. These are usually combinations of plastic and a solvent system. The bonding action is really not so very different from the solvent cements, but these materials have the ability to fill in.
gaps. However, there is a good deal of shrinkage associated with model cements.

The two-part adhesives are typified by the epoxies. The epoxies are thermosetting materials, and as such, are not satisfactory for model-building in bulk. However, for bonding, they don't cause any problem. I typically use them for joining large, flat surface areas and filling in small gaps. If I've taken a gouge out of a model and I want more strength than wax provides, I apply epoxy to the damaged area and finish the part. In small quantities, epoxies don't cause any problem in the casting process.

Of all the materials available, I prefer the so-called instant glues. They cure very quickly, and are relatively easy to manage. They are positionable to the extent that they don't cure until the joint is pressed tight, or alternately, until they've set a few minutes. If you create a sloppy bond area, and place the parts together without too much pressure, it may take several minutes for the adhesive to cure. This gives plenty of time to position the parts. You should always remember that these materials really do stick to skin, and once they cure, there's no adjusting the parts.

I've included wax under the bonding agents, because this is the way I join the vast majority of plastic parts. Although bond strength is low, it is adequate. Usually, I combine

Number 18
two different materials in wax joining. The first would be sticky wax, such as Kerr Utility wax. A very small amount of this is applied, and the parts are squeezed together to hold them in place. The area is then flooded with melted Kerr Blue Inlay wax and the excess is scraped away. One of the key advantages of working in plastic is the fact that it is so easy to construct fillets between various sections which you join. The waxes join the plastic parts much better when they don't fit together very well. Wax solvents don't attack the plastic, so it's easy to clean up the joint.

One insight on using wax joining might be useful. If the parts meet in a small contact area, the wax probably will not have sufficient structural strength to hold the joint together. A good example would be the joining of ring shanks with stone bases. These joints are fairly fragile and can be frustrating. I usually build up a small area of wax on the back of the joint. I attach a sprue at the same point and allow the wax mass to hold everything together through the investment process. After casting, the sprue is removed, and the area can quickly be ground down to the profile required.

To summarize, the choice of a plastic bonding agent is directly influenced by at least three major factors:

1. The material or materials to be joined
2. The requisite bond strength

Number 19
3. The physical configuration of the areas to be joined
FABRICATION

In developing this presentation, I have intentionally restricted the scope to materials which are readily available. I've intentionally avoided discussing fabrication techniques which require tools and machinery not commonly found in one man jewelry fabricating operations. Obviously, machine tools such as milling equipment, lathes or routing equipment could be used to prepare very precise shapes and forms from materials such as acrylic plastic. For those of you who have experience and/or access to this kind of machinery, the applications should be self-evident.

For the most part, the construction techniques used to work plastic are analogous to those used in fabricating metal and most of the same tools can be used. However, some specific insights may be useful.

First of all, I segregate the tools which I use for metal from the ones I use for wax and plastic. Contaminating the wax or plastic with metal filings does nothing to improve your casting quality. More important, working with plastic requires that your tools be very sharp. If you purchase a new file, and work in nothing but plastic or wax, it will stay sharp for years.

Polishing - Because of its higher heat distortion point, acrylic polishes well. Styrene can be polished, but it

Number 21
requires a good deal of care, and I seldom bother to use it if I'm interested in a highly finished part. Polishing acrylics is very similar to finishing metal. You must go through a series of finer and finer steps until you achieve the desired finish. In most cases, I use 220 and 400 grit wet-or-dry sandpaper before buffing. On larger surfaces, or if I'm after an unusually fine finish, I may also sand with 600 paper. The first buffing step is tripoli on a soft muslin buff with the stitching cut out. I use a small buff on my standard spindle to reduce cutting speed. Tripoli provides a finish which is about as good as the casting process will duplicate. If you would like to achieve a high polish, white chrome rouge or any of the commercial plastic polishing compounds can be used.

**Sawing** - I use conventional jewelers' sawblades to saw both the acrylic and styrene. However, there is some difference in the way they cut. The styrene tends to melt or soften and bind the sawblades. For this reason, a very slow, steady cutting action is required. If you've been cutting fast, you can't suddenly stop because the styrene will literally harden around the blade and probably break it. As you come to the end of the cut, slow down and you shouldn't have any difficulty. Acrylic saws a little better, but it also tends to bind. Most articles illustrated were sawn with a number #2/0, number #1/0, or number #1 jewelers' sawblade. A little silicone grease on the blade may also make the sawing easier, but may make the material harder to

Number 22
glue. Another small improvement can be achieved if you put scotch tape on both sides of the plastic before you start. This also preserves guidelines drawn on the plastic.

File/Carve - Excellent control can be achieved carving with small rotary files and filing with conventional jewelers' files. You will find that the plastic has considerably more resistance to cutting than carving wax. The tool will tend to skip or jump into the material. Very low or very high tool speeds seem to give the best results. The three flute wax carving burs are also useful in the carving operation. In recessed areas, it may be difficult to carve the plastic to a smooth finish. In this case, I often leave a fairly rough machine texture and flood the area with a coat of blue inlay wax to provide a smooth interior.

Marking - Depending on the operation, I mark the plastic parts either by scribing or with a pencil. It's mostly a matter of convenience. It's very easy to mark with a pencil on the plastic if you give it a quick frosted finish with 400 grit sandpaper. Generally, if I mark the material with a pencil, I will then put scotch tape over it before proceeding. Since I'm often concerned with duplicating precise shapes, I often work with templates. A set of small metric templates is a good match for calibrated gem stones.

Fixtures - In many applications a simple fixture will help align plastic parts which you want to glue together.

Number 23
Unfortunately, adhesives which work well on the plastics tend to glue everything else together. There are several ways which you can prevent this. One is to use various kinds of mold releases on your base material. Unfortunately, the best mold release is silicone grease. If this contaminates any of the surfaces you wish to glue, it's a problem. One of the easiest solutions I've found is to work on Saran wrap. If I'm working on a ring mandrel, I simply wrap it with a layer or two of Saran wrap and proceed. You'll find that you can slide the work off and worry the Saran wrap out of the inside later. One of the aggravating problems is often to develop a nice, clean, sharp, square corner. Most jewelry shops have a bench block. Cover this with Saran wrap and use it to align parts whenever you need to glue a square corner. The bench block can also be used as a sanding guide to help develop square edges on parts. Any time a flat surface is required, I assemble on glass.

Lapping - For many application, the thinnest plastic sheet in your stock may be a little thick. Additionally, you can often get crisper forms by lapping off some of the surface after parts are assembled. For example, if you were going to do a group of raised letters, even with fairly careful filing and developing the snape, the corners will tend to radius near the edges. If you assemble them and then lap own, you will not only get a lower relief but
PLASTICS

MATERIAL CLASSES

Even a basic textbook on plastics would be larger than this book so it's obviously not practical to prepare an in depth summary. Fortunately a brief discussion should provide you with enough information to make some basic material choices and it will prepare you for more detailed studies if they are of interest.

There are two basic classes of plastics: thermosetting and thermoplastic plastics. In simplest terms the thermoplastic materials behave like wax when heated to moderate temperatures. They will first soften and finally melt. On cooling they re-harden with their properties essentially unchanged. Thermo-setting materials do not have the same kind of reversible response. Once these materials have reacted and set, they can't be melted. Heat simply destroys them. The decomposition of thermo-setting materials sometimes yields a char or residue which is very heat-resistant.

The differences in properties can be related to the basic physical structure of the plastic. Thermosetting plastics are cross-linked while thermoplastics are composed of long coiled molecules.
Typical examples of both classes of material include:

**THERMOPLASTIC PLASTICS**

Acetal
Acrylic (methyl methacrylate)
Acrylonitrile-butadiene-styrene (ABS)
Cellulose plastics
Polyamide (nylon)
Polycarbonate
Polyethylene
Polypropylene
Polystyrene
Polyvinylchloride

**THERMOSETTING PLASTICS**

Epoxy
Melamine
Phenolic
Polyester
Urethane

Thermoplastic materials are used in jewelry modeling. In most cases they will burn away cleanly at conventional burnout temperatures. Conversely, the thermosetting materials seldom burnout well.
PLASTICS

HARD CARVING WAX

Based strictly on material classification the hard carving waxes should be treated together with the plastics. However, they are so widely used and offer so much potential that I would like to treat them separately.
PLASTICS

INTRODUCTION

The use of plastics as a model building material does not seem to generate much interest in the literature or classes and some references tend to focus more on the problems than the benefits. I have successfully completed hundreds of castings modeled in plastic. There is no doubt that the technique deserves a place in any model builders technique.

Why consider plastics as a replacement for wax? The use of natural and synthetic wax for model building places certain constraints on the artist craftsman. The substitution of plastics can help minimize these limitations.

Plastics can provide three principal benefits:

- **Unique Shapes** - Plastics allow the model builder to construct shapes or forms which would be very difficult and time consuming to construct in wax. This is particularly true when preparing crisp, well defined forms, or thin sections for casting in gold.

- **Speed** - The use of plastics allows the model builder to execute his design quickly. The speed of the process is particularly obvious in the preparation of highly detailed models or the addition of detail to conventional wax models.

- **Quality** - Better control of dimensional tolerances and section thicknesses can improve the finished casting quality. Improved casting can materially decrease finishing time on the final object.
This technique bridges the gap between the controlled style of fabricated jewelry and the inherent organic nature of wax modeling. As I have continued to experiment with plastic materials I have come to appreciate the complexity of the topic and to understand why its adoption has been slow. I believe that the material here can help avoid countless hours of experimentation.

The limited literature, and the popular folklore is full of misinformation concerning plastics in the model building process. Before we consider any details, two of the most popular misconceptions should be laid to rest.

- **Difficult Burnout** - Burnout problems are almost non-existent if the proper materials are used. As a practical matter, some carving waxes already contain plastics (polyethylene) appear to be cases where decomposition products chemically attack the investment, but proper material selection will eliminate the problem. Many or all of the problems ascribed to plastics are caused by improper material selection.

- **Health Hazards** - The pyrolytic decomposition of some plastics can generate toxic fumes. However, with the exception of a few plastics which contain significant amounts of the halogens of nitrogen, the hazard is minimal. As a practical matter, the materials most suitable for this application tend to be those which represent the least hazard. Burnout should be conducted in a ventilated fume hood no matter what model building material is used. Given that caution, the hazard appears to be less than that associated with many other art materials.
PLASTICS

As is often the case with any technical solution, plastics will not solve all your problems. However, if they are used in the appropriate situation and for the proper applications, they may significantly improve or expand your abilities. The use of plastic generally provides three benefits or opportunities for the goldsmith.

. Speed
. Precision
. Machine Ability
EPOXY ADHESIVES

Epoxy adhesives are very effective for joining both acrylics and polystyrene assemblies provided service preparation is adequate. To some extent, the use of epoxy adhesive violates the basic precept of this approach. That is that the modeling materials will generally be thermosplastic resins. Epoxy adhesives are almost setting materials which do not soften and reharden significantly during multiple heating cycles. However, if very limited amounts of epoxy are used to form a glue line, it has been my experience that these burn away cleanly since they represent a very small and fractional percentage of the total volume of material present. I have never had any burnout difficulties which I could attribute to the use of epoxy adhesives.

It should be noted that epoxies are essentially worthless for gluing polyethylene. As a matter of fact, this could be said about all of the adhesive systems except for some highly specialized industrial materials. My advice would be not to worry about the use of adhesives on polyethylene, but simply join any of these parts with wax. Polyethylene is hydrophobic and so it is relatively easy to join with wax since it is wedged and good surface contact is formed.

The cycro-anulate adhesives can also be used very effectively on styrene and acrylic resins. This material is
the so-called instant glue or tradename "Crazy Glue". These should be used with some caution since they can glue your fingers to the model quite as quickly as they can glue the parts together. However, in applications where the parts fit very well together and there is a fine glue line, the instant glues are very effective and certainly provide a way for very rapid assembly.
PLASTIC RING SHANKS

by: K. D. Austin

The August 1982 issue of AJM included an article dealing with a freenand turning technique which I use to model ring tops for small, round stones. The article used the same lead photograph which appears here. The previous article focussed on the materials, methods and economics of the turning process. I've also been developing faster techniques for other parts of the modeling processes. During the last few years I've focussed much of my work on the use of acrylic plastic for preparing models. This has turned out to be a versatile technique which can provide a wide range of effects with low labor and material content.

The shanks on all the rings in the lead photos were cast from models constructed of acrylic plastic. Like the turning technique, this approach is particularly useful for limited production shops who do a modest volume of rings in a broad range of sizes and styles. The technique offers a number of design options and it can provide a sense of variety at a low cost. It is particularly suitable for karat gold castings. Generally speaking, much lighter weight, more precise models can be prepared from acrylic plastic than from conventional modeling materials. In a sense it allows the jewelry fabricator the convenience and versatility which you associate from using conventional
forged shanks with a wider range of design options. Obviously, the specific designs can be tailored to suit your own requirements. Perhaps more important, inventories of material can be kept very low and the custom shop can put together a versatile operation which can respond swiftly to special orders or limited production opportunities. I find that the precision with which the molds can be prepared is especially useful when doing white gold castings where dimensional control of cross sections and finish can minimize porosity and other casting problems.

When this ring shank modeling technique is combined with the turning method presented previously, it offers an opportunity to prepare ring molds with low labor content, light weight, and a high quality level which is useful for a number of casting applications. Obviously, the use of acrylic plastic need not be limited to ring shanks. However, this application provides an opportunity to discuss the materials and their fabrication techniques. I hope that many of you will experiment with this material.

This discussion will really be presented in two parts. First, I'd like to talk a little bit about the general use of plastics in the investment casting process. Later, I'll discuss the specific techniques used in these examples.

There is a good deal of folklore about the use of plastics
for model making. It is widely stated that the burn out fumes are toxic, that plastic unduly stresses the investment or that it is difficult to burn out. Obviously, there are a number of different plastic materials which can be used to make a jewelry master. Obviously, some of these are more suitable than others for the process. However, I would like to limit this discussion to acrylic plastic for several reasons.

1. Acrylic plastic sheet is available in a wide range of thicknesses through a number of plastic supply companies.

2. It is relatively easy to machine or work by hand.

3. I have never had any serious difficulty burning out plastic parts, using the normal recommended manufacturers burn out cycle.

Rather than lead you through a long, complicated discussion about the alternate plastic materials I think this is a good place to begin and it should provide you with satisfactory results.

At the end of this article I've listed suppliers of acrylic sheet plastic that will sell this material in small pieces. You might look in your local yellow pages for a plastics supply house or distributor and see if you can find a local source. One of the easiest and least expensive ways to buy acrylic sheet plastic is to purchase the material sold for glazing. Sheets are normally sold in two thicknesses approximately 0.10 and approximately 0.54 inches thick.
This material is available from almost any shop which does replacement storm windows or commercial glazing. You can probably buy scrap material by the pound but a $10 sheet of this material will make hundreds or even thousands of ring blanks. All of the models illustrated here were made from .056 inch thick acrylic glazing sheet.

Almost all of our work in our shop is done to special order so the size is usually specified. This is particularly handy with the acrylics since it is very easy to control the dimensions and produce good quality models on demand to any size. However, the process of setting up to machine the material takes a little time so we normally prepare blank ring shanks in large batches. When you've purchased a sheet of acrylic, the first thing you'll find out that it is hard to store because it is too big. Since you never need very large pieces for jewelry making, I normally begin by cutting it down into strips about 6"x12". These can be stored on a shelf or in a file cabinet. The next step in preparing most ring shanks is to blank out the center holes. I usually do these in batches. The one foot wide sheets are cut into 1"x6" rectangles. Using a template, these are marked with five or six circles 5/8" in diameter. The next step is to drill a small hole through each circle and saw out the disc with a #2 jeweler's saw. This can be done quite crudely since the final size dimensions will be developed on a drill press. The secret of performing this operation quickly is
to use what is known as a multi-drill. These are illustrated in the attached figure and I have included the names of a couple of suppliers at the end of the article. The multi-drill is put in the drill press and the shank is drilled out to size working from both sides. The drill press is set up to work against the stop so that any given size shank can be produced. Once I have the drill press adjusted for any given size, I would normally do at least five and perhaps as many as 20 blanks in any given size. For example, many of our orders are in the range of size five and one half to size seven. For this reason I'll do a batch, perhaps in half size steps and do them all at once. In order to move quickly from one size to the next I have put a small dot on the stop adjustment on the drill press. Over the years I've determined what kind of rotation it takes to change the size. For example, I know that with this drill press and the multi-drills that I use it takes slightly more than one turn to change a full size. This makes it very easy to set up and do a large batch of blanks in small size increments. These prepared blanks are then inventoried for finishing to specific styles.

For those of you who do not wish to develop the turning techniques described in the previous article there is an alternate route to providing these simple mountings. Plastic Technicns provides a wide range of injection molded plastic jewelry components. Among these are a number of
stone seats. These can be very easily combined with the acrylic snanks to provide items such as that illustrated in Figure 4.

A number of industrial investment castings are made from injection molded plastic patterns but the process seems to have found relatively little application in commercial jewelry manufacture. This seems to relate to the high cost of tooling relative to production volumes. Special tooling techniques such as the tool casting method reported in AJM (May 1982) can make the technique feasible.

In the course of my work I've only encountered one company which has made a direct effort to capitalize on the possibility of using plastics in the jewelry modeling process. Plastic Technics provides a line of injection molded jewelry components. Many of these are alphabets for use in commercial jewelry. I've been more interested in the various small stone settings which they manufacture. Basically, these are analogous to commercial stone heads but they are molded in plastic. They can be incorporated into your own designs or they can be modified as needed. They shorten up the model making process considerably. I find that they have another advantage. They can cut down inventory cost and allow you to turn the work around much faster. If I were to inventory an in-depth selection of gold commercial stampings, the cost would be very high. For
a much lower cost I can inventory the plastic masters and incorporate them in my work. I'm not faced with the high inventory cost of carrying gold parts nor the delays incurred if I have to order them. The simple Tiffany ring illustrated here combines an acrylic shank with one of the Plastic Technics stone seats.
PLASTIC RING SHANKS

by: R. D. Austin

The August, 1982 issue of AJM included an article dealing with a fine hand turning technique which I use to model ring tops for small round stones. The article used the same lead photograph which appears here.

The previous article focused on the economics of turning techniques. I have also been developing faster techniques for other modeling processes. During the last few years, I've focused on the use of acrylic plastic for preparing models. This very versatile technique can provide a wide range of effects with very low labor content. All of the ring models in the lead photo were cast from models with acrylic ring shanks. Like the turning technique, this approach is particularly useful for limited production shops who do limited volume of rings in a broad range of sizes and styles. The technique is suitable for a range of designs and it can provide a sense of variety or uniqueness. It is almost as fast and easy as the use of commercial shanks. When this ring shank modeling technique is combined with the turning method presented previously it presents an opportunity to prepare ring models with very low labor content and a high quality level which is useful for a broad range of casting applications.

We should begin by discussing the use of plastics for investment casting masters. There is a good deal of folklore in the literature about the use of plastics for model making. There are a number of different plastic materials which can be used but for purposes of this discussion I would like to limit our consideration to acrylic and styrene plastics.
Acrylic plastic sheet is available in a wide range of thicknesses through a number of plastic supply companies. It is relatively easy to machine and it usually burns out cleanly. I have never had any significant difficulty burning out plastic parts using the normal, recommended burnout cycle. It should be noted that there are literally thousands of potential combinations of plastic and instrument systems. Not all plastics burn out equally well and some plastics may actually react with certain instruments during burnout. Any potential plastic material must be tested in your shop using your burnout conditions.

For the small shop, this approach offers a number of benefits. Obviously, some of the forms illustrated here could easily be duplicated by commercially available parts. However, even if it is used to construct conventional items, certain savings or advantages accrue to the shop. First of all, in our experience it tends to cut down inventory. If we are to provide a relatively wide range of options for our customers, we would have to either inventory the parts, have ready access to a good supply of commercial parts, or ask the customers to wait while we located a ring shank. None of these are particularly happy choices. We feel that the added labor in preparing a model in this form is more than offset by the incremental cost of commercial parts plus the aggravation and delay in getting them into the shop. There is certainly no doubt that it provides a distinct advantage in moving rush orders through our system. A $50 or $100 investment in plastic sheets of various thicknesses will provide enough material for literally thousands of ring models. If you spend a few more dollars on the tools described here you can prepare very high quality models in a short period of time.
It should be noted that we have used the generic term, acrylic plastics. When you actually set out to purchase these you will find a number of registered trade names for acrylic plastic sheet. Some of these specific trade names are:

**PLASTIC TRADE NAMES**

**ACRYLIC PLASTIC**

Because of the drill press set up time, we generally prepare a number of ring shanks blanks at one time. We typically cut out a strip of plastic about 1" x 5". This is marked for five holes, as indicated in the photograph. For rings of size 5 or larger, a 5/8" template can be used to scribe circles on the plastic. We use this approach so much, that we have ended up wearing out templates. For this reason, we prepared a series of brass templates in incremental sizes.

This gives us a little more flexibility in marking the sheet and the metal templates last almost indefinitely. Basically, the process is simple. After the holes are marked, each one is drilled with a small drill and a jeweler's saw is used to rough out the center opening. The next step is to core them out with a multi-drill which establishes the specific size. Drilling is done against the stop in the drill press and the drill is entered from one side and then the other side. This provides a cross section of the shank, roughly like that shown in the
attached illustration.
PLASTIC RING SHANKS

The August 1982 issue of AJM included an article describing a freehand turning technique which I use to model ring tops for small, round stones. The previous article used the same lead photograph which appears here. I've also been developing faster techniques for other parts of the modeling processes. During the last few years I've focussed much of my work on the use of plastic for preparing models. This has turned out to be a versatile technique which can provide a wide range of effects with low labor and material content.

The shanks on all the rings in the lead photos were cast from models constructed of acrylic plastic. This approach is particularly useful for limited production shops who do a modest volume of rings in a broad range of sizes and styles. The technique offers a number of design options and it can provide variety at a low cost. It is particularly suitable for karat gold castings. Lighter weight, precise models can be prepared more easily from plastic than from conventional modeling materials. It allows the jewelry fabricator the convenience and versatility which you associate from using conventional die struck shanks with a wider range of design options. The specific designs can be tailored to suit your own requirements. More important, inventories of precious metal can be kept low and the customer shop can respond quickly
to special orders or limited production opportunities. I find that the precision with which the models can be prepared is especially useful when doing white gold castings where dimensional control of cross sections and finish can minimize porosity and other casting problems.

When this shank modeling technique is combined with the turning method presented previously, it offers and opportunity to prepare ring models with low labor content, light weight, and a high quality level which is useful for a number of casting applications. Obviously, the use of acrylic plastic need not be limited to ring shanks. However, this application provides an opportunity to discuss the materials and their fabrication techniques.

This discussion will really be presented in two parts. First, I will discuss the use of plastics in the investment casting process. Second, I'll discuss the specific techniques used in these examples.

There is a good deal of folklore about the use of plastics for model making. It is widely held that the burn out fumes are toxic, that plastic unduly stresses the investment and that it is difficult to burn out. There are a number of different plastic materials which can be used to made a jewelry master. Obviously, some of these are more suitable than others for the process. Polyethylene, Polystyrene and acrylics seem to work
best. However, I would like to limit this discussion to acrylic plastic for several reasons.

. Acrylic plastic sheet is available in a wide range of thicknesses through a number of plastic supply companies.
. It is relatively easy to machine or work by hand.
. Many acrylics burn out well.

A properly tested acrylic material should provide you with satisfactory results.

The best way to locate the materials for this process is to look in your local yellow pages for a plastics supply house or distributor. One of the easiest and least expensive ways to buy acrylic sheet plastic is to purchase the material sold for glazing. Sheets are normally sold in two thicknesses approximately 0.062 and 0.125 inches thick. This material is available from almost any shop which does replacement storm windows or commercial glazing. You can probably buy scrap material by the pound but a $10 sheet of this material will make hundreds or even thousands of ring blanks. All of the models illustrated here were made from 0.125 inch thick acrylic glazing sheet.

Most of the work in my shop is done to special order so the size is usually specified. This favors the use of acrylics since it is very easy to control dimensions and produce good
quality models of any size. The process of setting up to machine the material takes a little time so we normally prepare blank ring shanks in large batches.

When you've purchased a sheet of acrylic, the first thing you'll find out that it is hard to store or use because it is too big. Since you never need very large pieces for jewelry making, I normally begin by cutting it down into strips about 6"x12" or 4"x6". These can be stored on a shelf or in a file cabinet. Cutting is done using an inexpensive plastic cutting tool. The next step in preparing the shank is to blank out the center holes. I usually do these in batches. The small sheets are cut into 1" strips. Using a template, these are marked with circles 5/8" in diameter. The next step is to drill a small hole through each circle and saw out the disc with a #2 jeweler's saw. If you wish, the size and finish can be done by hand files and sandpaper. However the blanking step can be accomplished more quickly with a drill press. The secret of performing this operation rapidly is to use what is known as a multi-drill. These are illustrated in the attached photograph and I have included the names of the two suppliers at the end of the article. The multi-drill is placed in the drill press and the shank is drilled out to size working from both sides. The drill press is set up to work against the stop so that any given size shank can be produced. Once the drill press is adjusted for any given size, I would normally
do at least five and perhaps as many as 20 blanks in any
given size. The majority of our orders are in the range of
size 5½ to 7. When I am set up I would normally prepare
batches of blanks in ½ size steps or increments.

In order to move quickly from one size to the next I have
marked the stop adjustment on the drill press. I've determined
the degree of rotation it takes to change the size. For
example, I know that with this drill press and the multi-drills
that I use it takes slightly more than one turn to change a
full size. This makes it very easy to set up and do a large
batch of shanks in small size increments. With care you can use
a small inexpensive drill press like the one shown. However,
it may tend to chatter. A larger industrial quality drill will
increase both quality and productivity.

A number of industrial investment castings are made from in-
jection molded plastic patterns but the process seems to
have found relatively little application in commercial jewelry
manufacture. This seems to relate to the high cost of tooling
relative to product volumes. Special tooling techniques such
as the tool casting method reported in AJM (May 1982) can
make the technique feasible.

In the course of my work I've only encountered one company
which has made a direct effort to capitalize on the possibility
of using plastics in the jewelry modeling process. Plastic
Techniques provides a line of injection molded jewelry components. Many of these are alphabets but I've been more interested in the small stone settings which they manufacture. Basically, these are analogous to commercial heads but they are molded in plastic. They can be incorporated into your own designs or they can be modified as needed. They shorten up the model making process considerably.

For those of you who do not wish to develop the turning techniques described in the previous article there is an alternate route to preparing simple models. Plastic Techniques provides a wide range of injection molded plastic jewelry components including a number of stone seats. These can be very easily combined with the acrylic shanks to provide items such as that illustrated in Figure 4.
RING SHANKS
ILLUSTRATIONS

I. Multi Drill
II. Plastic Sheet
III. Slicing
IV. Marking
V. Boring
VI. Step 5-
VII. Sequences
VIII. Potential Forms
PLASTIC FABRICATION

When two flat planes meet it may be very difficult to polish the piece on the inside of the joint. The more closed or V shape the joint the more difficult polishing will become. A slight fillet or radius at the bottom will make polishing much easier, and it might also eliminate or minimize 'hot tear papers' in the casting.

Whether you're fabricating jewelry, or assembling from cast or forge components, assembly positioning and holding the parts in place can be a serious problem. In many situations, the best way to proceed is to embed the parts in soldering investment to locate or hold them for joining.

The configuration and cross-section of the stone seat is influenced by aesthetics, as well as the cut of the gem being set. Figure 10 illustrates two wildly different stone sections. In the case of the shallow cut, it's possible to bring the stone seat completely behind the girdle of the stone. With a very deep cut, hiding the seat would result in a very thin fragile setting.

In the case of a mounting with cast prongs, it is usually preferable to have the girdle of the stone above the top surface of the seat. If the stone is set too low, the prongs must be bent through an ark of 90° or more.
This requires a dangerous amount of pressure and usually results in a gap under the prong.

Typically, there is a temptation to leave cast prongs too long during the final setting process. This provides a false sense of security and a poor finished product. Figure 11 illustrates this situation. If a prong of any given cross-section is increased in length the force at the tip required to bend the prong decreases. Conversely, a shorter prong of thinner section will be just as strong as a longer prong of thin section. In my own work, I typically developed the prong a length and cross-section in several stages. In the model, the prong may be two to four times it's finished length. However, the appropriate tapered cross-section will help insure a sound casting. If the prong is in a location which can be reached with sanding or grinding tools, I usually increase the cross-section of the model and cut it to size during finishing.

When you are mounting deep cabochons with a small bevel angle the form and taper of the prong becomes very important. If it is to thin or to straight it's impossible to maintain enough pressure to insure a secure stone. Figure 12 illustrates the proper prong section.

Closing the prongs will require some care. The objective is to bend the prong at its base and then finish by moving the material at the tip.
Since seep stones are usually not fragile, I often bend the prongs with a chasing punch in the sequence shown in the illustration.
When you are mounting deep cabochons with a small bevel angle, the form and taper of the prongs becomes very important. If the prongs are too thin or too straight it is impossible to maintain enough pressure to insure secure setting. Figure 12 illustrates the proper prong section for a deep cabochon.

Closing the prongs will require some care. The objective is to bend the prong at a space and then finish by moving the material at the tip. Since deep stones are not usually fragile, I typically bend the prongs with a chasing punch in the sequence shown in the second part of the illustration.

Typically, there is a temptation to leave cast prongs too long during the finishing process. This provides a false sense of security and a poor final product. Figure 11 illustrates the situation. If a prong of any given cross-section is increased in length the force of the tip required to bend the prong decreases. Conversely, a shorter prong of thinner section will be just as strong as a longer prong of thick section. In my own work, I usually develop the prong at a length and cross-section in several stages. During model construction the prong may be two to four times its finished length. However, a tapered cross-section will insure that a sound casting is achieved. If the prong is in a location which can be reached with sanding or grinding tools I usually increase the cross-section on the model and cut to size during finishing.
The use of plastic in the construction provides the opportunity to build a model which is highly polished in its recessed areas. The internal areas can be prepolished to any degree of polish required. However, the time required (although less than working down the metal) may still result in a high labor cost. In many cases, the parts can be sanded smooth with 220 or 400 grit sandpaper. The inner surfaces are then brushed or sprayed with a "gloss coat". Most model or hobby shops will carry one or more such compounds. If the manufacturers directions indicate that it is suitable for plastics, it will probably work. However, as is the case with all plastic materials, a test sample is advised.

You may wish to provide a fillet on the inside joints. This will avoid undercuts and minimize the chance of the sharp corner breaking away. You can form the radius with disclosing wax or blue inlay wax. If you work with inlay wax, it may be scrapped and then polished with wax solvent. Most of the common wax solvents will not attack the plastic or lacquer, a test sample is advised.

Many sticky waxes have melting points 10-20° F. lower than a typical inlay wax. If one of these is used to locate a prong it will often melt and the assembly will collapse. Try and use a sticky wax with a melting point at least as high as the inlay wax used.

Another method can be used for composite assemblies. PVA and instant glues may form a weak bond between waxes or waxes and plastics. Adhesives are used in mass production to bond wax subassemblies. For example an injection molded wax bezel may be glued to a wax model of a class ring. This allows rapid assembly of models which would be difficult to mold as completed parts.
All molded wax models, and especially those molded in silicone rubber molds, exhibit a significant static charge after molding. Although this charge will slowly dissipate (especially in high humidity) the models will attract all kinds of dust and dirt. If the models are washed in strong detergent and rinsed in cold water the charge will be removed along with any unwanted particulate material.

The lower injection temperature used in metal molds means that the model will shrink appreciably less during cooling. This will help to minimize dimensional change and sink marks.

Careful hand finishing can eliminate problems of poor surface texture on the casting. The U.S. industry still does a surprising amount of hand finishing. In contrast, English procedures tend to use less hand work. This places greater emphasis on the as-cast condition of the metal surface.

At some level, all castings will exhibit some shrinkage porosity. It may be so fine that it is not apparent even in highly finished surfaces. Obviously, it is preferable to minimize porosity, however, there is a second solution, which is to insure that the porosity is in a place which doesn't show. This second alternative is widely used. Specifically the porosity is moved to the core of the casting. This is accomplished by the formation of a sound skin on the castings. As long as a minimum amount of stock is removed the porosity is not objectionable.

Almost every traditional text on casting suggests the displacement method of measuring the metal required for casting. I have never observed this method in practice. It is difficult to accomplish with simple equipment. Even the simplest postal scale will usually provide more
accurate results at the same or lower equipment cost. The displacement method is likely to cause errors. It is not a viable alternative in quality casting operations.
PLASTIC BEZELS

In my own work, I find there is kind of a trade-off between the time spend in buffing or polishing the model and the time you spend finishing the casting. In areas that are large, smooth and open, it seems to be quicker to spend most of your time polishing the metal than to lavish a great deal of attention on the model. No matter how carefully the model is prepared, the finishing of the metal will be almost the same. In cases where it's more difficult to polish the model, such as textures or recesses, considerably more care is appropriate in the model building process.

As we stated previously, the plastic can be polished to a high gloss. However, there is another technique which provides fairly good results with a little less work. This is simply to lacquer the model after it's been sanded. Most hobby shops sell various types of spray lacquer which are specifically formulated to be applied to plastic models. Since the models are styrene, the paints are specifically formulated to not attack the plastic. It should be noted that many of the craft sprays and conventional lacquers will attack the plastic. In any event, if you can locate a plastic-compatible spray, this can be used on the parts to enhance their gloss. It is important, however, to note that any spraying needs to be done
This far, all of our discussions have been concerned with wax modeling. However, any material which can be burned out of the investment is a potential model making material. In the balance of this book we will discuss model making from materials such as wood, plastic, leaves and paper. In many cases the techniques explored will make use of various combinations of materials. Wax will often be used in conjunction with these materials to join, waterproof, add thickness or sprue the resulting model. We will conclude with a discussion of some special techniques such as mold making and spruing.

PLASTICS

The average American spends his life surrounded by objects of plastic. The plastic material may be recognizable or it may be disguised as imitations of all kinds of natural materials. The popular term "Plastic" actually describes hundreds of different polymers and blends of material. In any given case a particular polymeric material may be available by generic name or brand (trade) name. Even the most basic text on plastic materials would be a book in its own right. However, a little basic information should help you apply plastic materials to model making. There are two basic classes of plastics: thermosetting plastics and thermoplastic plastics. In simplest terms the thermoplastic materials behave like wax when heated to moderate temperatures. They will first soften and finally melt. On cooling they will reharden with their properties essentially unchanged. If the thermoplastics are heated to too high a temperature, or reheated too many times the material will deteriorate. Thermosetting materials do not have the same kind of reversible response. Heat may be applied
before wax parts are used for touch-up or to develop any radii since the lacquer will tend to break up in areas which have been touched by plastic. Also note that any contamination from silicone, molds, mold releases or sprays will also render this technique useless.
During the initial polymerization and forming but subsequent heating will not reverse the process. Heating may soften a thermosetting plastic but it will also damage it. Typical examples of both classes of material are listed below.

**THERMOPLASTIC PLASTICS**

Acetal
Acrylic
Acrylonitrile-butadiene-styrene (ABS)
Cellulose acetate
Cellulose Acetate butyrate
Nylon
Polycarbonate
Polyethylene
Polypropylene
Polystyrene
Polyvinylchloride

**THERMOSETTING PLASTICS**

Epoxy
Melamine
Phenolic
Polyester
Polyurethane

The thermoplastic materials are the ones which you want to use for jewelry modeling. In most cases they will burn away cleanly. Conversely the thermosetting materials seldom burn away well. They either require very long burnout times or they will leave a troublesome residue.
Fortunately it's not too difficult to locate and identify some of the thermoplastic materials that work well in modeling. Three of my favorites are acrylic, polystyrene and polyethylene. Acrylic plastic is widely used for glazing applications. 1/8" or 3/32" sheet is carried by many hardware or glass shops. Acrylite, Lucite, and Plexiglas are all registered trade names for various brands of acrylic plastic. If you wish to experiment with acrylic, go to a shop that replaces windows and ask if you can buy small pieces of leftover sheet. They may sell it by the pound or simply give you some scrap. (Add note on other forms.)

Polyethylene and polystyrene are both widely used in the packaging industry. The most common form for polyethylene is a tough, translucent white material used for bottles and containers, one gallon plastic milk containers being a good example. They are a readily available source of their polyethylene sheet that has a number of uses. Polystyrene is a much more rigid and brittle material but it can be easily molded in crystal clear form. All of the clear boxes illustrated in Figure 96 are styrene. Many hardware and variety stores sell small plastic boxes, and everything from razors to thumbtacks may come in a plastic box. If it's inexpensive, clear and rigid is probably polystyrene. In a typical box the plastic will be roughly 1/16" thick and useful for a wide range of modeling applications. You can buy polystyrene sheet at plastic suppliers and an occasional hobby shop but I seldom bother.

You will note that all of the materials that we have talked about thus far are either clear or translucent. As you know many plastic objects are quite opaque or brightly colored. Plastics are often
modified with additions of dye, pigment, fillers or reinforcing agents. These may range from dyes which will burn away cleanly, to glass fibers which will never burn out. If you want to try materials that are obviously pigmented or reinforced, begin by doing a burnout on a sample of the material before you expend a lot of time on model making. You might note that black polystyrene usually burns out clean. Although there are other plastics which you might wish to use, let's begin with some discussion about how these materials can be applied.

There are two fundamentally different approaches or viewpoints to the use of plastics in jewelry modeling. The first is to use the plastic as a jewelry modeling material in its own right. This would yield particular kinds of shapes, textures or character to the work. The second approach is to use the plastic as a base upon which to construct wax models. This second technique is often overlooked but it can save time and improve the quality of your work.

An example of this second case would be the situation where you wish to build up a very thin, more or less two dimensional shape. The conventional way to do this is to begin with a base of sheet wax and work up the details by adding inlay wax or wax penwax. This technique has some disadvantages. First of all, it is slow because you have to wait for the wax additions to cool. If you work too fast or apply too much heat the base sheet wax tends to lose its shape. Also, ordinary handling tends to damage the sheet wax and the result is a model which has a poorly finished or textured back. A thin plastic sheet can be used as the base. The plastic is cut out to the appropriate shape and
the wax is built up about it. The difference in melting points (the plastic being higher) eliminates any problem with the base melting. Also when you're done you'll find that the plastic will have maintained its smooth surface. This will make your finishing problems much easier.

The use of plastics in modeling has a number of advantages. Because it has a much higher structural strength than wax, it is generally easier to work with machine type tools. Also its hardness and higher melting point allow you to create crisp, sharp edges and corners which might be quite difficult to achieve with conventional wax. Certain types of assemblies are much easier with plastic, since it can be glued with conventional model building adhesives.

The question of adhesives for plastic is one that requires a little experience or experimentation. If you want to build a model that will be assembled by gluing I would recommend that you use polystyrene. It is easy to glue with conventional model building adhesives. There are two types of plastic model building adhesives. Either they are solvents which act by softening the surface of the plastic and making it its own adhesive or they do have some plastic base. Where possible I prefer to use the solvent type adhesive since the results are cleaner and neater. Other plastics may require other adhesive systems (polyethylene is very difficult to join with adhesives) or they can be heat welded. Epoxy glue can also be used in some cases. Although it is a thermosetting plastic, the amount present in a glue joint won't give you any problems. If you join plastic with epoxy, roughen the parts with sandpaper before bonding.
In many ways working with the plastic materials is rather like working in hard (high melting point) carving wax. If you work the material too fast it will tend to melt and clog your tools. If you are going to work in plastic you must use sharp tools and slow cutting speeds. Materials such as polystyrene are difficult to drill and tend to form star cracks as the drill bit moves through the back of the material. Special plastic drills are available with pointed, tapered points. However, if you work carefully you should be able to get by with conventional high speed metal drills.

Although all of the common plastics you will encounter will have higher melting points than most waxes, they still melt at relatively low temperatures. You can experiment with creating unusual shapes with almost all the plastics by heating them in various ways. Often times, plastic can be rendered quite flexible by simply dipping it in hot or boiling water. If you try this, be a little careful since the heat transfer is pretty effective and you can burn yourself working this way. If you heat plastics with a blow torch they will often crinkle and bubble and form very unusual forms.

Experimenting with either method may produce unusual textures or forms suitable for jewelry models.

PLASTIC FOAM

Almost all of the plastic materials identified previously have been produced as a plastic foam. As a practical matter only a couple of these are widely available and suitable for constructing jewelry models. Polyethylene and polystyrene foams are widely used in the packaging
Industry. Polystyrene is probably somewhat more common, but samples of both shouldn't be too hard to find. These materials are produced in the form of sheet, rods, granules or blocks for a wide range of packaging applications. Some good places to look would be the plastic meat trays and the packaging used around glassware or electronics equipment. Both of these materials are very low in density. Generally the polyethylene would be characterized by being much more flexible than the polystyrene, which tends to be rather rigid even in low density forms. The styrene forms are readily soluble in acetone. As a matter of fact, this is a pretty good test to determine what kind of foam you have. If you put a drop of acetone on the material and it eats in very very rapidly, the chances are that it is polystyrene. In any event, both of these materials can be used to construct models in various ways. One of my favorite techniques is to simply heat the materials with a small flame. A very small blow torch or soldering iron works very well. The process is a little bit hard to control, and you will waste a good deal of material, but, eventually you will create some very interesting and unusual shapes. Since the polystyrene foam is also rapidly effected by acetone, you can achieve some very different results by applying acetone drop by drop to the foam. This is even harder to control than the use of heat, but again, some very unusual forms will be created. Generally, the forms will not come out in a way that you can use directly. Usually it will be necessary to apply wax to backs to build up an appropriate thickness, or to fill in gaps or to develop shape in other ways. If the whole form tends to be too thin, you can try backing it up with sheet wax. If the form has voids or openings, blue inlay wax would be a good choice for a build-up material.
Polystyrene generally burns out quickly and cleanly, but larger pieces of polyethylene are somewhat more difficult to work with in this respect. Generally you will find that we will need to go to the maximum safe temperature for the investment and hold the temperature for a longer period of time. 1300 to 1400 degrees F may be required for at least a brief period of time. A large model might require holding polyethylene model at 1300 degrees for as much as 2 hours. Usually an insufficient burn-out will be indicated by black discoloration of the metal. If you run into this kind of discoloration very extensive pickling may be required, or you may have to go to some kind of mechanical abrasion to remove the effected surface material.

POLYMER EMULSIONS

A number of the common polymers are available in a water base emulsion form for use as paints or adhesives. Basically these are finely divided material dispersed or suspended in water. If the water evaporates the polymer forms a tough adhesive bond with itself or the material it is applied to. The process is irreversible. That is, the material will not readily redissolve in water after it has dried. Acrylic paints and "white" glues are examples of this type of compound. These materials are very useful as texturing media, adhesives and sealing materials for model building.

In recent years, acrylic artists paints have become very popular. These are based on an acrylic polymer emulsion. Although the pigmented forms of this material contain non-burnable solids, and are unsatisfactory for model building, unpigmented material is available. Liquatex (Registered trademark of Permanent Pigments Inc., Cincinnati, Ohio) Gel
Medium is suitable for use in model construction. This is a transparent gloss medium and should not be confused with the modeling paste which is also available under the same brand name. The modeling paste contains fillers which make it unsatisfactory for modeling. The gel medium is about the consistency of room temperature margarine and can be applied with a brush. In any reasonable thickness, it dries in an hour or two to a transparent, very glossy, finish. This material has several practical applications. First of all, it can be applied to many basic forms to achieve texture. The material can be applied with a brush or spatula to achieve a range of effects. It can also be used to build up the thickness of thin materials such as leaves. Thickness can be build up with repeated coats of the material. If desirable, the thickness of the coating can be varied as needed.

In the burn out process, the material burns away cleanly and leaves an excellent surface finish on the mold. The emulsion can be thinned with water and applied as a sealing coat to various organic materials. The physical properties of the gel are somewhat different than adhesives or other emulsions. The solid material is quite flexible. It's about the hardness of an automobile tire. There is quite a bit of shrinkage associated with the hardening process. If you are building up thin sections such as leaves you may have to pin them flat while the emulsion hardens.
PLASTICS

One of the few frustrations of using plastic materials for model making is the lack of sources for various kinds of material. In a commercial operations, it is annoying to rely on scrap material to keep the system going. On the other hand, commercial materials are difficult to locate and minimum order quantities are usually huge relative to the requirements of the jewelry maker.

I have never found any good solution to this problem and I end up purchasing material through commercial sources and scrounging what I can.

Acrylic glazing materials are about the only useful plastics widely available on the commercial market in quantities which are reasonable. Commercial glazing is carried in two or three thicknesses by most hardware and home supply stores. Sheet size varies but you can pick up four to six square feet of material for a few dollars and this should last you a lifetime. Since the sheets are way too big to work with jewelry tools, I would suggest you spend a couple of dollars on an inexpensive acrylic cutter such as the one illustrated in Figure 92. With this cutter, you scribe a line in the plastic and break it like a sheet of scribed glass. If you can't find a cutter, a sharp awl can be used to scratch a deep straight line into the plastic. Bend it
over the edge of a table to break it on the score. I generally cut the sheets down to a size which are handy to store (perhaps 4x6" sizes) that I can handle with a jewelry saw. The acrylic materials are ideal for model making, since they machine well, burnout well, and are strong and easy to work with. They should be the core of your effort to use plastics.

Polyethyene is quite a different matter. Probably the best and only consistent use I've had for polyethylene is to make prongs for master models. It is a great material for this application, however when I checked with my plastics supplier, he informed me that rolls were about four feet wide and hundreds of feet long. Since I didn't want to go into the plastic distribution business, I settled on using polyethylene milk bottles for this material. I find that a couple of one gallon plastic milk cartons a year are just about enough to keep me in business. Wash the carton out and cut out the flat, untextured portions of the bottle. If you take a micrometer, you'll find that the thickness varies because of the way the bottles are manufactured. You'll end up with a variety of thicknesses which can be used in different applications. I simply cut the material into rectangles about two or three inches on a side.

There are certain applications where polystyrene is the preferred material for model making. This usually relates
to bonding. However, I've never found a good commercial source of polystyrene sheet. For this reason, I fall back on commercial packaging materials. If you receive a product in a rigid clear plastic container, the chances are that container is made from one of the many varieties of polystyrene. I've had excellent results with these materials for model building. It is a bit of a nuisance for a commercial operation to be scrounging scraps of plastic, but it is probably worth it. If you accumulate plastic packaging materials, first of all, you'll find that they come in a wide range of thicknesses which is very useful for model building. When you work with the polystyrene, you will note that it tends to gum up in the saw blades more than acrylic and it cracks more easily. However, for certain kinds of solvent bonding, it is far easier to work with than acrylic. If you continue to accumulate plastic ware and packaging, you'll probably end up with a mixture of material similar to that shown in Figure 97.

The last general source I would suggest (in a major metropolitan area) is the local plastics distributing company. Most large cities have several such operations. First of all, you can buy materials at much more reasonable prices from the distributor but perhaps more useful, you'll be able to buy odd lots, samples and thicknesses.

About once every two years, I go to the plastic distributor
and ask to rummage through his scrap boxes. Generally, they sell scrap by the type of material and the pound. Ten or twenty dollars may provide you with a lifetime supply of acrylic materials in the thicknesses from one quarter inch to as much as an inch or more. You should question your local distributor to find out what other materials he carries and may have available as roll ends or scrap. There are a few special forms of material which are particularly useful for the model builder. One of these are acrylic spheres. These are used in laboratory and decorative applications. They are normally acrylic and vary widely in quality. Some of them are optical in quality and others are quite crude. You will find that you can buy acrylic spheres as small as one or two mm and up to marble size. I always pick up a collection of these whenever I have the opportunity. You would be amazed how quickly you can go through 1000 2mm acrylic spheres when you are making decorative jewelry designs.

There is another form of plastic which you may wish to experiment with. In our general discussion on wax, we discussed the carving waxes which I mentioned are generally blended from low molecular weight polyethylene. Most of the major plastics manufacturers make some grade of low molecular weight polyethylene with a melting of 250°F or less. If you decide that you would like to work with blending your own carving waxes you can begin with one of
these materials. The problem is that there are a wide range of material offered and they are sold in bulk, usually in 50 pound bags or even larger fiber drums. However, if you want to talk to a plastics distributor you can usually purchase a sample to experiment with. If you are satisfied with this, there certainly is a savings to be achieved by picking up 50 or 100 pounds of polyethylene and blending your own carving wax. However, I caution you that this is somewhat more difficult than it seems and if your labor is of any value, you are probably just as well off to buy commercial carving waxes.

**Adhesives** - There are literally thousands of adhesives which are suitable for bonding different plastics and combinations of plastics. The choice of adhesives depends on the material being bonded, the speed required, the quality of the joint, and a host of other factors. Generally speaking, bond strength is not the primary requisite in model making. All that is required is that the bond be strong enough to withstand the investment process. The most the investment is set, the adhesive strength is of no further interest. In my selection of adhesives, I am generally far more concerned with the properties of application and speed of settling, than I am with brute strength. The best way to examine the applications are to discuss the general classes of adhesives which you have available to you.
First of all, we should begin by segmenting the bonding agents into two types. First, are the strictly solvent adhesives and then there are materials which contain some solid material of their own. Let's talk first about solvent adhesives.

Basically, a solid adhesive works by softening the surface of the parts to be joined and causing them to intermingle and bond. After this bonding occurs, the solvent migrates out of the system and the parts are one unit. Solving bonding generally works well where you bond very narrow lines. If you attempt to bond two large flat sheets with solvent adhesives, you can saw the sheets down the middle in a couple of years and discover that the solvent hasn't fully evaporated from the middle of the bond. Solvent bonding is quite rapid and fairly clean in certain applications. However, since the material does dissolve the plastics involved, any traces of the material which get out on the surface will tend to affect surface texture to varying degrees. Generally speaking, the degree of surface texturing or modeling from the solvent may be quite extreme when it is spread over a wide area. If you don't believe this, sprinkle a little acetone on a scrap of polystyrene and you will discover what we are talking about.
COMMON PLASTICS

ABS  Acrylonitrile Butadiene Styrene
Acetal
   Delrin (Registered)
   Celcon (Registered)
Acrylic
   Acrylite (Registered)  Methylene Chloride
   Lucite (Registered)    Ethylene Dichloride
   Plexiglas (Registered) Trichlorethane
Available to 1/32" sheet, 1/6" rod
Polish at surface speed of 3500 to 4000 fpm
Butyrate
CAB  Cellulose Acetate Butyrate
Nylon
Phendic
Polycarbonate
   Lexan (Registered)
Polyester
Polyethylene
Polypropylene
Polystyrene
Poly Vinyl Chloride PVC
Silicone
Teflon (Registered)
Vinyl
PLASTIC

There are two basic classes of plastics: thermosetting and thermoplastic. In simplest terms the thermoplastic materials behave like wax when heated to moderate temperatures. They will first soften, then finally melt. On cooling they will harden with their properties essentially unchanged. If the thermoplastics are heated too high a temperature, or reheated too many times they will deteriorate.

Thermosetting materials do not have the same kind of reversible response. Heat may be applied during the initial polymerization and forming but subsequent heating will not reverse the process. Heating may soften a thermosetting plastic but it will also damage it. Typical examples of both classes are listed below:

Thermoplastic Plastics

Acetal
Acrylic
Acrylonitrile-butadiene-styrene (ABS)
Cellulose acetate
Cellulose acetate butyrate
Nylon
Polycarbonate
Polyethylene
Polypropylene
Polystyrene
Polyvinyl chloride
Thermosetting Plastics

Epoxy
Melamine
Phenolic
Polyester

The thermoplastic materials are the ones to be used for jewelry modeling. In most cases they will burn away cleanly. Conversely, the thermosetting materials seldom burn away well. They either require very long burnout times or they will leave a troublesome residue.

Fortunately, it is not too difficult to locate and identify some of the thermoplastic materials that work well in modeling. Three of my favorites are acrylic, polystyrene and polyethylene. Acrylic plastic is widely used for glazing applications. Many hardware or glass shops carry 1/8 or 3/16 inch sheets. Acrylite, Lucite, and Plexiglas are all registered trade names for various brands of acrylic plastic. If you wish to experiment with this material go to a shop that replaces windows and ask if you can buy small pieces of leftover sheet. They may sell it by the pound or simply give you some scrap.

Polyethylene and polystyrene are both widely used in the packaging industry. The most common form for polyethylene is a tough, translucent white material used for bottles and containers, one-gallon plastic milk containers being a good example.
Polystyrene is a much more rigid and brittle material but it can be molded in crystal clear form. All of the clear boxes illustrated in Figure 75 are polystyrene. Many hardware and variety stores may sell small plastic boxes, and everything from razors to thumbtacks may come in such a box. If it is inexpensive, clear and rigid, it is probably polystyrene. In a typical box, the plastic is roughly 1/16 inch thick and useful for a wide range of modeling applications. You can also buy polystyrene sheet at a plastic supply house or an occasional hobby shop. In addition to sheet, there are many formed plastic items that can be used for modeling.

You will note that all of the materials that we have talked about thus far are either clear or translucent. Of course, many plastic objects are quite opaque or brightly colored. Plastics are often modified with additions of dye, pigment, fillers or reinforcing agents. These may range from dyes that will burn away cleanly to glass fibers which will never burn out. If you want to try materials that are obviously pigmented or reinforced, begin by doing a burnout on a sample before you expend a lot of time on model making. Black polystyrene usually burns out clean. Although there are other plastics which you might wish to use, let's begin with some discussion about how these materials can be applied.

There are two fundamentally different approaches to the use
of plastics in jewelry modeling. The first is to use the plastic as a jewelry modeling material in its own right. This would yield particular kinds of shapes, textures or character to the work (see Figures 77,78 and 79). The second approach is to use the plastic as a base upon which to construct wax models. This technique is often overlooked but it can save time and improve the quality of your work.

An example of this second method would be a situation where you wish to build up a very thin, more or less two dimensional shape. The conventional way to do this is to begin with a base of sheet wax and work up the details by adding inlay wax or wax from a pen. This technique has some disadvantages. First of all, it is slow because you have to wait for the wax additions to cool. If you work too fast or apply too much heat, the base sheet wax tends to lose its shape. Also, ordinary handling tends to damage the sheet and the result is a model which has a poorly finished or textured back. A thin plastic sheet can solve these problems. The plastic is cut out to the appropriate shape and the wax is built up on it. The difference in melting points (the plastic being higher) eliminates any problem with the base softening. Also, when you're done you'll find that the plastic will have maintained its smooth surface. This will make your finishing much easier.

The use of plastics in modeling has a number of advantages.
Because it has a much higher structural strength than wax, it is generally easier to work with machine type tools. Also, its hardness and higher melting point allow you to create crisp, sharp edges and corners which might be quite difficult to achieve with conventional wax. Certain types of assemblies are much easier with plastic, since it can be cemented with conventional model building adhesives.

The question of adhesives for plastic is one that requires a little experience or experimentation. If you want to build a model that will be assembled by cementing, I would recommend that you use polystyrene. It is easy to bond with conventional model building adhesives, of which there are two types. Either they are solvents which act by softening the surface of the plastic and making it its own adhesive or they do have some plastic base. Where possible I prefer to use the solvent type since the results are cleaner and neater. Other plastics may require different adhesive systems (polyethylene is very difficult to join with adhesives) or they can be heat welded.

Epoxy can also be used in some cases. Although it is a thermosetting plastic, the amount present in a glue joint won't give you any problems. If you join plastic with epoxy, roughen the parts with sandpaper before bonding.

In many ways modeling with the plastic materials is rather
like working in hard (high melting point) carving wax. If you work the material too fast, it will tend to melt and clog your tools. If you are going to model in plastic you must use sharp tools and slow cutting speeds. Materials such as polystyrene are difficult to drill and tend to form star cracks as the drill bit moves through the back. Special plastic drills are available with pointed, tapered ends. However, if you work carefully you should be able to get by with conventional high speed metal drills.

Although all of the common plastics you will encounter will have higher melting points than most waxes, they still melt at relatively low temperatures. You can experiment in creating unusual shapes with almost all of them by heating in various ways. Often, plastic can be rendered quite flexible by simply dipping it in hot or boiling water. If you try this, be a little careful since the heat transfer is pretty effective and you can burn yourself working this way. If you heat plastics with a blow torch they will often crinkle and bubble and form very unusual forms.

Warning! Heated or molten plastic sticks and burns the skin very quickly. Be sure to work in a well-ventilated area and proceed at your own risk.

Experimenting with either method may produce unusual textures or forms suitable for jewelry models.
Plastic Foam - Almost all the plastic materials identified previously have been produced as foam. As a practical matter only a couple of these are widely available and suitable for constructing jewelry models. Polyethylene and polystyrene foams are widely used in the packaging industry. Polystyrene is probably somewhat more common, but samples of both shouldn't be too hard to find. These materials are produced in the form of sheet, ross, granules or blocks for a wide range of packaging applications. Some good places to look would be the plastic meat trays and the packaging used around glassware or electronics equipment. Both of these materials are very low in density.

Generally the polyethylene would be characterized by being much more flexible than the polystyrene which tends to be rather rigid even in low density forms. The styrene forms are readily soluble in acetone; as a matter of fact, this is a pretty good test to determine what kind of foam you have. If you put a drop of acetone on the material and it eats in very rapidly, the chances are that it is polystyrene. In any event, both of these materials can be used to construct models in various ways.

One of my favorite techniques is to simply heat the materials with a small flame. A very small blow torch or soldering iron works very well. The process is a little hard to control, and you will waste a good deal of material,
out eventually you will create some very interesting and unusual shapes (see Figures 80 and 81).

Since the polystyrene foam is also rapidly affected by acetone, you can achieve some very different results by applying acetone drop by drop to it. This is even harder to control than the use of neat, but, again, some very unusual forms will be created. Generally, the forms will not come out in a way that you can use directly. Usually it will be necessary to apply wax to backs to build up an appropriate thickness, or to fill in gaps or to develop shape in other ways. If the whole form tends to be too thin, you can try backing it up with sheet wax. If it has voids or openings, blue inlay wax would be a good choice for a build-up material.

Polystyrene generally burns out quickly and cleanly, but larger pieces of polyethylene are somewhat more difficult to work with in this respect. Generally you will find that you need to go to the maximum safe temperature for the burnout and hold the temperature for a longer period of time; 1300 to 1400 degrees F may be required for at least a brief period of time. A large model might require holding the burnout at 1300 degrees for as much as two hours. Usually an insufficient burnout will be indicated by black discoloration of the metal. If you run into this kind of discoloration, very extensive pickling may be required, or
you may have to go to some kind of mechanical abrasion to remove the affected surface material.

Polymer Emulsions - A number of the common polymers are available in a water base emulsion form for use as paints or adhesives. Basically these are finely divided materials dispersed or suspended in water. If the water evaporates, the polymer forms a tough adhesive bond with itself or the material it is applied to. The process is irreversible. That is, the material will not readily redissolve in water after it has dried. Acrylic paints and "white" glues are examples of this type of compound. These materials are very useful as texturing media, adhesives or sealing materials for model building.

In recent years, acrylic artists' paints have become very popular. These are based on an acrylic polymer emulsion. Although the pigmented forms of this material contain non-burnable solids, and are unsatisfactory for model building, unpigmented material is available. Liquatex (Registered trademark of Permanent Pigments, Inc., Cincinnati, Ohio) Gel Medium is suitable for use in model construction. This is not a transparent gloss medium and should not be confused with the modeling paste which is also available under the same brand name. The modeling paste contains fillers which make it unsatisfactory for modeling. The gel medium is about the consistency of room temperature
margarine and can be applied with a brush. In any reasonable thickness, it dries in an hour or two to a transparent, very glossy, finish. This material has several practical applications. First of all, it can be applied to many basic forms to achieve texture (see Figure 82). The material can be applied with a brush or spatula to achieve a range of effects. It can also be used to build up the thickness of thin materials, such as leaves. The build-up can be achieved with repeated coats of the material. If desirable, the thickness of the coating can be varied as needed.

In the burnout process, the material burns away cleanly and leaves an excellent surface finish on the mold. The emulsion can be thinned with water and applied as a sealing coat to various organic materials. The physical properties of the gel are somewhat different than adhesives or other emulsions. The solid material is quite flexible. It is about the hardness of an automobile tire. There is quite a bit of shrinkage associated with the hardening process. If you are building up thin sections such as leaves you may have to pin them flat while the emulsion hardens.
PLASTICS

It is not practical to become an expert on plastic materials just to make a few jewelry models. However, if you would like to experiment with plastics, a few basics will help. There are two basic classes of plastics: Thermosetting plastics and Thermoplastic plastics. Typical examples of both classes of material are listed below.

THERMOPLASTIC PLASTICS

Acetal
Acrylic
Acrylonitrile-butadiene-styrene (ABS)
Cellulose acetate
Cellulose acetate butyrate
Nylon
Polycarbonate
Polyethylene
Polypropylene
Polystyrene
Polyvinylchloride

THERMOSETTING PLASTICS

Epoxy
Melamine
Phenolic
Polyester
Polyurethane

In simplest terms, the thermoplastic materials behave like wax when heated to moderate temperatures. They will first soften and finally melt. On cooling they will renarden with their properties essentially unchanged. As is the case with wax if they are heated to too high a temperature, or
reheated too many times the material will deteriorate. Thermosetting materials do not have the same kind of reversible response. Once these materials have reacted and set, they cannot be melted. Heat simply destroys them.