BUILD YOUR OWN CUSTOM CASES

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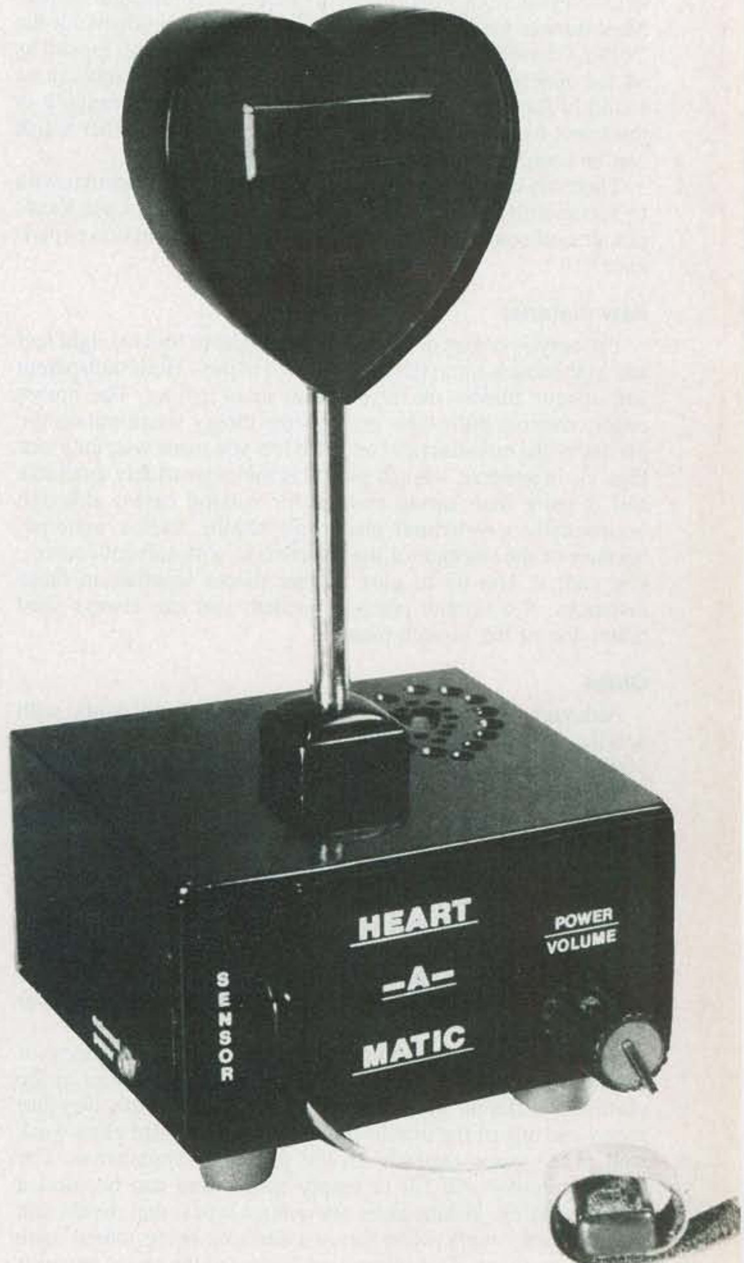
If you want your project to be appreciated by others, it must be packaged properly. Here's how to make custom cases that are sure to get your project the attention it deserves.



IF YOU'VE EVER BUILT AN ELECTRONIC PROJECT YOU KNOW THE feeling. After hours spent at your workbench, the magic moment arrives—you're finished. You go running to the rest of the house and round up the family. You gather them at the table and excitedly demonstrate your new mousetrap. Again and again you send small mechanical mice in and your new invention does all that you promised but no one seems impressed. When you start looking around for real mice the kids go back to watching TV, and your wife shrugs her shoulders, sighs, and leaves the room.

Sound familiar? What went wrong is something that even the most junior executive on Madison Avenue would recognize—poor packaging. It's sad but true. What something looks like is just as important as what it does. If you've spent every evening for a month buried in the back room building a gadget, you've also built something else—expectation.

The mistake you made with your mousetrap was simple. The project wasn't finished when you thought it was. It wasn't packaged properly. If you had spent as much time on the case as you had on the circuit, you would have gotten the desired "oohs" and "ahs" from your family. Unless your project is something for your bench—a special front end for your scope or meter, for example—something that will never see the light of day, the case is as important as the circuit.

You could just stuff everything into a standard chassis box or plastic case but the result will always be the same. A standard box gives a standard appearance. Besides, there is no such animal as a commercially available custom case. Think about that for a while.

Building a case for your project involves as much planning as any other part of the job. Once the circuit has been breadboarded and you've gotten rid of all of the glitches, it's time to consider the case. The first decision you have to make is the shape of its case. Often that will determine the shape of the circuit board and the material you're going to use for the case. Let's go back to our mousetrap. Housing it in a square box would be really boring. The nature of the project is such that it calls for something much more whimsical. We need some sort of box to hold the mice but supposing the actual entrance to the trap were shaped like a cat with its mouth open. Not only would that be eye-catching but chances are that the finished project would be on a table in the living room rather than behind the refrigerator.

Once the shape is decided, we have to choose the material. Metal is an obvious choice but it has its problems. It's hard to shape and harder to work. Unless you have access to a machine shop, precision pieces are going to be very difficult to make. And if you don't weld the different pieces together you're going to have lots of screws and tabs showing. Metal cases also have a nasty habit of shorting parts of the circuit and blowing up those components it took you three and a half weeks to get by mail.

Wood is a possibility. The grain and color are attractive and it's easy to work with standard tools. The problem here is joining pieces together. Screws still have to be used and glue takes a while to dry thoroughly. That means that the pieces will have to be made and fitted together over a period of days. And any curved pieces are going to be a real problem.

Our last alternative is ideal for case making—acrylic plastic. It can be easily cut and shaped using ordinary tools, and solvent cement will immediately bond pieces together. As a matter of fact, the cemented joint is often stronger than the piece itself. The plastic can be bent and shaped by heating it and is extremely forgiving of mistakes. Repeated heating and bending won't even weaken the material. Scratches and abrasions are inevitable when working the plastic but they are easy to sand away. The plastic can be buffed and polished to any degree of luster you want.

Acrylic is available from a wide variety of sources and comes in an overwhelming assortment of thickness, colors, and shapes. Most lumber yards and stores that specialize in products for the "do-it-yourselfer" will carry a good range of acrylic as well as all the material you'll need to work it. The plastic itself can be found in flat sheets, tubes, pipes, and other shapes ranging in thickness from 1/16 to over two inches. Cubes and other solids can be found in every size and color imaginable.

There are a variety of techniques you should be familiar with to successfully work with acrylic. Before trying to use them, practice on some scrap material to get a bit of hands-on experience.

Raw material

The acrylic comes in sheets measuring up to four by eight feet and in thickness up to greater than two inches. Both transparent and opaque plastic are available in many colors. The brown paper covering both sides protects the glossy finish put on the plastic by the manufacturer and also lets you mark your cuts (see Fig. 1). In general, 1/8-inch plastic is the most widely available and is more than strong enough for making cases, although occasionally a structural piece will require thicker material; because of the strength of the bond made with solvent cement, you can, if you wish, glue thinner pieces together in those instances. If a thinner piece is needed, you can always sand down one of the 1/8-inch pieces.

Glues

Although all of the glues shown in Fig. 2 will work with acrylic, without doubt the best glue to use is the solvent cement; you can get that cement at the same place you bought the plastic. It isn't really a glue in the strict sense of the word. What solvent cement does is soften and partially dissolve the plastic. When the two pieces being joined are put together the bond formed between them is as strong, if not stronger, than the plastic itself. The joint hardens in a minute or so and can be sanded or shaped immediately. The solvent action of the cement can cause problems, however. If you press your finger against any part of the plastic that has been softened by the cement, you'll leave your fingerprints in the surface. They can be sanded out but it's better to avoid doing it in the first place.

Remember though, solvent cement *only* works with pieces of acrylic. Anytime you want to glue some other material to the plastic, a different glue will have to be used. Both two-part epoxy and any of the instant-bonding cyanoacrylate glues work well. The choice depends on the particular application. The two-part epoxy will fill in empty spaces and can be sanded smooth, but the instant glues are contact types; that means that they will only work when the two surfaces being joined mate together perfectly. One interesting feature of the epoxy cements is that they can be colored. Powdered fabric dyes work well but be careful—a little dye goes a long way. The best method I've found is to mix the two parts of the epoxy together with a small amount of the dye and stir them until the color has become uniform. *Slowly* add more dye, mixing it in continuously until you get the color you want.

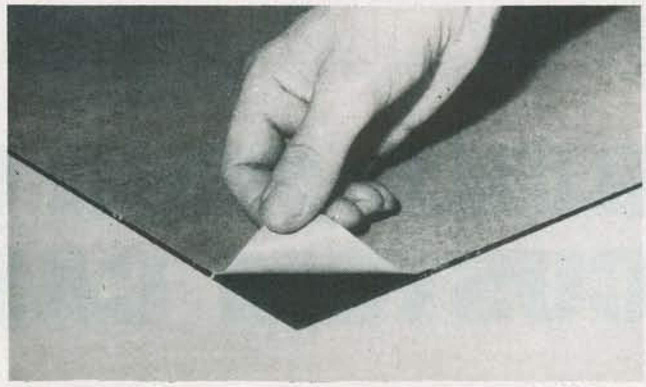


FIG. 1—WHEN YOU BUY IT, acrylic plastic is usually covered with brown paper to protect its surface. That paper is easily removed.

FIG. 2—ALL OF THESE GLUES will work with acrylic plastic, but the solvent cement is best for joining two pieces of plastic.

FIG. 3—ACRYLIC PLASTIC CAN BE EASILY BENT into any shape, if it is heated.

Tools

Any tool used for woodworking can be used with acrylic plastics, including power and hand tools. The only thing to watch out for is heat. If you are using power tools there are two basic precautions to be aware of. Make sure to use only the bits and blades that have been specially rated for use with acrylic. That usually means that the blades have fine teeth and are not hollow ground. The bits should be sharp enough to bite into the plastic without having to apply an undue amount of pressure. Rough cutting blades and bits will crack and shatter the plastic and dull ones will generate so much heat that the plastic will melt at the cut and the waste, rather than falling away, will melt together and harden behind the blade.

Sanding and polishing

Acrylic is easily sanded. The key to success here is to avoid the build-up of heat. For general work, I've found that a medium grit paper is the best to start with. Coarser papers score the plastic and leave sanding marks that are almost impossible to remove. If you use a sanding disc on an electric drill, you'll get the best results by use the drill's highest speeds—the higher the speed, the less pressure you have to apply. Do the sanding in short bursts to keep the heat down; if you have to sand off a ¼ inch of plastic, do 1/16 inch at a time. If you try to do it all at once. you will generate so much heat that the plastic will melt at the surface and leave deep marks. That is to say nothing of the blocking up that will happen to the paper. There will be so much build-up of hardened plastic on the sandpaper that you'll have to replace it. If you've ever sanded paint you know what I'm talking about.

Polishing the plastic is similiar to polishing metal. Use successively finer grits and then use fine steel wool. Always sand in the same direction. The last bit of polishing you need to do is with a kitchen steel wool pad. Use a new one that's loaded with soap. That will leave a very high luster on the plastic and the sanding marks will be just about invisible. If you want to go farther, use 0000 steel wool and oil and do the final polish with a soft cloth and pumice. Keep in mind though, that the plastic is really susceptible to scratches and there's nothing like a mirror-smooth finish to show off imperfections.

Bending and shaping

Now we get to one of the best reasons for using acrylic plastic. Anyone who has ever tried to get uniform curves in flat pieces of metal, or shape a smooth curve in wood, will appreciate the ease with which it can be done in plastic. There are two basic ways to shape the plastic—sanding and heating. If you want to round a corner or taper something, sanding is your best bet. Use a medium-grit paper on a sanding disc and carefully shape the plastic. Examine your work frequently because it goes very quickly and it's easy to go too far. Remember that a little bit of impatience on your part when sanding something to shape will ruin both the last three hours work and the rest of your day.

Creating a curve, or some other complex shape, from a flat piece of plastic is done by heating. Acrylic becomes bendable when it gets to a temperature of about 350 degrees Fahrenheit. That isn't particularly high and there are several commercially available tools made especially for heating plastic to that temperature. Basically, they are all heating elements that have some sort of guard on them to keep the plastic about ¼-inch away. You hold the plastic against the guard and bend it when it softens. Those are fine for creating a simple corner or lip but are useless when you're trying to bend the plastic to conform to some complex jig.

There are several ways to heat the plastic so it can be wrapped around a bending jig. You can use a hair dryer but that takes a long time, because the hair dryer has to be kept away from the plastic so the air flow isn't restricted. If you hold it too close, the motor will load down and the dryer will blow its thermal fuse. You can heat the plastic over a high-wattage lamp but it's hard to work with spots in front of your eyes, and there's always the danger of the plastic touching the lamp and either sticking to it or breaking the glass.

The simplest way to heat the plastic is over an open flame from either a candle or the top of the stove, as shown in Fig. 3. The only problem with that is that the plastic can start to burn; but that can be avoided by moving the plastic rapidly in and out of the flame and only using the cooler part of the flame (at its base). If the plastic *does* start to burn, it's a simple matter to blow it out or douse it in water. The advantages of doing it that way are that the plastic heats quickly and the flame provides only localized heat, which means that a long complex bend can be made a little at a time. The acrylic is a good insulator and only the area in the flame will get hot enough to bend. As a result, as you work your way along a complex bend, previously curved areas will stay that way. As you finish each part of the bend, set it by immersing it in cold water. That will immediately cool the plastic and make it rigid again. Don't force the plastic to bend because it will break. There's absolutely no way you can be mistaken about when the plastic is hot enough to bend—it will flap around like a piece of wet cardboard and stay that way more than long enough to let you make your shape. Wear protective gloves because not only can you burn yourself, but it's impossible to have any control over the plastic unless you can hold it firmly while you're bending it. And remember that you have to hold it until it cools off enough to become rigid again.

Cutting

The best way to cut acrylic is with a saw, as shown in Fig. 4. That sounds a bit trivial but it isn't. Plastic suppliers sell a scribing tool that's used to score the plastic so it can be broken much the same as glass—I've never gotten that tool to work. When I went back to the supplier to ask if I was using it correctly I noticed that they always used a saw—case closed. As long as you make sure that the blade is designed for acrylic, and you don't force the cut you'll find it easier to cut plastic than to cut wood.

FIG. 4—THE BEST WAY to cut acrylic plastic is with an ordinary power saw, as shown here.

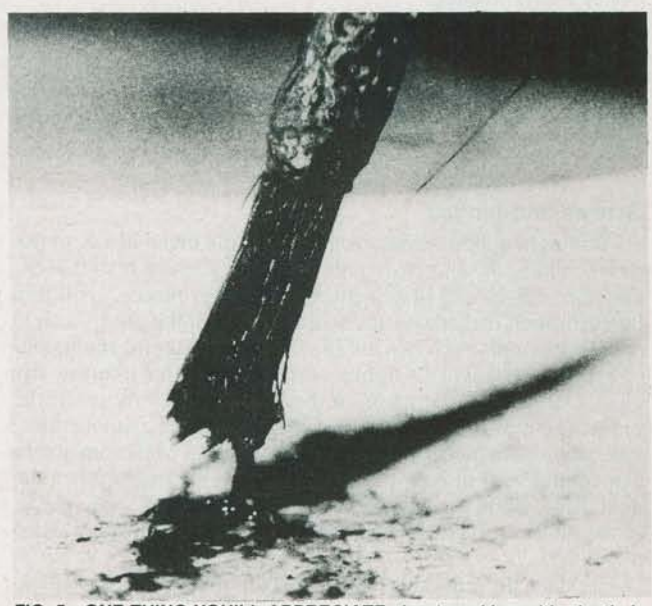


FIG. 5—ONE THING YOU'LL APPRECIATE about working with plastic is that you can correct mistakes with an easy-to-make paste.

"Welding" and embossing

That technique is extremely useful and can only be used with plastic. Because we're all human, we make mistakes and cuts aren't always made as smoothly as we'd like. If a gap turns up along a joint there's an easy way to correct it. Save the plastic "sawdust" and soak it with solvent cement. Work it around with a brush and you'll wind up with a pasty gunk like that shown in Fig. 5. That can then be used to hide any minor mistakes, such as mis-cuts, imperfections, and even small holes. As shown in Fig. 6, work the gunk into the gap with brush that is kept soaked in cement—if the brush gets too dry it will start pulling the gunk out of the gap. A bit of brushing back and forth, and the gap will be entirely filled with plastic gunk. The color will be the same as the surrounding area and, after sanding, will be flush with the surface. Make sure to allow time for the repair to dry before sanding it—since you've really soaked it with cement you'll find it takes longer to dry than a regular joint. That "welding" technique will go a long way toward correcting errors in measurement and slips of the saw. After a bit of practice you'll find that corrections made by welding are virtually invisible.

Embossing is a technique that also takes advantage of the solvent action of the cement. If you brush cement repeatedly over an area of plastic it will get soft enough for you to press in a design, as shown in Fig. 7. The only precaution here is to make sure that whatever you press into the plastic is unaffected by the cement. You want to remove if after you've pressed in the

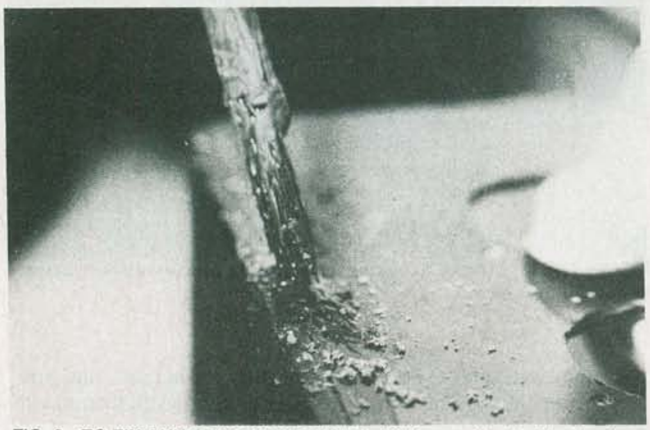


FIG. 6—TO FIX ANY CRACKS OR HOLES, fill them with plastic shavings soaked in solvent cement. After it dries and is sanded smooth, the repair will be almost invisible.

design. Coat the embossing piece with some thin oil before pressing it in the plastic. That ensures that the plastic won't stick to it and ruin the transfer of the design. After the acrylic has hardened, brush it lightly with fine steel wool to remove any burrs.

Screws and hinges

Although regular hinges *can* be used, it's much neater to use pins or brads. If your case requires a door, design it so that the door fits snugly and flush between two other pieces. Drill thin holes through the side pieces and the edges of the door. Push in small wire brads as shown in Fig. 8. If you're careful about your sizes, the brads will fit tightly and you won't have to use any glue. Don't force the brads in, because you'll only crack the plastic. If they're not tight enough, use a drop of cyanoacrylate glue on the side piece to hold the brad in place. Make sure not to cement the brad in both the side piece and the door. When the glue dries, grind the end of the brad flush with the side piece. Make sure that the door opens easily and stays in position when it's closed.

The same precaution against forcing things applies to screws. Acrylic is rigid and won't compress, so the hole sizes for screws are more critical than they are with wood. Make the screw hole

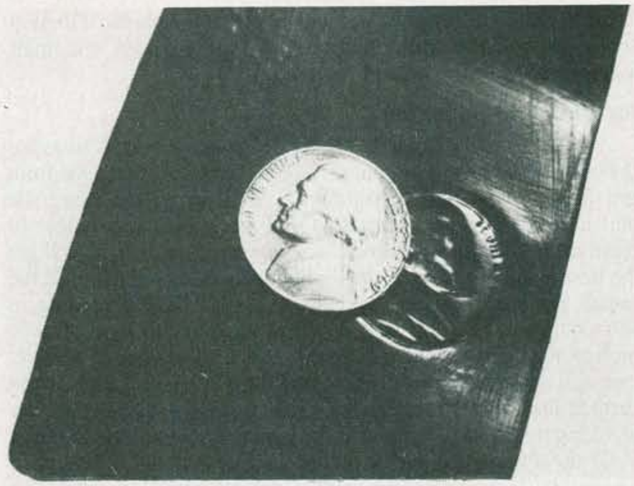


FIG. 7—IF YOU SOFTEN THE PLASTIC with solvent cement, you can emboss any designs you wish into the surface.

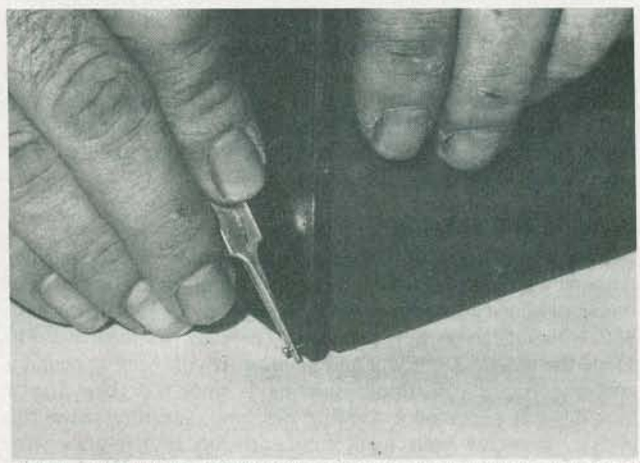


FIG. 8—IF YOUR PROJECT requires hinges, make them by inserting small brads into pre-drilled holes.

at least as wide as the inner shaft of the screw. It goes without saying that you shouldn't use tapered screws. If there's any doubt about the size of the hole, make it larger and stuff in part of a toothpick. The screw will compress the wood and that will keep the whole thing tight.

Lettering

Transfer-type lettering is available in a wide variety of fonts, sizes, and colors. You can even get sheets with graphic designs, borders, lines, and so on. The secret to making lettering look good is simple—keep it straight. Put a piece of masking tape on the case about a ¼-inch below the line for the lettering and use it as a guide. A fairly wide burnisher will lessen the chances of having hairline cracks develop in the letters. Once lettering is applied, it has to be protected because it is fairly easy to scrape it off—that is great for correcting mistakes but when you finally get it straight on the tenth try you want a bit more permanency. Any art-supply store will sell you a protective spray, or you can get a can of spray lacquer. Use it sparingly and avoid runs. Spray the entire case to make the finish uniform, and don't handle it until it's dry. An easy test to see if the case is dry is to smell it—if it is wet, you'll know it. When the lacquer is dry it will no longer have an odor.

With a little bit of practice you will be able to make cases that do justice to your electronics handiwork. And I'm sure that you'll even find that your projects work better. You can be sure that housing your project in an imaginative case will make all the difference—everyone in your family will want to be first in line to try it, instead of first in line to leave the room. **R-E**