# 4

# Hazards of Working in Concrete

There are serious hazards and health effects involved in some of these processes and materials and it is your responsibility to educate yourself about these hazards. This statement is not meant to dissuade you from working in concrete but it is a plea to be careful and inform yourself of the potential hazards. This chapter is only a starting point. Further details are available throughout the **MATERIALS** sections. Look for this symbol:


Please read the disclaimer at the beginning of this book.

Educate yourself about each of the materials you use by carefully reading the hazard warnings on the label, then follow that up with the MSDS (Material Safety Data Sheets). You can get these from the supplier where you purchased the product, or you can find them easily on the Internet searching for such terms as: 'MSDS Portland cement' or 'Material Safety Data Sheet' + 'fly ash'.

Concrete and Portland cement are **not** suitable materials for unsupervised children's art projects.

## General Guidelines

Dust is a major problem in concrete projects. There is dust from cement, dry aggregates, both stone and sand, dust from other materials, admixtures and pigments, and most of these materials have hazards. Dust is thrown up from pouring, measuring and mixing these dry ingredients. Dust from cement can contain crystalline silica dust. Wear a mask, and make sure the mask (respirator) is approved for these dusts. If you are not sure, go to your local safety equipment and clothing supplier and explain to them what you need the respirator for. Make sure your mask is kept in a sealed bag or container when not in use. Wear waterproof gloves and long sleeves, as a lot of these

dusts can be skin irritants. Wear eye protection as some of these dusts are eye irritants and can cause damage. Keep the workplace as free from dust as possible.

Store all materials and chemicals out of the way of children. Keep hazardous materials in non-food containers, and label them clearly.

When wet, Portland cement is extremely caustic and can burn your skin, so wear eye protection to prevent splatters, gloves and long sleeves to prevent skin contact. If you get it on your skin wash it immediately with soap and water. Use a barrier cream on your skin as an extra precaution before you put on protective gloves. Lack of pain is not an indicator that the cement is harmless. If you get it on your clothes, change them; otherwise the unset cement can continue to burn your skin. Third-degree burns are possible. More information in the **MATERIALS** sections and the MSDS in the **GLOSSARY**.


Some safety equipment: rubber and latex gloves, hearing protectors, safety glasses, toxic dust mask, nuisance dust mask.

## For Further Reference

- ***Material Safety Data Sheets*** (MSDS) are available for any material that you buy that has safety issues.
- ***Artist Beware*** by Michael McCann, Lyons and Burford, New York, 1993. ISBN 1558211756.
- ***The Artist's Complete Health & Safety Guide*** by Monona Rossol, Allworth Press, 2001. ISBN 1880559188.

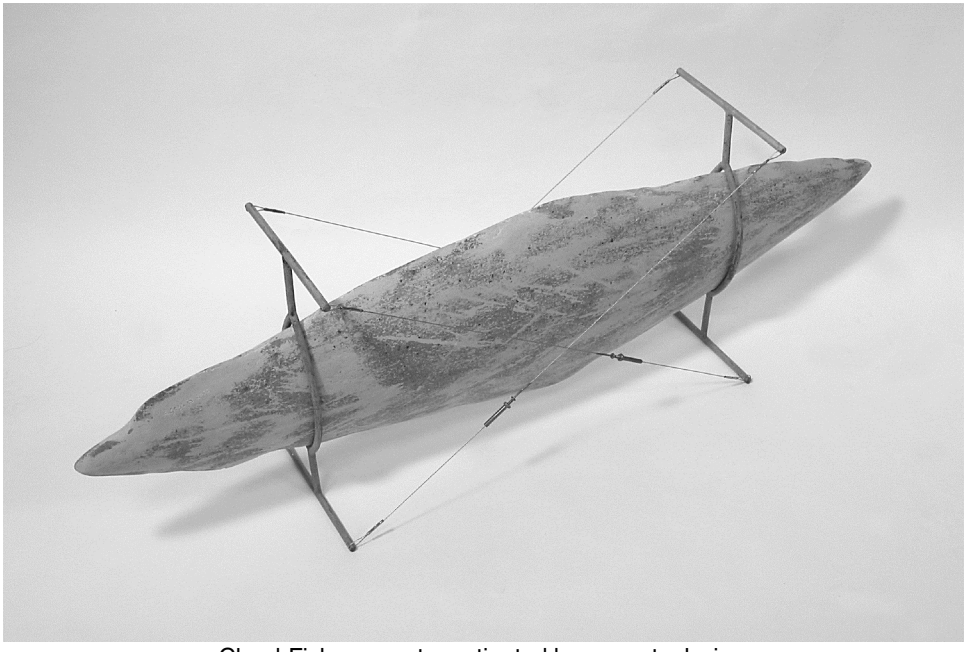
# 10b

# Mesh: Step by Step

This section shows how to apply layers of concrete onto the *outside* of a pre-made form. Various materials can be used to rough out the three-dimensional form:

- Carving a block of expanded polystyrene, foamboard or Styrofoam®
- Cutting and taping together pieces of cardboard
- Cutting and taping together cut pieces of corrugated plastic (Coroplast®)

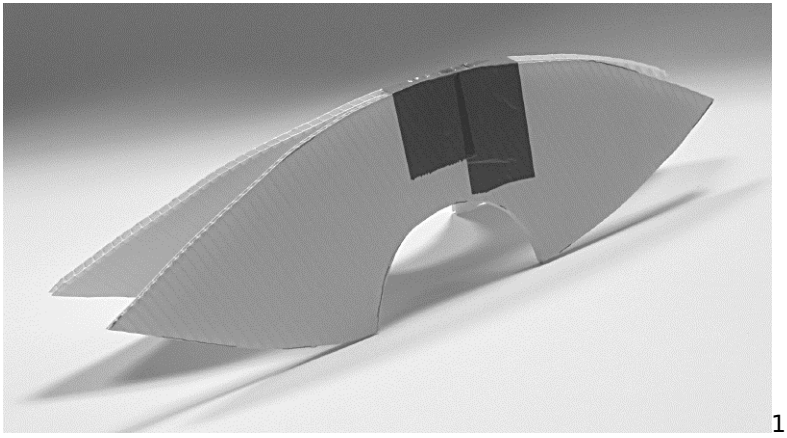
Steel mesh is then cut to wrap or enclose the form, tied together with wire. Concrete is applied in successive layers, gradually refining the shape. This was the technique used in the concrete portion of the sculpture below.



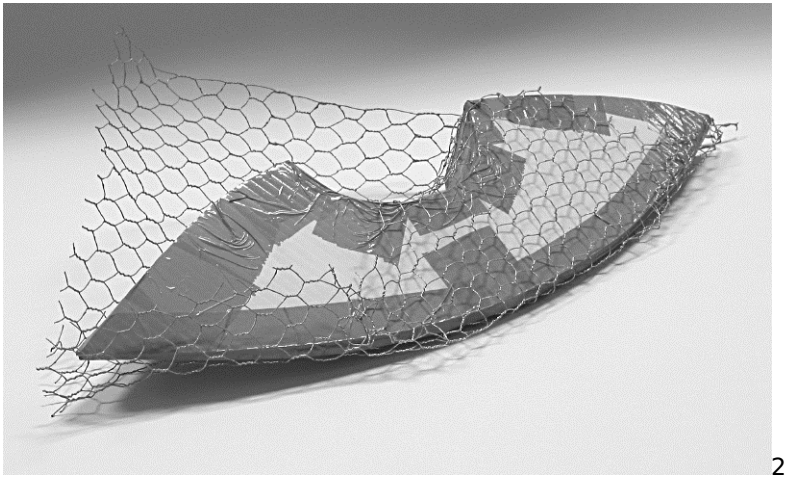
Cloud-Fish: concrete, patinated bronze, steel wire.
10" X 31" X 6" (25 cm X 79 cm X 15 cm), 1999. A. Goss.

## Process #1

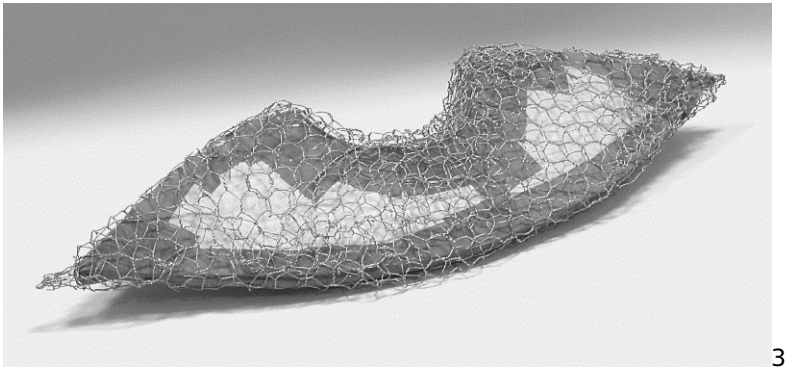
First, parts are cut out of plastic board to make a hollow three-dimensional form. Old election campaign signs work well. Strong cardboard can also be used. This method is particularly suited to making forms that have strong planes.


1

The parts are taped together into a three-dimensional form using packing tape, masking tape or duct tape. (1) The corrugated plastic is easy to bend into curves and hold with more tape. If you use cardboard you must completely cover it in waterproof tape. Remember that the structure has to hold together, while wet, for about 24 hours until the concrete sets.


2

Steel mesh is wrapped around the form, which is now a hollow three-dimensional shape. (2) You can use chicken wire, expanded mesh or hardware cloth. The joins are tied together with binding wire. Loose ends are tucked in using pliers. With the thinner mesh like this chicken wire, you may need two or three layers for strength. (3)

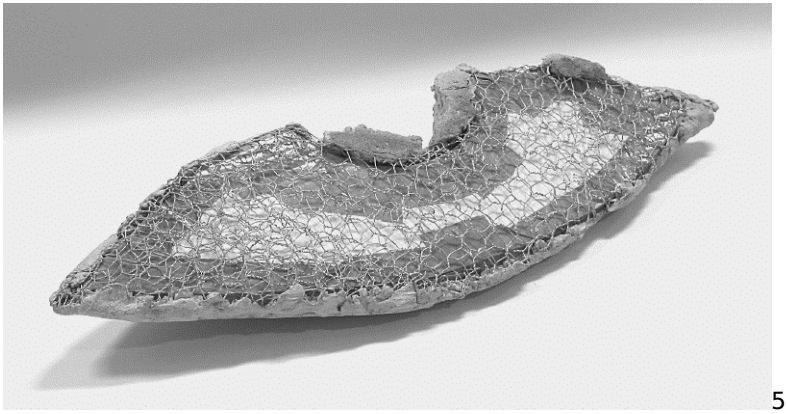


3

Mix the concrete – see Mesh Sculpture mix in the **MIX** chapter. Apply it by hand. Wear rubber gloves (please read the **HAZARDS** and **MATERIALS** chapters if you haven't already done so!) and push it through and around the mesh. You want a mix that is clay-like; if you make a ball with it, the ball should hold together, not slump too much. If it's too wet or too dry the mix will not stick to the wire. Remember that if the mix is too wet it will be weak. The wire must be completely surrounded and in contact with the concrete. Overlap each section of wet concrete you apply, so the join-line areas are well mashed together.

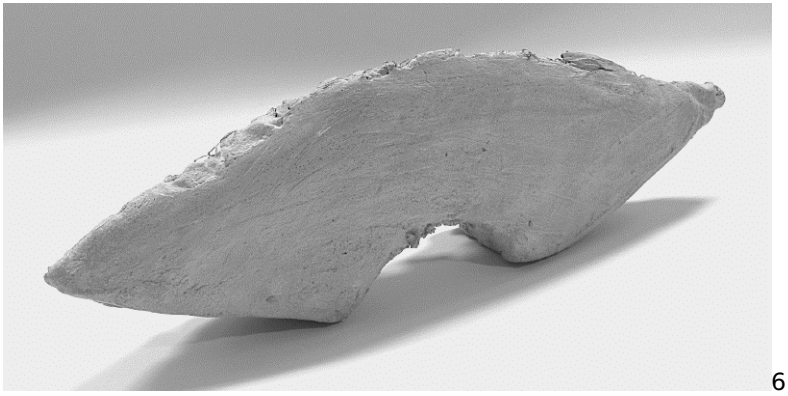
4

The concrete is applied to one side of the form and should be about .5 cm to 1 cm (1/2") thick. (4) It is difficult to get the concrete to hold upside down, so after completing the top, side and most of the vertical parts, leave the piece for 12 to 24 hours. Cover it in plastic to prevent water loss.



5

After the concrete has set on that first side you may want to rough sand or file it. If it looks dry, spray it with a mist of water. Flip the piece over – it looks like this. (5) Now mix up more concrete and apply it to this side. Cover and let it set for another 12 to 24 hours.



6

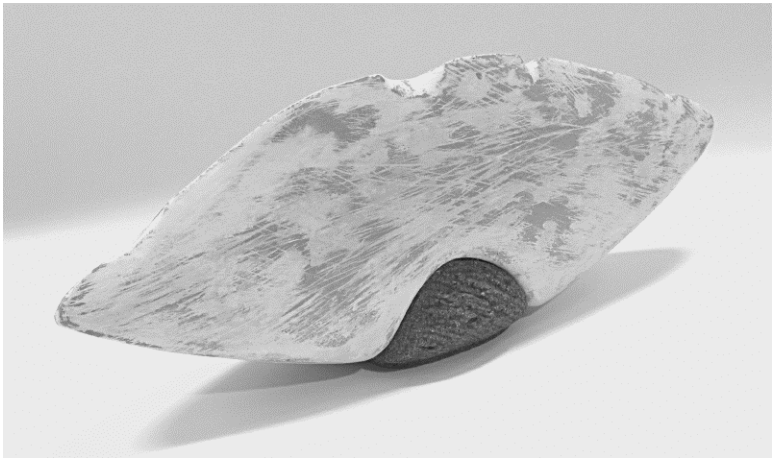
The first layer has been applied to both sides. (6) Rough sand (16 to 24 grit) or file it with a rasp to obtain the rough shape you want. At this point it should be hard enough not to break and soft enough to sand. (Wear gloves and a mask.) Don't let the concrete dry out: keep it damp with a mist of water from a spray bottle.

7

After sanding, wash off the concrete to get rid of the dust, remove excess water and apply a second layer of concrete (.5 to 1 cm) to the top surfaces. (If you have waited more than a couple of days, you can increase adhesion of the second layer by painting on a slurry of Portland cement and latex solution before adding the second layer.) This second layer can be textured before or after the set, to provide "tooth" for the third layer, and visual interest. Let it set for 12 to 24 hours, covered. The second layer means the concrete is now 1 to 2 cm thick on the one side. After it has set, sand it, flip the piece, and apply the second layer to the reverse side. Again, the surface can be textured. The form should now be very close to the final shape you want.

Mix up a third and final smooth concrete mix (see Smooth Coating in the **MIXES** section) if you want a dense or polished surface. This final mix can be a different colour. Apply this mix to one side with a trowel, spatula or smooth rubber gloves. You may be able to do all sides at once with this thin layer. Let it set. Except for filling minor blemishes you are now finished applying concrete. See also the **SURFACE FINISHING** chapter for details about adding material.

Wet sand all surfaces with a wet/dry sand paper, emery paper, or corundum paper (120 through to 400 grit) if you want a smooth surface. You can sand through parts of the last layer to reveal the base colour underneath. If fibres show above the surface at this stage, you can burn them off with a small propane torch, being careful not to get the concrete too hot. The piece should then be covered and kept damp for a week or longer, then sanded again (400 or 600 grit) to remove stains, and then dried and sealed.



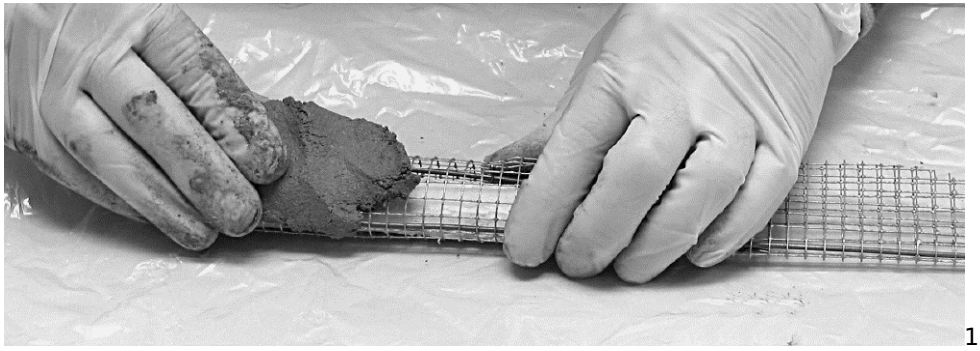
Sculpture: concrete, 7" X 21" X 4" (17 cm X 54 cm X 10 cm) , 2000. A. Goss

In the completed piece shown here I used a white final smooth coat over a grey body and sanded through the white to reveal tool marks. Then I cast a small base for the sculpture – the dark piece – and later joined the two pieces together with silicone adhesive.

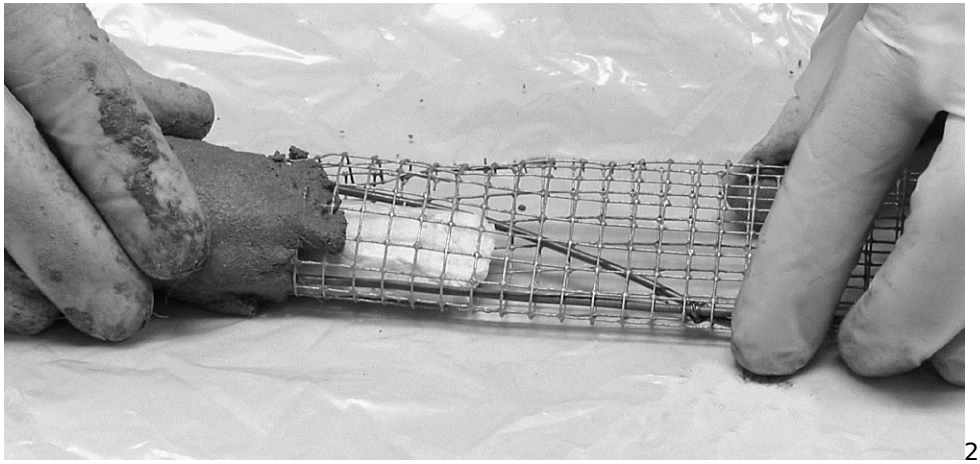
## Process #2

Concrete Knife: 14" (35 cm), 2002. A. Goss

The following series of photographs illustrates the steps in applying a smooth mix to a smaller armature. This knife shape has a flat blade area and a round handle. I made it as a technical challenge, but I also like the aesthetic of making such an object in an unexpected material. The handle has foam in the middle to create a hollow core, with the reinforcing mesh running close to the surface. A stronger piece of steel rod traces the edge of the armature and gives it rigidity. (See **STRESSES AND STRENGTH** chapter for an illustration.) The mesh is wired to itself and to the rod with pieces of wire. Sharp ends are bent under.


1

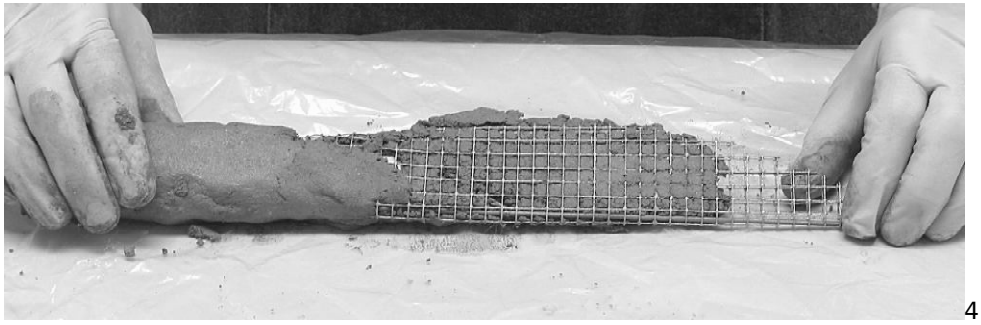
Apply a smooth concrete to the small mesh form by pushing it well into the wire to completely cover and surround it (1). The foam core stops the mix from being pushed to the other side. On the blade part you must use your own fingers to stop the mix from being pushed through.


2

More detail (2) showing the mesh, the steel rod, foam, and the concrete pushed into place. Try and cover all the wire in this first step.

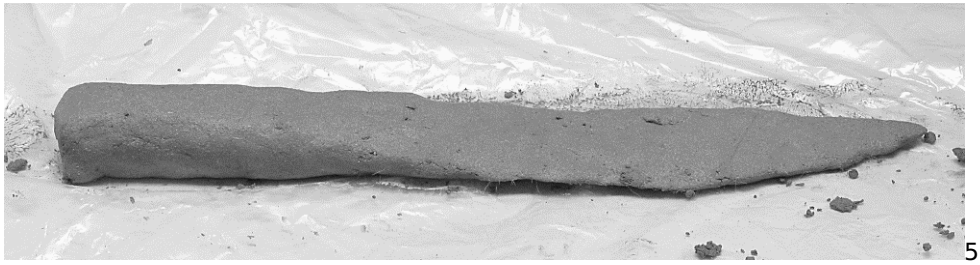
3

Close up (3) showing how the concrete is pushed through and under the wire mesh. Try and get rid of all air spaces so all the steel is contacted by concrete on all sides.



4

Finish applying the concrete to the "blade" part of the form (4). Notice how the mesh is almost buried on the one side.



5

Completely coat the armature with concrete on all sides (5). No steel shows through. If your mix is the right consistency you can do all sides in this first procedure. If it's too dry it won't contact the mesh properly; if too wet it will fall off.

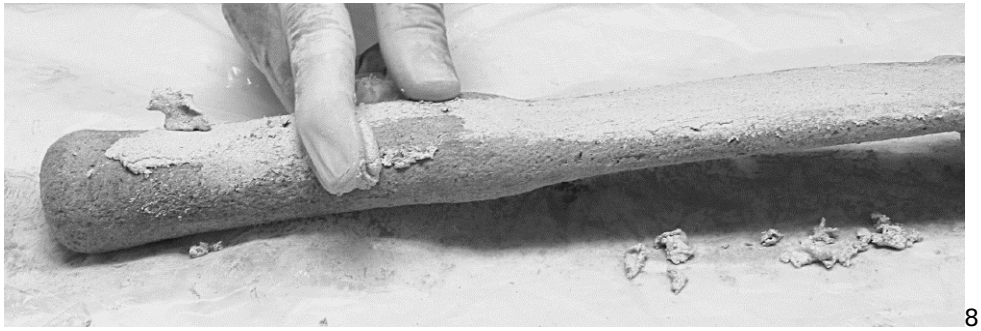
6

After more material is added to the handle, the form is wrapped in plastic wrap (6) to let it set for 12 to 24 hours. You want to remove the plastic when the concrete is:

1. hard enough to be resistant to breaking and
2. still soft enough to grind easily.

7

After this initial set, use a 16 to 24 grit heavy sandpaper wrapped around a piece of wood to shape and refine the form. (7) You are trying to define the form clearly without worrying about surface finish



8

After dampening the surface (not wet – you are just trying to stop the concrete from pulling moisture from the new mix) you can add a smoother mix by rubbing it into the surface with rubber gloves. (8) Apply enough pressure to force the mix into any holes or crevices. Larger pieces might need a small trowel or a flexible putty knife to do this. When completely covered with this smooth mix, wrap again in plastic for 12 to 24 hours making sure after the first few hours that it is damp enough.

After wet sanding with 120 to 180 grit any protruding fibres can be burned off with a small propane torch, being careful not to overheat the surface. Then the piece is wrapped and kept damp for several more days, wet sanded with 400 grit, dried, sealed and waxed.

## Connections

In all concrete work, connections to other materials or other concrete pieces must be planned in advance. There are several possibilities:

- Shape the work itself so that a metal or other structural piece will fit in a groove or some other shape to provide a mechanical connection. See *Cloud-Fish* sculpture at the beginning of this chapter or *Grooved Pendant* on page 61.
- Cast or imbed metal fittings in place. These could be bolts, threaded tubes, eyehooks, or solid metal that could later be drilled or tapped. Brass, bronze, stainless steel or galvanized steel are all suitable materials.
- Cast or imbed small blocks or cylinders of plastic foam in place. Later these can be cut out and the holes used for mechanical connections held in place with glue or cement paste.
- Concrete objects sitting on furniture may need protective bases such as cork or rubber. Use contact cement.
- For joining concrete parts together, use imbedded metal connections described above or adhesives such as contact cement, silicone or epoxy glue.
- After concrete has set, a concrete bit can be used in a power drill to drill holes. A connecting device such as a bolt could then be epoxy-glued into the hole. (Casting the bolt in place is a stronger alternative than this.)

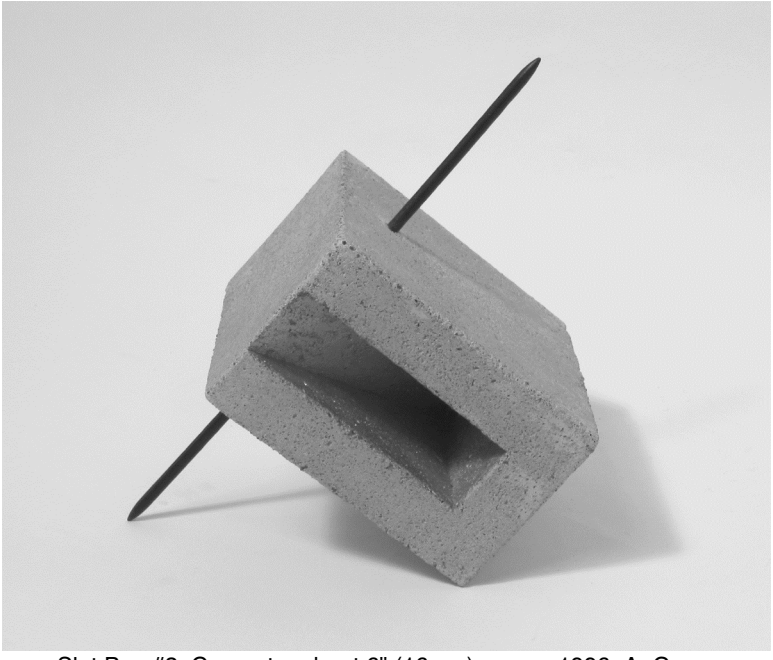
# 10c

# Casting: Simple Shapes

This is a description of simple casting. These processes could be used for casting shapes that are to be carved, or for final simple shapes. Casting of detailed, reproducible forms in plaster or flexible moulds is a highly specialized area and will not be covered in this book. (See **BOOKS** section for further references.)

The basic principle is to create a negative space that is filled with concrete. Any number of materials can be used that have the following characteristics:

- strong enough to resist the weight of wet concrete
- waterproof or able to be waterproofed
- easily assembled and disassembled when the concrete has set, or flexible

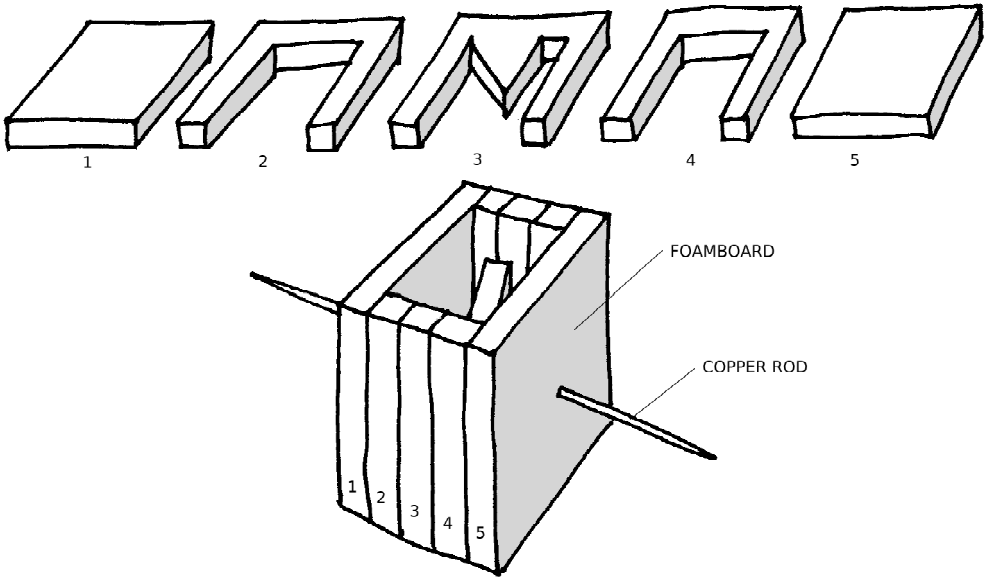


Slot Box #2. Concrete, about 6" (16 cm) across,1996. A. Goss.

A variety of mixes are used for different purposes. A cement and sand mix (1:1 or 1:2) can be used for the basic cast shape, followed by a cement mix with no aggregate or a very fine admixture (such as stone dust or metakaolin) for patching and finishing. [See the **MIXES** chapter for more details.]

## Foamboard

For casting geometric forms like these, I use expanded polystyrene insulation, also known as Styrofoam®, or foamboard. It can be cut quickly with a sharp utility knife, or accurately with a scroll saw with a fine blade. This method is particularly suited to simple geometric forms. In the diagram below, five layers of 1" (2.2 cm) polystyrene are sandwiched together using double-sided tape and duct tape on the outside to hold it all together. Adhesive made for foam insulation can also be used. A forged copper rod was cast in place. When you are embedding metal or other materials in concrete always make sure there is a mechanical bond; in this case I filed grooves in the copper.



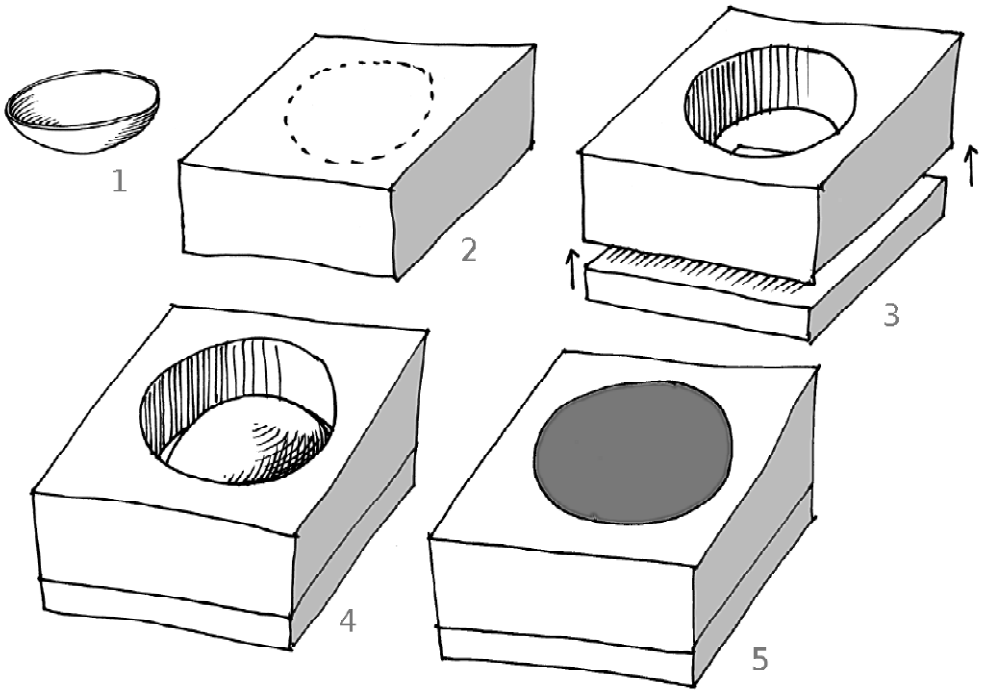

Top: foamboard pieces are cut and stacked. Bottom: assembled waste mould for Slot Box.

This is a one-off mould process, also called a waste mould. The mould is broken to release the concrete. The mix for casting should be wet enough to slump in the mould, to fill corners and spaces, but not so wet that it weakens the end result. The mix I used was a hardware store "sand mix" with added polypropylene fibres (loose) and latex solution (1:3 latex:water). The mix is tamped into the mould using pieces of wood, and tapped lightly on the outside to release air bubbles. (A power palm sander makes a good small vibrator for this scale of work.) Cover the exposed concrete with plastic sheet.

After two days the mould is broken open by releasing the tape. The foamboard that makes the slot (piece #3 in the diagram) has to be broken out.

## Bowls

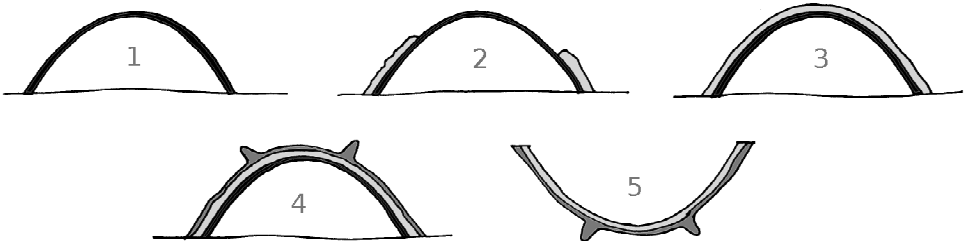
A mould for a bowl form can be made from foamboard and a bowl, as shown below. Any bowl form, such as a mixing bowl, will work as long as it has enough flexibility to be pried from the concrete after it has set (1). A circular cut is made in thick foamboard (you can laminate thinner pieces together with foamboard adhesive to make thick pieces). This is glued or taped onto a base piece (2 and 3). The bowl form is turned upside down inside the cutout circle for the negative part of the form (4).




A concrete mix is placed in the mould (5). After it sets the foamboard is broken apart to release the concrete. Then the original bowl is removed. This mould produces a bowl with a flat bottom.

Concrete bowl: cast using the process above. 12" (30 cm) across.

You can also use a bowl form as a one-part mould, and apply the concrete mix to the outside by hand, as was done in the series shown below. A flexible bowl is chosen and inverted on the work surface (1). You might want to cover it with plastic wrap or petroleum jelly as a release agent. A fibre-reinforced mix (glass fibres work well here) is applied starting at the bottom and building it up about 1 cm (1/2") thick, overlapping sections as you go (2). See the **MESH** chapter as this technique is similar to the layer building in that process. When the bowl form is completely covered in concrete (3), cover with plastic and let it set 24 hours. Uncover, make sure the first layer is not dry and add another layer of mix (4). You can shape feet or a rim at this stage.




Cross-section series of forming a bowl over a bowl mould.

After another 24 hours, turn the mould and the concrete upside down and carefully remove the original bowl (5). You can shape the rim with a rasp or coarse sandpaper at this stage and add a smooth layer of mix to the inside and outside.

An alternative method for making concrete vessels or containers is to place the concrete mix on the *inside* of the mould, building it up from the bottom. For these thin-walled forms you must use fibre reinforcing in the mix, or embed steel mesh.

Left, plastic form. Right: three-footed concrete bowl, 13" (32 cm). 1999. A. Goss

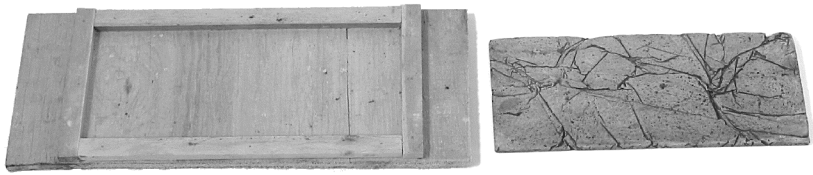
The three-footed bowl on the right was made using the technique above, applying a glass fibre concrete mix to the outside of an inverted plastic half-spherical bowl, shown on the left. (This is actually a squirrel guard for a bird feeder.) The initial thin layer applied against the form was a combination of white and grey Portland cements. The second layer was a grey mix of cement, sand and alkali resistant glass fibres. The feet were moulded by hand at this stage. The third layer was pigmented black and rubbed on. Total thickness is about 1 cm (1/2").

Bowl: concrete, 12" (30 cm), 1999. A. Goss

The bowl above was made of glass reinforced concrete applied by hand over an inverted bowl form also made of concrete. Rubber non-skid material was pressed into the wet concrete to make the outside texture.

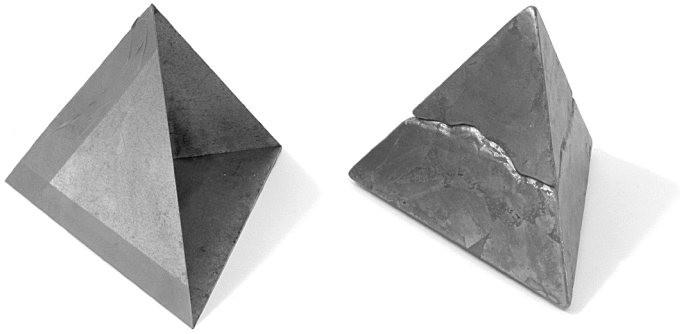
## Wood and Metal

Moulds can be made out of wood and sheet metal (such as galvanized steel used for roof flashings and stovepipes) either alone or together. The steel gives a smooth planar surface and the wood acts as a support. I use packing tape or duct tape as a way of temporarily holding the mould together. Large moulds would need screws or nails.

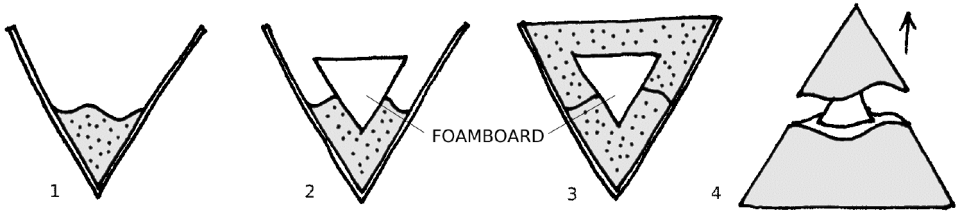


This is a suitable mould for making tiles, made with thin strips of wood and plywood. A cast tile is on the right. The mould was lined with plastic sheet that was wrinkled to give the texture. Surface stains were used to exaggerate the depth of the texture.

This is a simple small wooden mould used to make the concrete frame piece shown in the **MIXES** section: Feather #2. It was made from 1" X 2" pine, spray-painted to make it waterproof. The wood could also be shellacked. The foamboard pieces in the middle made the negative space, and were cut to come apart without breaking. They also held the silver wire that was embedded in the concrete to hold the pin.



Simple moulds can be made from sheet metal, held together with plastic packing tape. In this concrete box, galvanized steel sheet (left) was used to cast the tetrahedral form. Carved foamboard was used to create the negative space in the box and cut out later. To keep the lid as a separate piece, the box was cast in two stages (see drawings below).




Process used to make the tetrahedral box shown above. 1. Sheet metal mould partially filled with concrete. 2. Foamboard piece to make hollow space is pushed into place. 3. After concrete has set, release agent is applied to exposed concrete and the rest of the concrete is added. 4. Mould is removed, concrete lid is removed, and the foamboard is cut out.

These images shows the same process: left, sheet metal parts for curved form; middle, metal held together with tape; right, the final form. These pieces are about 8" (20 cm) in size. To prevent distortion, this mould and the tetrahedral one above required extra support when casting, such as supporting the mould in sand or a wooden frame.

## Miscellaneous

The number of things in which you can cast concrete is limited only by your imagination. Remember that the material has to be strong, waterproof and easy to disassemble, or at least flexible. Think of things that can be nailed or screwed together, things that can be taped or glued together. In producing really small pieces like jewellery, strength may not even matter in the mould material.

I use modelling clay (Plasticene®) to make a negative mould for jewellery-scale pieces. It releases quite well from the concrete, but first make sure that the concrete is hard enough to withstand the stress of pulling it off. A release agent like petroleum jelly helps. You can use sheets of modelling clay to form textures and drawings in combination with wooden moulds to make relief tiles as well.

You can also use pottery clay and cast into it while it is still damp. If you let it dry it will absorb too much water from the concrete. It should be slightly softer than what potters describe as "leather hard." Depending on scale you may need to reinforce the mould. This supporting structure could be made of wood – waterproofed with a sealer of some sort – or plaster. After releasing the concrete you can wash off the clay that sticks to the surface.

Damp sand can be used to quickly make simple moulds, modelling the shape in reverse. The moisture helps it hold together and also stops water in the concrete mix from being wicked out. You can also line the mould with plastic wrap, if you are going to rework or add to the surface of the finished piece.

There are many flexible rubber and plastic mat materials sold in hardware stores. Some have textures that are interesting. But even without texture these materials can make flexible moulds. They can also be used to line other moulds to make them waterproof.

Various plastic forms can be cut apart and taped back together (if necessary) and used as moulds for either casting or forming concrete against the surface. Such shapes as bowls, storage containers and planters can be used. After the concrete has set, remove the tape and the plastic form.

## Connections

See the end of the **MESH** chapter for connection solutions.

## Mould Releases

See the end of the **OTHER MATERIALS** chapter 5c for mould releases.