

Craft & Technique

YOU CAN MAKE A CANOPY FOR your project two ways. You can pneumatically form the plastic sheet in a mold or form (commonly called "blowing" a canopy), or you can draw a sheet of plastic over a form.

Both methods have advantages and disadvantages. A blown canopy is generally free of defects that cause visual distortions, and usually one person can perform the task. But, the canopy's shape is difficult to control, the thickness of the plastic varies, and you shouldn't glue the formed plastic because of crazing.

A drawn canopy does not alter the plastic's thickness, you can use a smaller sheet of plastic than you would if you were blowing the same canopy, and you don't need as large of an oven to warm the plastic before drawing (or blowing) it. But, when drawing a canopy the plastic's temperature must be just right to avoid the possibility of rips and distortion-causing ripples, and the task can require up to four people.

Blowing a Canopy

To blow a canopy the first thing you need is an oven in which to heat the plastic sheet. Your oven must be large enough to hold your finished canopy, with room to spare. My oven measured 4-foot square by 10 feet long and could handle a 38-by-96-inch sheet of plastic.

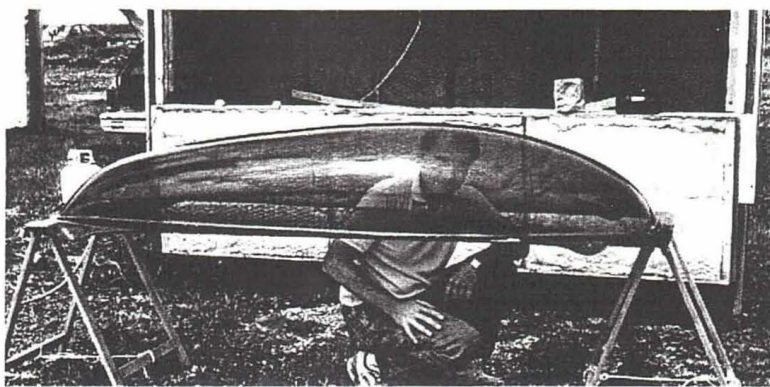
Making the oven of ordinary plywood, I lined the interior with Fiberglas batting, held in place with chicken wire, to insulate the cabi-

Blowing Your Own

Making an aircraft canopy

PAUL MOFFAT, EAA 602025

Before heating the plastic, prepare a female mold that matches the aircraft structure the canopy must fit so you can bring the outline shape in line with the finished surface.



Before blowing the final version of the canopy we created this test version (and used a plastic sheet too small for the airplane).

net. Using the heat-resistant glass from an old lamp, I put an inspec-

tion window in one side of the oven, and I put a lamp inside so I could inspect the blowing process.

Almost any readily available heat source will work with the oven, and I used a 200 KBTU propane torch heater. I located it at the center bottom of the oven and used an air recirculating blower to keep the air moving. Just above the plane where the plastic sheet would go I located a temperature gauge. For the acrylic to blow freely the oven needs to reach 325°F.

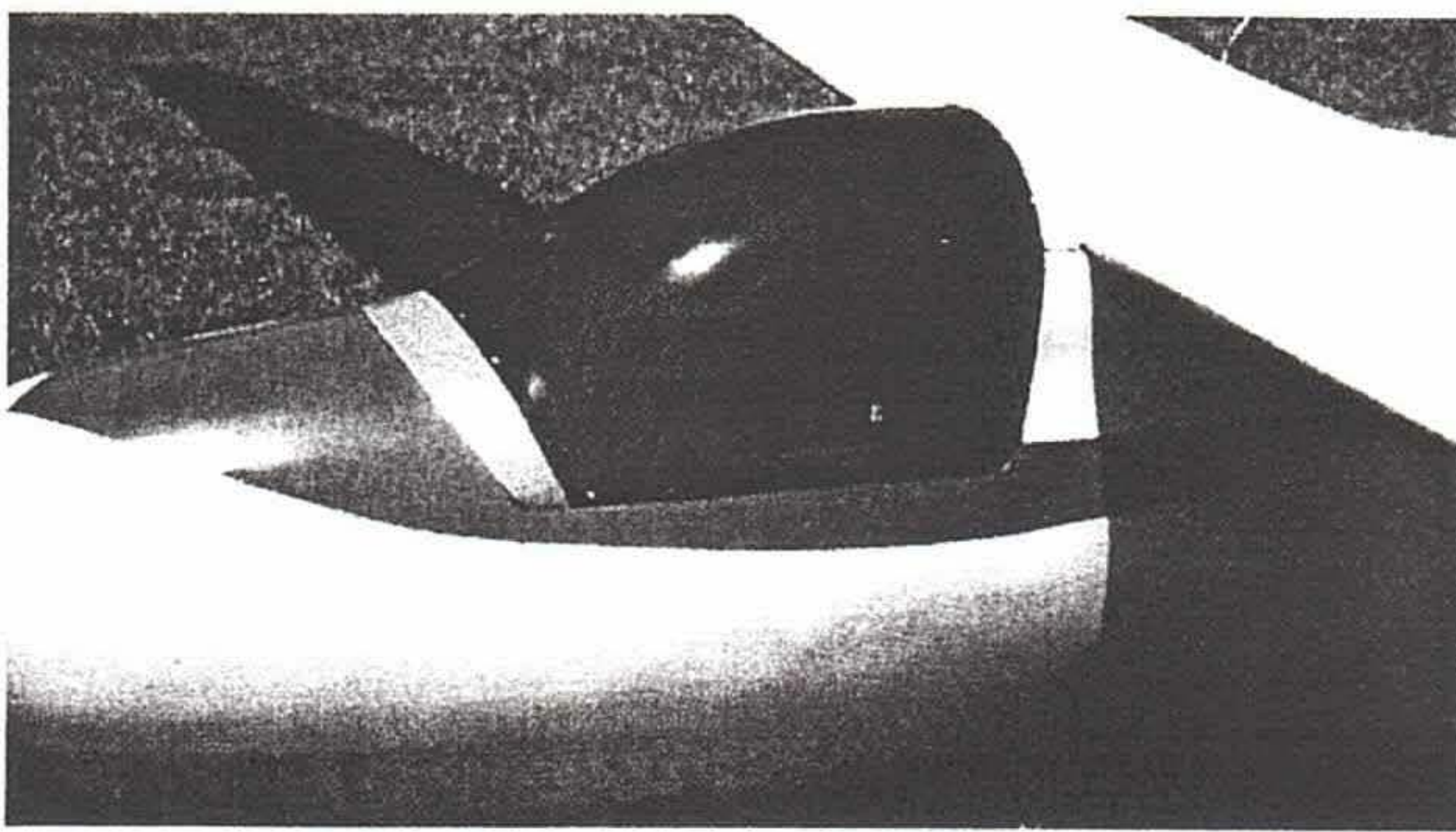
The plastic sheet is attached to a flat sheet of plywood with the pattern retainers, which are pieces of wood screwed in place that outline the shape of the canopy's base (and also determine its vertical dimensions and shape). In the bottom of the plywood base is a 1/4-inch steel tube that introduces that air that blows the canopy.

When attaching the plastic to the plywood base, creating an airtight seal with the retainers is important because a leak will require more pressure to blow the canopy. A leak will also create a cold spot that

causes distortion. When blowing the canopy the air pressure only needs to be about 10 psi, and I control it with a needle valve and measure it with a low pressure gauge.

Before heating the plastic start a 1 or 2 psi flow of air under the plastic to lift it off the plywood, which keeps you from having a plywood-grained canopy.

The plastic sheet should be about 1.5 times thicker than the target, but



We formed this canopy by pulling a sheet of plastic over a mold.

screw points.

Before heating the plastic, prepare a female mold that matches the aircraft structure the canopy

two times may be more practical.

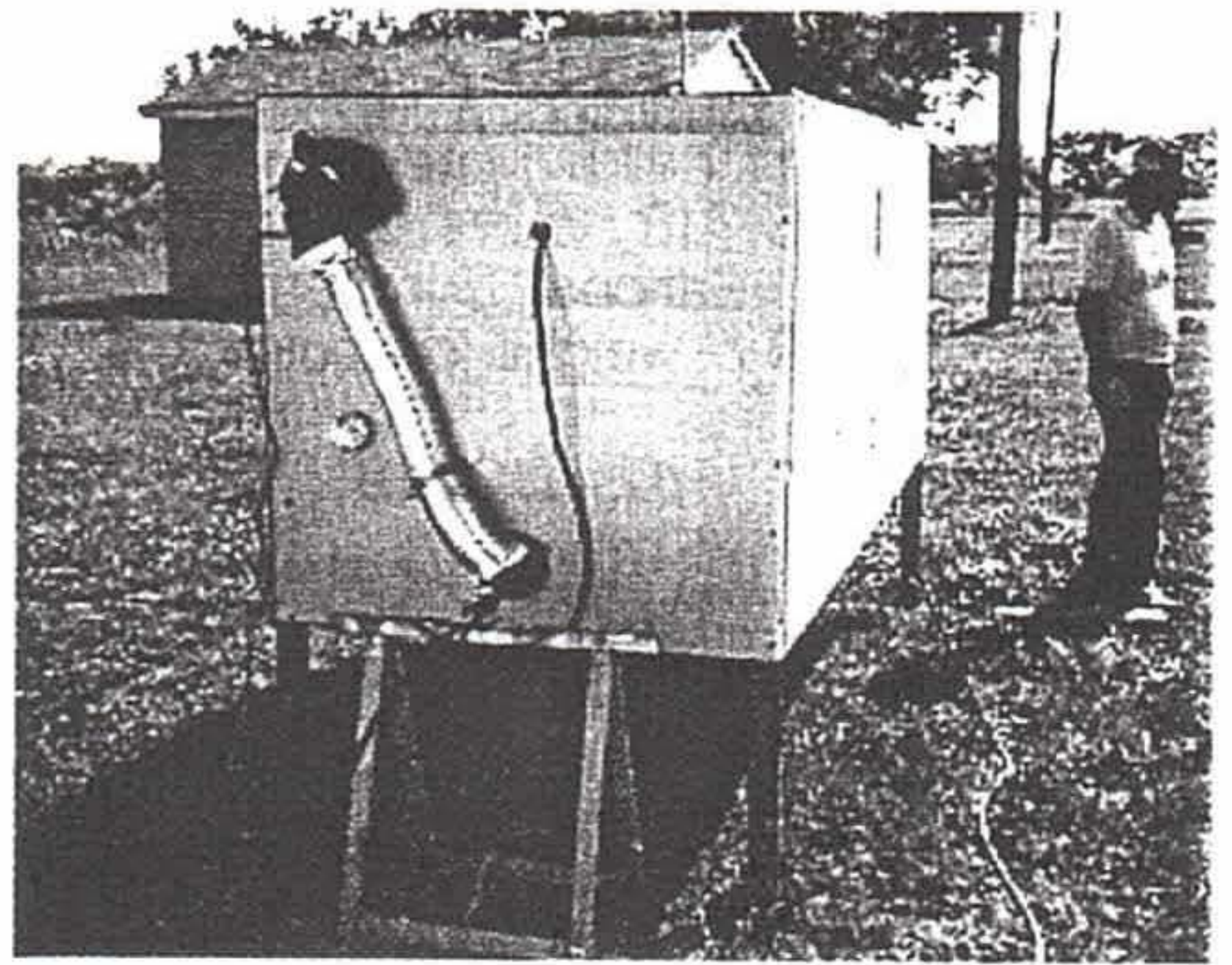
Blowing a Shape

When blown, the plastic wants to follow a spherical shape, which may be far from the shape you desire. To get the shape you want, use this concept: The desired *height* equals the *radius* on the plywood. If you attempt to shape the plastic according to the outline of the retaining frame, the plastic will become grossly overblown.

As shown in Figure 1, the desired portion is a small part of the whole sheet. To preserve the desired shape the excess room would be best used for a second canopy. The retaining clamp follows the outline and is securely screwed to the sheet below. To keep the form airtight and to prevent blowouts, you'll need a lot of screws. A screw every 2 inches is adequate.

NOTE: After you blow the canopy remove the screws as soon as the plastic is firm. Depending on the grade of plastic, the sheet will shrink almost 2 inches over an 8-foot length. If the plastic is still screwed in place, it will split at one or more

must fit so you can bring the outline shape in line with the finished surface. This mold should have all surfaces that may contact the plastic.



Your oven must be large enough to hold your finished canopy, with room to spare. My oven measured 4-foot square by 10 feet long.

To prevent scratching, cover the female mold in soft felt that is liberally covered in grease. (Bacon fat works well and is easily removed.)

Without this female mold and final step, the finished canopy may split as you draw it to the frame. The forming is made easier if the mold is hinged on the top and closes over the bubble like a clamshell. That will avoid scrapes if the frame is pulled

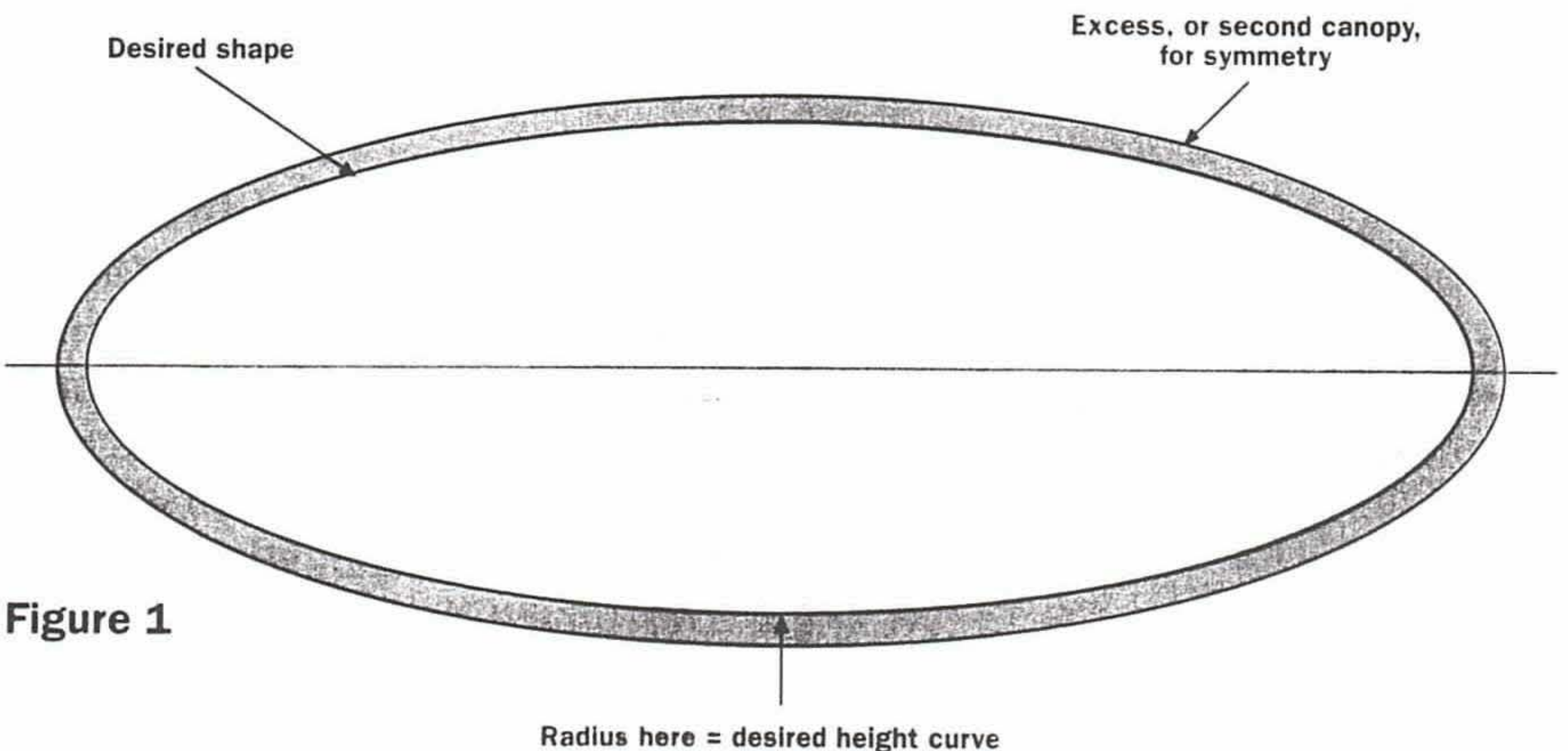
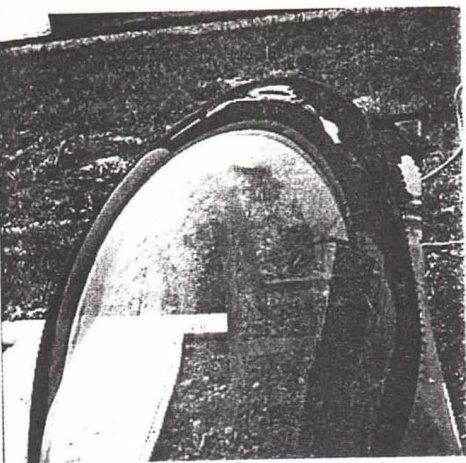


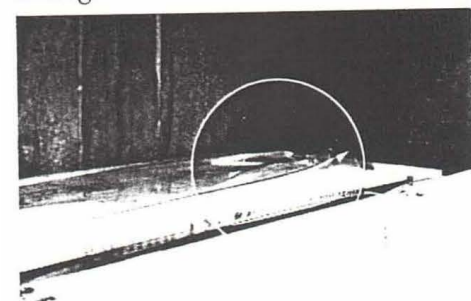
Figure 1



This is my first successful canopy (on my second overall attempt) from the oven. Just visible in the top is a cold spot. This is the same canopy pictured at the start of the article.

down over the plastic.

Blown Plexiglas is more prone to cracking from added stress lines, so do not glue it with any solvent-based cement because the adhesive will craze the plastic. Silicone or other glues such as Goop work well. Goop is especially adhesive, and the plastic may never be separated on curing.



This is a blowout, which was caused by using too thin a sheet of plastic and the existence of a hot spot at the far end of the canopy.

By the Numbers

Once you have all the forms and patterns ready, check the plastic's airtight seal by applying around 8 psi of air pressure and closing the valve. If the pressure remains constant, you've got an airtight seal. If it doesn't hold, find and fix the leak.

To mark the canopy's target height I used a small wire hanger from the oven's ceiling. When the

plastic just reaches the marker I turn off the air pressure and open the oven to start the cooling process.

Start with a 1/4-inch acrylic sheet. The medium thickness at the peak will reduce the thickness to about 0.100 inch. You can use tinted plastic, but the tint will lighten because blowing thins the plastic.

By the numbers:

1. Heat the oven to 325°F and let the plastic soak for 20 to 30 minutes (20 minutes seems right for 1/4-inch plastic). The sheet should have only 1 psi on it to lift it off the plywood.

2. Turn off the heat and let the plastic "relax" for about five minutes.

3. Now start slowly blowing the canopy to the desired height. Slow down the pressure rate as the sheet nears the marker. The oven will heat the air in the form, causing it to expand and add to the blowing process.

4. Once the canopy reaches the desired height, wait a minute or so and then open the oven to start the cooling process.

5. Pull the sheet out of the oven and slip the frame form over the plastic to shape the peripheral edges. You will have to keep the air pressure up to keep the plastic from collapsing. When pressing your fingers on the plastic no longer deforms it, cooling has progressed to the stage where you can remove the canopy from the form.

Remove all the screws and separate the plastic from the form; hot air will be trapped in the canopy, so take care when lifting it off.

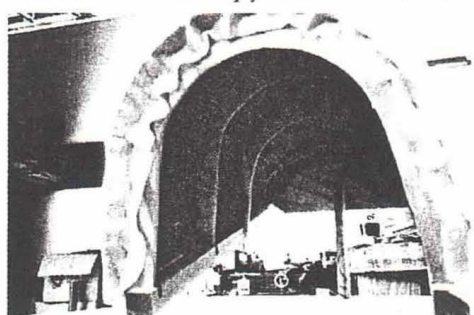
Drawn Canopy

Making a drawn canopy requires you to create a male mold that duplicates the desired canopy

exactly, and you need a way to heat the sheet for forming. The mold must be precise, and every imperfection in its finish will be painfully visible in the final product.

You can build your mold using plywood and wood stringers to create the desired curves. Strive for a mirror finish on your mold because every defect you see or feel will be magnified 10 times in the finished drawn canopy.

Over this mirror finish stretch a release surface. If you don't, the drawn plastic glues itself to the mold. I used felt on my first attempt, and it left ridges in the plastic.



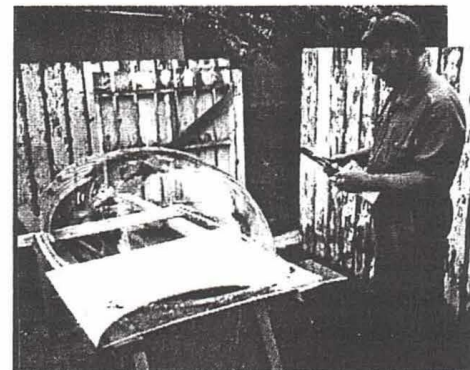
This is the inside of my form, with its bulkheads and stringers. The attached fabric was a failed attempt at a release surface for the plastic. I used felt, and it left ridges in the plastic when we drew the sheet over it.

After numerous experiments I found that a plain cotton bed sheet works best. The higher the thread count the better, but go no lower than 180 to 200 threads per inch.

To heat the plastic I used hot oil. Using an outdoor cooker (turkey fryer), I heated 10 gallons of inexpensive deep-fry oil from Sam's Club

in a metal garbage can. Next to it was a tray that was 3 inches deep and several inches bigger than the sheet of plastic.

After heating the oil to 380°F we poured it into the tray to preheat it. We poured the oil back in the can to reheat the oil, and then poured the oil back into the tray and put the



Cut the finished canopy with a hot knife or a Dremel tool with a cutoff disk.

plastic sheet in the oil. The sheet tends to float on the oil so you have to use some daubers to keep the sheet submerged. Use care with the daubers because the plastic will "remember" this prodding and will retain a mark.

After about five minutes the plastic should be ready for drawing. Just before you and your team of helpers pull the sheet over the mold, pour some hot oil on the mold to preheat its surface. To give us a good grip we added handling rails to the plastic, short stubs of 2-by-2s with bolts that entered holes in the stretching frame. Hot oil dripping on your hands is not nice!

Pulling the sheet over the form takes a lot of force, and this is where your friends come in. Put one on each corner. And you need to work quickly. Because the plastic begins to cool immediately, you've got a minute or two to complete the job. After you've drawn the canopy, remove it from the mold and clean off the oil. If you don't clean the oil off right away, it will leave a "sheen" that's difficult to remove later.

Whether you've blown or drawn your canopy, trimming it is your final step, and you can do this with a hot knife or a Dremel tool and a cut-off disk. A band saw also works. Don't use a jigsaw because the blade can snag the plastic and cause a split. When you mount the canopy, to prevent thermal cracking remember to leave some expansion room around any screws or bolts.

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