How to Build Garage Kits

by George Robbert

While this paper is about building cast resin and vinyl garage-kits, most of these techniques can be transferred directly to building other types of kits as well.

A big caveat should go at the beginning of this. I will talk about a lot of things and make a bunch of recommendations. These are only based on my experience in building models and talking to friends in the hobby. I am not the oracle at Delphi who has all the answers. If you know or find out another technique, tool or material that works for you, go ahead and use it. In fact, let me know, I am always interested in learning new methods. Also, just because something works best for me, doesn't mean that it will work best for you. Tools and materials are an extension of the artist, since that's what you are, and different ones work best for different folks.

1. Where They Come From

Everyone knows that these kits come from some hobby store, either local or mail-order, so why am I talking about this. Well, just like some folks are curious about the life of a piece of cheese before it ends up on the grocery-store shelf, some folks also want to know more about the background of garage kits. If you just want to get on to the building part, and don't care about this background, feel free to skip this section. I'll wake you up later.

1.1. History

Long long ago in a certain place, there lived an old man and an old woman. Or at least that's the way the old legends all begin. In this case, it began when a couple of anime fans discovered that they could make copies of the little mascot girl they sculpted for DaiCon III. The little DaiCon Girl mascot could be said to be the mother of the rest of the anime resin garage kits. Or at least that's the story as I've heard it. Over time, garage kit companies skill with sculpting and production have improved, and the number and variety available have increased.

As an outgrowth of the resin garage kit trend, companies have branched out into soft vinyl kits as well. These are suited to a bit larger production run than resin kits, and are a bit cheaper to produce in quantity. One of the advantages of the resin kits is their ease of modification and suitability for very small production runs. Thus, you don't have to have an extremely popular character to get a resin kit, whereas you need to have a bit larger production run for a vinyl kit to be economical. On the other hand, simple vinyl kits can be less expensive and may be easier to build.

1.2. How are they produced

As you might guess from their name, cast resin kits are molded from polyester casting resin. A big advantage of it over some other plastics is its suitability for small production runs with minimal equipment (that could easily fit in a garage). In contrast, the standard "plastic model" requires large, specialized and expensive equipment. Resin kits are cast in molds made from RTV silicone rubber as opposed to the sophisticated steel or copper molds used for injection molded kits (which easily cost many thousands of dollars merely to make the mold itself). While these RTV molds do not last anywhere near as long, they are much easier to make, since they simply need to be cast around the master, as opposed to machining and polishing by skilled tool and die makers using special equipment.

The combination of easy-to-use RTV silicone rubber for mold making and polyester resin for casting have enabled the resin garage-kit market. However, this medium does have a few drawbacks which mostly translate into higher cost for these kits. First, the polyester resin itself is somewhat more expensive than the raw styrene used in injection molded kits. This is exacerbated by the fact that the scraps and defective parts cannot be melted back down and re-used like with styrene.

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Also, the RTV silicone rubber molds wear out much faster than their metal cousins. This means that the cost of a mold must be amortized over fewer castings out of it. This is offset by the greater ease of construction of the mold, but nowhere near enough to make RTV feasible for large production runs. Also, while the fact that polyester resin cast in RTV molds is well-suited for a wide variety of small volume kits, it cannot take advantage of any of the economies of scale available in the much larger production runs of injection molded plastic kits.

Soft vinyl kits occupy a niche in between resin kits and full blown injection-molded kits in requiring more extensive and expensive equipment. Vinyl kit molds are metal, but these are electro-plated around a master as opposed to being machined out of a solid block by a skilled die-maker. They way they are filled is also unique. The molten vinyl plastic is poured into the mold and allowed to partially harden. After a little while, the excess is poured back out and used in the next casting run. The plastic begins hardening at the mold surface and progresses inward. This process leaves the surfaces of the mold coated with hardened plastic with a hollow center. After the part has cooled a bit more, but while it is still flexible, it is pulled from the mold. The parts are then allowed to pop back into the shape they had in the mold. This flexibility allows undercuts and reverse tapers (such as a foot on the end of a leg) that would not be possible to remove from the mold in another process.

The mold-making process for vinyl kits is a more involved and expensive process than for resin kits. However, the molds do last longer. This leads to vinyl kits requiring larger production runs to be economical. Thus, you tend to find the more popular characters produced as vinyl kits and the new or off-beat produced in resin. Also, due to economies of scale, often you can find vinyl kits for lower prices than resin kits of the same scale and complexity.

2. Kits

Those of you who went to sleep during the discourse on history can wake back up now.

There is a large variety of both resin and vinyl kits out there. Most of these are from Japan, but there are also some manufactured elsewhere. The most common subjects are anime characters, mecha and monsters, but these are far from the only ones: ships, tanks, planes and practically anything else are possible. This class will tend to focus on the figure kits, but as with all model building, techniques may be transferred to other subjects or media.

What type should you choose for your first garage kit? It first depends on what you're interested in, and what confidence you have in your abilities. The fact that garage kits (and especially resin ones) tend to be a bit more expensive may tend to deter some of you, but don't let this put you off. Some factors to consider in a kit are:

- How complicated is it (number of parts and intricacy of assembly required)?
- How clean is the molding? This is especially a consideration with resin kits. All kits will need some work at parting lines and joints, and some surface preparation. Look to see the amount of gross molding defects and the difficulty of fixing these. Some of the much older kits came from a time when processes were not so well under control, and have more problems than some newer ones.
- How interested are you in the subject? You'll be spending some time working on the kit; it naturally makes sense to do it on something you like.
- What's available? It's really tough to build a kit if you don't have it.
- Do you feel like working in resin or vinyl? Either can be a good starting point for working on garage kits. Look at the other questions above before settling firmly on one type or the other. I have friends who prefer each type.

Now is probably the time to talk about recasts. These are reproductions of original kits by another manufacturer. They are more common among resin kits, but they do exist among vinyl as well. Usually, they are not licensed at all and are made by using another manufacturer's kit as the master, and casting duplicates of this. While, obviously, the sculpting of the recast is the same as that of the original, the manufacturing and material quality on these recasts varies across the board. Some of them are as good or better than original kits I have seen. Others will cut many corners and are severely lacking in quality control. This variation happens across original kit manufacturers as well. Experience may be the only guide here.

3. Basic Building

Now that you've gotten your kit, it's time to start building it. Most folks agree that they do look better once built than just sitting in the box as a bunch of parts.

So, gather up your tools and courage and let's have at it. Remember, there are no fatal mistakes in kit-building like this. Anything can be corrected. I'll discuss what to do when things go wrong later, but the key point here is not to let fear of making a mistake hold you back.

Most of the sections her apply to both resin and vinyl kits. Some are specific to one type or the other, these are marked with **(R)** (for resin) or **(V)** (for vinyl).

3.1. Look over parts closely

This not only gives you a chance to gloat over your kit, it also familiarizes you with the various parts. Examine how they will fit together. Determine what parts are what. Make sure that you're not missing any. While it's rare, occasionally the manufacturer will omit a part by accident. Look over the parts for any and all casting flaws that will have to be dealt with (pits, holes, mold-parting lines, flash, bent or incompletely formed parts). Figure out how you'll deal with these (filling, removing, rework). This is also the time to figure out how you'll mount the figure.

3.2. Plan mounting

Most figures need some kind of an extra base to hold them up (otherwise they tend to stand about as well as a person after a gallon of sake). A few kits will come with some kind of a base (Tsukuda's come to mind), but most do not. Even those that do can sometimes have their stability enhanced with a more extensive base. Now is the time to plan for how you're going to mount the figure. Sometimes you can put this off 'til much later, but it helps to think about it now.

There is a wide range of options when it comes to mounting your figure. Sometimes a simple square of finished wood or plastic is all that you need. This has the advantage of being easy to do and not drawing much attention. I've also had good results using old CD-ROMs as bases. These provide a nice circular "mirror" for the figure to stand on. At other times, you may want to get fancier and build a little bit of scenery for the figure to stand in. This can go all the way up to building a full diorama for your figure (or figures), which can be a full model in it's own right.

3.3. Wash the kit

All kits use some mold-release compound to help make sure that the finished casting doesn't stick to the mold. It's best to wash this off. This will also take care of any oil and dirt that may have gotten on during manufacturing and shipping. While manufacturers do this to varying degrees, it's probably best to do this yourself as well. The mold-release compound is designed to make the model not stick to the mold. It will do the same function for paint on the model or glue trying to hold pieces together. There are several commercial preparations out there for this purpose, but I find that ordinary dish-washing soap and a decent scrubbing work just fine.

This can either be done now, or just before painting, and their are good arguments for either way. Doing it now ensures there is none left to interfere with glue at the joints. On the other hand, it's also a good idea to wash off any oils or fingerprints from the model just before painting to avoid them causing any problem with the paint adhering, and doing it then saves washing twice.

3.4. Remove flash (R)

All resin kits have mold-filling runners that need to be removed. Sometimes there will also be some flash or extra small runners in the part to ensure that the resin fills the mold completely and reliably. These need to be trimmed off, too.

The tools I use here are files, knives, sandpaper and occasionally nippers. First I tend to go after this with an X-acto knife, sometimes cutting and sometimes scraping with the blade. For various uses I've found the #10 and #16 blades are occasionally a help when the standard #11 doesn't fit the bill. When filing, sometimes a big file will help in taking off a runner, or provide a large flat surface (like shoe soles), but most of the time I use a selection of jeweler's files. Sandpaper, often on a sanding block sometimes not, is also a good tool here. Whether you tend toward that or files is a matter of personal preference.

Make sure it's really flash you're removing, then go to it.

3.5. Remove flash (V)

Because of the way they are produced, all vinyl kit parts have a large chunk of flash attached to them. This needs to be trimmed off. I tend to do this in two stages, the first being a rough cut that removes most of the flash and the second trimming gradually to the desired line. For the first stage use either hefty scissors/shears or a knife. For the second stage, use a *sharp* X-acto knife. Sometimes the trimming can be made easier by heating parts to soften them. This can be done with boiling water or with a hair dryer. If you use the boiling water route, make sure that you use chopsticks or something other than your hand to fish them back out. The softened vinyl will be easier to cut, but realize that this also means you have to be more careful not to let the knife slip and cut into the piece itself.

Some vinyl kit parts will also have small ridges or runners in place to help the vinyl plastic completely fill the mold. These also need to be carved off, again with a sharp knife.

3.6. Fit joints

This is one time to start test-fitting the parts together. Not only does this give you the satisfaction of seeing something closer to a finished model, but it also reveals where joints may need extra work in fitting or filling. This is also the stage to do the bit of little sanding, carving, or filing will be needed to get the best joint possible between pieces.

For vinyl kits, it often helps to soften one or both of the parts at a joint (as when trimming flash) to get a better fit. This is especially the case for those joints where the manufacturer has supplied a bulge so you can make a “snap fit.”

3.7. Fill molding defects

There are three common kinds of molding defects. First of these are mold parting lines (which usually occur only in resin kits). These come from the fact that the two halves of the mold don’t line up 100% precisely. For these, I find a combination of sanding/scraping them down and filling up the little step with putty is the best combination. Note that if these occur on a vinyl kit, filling with putty is probably a better choice than sanding down the vinyl. Sometimes I’ve been able to handle it fully with sanding on resin kits, sometimes not. For filling using relatively small thicknesses of putty, I tend to use “plastic model putty” or polyester putty. Plastic model putty can be thinned with lacquer thinner or styrene cement if it is too stiff a consistency for the spot you’re filling.

The second kind of molding defect is small bubbles in the casting. These can be very aggravating if they occur in an area of fine surface detail. The very smallest of these (almost acting like a slightly porous surface) can sometimes be filled with multiple coats of primer, but don’t always count on this. One common method for filling these bubbles is thinned plastic model putty. I have also had luck using super-glue gel or ordinary super-glue (depending upon the size of the bubble) for these.

The third type of common molding defects are large bubbles or spots where the resin didn’t completely fill the mold. In both of these cases, you need to fill up the void. In some cases, you can use plastic model putty, but for most of these, I tend to use two-part epoxy putty or polyester putty. Since they cure chemically rather than by solvent evaporation, thick sections are no problem. Also, I find epoxy putty much tougher than plastic putty when formed. In fact, I use it as the major component in larger conversions. One place is cases where a part didn’t fully fill the mold. This can often happen in smaller protruding parts like fingers. In this case, it may be useful to provide some kind of an armature to build the putty around. I tend to use a rather stiff wire as a core in these cases and build up the putty around it. In some sense, it’s another kind of drilling and pinning a joint.

3.8. Fill the legs (V)

It often makes sense to fill the legs of vinyl figure kits both to improve their balance by lowering their center of gravity and also to make sure that the legs won’t deform on hot days. I’ve done this with plaster, Alumilite resin or even a mixture of buckshot and glue. This filling will also provide a firm matrix to lock in the mounting pins to hold the figure to its base. This is also the time to drill holes for these pins, if you’ll be using them.

3.9. Drill and pin critical joints (R)

Not every joint will need this, and sometimes manufacturers will provide enough locating pins and the like to hold the joint firmly in place. If they don’t, this is how to make them. In fact, I will often provide locating pins like these even if the manufacturer has provided their own. For smaller kits, I tend to be cheap and use paper-clip wire instead of more expensive brass stuff. This is also the time to drill for the pins you’ll use to attach the figure to your base (if you need them).

Since pins like this also function for alignment, you need to make sure that the holes line up in the two pieces. Sometimes you can use existing features in the joint (I’ve seen several manufacturers mold matching dimples you can use to start). Often I will end up just eyeballing it, but this takes a practiced eye. If you need to find an exact spot in a joint, here is one method. Fit the joint together and make 4 marks across both halves of the joint. These should be spread around the joint, since the next step is to open it back up, and connect opposite pairs of these marks with straight lines. These lines should cross around the middle of the joint surface, and provide matching points on each half to drill. Another option is to drill through from the outside and fill the resulting hole afterwards.

3.10. Build major sub-assemblies

This is where I glue the major sub-assemblies of the kit together. What constitutes a major sub-assembly is a good question at times. The real answer all depends on what will be easier to paint. If there are joints that will require major work, I try to handle these now and leave the joints that can get by with little or no filling 'til later. On the other hand, there is no reason to expand the number of sub-assemblies beyond what is absolutely necessary. Another factor to take into account is how a given part will obstruct your painting if it was attached. One common division, especially with long-haired characters is to have the hair, or head and hair, be one of the sub-assemblies. This makes finishing the back a lot easier.

3.11. Fill and sand joints

Some joints will end up not needing to be filled, usually where they are hidden or there is a clean joint at a natural seam. On the other hand, a lot will require some work. Fill these the same way you do molding defects, sanding and filing to clean up when you're done.

Note that vinyl does not respond as well to sanding as resin or putty does. The softer the vinyl, the more that sanding and filing will tend to leave a rough surface behind. Experiment with some flash you've removed to see how the plastic in your kit behaves. Fortunately, vinyl kits tend to need less putty-work than resin ones. One technique that I've found can help when filling seams on vinyl kits that don't respond well to sanding is to use plastic model putty and smooth the final layer with a brush or rag moistened with lacquer thinner or liquid styrene cement. If this isn't quite smooth enough, some very fine sandpaper should do the trick. A similar trick may be used with epoxy putty and water, although you can't go back and rework the epoxy putty like you can the plastic putty with further application of styrene cement.

3.12. Prime

When you've finally gotten all of the sub-assemblies put together and the joints filled and sanded to your satisfaction, take one final look over and correct any flaws you see. After this, apply a coat of primer to the figure. There are three reasons for priming. First, it provides an even color over which to apply the rest of the paint for the figure, making it easier to get an even coat there. Second, it places a barrier between the plastic and the real paint, thus isolating it from any chemical reactions with the base plastic. Third, it provides a nice uniform coat that will reveal small defects at a stage where you can correct them, before you get around to the final painting.

What primer should you use? As with paint, use what works well for you. I've used Floquil's white figure primer and also just plain Testor's flat white model paint. One friend has had some bad experience with primer from the Armory. Theirs had far too coarse a grain and was much more suitable to full-size automobiles than to smaller models. He has had good luck with Citadel and Ral Partha primers as well. Again, experiment and find what works well for **YOU**.

Note that some paints are incompatible with vinyl. For these, the plasticisers may interact with the paint and prevent it from ever drying. Read the label on your primer to make sure that it is compatible before using it on vinyl kits. Once a vinyl kit has been primed completely, you can use any type of paint on it (provided the paint and primer are compatible, which most are). If you're in doubt, do a test on some scrap before trying on the real model.

3.13. Correct any problems

In my experience, you will always find some little flaws that the primer reveals. Now is the time to correct these. Usually a little putty and/or sanding will do the trick. Take a close look at the primed figure to make sure you've caught all of these before going on to the next step. Also, reprime after fixing these problems.

3.14. Paint major sub-assemblies

Now is the time to get out your paints and go to the figure. I tend to use a combination of brush, airbrush and spray-can as is convenient and as the spirit moves me. There are things that each is good for. For example, I always us a brush for painting the eyes. Another common questions is what paint to use. Again, use what works well for you. This is one of those instances where suiting the paint to your style is much more important than the type of paint itself. I tend to use acrylic paints for models (like Poly-S), and some occasional enamels (like Testor's), but this is just personal preference. I've also seen superb work done with artists' oils, which allow some very nice shading and blending. Again, use what works for you, and experiment around until you find something you like.

3.15. Final assembly

Glue major sub-assemblies together. This includes mounting the figure in the way you planned earlier. If needed, fill the joints you just assembled. Touch up the paint as required (I always need to).

Depending on the number and arrangement of your sub-assemblies, this can be a multi-step process. You can look at it as building sub-sub-assemblies, and then putting them together as sub-assemblies and then doing final assembly. Each of these can be a little model in and of itself before being incorporated into the larger whole.

3.16. Final inspection

Your figure should now be finished. Go back over it, looking for any little flaws that you can correct (e.g. touch up that little overspray you never saw before). This inspection is a two-edged sword. If you find something major, you have to decide whether to let it be, or tear into this figure you've worked so long on. More often than I like, I've decided to just live with it.

4. Tips

While this section is titled "Tips," it's really more of a catch-all for other ideas that didn't flow out exactly right for the rest of the format.

4.1. Holding for painting

In addition to pinning the pieces together, I find it useful to drill holes in the major pieces so they can be held on a stiff wire (e.g. coathanger) for painting. This helps you avoid showing up at work with a different color hands each day.

4.2. Painting eyes

... "I'm not talking about landscape painting." "But you were talking about horizon." "No! I was talking about painting Her Eyes On the figure you're building." Many folks are worried about their ability to paint eyes successfully. It's not that bad, and in fact with anime figure kits we have a couple advantages. First, the eyeballs are molded in, so you don't have to worry and guess about where they'll be. Second, this is anime, you've got a much bigger area to work with.

Here's the way I do it. It may not be the best for you, but at least it gives you a place to start if you're uncertain. I start by painting the eyeballs themselves flat white. The molded edge of the eyeball is a good guide to your paintbrush here. After this is dry, I paint in the colored iris. This is just a big circle or oval of paint on the eyeball. Take a look at some anime artwork to see how these are placed. Try not to make your character cross-eyed unless you really want to. Next, paint the black pupil in the middle of the iris (when it's dry). I generally paint the eyelashes at this time. Those little fine lines of black above and below the eye help delimit and set off the eye. They can also hide some tiny misalignments of your paint. I tend to paint eyebrows the same color as hair, except for very light-haired characters, though sometimes they're done in black as well. Look at an example. Now that you've got the basic eyes done, it's time for those anime specular highlights on the eyeballs. Grab a fine brush and some white paint. Carefully put a couple spots and/or streaks over the iris and pupil. Take a good look at some original anime art to see where these would be. Finally, when everything is good and dry, I apply a coating of clear gloss to the eyes to give them that shiny liquid look. If you have trouble finding clear gloss, I have found that Future floor polish also works well for this. It is essentially acrylic gloss medium to make your floor shiny.

One question you will wonder about is how much detail to paint into the character eyes (or other aspects). You can find individual illustrations with exceedingly great amounts of detail in this area. Stop and think about it. These illustrations are usually much bigger than your figure kit (and may be viewed at a closer distance as well). If you can't see a detail on your kit when viewing it from the normal distance, then in my opinion, you're wasting your time painting it. Naturally, there's a lot more that can be done in painting eyes and other details than I have described here. Extra highlights, shadows, shading, outlines and the like could well be done. Give it a little practice and make sure you have a good rest to steady your hand on when painting, and you'll do fine.

4.3. Painting methods

There are three basic methods that you can use to apply paint to a figure kit like this (I don't recommend the wall-roller myself). These are spray-can, airbrush and hand-brush. Each of them has their advantages and drawbacks.

First, let's discuss the spray can. These are convenient, can apply an even coat, but do not give you the fine control of an airbrush. I tend to use spray-cans mostly for applying primer, or occasionally an over-all color coat. When you have to paint smaller areas, masking can become tedious and a bit of a drag. Also, you need to do this in an area where the overspray isn't going to be a problem. The living-room is right out.

Second comes the airbrush. This can spray paint on in a very nice and controlled fashion (much more so than spray cans). It still requires masking for fine separation, but once you are skilled, you can get away with a little less. Also, the airbrush allows you to do some nice shading techniques and such that other methods will not.

Third comes the old-fashioned paintbrush. This is definitely less expensive than an airbrush, and with only a little practice can yield extremely good results. It also offers some of the best control. I actually tend to use the ordinary brush for a great deal of my work. One bit of advice, don't get the cheap brushes. They'll give you far more grief than they save you money. Spending a just a little more will get you good quality brushes, which will do more for your painting than just about anything else.

5. Handling Mistakes

No matter how careful you are, sometimes you, or the manufacturer, will make a big mistake. Every one of these can be handled. Don't worry, it can be fixed.

5.1. Broken parts

This is probably the easiest to fix. Just consider this another joint in the kit. These may or may not need pins (funny how accidental breaks almost never have locating pins built in). Since resin tends to break cleanly, you may not need much, if any, filling of the resulting joint.

5.2. Slips of the knife or file

If you ended up cutting a big gouge where you didn't want to, just get out the putty, and fill it up. Once the putty is dry, sand, carve and file it into the shape you wanted before the mistake. A lot of these gouges and the like can be treated just like another molding defect.

5.3. Bent or deformed parts

This occurs most often with vinyl kits because of vinyl's low softening temperature. With them, simply heating them in boiling water will usually make them pop back into the desired shape. If they don't a little coaxing by hand or tool can push them into shape. Remove them from the heat and then let them cool and harden in the correct shape.

This also occurs occasionally with resin kits as well. Resin too can be softened with heat, though not at as low a temperature as vinyl, and re-bent into shape. I use a hair dryer or heat gun for this process. I find that it occurs most often in larger parts of thin cross-section (such as a staff or flowing locks of hair).

5.4. Voids or partly formed parts

Dealing with this type of problem can range anywhere from filling an overly large hole with putty to cutting off a big portion of a part and building a replacement from scratch.

5.5. Missing Parts

One way of thinking of this is a really big void in a part (encompassing the entire thing). One possibility, though not very easy with imported kits, is to write the manufacturer and try to get a replacement part. If this isn't an option, you are left to make your own. See the section on conversions and scratchbuilding for more tips on how to go about this.

5.6. Misproportioned parts

If a figure's hands are too big, it will look wrong, no matter how well finished (unless you're after SD). This is one case where you pretty much have to make a new replacement. Sometimes the existing parts can be used as the basis, but not always. Fortunately, this does not seem to be a very common malady. I would guess that, by now, far less than 1% of the kits out there have this problem. It's also usually easy to find this before even buying the kit.

6. Conversions

One way of looking at conversions is that the manufacturer made a big mistake and didn't mold the kit the way you wanted. There really is a continuum running from building the kit exactly as it was designed all the way to completely scratchbuilding a model. Where along this line you like to be is a matter of personal taste. I know some folks who always build kits straight out of the box, and I know of others who have the reputation of always doing some modification, or rebuild.

Here are some simple types of modifications. Of course this list is nowhere near exhaustive, but maybe it can give you some ideas or inspirations for your own work.

6.1. Creating a base

Some folks may not even consider this as being a conversion, but it does involve using things not included in the kit and can arguably fall in this category. Right now, I'll just talk about simple bases, since as you can get as complicated as you want. Building an extensive diorama for your character can become a big project in and of itself.

For an example, a plain sheet of plastic can be scribed to simulate paving stones and another piece or two glued along one edge as a curb or sidewalk edge. With this painted, the figure is now standing on the street and not just floating in space. It's surprising how much a simple addition like this can do to provide a context for your figure.

When you're making a simple base like this, think about where the character might likely be. Sidewalks, floors and grass are all easy to create. You can even add a wall or two or a fence to provide a backdrop. Think about it. Be creative. You can surprise yourself with what you can end up with for just a little work.

6.2. Adding accessories

Probably the simplest type of conversion is adding an item or two onto an existing kit. These modifications have the advantage of requiring practically no changes to the basic kit, however you need to be able to make the added items from scratch or scrounge them from other kits.

For example, if the kit has her hand held down at her side in a fist, it's not that tough to add something that she's holding, say a shopping bag. In this case, the shopping bag could be made of paper with thread for the handles. A small hole could be drilled through the fist to thread the handles through, so the figure is carrying the bag. One easy cheat on the bag decoration is to glue on some illustration(s) cut from a magazine rather than trying to paint them yourself.

6.3. Moving limbs

Next in ease probably comes the simple repositioning of limbs. With this, you do have to take a saw to the original kit (and this can take a bit of courage when you paid $75.00 for it). The usual method is to cut out a section at the joint(s), re-assemble the limb using heftier wire pinning there (usually leaving some bare wire showing) and then filling in and re-sculpting the joint with epoxy putty. Don't worry, most of the time this resculpting is similar to filling in a really BIG gap at a joint. Similarly, some simple work on the hands can change a figures gesture, or allow them to hold something. if they weren't already.

A couple of caveats to note method. When you're repositioning a limb, think about it carefully to make sure that you're putting it in a natural position (or at least one that is physically possible for the human body). Also, be aware of other changes in posture affected by this. For example, when you reach up, your whole shoulder rises, not just your arm.

6.4. Adding clothes

Similar in difficulty comes simple clothing changes. For example, a miniskirt can be lengthened to the knee (or even the ankle) buy simply filling in with epoxy putty. Remember to put in the appropriate wrinkles that would occur with the new size of garment. Observe outfits in real life to see how these fall. Other changes could be the addition of an apron (using either paper soaked in white glue or epoxy putty rolled thin) or hats, scarves, socks, etc. The key to this is to ADD to the existing kit. I usually find that accurately carving away existing clothing is tougher. Also, looser clothes allow you some greater freedom in where they lie.

6.5. More extensive conversions

More extensive changes are also possible. When doing these, the question arises whether it is better to cut away a big piece and then build up the new area with epoxy putty, or whether to try to cut off the minimum necessary and carve the remaining part to the correct shape. Both of these are valid alternatives, and which to choose will depend a lot on the exact nature of the conversion and also your skill with carving vs. sculpting putty.

7. Tools and Materials

In this section I will list a bunch of tools and materials you can use for building garage kits like this. Don't be frightened at all by the size of this list. Some of these are only rarely used, and the the minimum set is actually quite small.

Here's what I think the minimum set for building kits is. Knife, sandpaper, glue, putty and maybe tweezers. Not long after, a pinvise and some drills will prove helpful. You may need a few more for getting into extensive conversions, but by the time you start doing these, you'll have probably have built up your collection anyway. The way I've built up mine is over time buying the odd tool or material when I found a need for it on a current project. Keeping these around has left me with a large collection of tools and materials to draw on.

7.1. Tools

Knives I don't know if there is a more general purpose tool than the modeler's knife. The old standby is an X-acto knife with a #11 blade. Sometimes the #10 or #16 blades will fit the bill exactly in places the #11 won't. One point to make. Blades are cheap, replace them often. You can get more done easier with a new sharp blade than with an old dull one.

Other folks have used other types of knives. The important part being that they are sharp enough and that they have a blade of the right shape to get where you need to.

Sandpaper There's a bunch of stuff that needs sanding or smoothing on these kits, from putty on the seams, to molding defects. You'll need a couple grades ending up with 400 or 600 grade for fine finishing. The wet/dry grades are better since sanding wet can yield a finer finish and also helps keep the paper from getting as clogged.

Files One alternative to sandpaper is files. Personally I tend to prefer them for a bunch of the shaping. I use a selection of small jeweler's or modeler's files and only fall to sandpaper for the final finishing. Also some larger files are good for those cases where you don't need as much precision, or where you need to make a large flat surface.

Tweezers I don't know about you, but my fingers are far to fat to hold the small pieces of a kit, especially when gluing them. This is where tweezers come in *very* handy. There are a wide selection of types out there. Experiment until you find one that works well for you. The major differences are jaw shape and size, whether they are flat or knurled, and whether they are ordinary or locking. The knurled jaws give you a somewhat better grip, but they can also leave marks on delicate parts. Locking tweezers can help holding a part for a long time, such as when painting, but you don't have quite the control over them as with ordinary ones (at least in my experience). The type I use most, are the ordinary straight-, smooth-jaw type.

Pin-vise and Drills When time comes to adding extra locating pins at joints of a kit, you have to drill holes for these. For the small sizes you'll be dealing with here, I find that you get the most control with a pin-vise. This is a small collet that fits in your hand and holds the drill. You spin the drill with your fingers. Don't worry, it gives good control and goes quickly for the size holes you'll be doing.

Razor saw Time will come when you have to separate something more than is easy with your knife. This is common in conversions and sometimes is the best way to get larger casting sprues off as well. Here's when a *razor saw* comes into play. The name of these comes from the backing strip for stiffening just like a single-edge razor blade. This keeps the blade cutting straight. In addition to this type of razor-saw, there are also a few other types of saws out there. These don't have the backing of a razor-saw, so don't stay so straight, but have other advantages. One type is the *jeweler's saw*. This is a finer version of the coping saw. It has a thin shallow blade kept straight by tension. This is good if you need to make some curving cuts. Another type has a single thin stiff blade. It is good for places where you need to saw into narrow places or where the stiffening back on an ordinary razor saw will get in the way.

Nippers Also known as wire-cutters, these are important to have once you get to cutting wire for locating pins. These are also very useful with injection molded plastic kits for cutting parts off the sprues. They can also do the same function on some resin kits, but there isn't the call for them as often.

7.2. Materials

ACC glue Also known as super-glue or cyanoacrylate cement. This is what I tend to use for most fastening because of it's speed and convenience. Because it dries so quickly, you have to be careful not to glue yourself to the model (I've done it more than once).

While it's good for many things, ACC glue does have it's drawbacks. It is not good for filling in gaps, and has it's best strength in a tight fitting joint. There are "gap-filling" formulations available as well as gel versions, but sometimes the old standby of epoxy is best. Also, there times when you want time to position a joint and the extra drying time of other glues are a benefit.

This is probably the time to mention that standard plastic-model cement will not work on resin or vinyl kits. It works by dissolving the styrene and welding the parts together. Polyester resin and vinyl are mildly affected by this, if at all, so you don't get a workable joint.

ACC Accelerator While ACC glues set quickly, this stuff can make the process almost instantaneous. This is a catalyst that you can spray on, setting the glue practically instantly. I keep it around for those times when I need to set up a joint quickly. Also, I'll use it if I get a little too much spread around to set it all and make sure I don't have extra glue seeping into places I don't want it and spoiling things. Once the glue is set up, I can file and scrape away the excess.

Epoxy The standard 5-minute variety is fine. The advantages of this are that it retains strength even in joints that have a big gap. While there are gap-filling super-glues, epoxy works better on really big gaps. Also, its longer setting time gives you that extra time to play around and get a joint positioned just right (though then you have to make sure it stays there). Another technique to use in filling gaps at joints is to use epoxy like this and mildly over-fill the joint so a little excess squeezes out. Once set, this can be sanded and filed down instead of having to add putty. The disadvantages of epoxy are the fact you have to mix it before use and it's long setting time.

Plastic Model Putty While it is theoretically possible to build a kit without using any putty for filling, I wouldn't count on it. There are three basic types of putty out there. First is the standard "plastic-model" putty, such as Dr. Microtool, Tamiya or Squadron (Green or White). Second are the types of epoxy putty, mentioned below. Third is Polyester putty, also described below. All three classes have their advantages and disadvantages. Also, while I have only mentioned a couple different brands here, there are *many* others to choose from. Also, each of the different brands have slightly different behaviors so a little experimentation may be helpful here. Although they may not be easy to find, my personal favorite is Dr. Microtool. However, I've had good luck with the others mentioned as well.

There is also another filler that I consider in this class. You make it yourself by dissolving scraps of styrene (ordinary plastic model plastic) in liquid plastic cement. When you get a reasonably thick goo (you control how thick you want it), you've got a putty to use. This will dry back to the styrene it started as and can then be treated and finished as such.

Standard plastic-model putty can be thinned with lacquer-thinner or styrene cement if its consistency out of the tube is too thick. This can be useful for filling small pits and molding defects. One disadvantage is that since it dries by evaporation of solvent, thicker sections dry slower. Also, if you get too thick (over about $1/8$ inch), it may not dry in any reasonable time at all. That's a job for epoxy putty or polyester putty.

Epoxy Putty The next type of putty after the plastic-model type above is epoxy putty, such as Miliput or A+B by H.B. Fuller or Duro Epoxy Ribbon. Epoxy putty comes in two parts that must be kneeded together in equal parts (just like you mix standard epoxy). Some come in two separate "sticks," others come as one "stick" that is divided into two halves. Only mix as much as you need, since once you do, there's no stopping the hardening. Again, there are others with varying properties as well. My favorite is A+B, with Miliput grey running second. However this may be different for you.

The advantage of epoxy putty is that it cures chemically rather than drying, so it can be applied in any thickness. The fact that you have to mix the two parts is a disadvantage. On the other hand, I tend to use epoxy putty as a big component in conversions. See the section on handling epoxy putty later for some more tips.

Polyester Putty A third type of putty, which seems to be hard to find in American hobby shops, is Polyester putty. The main brands I have found for this are Tamiya and Mori Mori (both from Japan). Polyester putty, as its name implies, will cure into a polyester resin plastic similar to the stuff that resin kits are made of. It comes in two parts, a big tube of resin and a small one of catalyst. These need to be mixed before use just as with epoxy putty. Once mixed, this has a similar consistency to plastic model putty. However, as it cures chemically and not by drying, you can apply it in any thickness. Likewise it does not shrink when drying. It also doesn't contain the solvents that plastic model putty does, and thus can't etch or soften styrene parts like that sometimes can in large quantities. As polyester putty does not cure as hard as epoxy putty, it is easier to carve and sand. This ma make it preferable for carving fine details where strength is not as important. I have only begun using polyester putty recently, but am coming to prefer it over plastic putty for filling jobs. I still tend use epoxy putty for heavy duty filling and sculpting.

Stiff Wire The first use for this is in making the locating pins for for joints. The upscale choice is brass wire and rod (ranging from .010 to $^1/_{16}$ inch and thicker. I'll use the thicker stuff for main joints and thinner where I don't need the extra strength and there isn't the extra room. Another advantage of using thicker ($^1/_{16}$ in) wire at the main joints is that you can use a longer piece of the same size rod to hold the part or sub-assembly for priming and painting. There are alternatives to brass rod. I've made many locating pins out of straightened paper-clips (which are just soft iron wire) or even, for thicker sections, out of coathanger wire. Another friend of mine uses brass welding rod with good success. Don't tell folks you're using the cheap stuff here and no-one will ever know.

Masking Tape This is not only useful, as it's name implies, for masking during painting. It's also a handy way to temporarily hold parts together while epoxy sets and other things.

Paper Towels/Tissues If you're anywhere near as far from clean and precise as I, you'll end up using a bunch of these. They can mop up spills, absorb the little extra ACC glue you put in the joint, or a myriad of other tasks.

Soap & Water This is used primarily for washing off the mold-release compound. I use ordinary dishwashing soap, and it seems to work fine. Also, water also helps to keep epoxy putty from sticking to you and your tools.

7.3. Other tools & materials

While I've described some reasonably standard tools and materials above, in this section, I will continue on and talk about a bunch of others that may be more useful once you get to conversions or scratchbuilding.

I'll make one point here that is actually applicable across the entire field of model-building. There are many different materials that can be used for a given task. Which one you choose depends on a lot of things, but think how well a given alternative will work, and how easy it will be to use. For example, if you want to add a staff to a figure what do you make it out of. Well, you could use styrene or brass tubing or rod. Brass is stronger, but somewhat more expensive and may be harder to work. Other alternatives are that you could roll a "sausage" of epoxy putty (useful if the staff isn't a true cylinder). You could also roll a tube of paper, stiffen it with glue and use that. You could use a sprue from an injection-molded plastic kit (cheap), or even the ink-tube from a ball-point pen (cheaper). All are possible. Which is best depends on exactly what you're doing, what you feel comfortable with, and what's convenient. The consideration of, "what do I have on hand," is always a question to ask. Over time, I've built up a collection of tools and materials to draw from.

Spatulas This is something you don't need right at the beginning. You can get some small spatulas or pallet knives for applying putty of various kinds. I find these useful, but have also gotten along for years without them. Before, I used a dull knife blade for the same thing with good success. A friend successfully uses a pointed pallet-knife for the same job. In all cases, it's just a convenient way to apply putty. I've also used a couple different shapes of spatula's for shaping epoxy putty when building up and sculpting something out of it.

Small Chisels I have found small chisels or gouges sometimes useful for carving a modification or removing flash from an awkward spot. These are also something I wouldn't go buy until I found the specific need for them.

Motor Tool Again, this is not a tool I'd buy at the beginning. While these hand-held motor tools (the most common brand is Dremel) can help with a few tasks, I've found that the extra speed-up made possible by power assist comes at the risk of more damage from an accidental slip. Also, unless you slow them way down, the cutters on these spin fast enough to melt the plastics we're dealing with.

Plastic One of the first items I look at as a material (along with epoxy putty), is styrene (or ABS) in its various forms. Most model shops will have a reasonable selection of this. Two of the common companies here are Evergreen and Plastruct. In addition to making flat sheets in varying thicknesses, they also make plastic tube, rod and other shapes (including structural pieces like I-beams). When you're working with plastic like this, some further techniques come into play. Although you can well use ACC and Epoxy, liquid plastic cement is also suitable for use (amazing that). This will glue two pieces of plastic together by dissolving them at the joint and welding them together.

Brass Next after the various forms of plastic, I probably reach for brass as a building material. It's stronger than plastic, which is sometimes important for building delicate shapes. Again, your hobby shop should have a reasonable selection of both sheet (and shim, which is the same but thinner), tubing, rod and other shapes. The common company making this is K&S.

As metals go, brass is comparatively soft and easy to shape, but is also strong enough to hold its shape afterwards. If you feel like it, good joints can be made by soldering, but you can also have just as good luck with epoxy or ACC.

Wire Although I just mentioned brass rod and wire above, it's not the only metal you can use as wire. Here are some other options. Piano wire is much sturdier than brass, being made of something close to spring steel. Watch out not to nick inexpensive wire-cutters with this. If brass wire ain't quite strong enough for a fine task, use this. The common household paper-clip is usually made of a grade of soft iron wire. These are cheap, commonly available, and easy to use. Probably the most common kind of wire folks think of is copper. This is similar to brass, but is softer and easier to work (though not as strong). Probably it's easiest to get as electrical wire (just strip off the insulation). Stranded wire will give you a bunch of fine wires, and solid will give you single larger strands. Finally, the winner in terms of being easy to shape is solder itself. Yup, a lot of solder comes as wire. It has almost no strength to use as a structural material, but if something else is there to support it, solder can be easily bent into whatever shape you want. I'd tend to use Epoxy or ACC for most of these wires, although soldering is an option.

Paper Yup, paper is definitely a material to consider. It comes in thin sheets and is easily available. If you soak it with ACC or thinned white glue you end up with a fiber-reinforced plastic in the shape you had the paper in. It can then be filed, sanded and otherwise shaped. One option for making clothing (such as scarves and capes) is to make them out of tissue-paper (or something similar) and reinforce this by soaking it with either thinned white glue or ACC. One thing to be aware of is that paper doesn't have a perfectly smooth surface texture. If you want that, you'll need to fill and/or sand it that way (often a coat or two of thinned white glue can do the trick).

Putty I've already mentioned putty above, but in conversions and scratchbuilding, it can turn out to be a major material. Epoxy putty and polyester putty can be used as the basis for building up and sculpting major parts of the figure. See the section below on Epoxy Putty Concepts for further details. I tend not to use plastic putty in conversions and scratchbuilding as anything more than the filler as when just building a kit.

One other type of "putty" that some people use for scratchbuilding is sold under the name "Sculpy". There are other similar brands, but I don't know their names off-hand. Sculpy is a plastic formulation that may be shaped like putty and hardens when baked (typically in the oven). Since it is cured by heat, it really isn't suitable for conversions since both resin and vinyl kits soften under heat. I have no personal experience with this, so I can't really recommend for or against it. The one thing I have heard is that sometimes, over time, it can form a crystalline exudate on the surface. Newer formulations should have fixed this problem.

Wood While I tend not to use this much in figure kit building or conversions, there are times when wood is just what you are looking for. Check your hobby shop for what's out there. The main types are Basswood (or other fine grained hardwood) and Balsa. Both come in stripwood (small sticks) or sheet form (sheet basswood is often milled to simulate planking). There are times when nothing simulates wood grain as well as wood, for example for a hardwood floor.

Traditionally, some folks have carved and build models out of these woods (for example sailing ship builders). I tend to be more of a plastic user myself, so I won't go into detail here, but keep in mind that this is a well-known alternative.

ANYTHING else And when I say anything, I mean ANYTHING. Look around at everything, including trash, as a possible material for model-building. Here are some examples just to get your brain moving. I've used sections of the tubes mechanical pencil erasers come in as water-glasses in one conversion. Table-salt, held down with a thick coat of paint, made a good simulation of sand in one base (though real sand would also have worked). I've already mentioned using old CD-ROMs as nice shiny bases, paper clip wire for pinning joints. I know of one person that uses old credit cards as a source of sheet plastic (in smaller sizes).

8. Epoxy Putty Concepts

Above, more than once, I've mentioned using epoxy putty for conversions and larger gap filling. Here are some techniques I've learned to deal with it. I'm sure there are many more that I haven't learned yet. If you know others, please let me know. I'm interested in learning.

1) First, only cut off and mix as much as you are going to use at one time. Once you mix the resin and the hardener, there's no turning back. Also, make sure that you mix it thoroughly. I just kneed the two parts together in a blob with my fingers. Most brands have the two parts colored differently, so you can tell when they're fully mixed by the uniform color attained in your blob. Go on and keep kneeding it a bit longer just to make sure. If you end up with a bit of your blob that is not fully mixed, it may take forever to harden (and may never do so).

2) There are basically three stages in which epoxy putty goes through as it hardens. Each of these has different characteristics for working, and I do some in each of the stages. These stages are: the initial very soft stage; the "leather-hard" stage, which it will reach in about 30 minutes to an hour; and finally the fully cured hard stage, which takes several hours to overnight to reach. The putty slowly hardens from one stage to the next, so there are no sharp boundaries between these.

   In the initial very soft stage, it is easy to push and prod the putty into whatever shape you want. I use a variety of tools for this including toothpicks, knife blades, some small spatulas and my fingers. At this stage, keep your tools (or fingers) wet to avoid the putty sticking to them. I tend to do the rough or gross shaping of the putty at this stage, and wait until later to finish in the fine details (I find that I always push them out of shape if I try here).

   After 30 minutes to an hour, the epoxy putty has hardened into a "leather hard" stage where it is more suitable to carving than "pushing around." In this stage, it is still somewhat bendable (if you need to do that). Also, it is hard enough to carve, but not so hard as to make a tough job of it. I'll do the next stage of carving and refining detail at this stage.

   Finally, after the epoxy putty has finally cured, it reaches a almost rock-hard stage. This is the stage where I pull out the files and sandpaper to give the final shape and finish to whatever part I'm working on. You can also carve it in this stage, but it takes a sharper knife and more work. In my experience, the final hardness of epoxy putty is harder than the polyester resin that kits are made of. Don't let that stop you from working it at this stage though.

3) Wash your hands after working with epoxy putty. I tend to do this after the initial kneeding/mixing, before working with it and then again when I'm done. Some folks have developed a contact allergy to uncured epoxy, but this is rare. Washing your hands off will cut down on long-term exposure and reduce the already small odds of this. The first washing also gets any residue off your hands and helps keep the rest from sticking.

4) One technique for working with epoxy putty may not be obvious at first glance. This will create a flexible sheet, suitable for making capes, dresses and other such clothing. The sheet is initially soft enough to shape, but will cure hard into whatever form you put it in.

   Mix up your usual blob of epoxy putty. Instead of putting on the model and shaping it, take a couple sheets of plastic wrap (or a plastic bag), and roll the putty between them. You'll want to coat the plastic with a thin coat of salad oil or the like to keep the putty from sticking. Leave the putty here until it is somewhat stiff but still flexible (30 minutes to an hour). You can then remove it from the plastic, cut it with a knife and shape it to your figure as you wish. Since the putty has already partly cured, it will not stick quite as well as "fresh" epoxy putty, so a little super-glue at the joint sometimes helps.

I use a knife handle as a mini rolling-pin here, but anything will work. Roll the sheet as thin as you need. I usually go to about $1/32$ inch or so, thinning the edges later if I need the piece to look thinner.

I've used this technique to make skirts, aprons, flowing sleeves and other items. I've also known other folks to use this to make flags that seem to be blowing nicely in the wind for their figures.

9. Scratchbuilding Concepts

Don't stop reading just because this section has scratchbuilding in the title. Many of these apply equally well to conversions and some may even be of benefit when building a kit "out of the box." Anyway, this seems as good a place as any.

1) Don't let the thought that you're scratchbuilding a figure prevent you from using parts from other figures if it makes your job easier. I've used heads re-cast from other figures on more than one of mine where the rest is basically scratchbuilt. Do these count as fully scratchbuilt or not? I've decided I no longer care.
2) Even when your building a figure completely from scratch or are doing a major conversion, building it in smaller pieces or sub-assemblies is still a good technique to follow. Sometimes this can be separate pieces which are joined later. Sometimes it can be several steps of building up a figure and clothes around one armature.
3) I've found that, when building a clothed figure, it's usually best to sculpt the basic nude first and then add the clothes on top. You don't have to to go into great detail on this, just the basic contours such as bulges of muscles and the like. The body tends to shape and show it's shape through the clothes even though they cover it. Having the basic body contours will help in establishing the clothes in these shapes.
4) When you're forming epoxy or polyester putty into free-standing shapes, as opposed to just applying a layer of it on top another part, I often find it useful to shape it around a wire armature. This armature performs several functions. It gives you a rough idea of the proportions the part will have (especially important if you are scratchbuilding a whole figure). It gives you a guide as to where to put the putty. It gives a little structural support so the putty doesn't droop while it's still soft. Finally, it gives some reinforcement (just like re-bar in concrete) for extra strength and durability.
5) When completely building a figure from scratch I sometimes find it easier to cast a rough block out of Alumilite (see below) for larger pieces such as the torso rather than building them up from epoxy putty. For these, I make a rough mold out of aluminum foil, cast the piece and trim it roughly to shape with power tools. This forms a decent base form to then begin building up the exact contours with epoxy putty. Also, you can make blocks like this for the major parts of the body (torso, arms, legs) join them together with thicker brass rod and perform final adjustments on your figure's pose to this armature.
6) When building sub-assemblies, there are two ways of going about creating joints between the pieces. The first is to build the two pieces together and then saw them apart so they can be handled later. The second is to coat the joint surface with some mold release compound and build the second part in place. This should prevent the two from sticking firmly to each other and should be washed off before final assembly. What I've found works well with epoxy putty and polyester putty is ordinary chap-stick. Its wax base makes it easy to apply, yet it will stay in place and not run all over.

10. Doing Your Own Casting

You can even do your own casting of parts, just like the big boys do. I'm not going to go into great detail here, but here are a few pointers. You might try checking with a better equipped hobby store in your area for the materials. They may also be able to give you some pointers as well. My favorite mold material is RTV Silicone Rubber, the same stuff used in the original figure kits. The two major manufacturers of this are Dow Corning and GE. Options for the casting resin are polyester resin, Alumilite (which is a polyurethane resin) and Epoxy. Most of my experience has been with Alumilite, and it seems to work well and not require sophisticated vacuum de-airing or the like (though that would definitely reduce the instances of air bubbles). They also include a nice pamphlet in with their bottles of resin explaining mold making and casting and giving addresses where you can buy materials. Check out their web site at `http://www.alumilite.com` or give them a call at 1-800-447-9344.