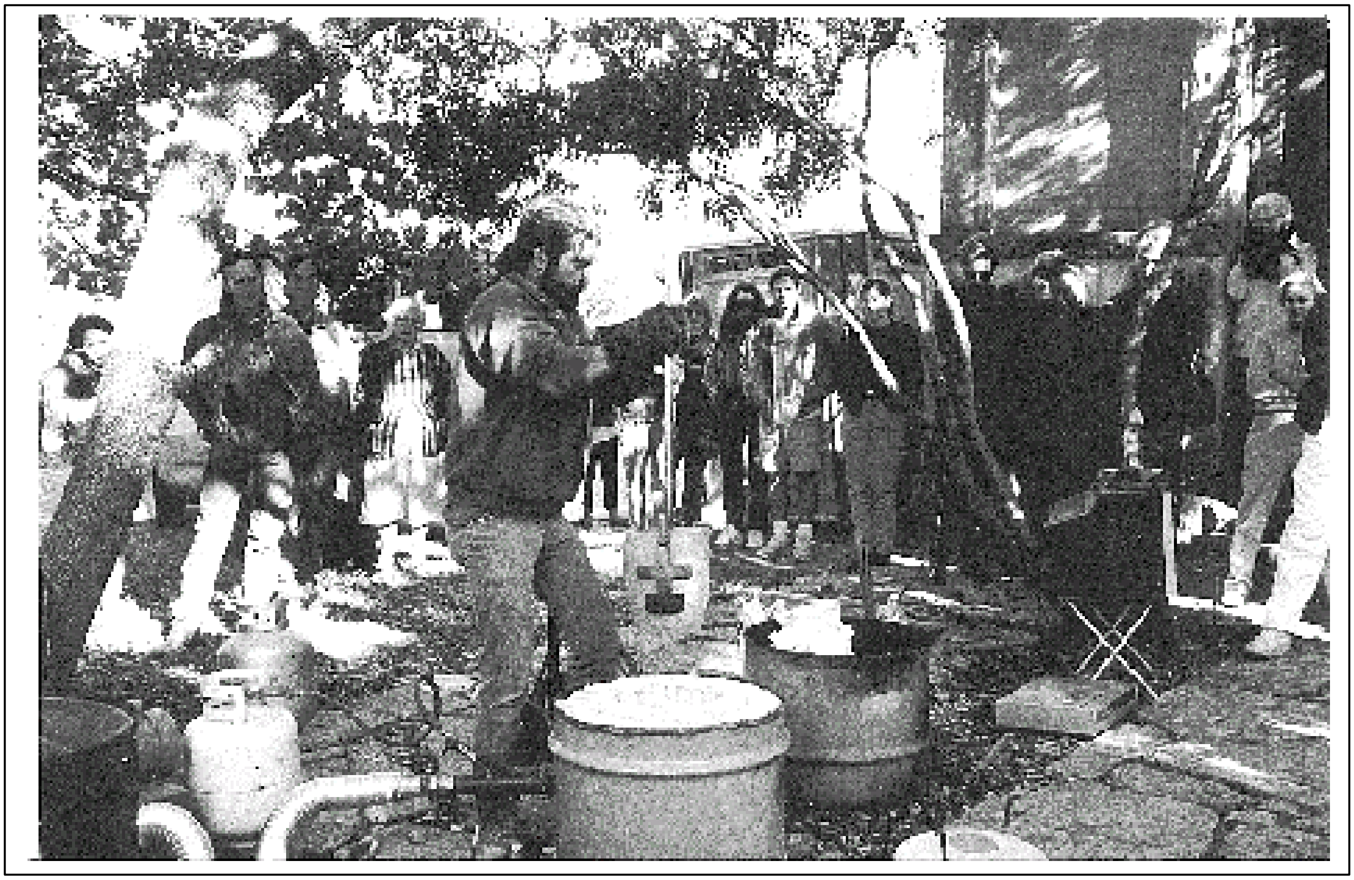
The Pocket Foundry

How to build and operate a one-man bronze casting foundry for less than $6,000 – Really!

By Daniel Butler, BFA, ALI



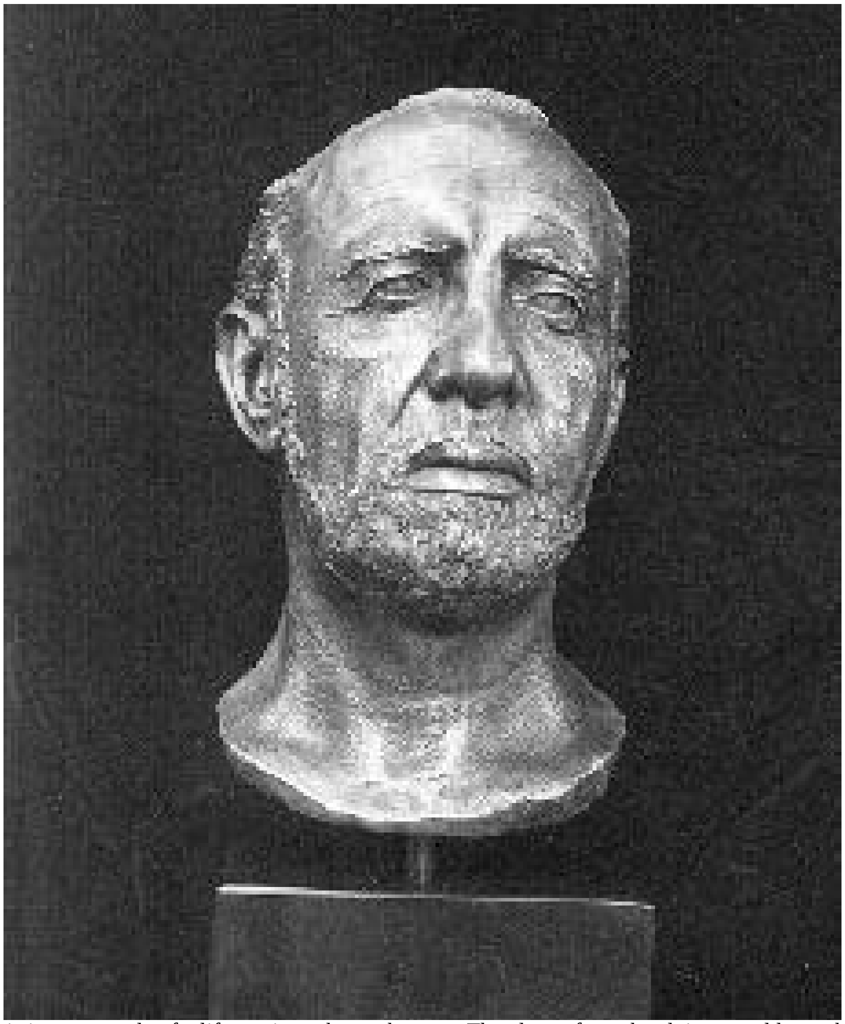
Placing a #20 crucible into my home made furnace. I made the tongs that I'm using to hold the crucible from scrap steel I found at a junkyard. You can purchase a set of tongs and pouring shank from a foundry supplier such as McEnglevan (MICO) for about $450. Notice the tanks of propane gas behind that are used to fire the furnace as well as the position of the forced air line entering the top of the furnace. This is an aluminum clothes dryer vent.

The ultimate in casting materials is bronze going back to antiquity. The market screams for it. As a member of the Association of Lifecasters International, I continue to point out to our members that the prices of bronze lifecasting works command the highest values since collectors look for bronzes – not plaster, cold casts or resins. Yet it is the very nature of bronze casting that intimidates most artists.

Most sculptors' first visit to a metal casting foundry can be an overwhelming experience. Depending on the scale and volume of work being produced, one encounters an industrial environment with heavy, expensive looking equipment, loud noises, a crew of casters in heat reflective gear moving a large, glowing crucible hung from an electric hoist on a movable "I" beam.

The first reaction is "bronze casting is a very expensive process. I could never afford a setup like this." The answer is you can and you should strongly consider it because as an artist it says you have arrived.

Actually it's only a matter of scale. If you want to cast monumental bronzes, of course it's best to hire one of the large foundries that are equipped



This is an example of a life casting taken to bronze. The plaster from the alginate mold was then molded in Polytek 74-30. A wax casting was made into this mold. I used a 'standard' (traditional) plaster and sand flask mold with the wax inside. It was burned out in the ‘pocket’ foundry barrel kiln and then cast in bronze. The casting needed minimal work, mostly sanding and welding a stainless steel post in the neck for mounting on the marble base.

to manufacture bronze in terms of tonnage.

But for the average sculptor whose work is in the 18” to life-size scale, it can be quite affordable to build your own small casting foundry. I call such a foundry a pocket foundry. Because of its pocket-sized footprint (see diagram) it can be easily built in the back yard in a garage, work shed or small barn

How can we reduce such a seemingly complicated process so that it is reach of an artist’s budget – say less that $6,000? Let’s say that an 18” figure will weigh roughly 40 to 60 lbs in bronze. A #20 crucible can accommodate this amount. The number of the crucible indicates the number of pounds of aluminum the crucible can hold. Bronze weighs three times the weight of aluminum. So a #20 crucible will hold 60 pounds of bronze.

You can do a lot with a #20 crucible. A sturdy silicon carbide #20 costs around $105. If you are only casting your own work, you will probably cast less than 20 small bronzes a year, so your crucible may last you for 2 or more years.

Now, the next good news is that the equipment needed for a #20 crucible is small, and fairly inexpensive. You can purchase a set of tongs and pouring shank from a foundry supplier such as McEnglevan (MICO) for about $450.

If you are a passable welder, you can make your own tongs and shank for the cost of new or scrap steel. And why not make it yourself? You are going to need to buy a heli arc (a.k.a. ‘TIG’) welding machine and learn how to use it to weld your bronzes.

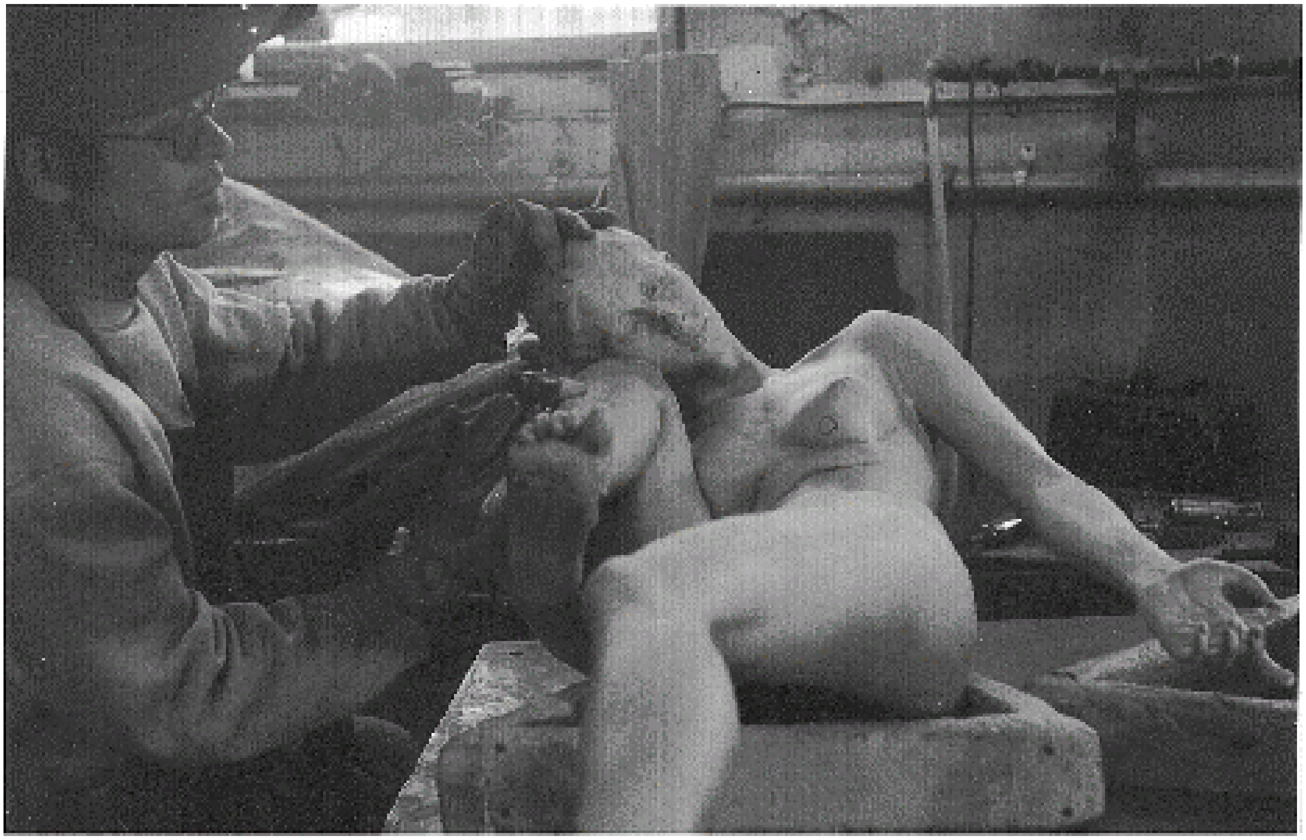
Are you starting to wonder if you have the knowledge and skills to build and operate your own foundry? For those who didn’t take shop in high school or have no industrial training, you will have to invest some time in welding and shop classes at your local community college, and do some research and reading on lost wax bronze casting and mold making. But it’s best to learn it by seeing it done. If a small sculpture foundry exists in the area, you should definitely visit there and befriend the owner or someone familiar with the equipment and processes.

You *can* do it. Bronze casting is one of the oldest technologies. The smelting of copper/tin alloy is believed to be about 6,000 years old, or 3800 BC. It is therefore considered 'low tech'.

This is the good news for the aspiring caster for two reasons. Low technologies are usually fairly simple, and there is some tolerance for error. An old foundry man once said, “there are a lot of ways to make a mold and cast metal, and they all *work*.” Even if you start out with little experience, in time you will improve your skill and even invent some of your own methods and techniques that work best for *your* setup.

The Basic Process. The lost-wax casting process is simple, but it does involve a number of steps The following descriptions presume some knowledge or familiarity with the lost wax casting process and the terms used.

Mold-making. Mold making for bronze casting is an artisan’s field in it's own right, but in a nutshell you are making a reusable mold with a flexible material such as silicone, latex or other rubber-like material. This flexible material begins in liquid form and is



Picture 3. *Here the work begins. It is know as de-vesting the casting, sandblasting, cutting sprueing off the sculpture with a body grinder, reciprocating saw, or plasma cutter. You will inspect the metal for flaws in the metal, which have to be repaired, and do a lot of precise welding. I'm using a heli arc or TIG welder to join the pieces of a full body lifecasting.*

applied directly to the object to be molded. This is *not* the mold that the molten metal will be poured into. This is the mold from which you make the wax duplicate that will be used as the *pattern* for the final casting in metal.

Wax work and wax dressing. The 'lost wax' process gets it's name from the process of embedding a wax pattern in a heat refractory waste mold. Wax work begins with pouring melted wax (generally at 160 degrees Fahrenheit) into the rubber mold and, after cooling, removing the wax pattern and 'chasing' or 'dressing' parting lines, air bubbles gaps, and other imperfections that occur during the pouring of the wax. As with the metal casting, most items aren't perfect after casting and repairs and work on castings to get the refined product is routine.

Wax spruing. When pouring molten metal into an empty space, a pathway must be made for the metal to enter and the air to exit. So the wax patterns must have 'feeders' which will leave a path for bronze to be poured in to the mold, and *vents* so that the air can escape and not trap bronze in the mold in what is known as a 'cold shut.' Basically, bars of wax (about the width of a Tootsie Roll or larger) are 'gated' to the pattern as feeders, with the entrance point of the metal being visualized to begin at the bottom and rise to the top of the piece, which is vented. Atop the main feeder you place a cup—paper, plastic, or wax. This leaves a space shaped like the cup in the refractory mold.

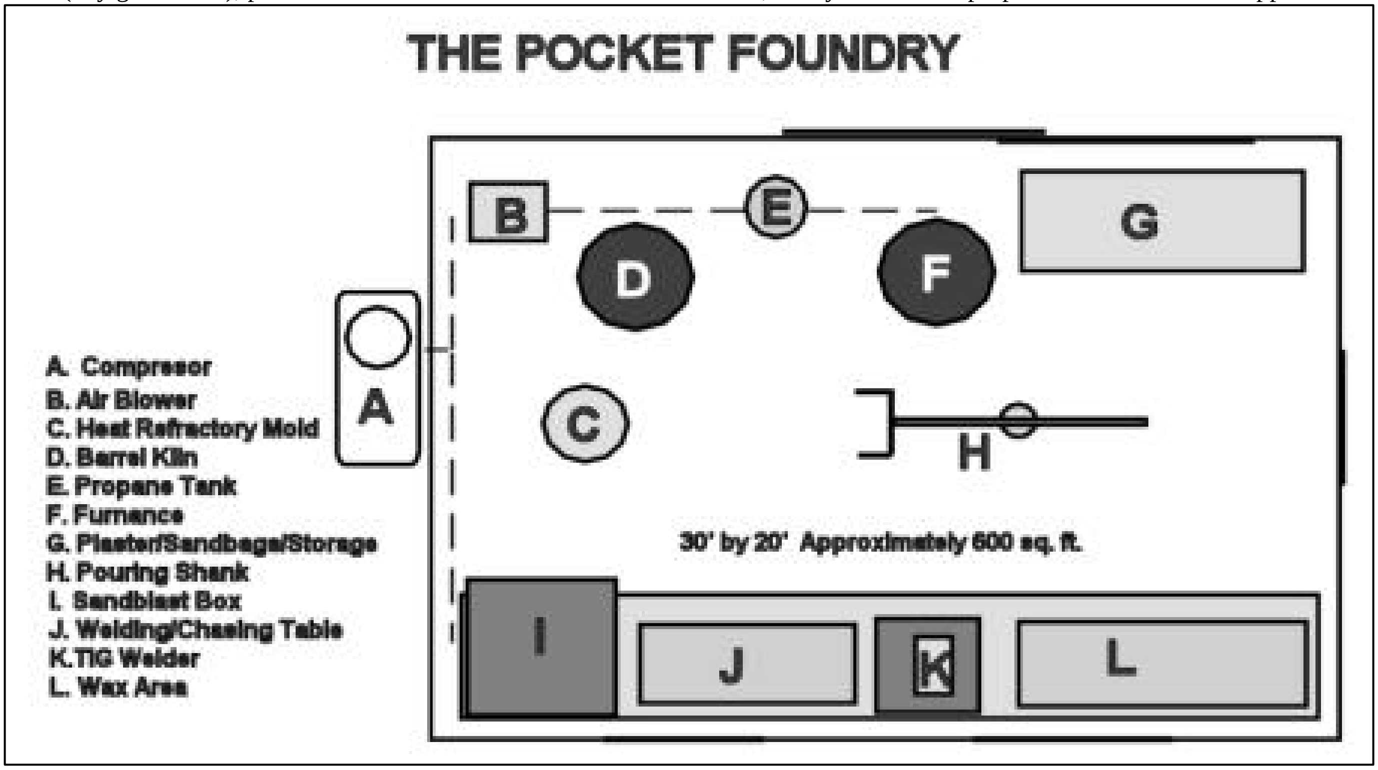
The heat refractory mold. This is the final mold into which the metal will be poured. Most commercial foundries use ceramic shell, a specialized material requiring special mixers, 'fluidized' bed containers into which sprued wax patterns are 'dipped' and hung to dry. The liquid ceramic material is dipped an dried and recoated about five times. This process is expensive and time consuming, but the refractory molds are fairly light weight and easy to handle which is useful if you are casting dozens of pieces a week, or very large sections in one shot.

Since our 'pocket' foundry will be casting only one to four small castings a week at most, I prefer a much less expensive and time-consuming method.

Traditional or 'standard' investment. The term 'standard investment' used to mean plaster and sand combined, which has been the material most used in metal casting for thousands of years. Today I think most commercial foundries would say that ceramic shell has become the standard since WWII.

To make a heat refractory mold, one needs only mix common molding plaster with equal parts of common sand (any grit is fine), pour this into a that when you fill it, the investment will not push up the paper flask and go running out all over the concrete floor!

When the flask is full, take your investment gives you a wax pattern invested in a raw refractory mold in less than 3 hours, including all the preparation time. This is opposed to



This is the recommended layout for a one-man Pocket Foundry. Six hundred square feet is optimal. The layout is established for efficiency and convenience that it can be varied to fit your specific space.

mold flask you make by rolling a piece of roofing paper around a roll of chicken wire. Advice: to make enough investment to fill a 1' diameter by 18" tall mold flask you need to mix the plaster and sand in a 30-gallon plastic garbage can. First fill with water to approximately one foot deep, then add the plaster and sand mixture until you get an 'island' of plaster and sand above the top of the water. By the time that happens your garbage can will be two thirds full of the liquid mixture. Stir the whole time that you are sifting dry investment into the mix. When the mixture leaves a coat on your hand that you can't see through and doesn't run off, you're done.

I prepare the mold flask by mixing a smaller, thicker batch of investment and pouring a 2-inch layer in the bottom and letting it set up before going in with the garbage can batch. This seals the bottom of the flask so sprued wax pattern and submerge it all the way to near the top of the cup. Do not allow investment to spill over into the cup. Hold the wax as close to the top as possible and keep it held under the surface until the investment 'snaps', or becomes solid. This can take about 5 minutes or less, because the plaster started to react as soon as you started mixing it with water. Getting the timing right takes a little practice...the first time you try to mix a batch this large you may find that the investment has thickened before you can get the wax into it! If you see that happening it's best not to try to force the pattern into thickening investment. Put it aside, make another flask, and try again – *faster.*

Aside from simplicity of material and process, and no need for more equipment than garbage can and 4-foot metal rod with some kind of mixing paddle on it, sand and plaster mix several days of dipping in the ceramic shell process.

The mold you get will be much thicker and heavier than a ceramic shell mold, but it is also easier to 'de-vest' (remove from the casting). Plaster can be used for road fill, hillside fill to stop erosion, or it can be recycled and mixed one third 'burnout' investment to 2 thirds 'fresh.' You will need to purchase or make a mulling machine to crush it up if you want to recycle it, though.

'Burnout' and the Burnout Kiln. The 'lost wax' process gets its name from the part of the process where the wax is melted out, then burned out of the investment mold. Visualize that the wax pattern and attached spruing system and cup will now be a hollow space in the mold, waiting to be filled with molten bronze which will assume that shape and texture. Wax burnout generally should be in a kiln at a constant temperature of 900 degrees Fahrenheit. The rule for time length of the burnout is 24-hours per one foot width of the investment mold. I have found that this time can be reduced as much as half depending on the design and efficiency of your kiln.

I prefer a simple *barrel* kiln. You can construct one from a steel drum lined with heat refractory ceramic wool (obtained through pottery supply houses), and held in place by a cylinder made of heavy wire fencing material. To supply the heat, I use a forced air and gas pipe blower. Essentially this consists of a one and one half inch steel pipe about a foot long, with a gas injector (60-67 gauge orifice for propane), and with air fed from a blower through a collapsible aluminum duct—the kind used to vent clothes dryers. You should not use plastic ducting, as this may melt in proximity to heat. The pipe blower is inserted in a hole near the bottom of the barrel. You must have a hole and an air escape pipe at the top of the barrel. Like a woodstove, the chimney pipe allows the heat to 'draft', which keeps the temperature constant once the blower has been set and running for a few minutes. To learn what settings give you a constant 900 degrees, I recommend using a pottery kiln pyrometer for the first several runs, until you become familiar with what your equipment will do.

Your barrel kiln should sit atop a solid steel grate, mounted on one course of cinderblocks. You can place a steel pan several inches below the grate to collect and re-use wax. This pan should be pulled out about two hours into the burnout, otherwise the wax will catch fire several hours later, and you don't want that.

Pouring (casting the metal). For me, this is the *fun* part of the process. It's hot and heavy, and for pouring bronze even a 'one man' pocket foundry should have two people participate in lifting the crucible out of the furnace with foundry tongs, and pouring the metal with the crucible held in the shank. I have designed a system, which enables one person to manage, but I prefer to have a helper because it's faster with a two-man shank, and you have more control.

The Furnace. Commercially manufactured furnaces for a #20 crucible have a starting cost of around $3000. I prefer the ones I make myself for about $200 in materials. A furnace is nothing more than a cast able refractory lined steel cylinder. I use a steel barrel cut to size. The dimensions are important, and the angle of the pipe inserted for holding the forced air gas blower is critical. You want the flame flow to come in at an angle that will aim in the space between the wall and the crucible. You don't want it to deflect off the wall or crucible. The forced air flame is traveling very fast, and will spin flame around the crucible, creating an even vortex of heat. You need to make a 3" to 5" cast able refractory cement lid, surrounded by a ring of steel, and with a hole in the middle large enough to insert bronze ingot held by tongs through. About 7" works well.

Summary List of Materials	
Compressor	$ 400
TIG Welder	1,000 – 3,000
Furnace	200
Crucible	105
Tongs and shank	400
Miscellaneous Material	500
Supplies	200
Tools	1,000
Total	$3,955 - $5,955

After Casting. As the old foundry man told me, "and now the work *begins*". After the metal is finally and safely in the investment mold, another process begins. It is know as de-vesting the casting, sandblasting, cutting spruing off the sculpture with a body grinder, reciprocating saw, or plasma cutter. You will inspect the metal for flaws in the metal which have to be repaired, and do a lot of precise welding, and metal grinding and chasing with an assortment of grinding and pneumatic tools. The key equipment required for this part of the process are an upright air compressor (a 60 gallon, 5 horsepower compressor will suffice, at about $400 up), and a helix arc (TIG) welding machine, which uses an argon gas tank from your local welders supply, and usually requires a 220 outlet with a special plug configuration.

I prefer Miller welding machines. A machine, which you will never regret, having bought starts at about $3000. You can get by with machines that sell for a little over $1000. There is now way to make your own, and this is the most expensive item in my small foundry design. But when you become a proficient welder with a TIG, you will be able to do a lot more with it than just sculpture welding. And as I mentioned earlier, you can save a lot by making much of your own foundry equipment with it.

A thousand questions: This has been a *very* brief outline of the basic processes and equipment required for a small bronze-casting foundry. Each aspect requires a lot of practice, and if possible, training by those who have years of experience doing it every day. The best place to begin is to look for foundries and schools who teach either casting or welding in your area. Many community colleges have welding classes.

Lists of schools and suppliers are too numerous to mention here, but you may find further information on my website at: http://www.danielbutler.com or go directly to the small foundry information page at: http://www.danielbutler.com/WORKSHOPS/Foundry_.htm

Daniel Butler is an accomplished figurative sculptor and qualified bronze sculpture Artisan. He has 14-years of commercial art foundry experience with large and small operations throughout the United States, including the internationally known Shidoni Foundry in Tesuque, New