# RESIN, FIBERGLASS AND BALSA MODEL CAR BODIES
# Vol. 2

**Recap**

Vol. 1 began with the question:

“What’s the best method for scratch building a body for a large scale model car?”

The model in question was a 1/8$^{th}$ scale model of this streamlined, teardrop fendered, 1932 Rolls-Royce Phantom II with coachwork by Figoni & Falaschi.

For a variety of reasons, all detailed in Vol. 1, I decided to resin cast the front and rear fenders. The rest of Vol. 1 then describes step-by-step, the process and materials I used.

With the fenders complete, my focus could now shift to the body shell. And that is the subject of Vol. 2.

Here’s a picture of the balsa wood shell. The photo was taken before a finish primer was applied and when the floor has been temporarily installed to validate the fit between body and floor. The shell is approximately 18” long, 8” wide and 8” tall.

How then to make this shell? Resin cast or fiberglass?

**Making the Body Shell**

My initial thought had been to resin cast the shell between silicone molds. But the more I thought about it the more uncomfortable I became. Here's why;

- The body shell has a large surface area with thin walls. So the interior mold has to be precisely positioned to get the required wall thicknesses and to ensure the resin could reach and properly fill the cavities. Kit makers would no doubt have used injection molding and steel molds, but I didn't have that option. I was pretty much committed to silicone.
- Silicone is inherently flexible … great for extracting masters and cast parts, but not good if you want rigidity for dimensional control. So, I would need to use a rigid shell to give strength to the silicone outer mold and hold it in place and then use spacers (in the window areas) to align and hold apart the interior and exterior molds.
- Making the interior mold by simply filling the interior of the shell with silicone was going to be prohibitively expensive (and heavy). A possible alternative was to use brushable silicone to create an approx 3/8" layer on the interior of the shell and then reinforce that with pourable foam. That would give the requisite strength to the interior mold. However, in order to remove the master or the cast part, the interior mold would have to be without undercuts of any kind. De-molding would then be a matter of removing the outer reinforcing walls, peeling off the outer mold and then pulling out the interior mold.

In contrast, laying up fiberglass looked a lot simpler and certainly less expensive, even if it was messier and smellier. I would still make an exterior silicone mold, but then simply layup gel coat and fiberglass on the inside of the mold. Wall thickness could be controlled by the number of layers. With no interior mold to worry about, de-molding would consist of simply removing the side walls reinforcing the mold and then peeling away the silicone mold from the fiberglass. With summer coming and the option of glassing in the garage, I decided to go with fiberglass.

**Exterior Mold**

The first step was to make the outer mold.

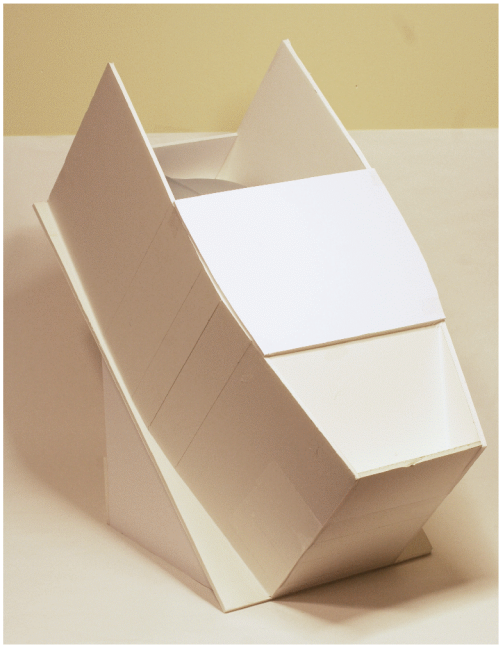
The simplest way to do that was to build the shell on low foam board walls (see below), place the shell in the bottom of a foam board box and then pour silicone over the shell and into the box. A slow pour over the shell would help eliminate bubbles but also help keep the shell in place.

Here's the shell sitting on the foam board walls, which also fill the rear wheel wells. The windows are covered from the inside with 0.010" styrene sheet (lightly glued in place) and an end wall was built to fill in the space for the firewall. Latex caulk was used to fill any gaps between the foam board or styrene sheets and the shell. This is an important step since silicone will find and seep through any gaps.

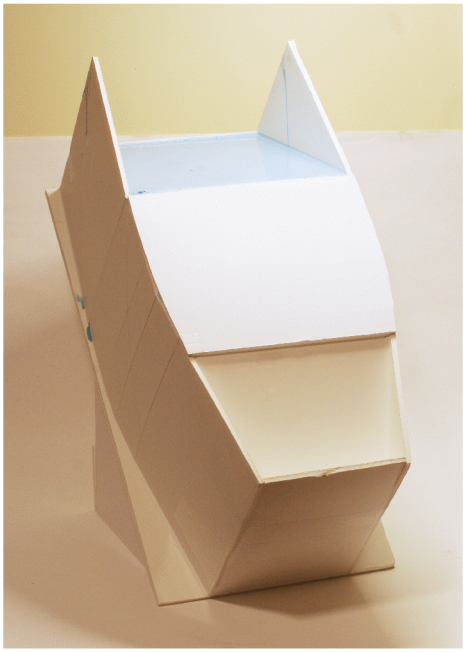
Foam board strips were used to reinforce the interior walls and window covers against the weight of the silicone.

The assembly of shell and walls was then lightly glued to the foam board base of the mold box and the edges caulked. The mold box walls were added next. Again they were lightly glued in place and caulked. The walls were cut to be ½" higher than the roof of the shell so the mold would be at least that thick over the roof. The side walls were also positioned such that the mold walls would be at least ½" thick.

Since silicone is expensive, the foam board box was shaped to minimize the use of silicone, but still ensure the mold walls would be at least ½" thick. Tilting the mold box approximately 45° helped reduce the amount of silicone needed to cover the trunk:



Before pouring the mold.



After pouring.

Once again I used Smooth-On's Mold Max XLS II mold material. The mixing process was the same as for the fender molds.

Here the mold has been turned upside down after curing and the base removed. Normally the shell and mold would be snug up against each other but, as you can see on the left, I had begun to test de-molding when this photo was taken.

The round indents in the window areas were made by the tops from acrylic containers. They are not needed for fiberglass, but would provide mating points if I used an interior mold (I was hedging my bet!).

With the base out of the way, the walls can be removed and the silicone carefully pulled away from the shell. Take your time and ease the mold away slowly one bit at a time. The silicone is tenacious and the balsa wood shell relatively fragile.

This is the finished mold with all the relevant features captured in the silicone.

The next step was to rebuild the mold box so the mold could be held firmly in place when laying up the fiberglass.

**Fiberglass**

There are several decisions to be made when laying up fiberglass;

- Polyester or epoxy resin?
- If polyester, which kind; orthophthalic, isophthalic or vinyl ester?
- Chopped strand mat (CSM) or cloth, or both? And what thicknesses?
- Gel coat or no gel coat?
- What kind of mold release, if any?

Fortunately, you can find lots of good advice (and, of course, some strong opinions with not so good advice) by searching the Internet. These are some of the sites that I found most useful:

- http://www.fiberglassics.com/restoration/fiberglassic-guide-to-boat-construction-and-repair
  Although the site is focused on boats, the information is extremely useful for large scale models.
- http://www.evercoat.com/imgs/pis/GELCOAT.pdf
  This is an excellent note on different gel coats and how to apply them.
- http://www.fibreglass.com/HOWTO/How-To.htm
  'Fundamentals of Fibreglass' has an excellent section on how to calculate the quantities of materials you will need. This is a Canadian site, which explains the spelling of fibre!

**Selection**

I chose to use a laminating gel coat and, behind it, a vinyl ester polyester resin reinforced with thin alternating layers of mat and cloth. Here's my reasoning:

- Although epoxy resins are stronger and more water resistant than polyester resins they are 30% to 50% more expensive. And epoxy doesn't work well with CSM (mat) which I would need. Also, while epoxy resin will adhere well to other cured resins, other resins won't readily bond with cured epoxy. Since I had been successfully using polyester resin for body filling and planned to use it in the future, I would only complicate things if I now started using epoxy.
- There are three types of polyester resin to choose from; orthophthalic, isophthalic and vinyl ester. All are catalyzed by MEKP (Methyl Ethyl Ketone Peroxide). Isophthalics are very good, general purpose resins. Because they are stronger, more durable and more solvent resistant, they are almost always recommended over orthophthalics. Vinyl ester resins go one step further. They are more waterproof and shrink less. The 10% to 15% premium over isophthalic resins seemed well justified, so I chose to use vinyl ester.
- Gel coat is simply a special polyester resin designed to provide a high quality, tintable surface. It may not be strictly necessary since I was going to prime and paint the body anyway, but the cost was modest and I saw no downside.
- The surface of the laminating gel coat (and any laminating resin) won't cure completely in air, so there is no need to sand between layers. But the surface of a mold needs to be air tight so the face will cure. Fortunately, silicone performs that function very well so no sealer coat was needed.
- Behind the gel coat, a layered combination of fiberglass mat and cloth seemed to make the most sense. Mat would fill the corners and indents (where cloth doesn't work well), and layers of cloth would add greater structural strength; an important consideration for the thin, large surface area shell. The general recommendation is to sandwich cloth between layers of mat. That would work well for the shell and by using very thin mat and cloth I would be able to use multiple layers without creating unnecessarily thick walls. More work, but more precision.
- The general recommended practice is to first cover the gel coat with a 'surfacing mat' followed by a layer of regular mat before adding a layer of cloth. This reduces any possibility of 'read out' of the cloth texture through to the gel coat. Since the body shell needed to be thin and strong, I decided to use the thinnest possible mats (3/4 oz) and cloths (1.4oz). I ended up using surfacing mat throughout and in the following sequence:
  - Gel Coat / Gel Coat / Surfacing Mat / Surfacing Mat / Cloth / Surfacing Mat / Cloth / Surfacing Mat. I estimated each layer would be approx. between 0.25 and 0.5mm thick so the overall shell thickness would be roughly 2 to 3mm. That would fit in very nicely.

The gel coat and vinyl ester (as well as PVA and surfacing wax) were purchased from US Composites at www.uscomposites.com. The mat and cloth were purchased from TAP Plastics at www.tapplastics.com.

**Protection**

When I was younger I tended to ignore (or just didn't know about) the dangers inherent in handling certain chemicals or noxious materials. We casually played with mercury in the high school chemistry lab and used asbestos tape to repair leaky mufflers on our cars!! Now I know differently and so take warnings much more seriously. You should too. You definitely need to avoid breathing in or having direct skin contact with the chemicals used in fiberglassing. MEKP, in particular, can cause skin burns and/or severe eye damage. So, I wear:

- An organic vapor respirator for layup work. I use an R-6211HC dual cartridge respirator from 3M which I purchased from www.amazon.com. It's specifically designed to filter organic vapors as well as paint spray. Cost was about $22 and although it's the most expensive item, it's essential. Here's a picture of the mask:


  I also use a dust mask for sanding and filing work.
- Nitrile (or vinyl) gloves; but not latex which can cause an allergic reaction. Nitrile and vinyl gloves are available in the paint departments of home improvement stores or from pharmacies. I prefer nitrile just because they are tougher.
- Long pants, a long sleeved shirt, a hat and tennis shoes - all old. These reduce the risk of getting chemicals or fiberglass fibers on the skin and it's no great loss to throw them away.
- Safety glasses.

**The Test**

Since I didn't have much experience laying up fiberglass, I decided to make a roughly 5" x 10" test section using the same gel coat, mat and cloth combination that I would use for the body shell. The base for the test was the top of one of the silicone molds I used for casting the rear fenders. This proved to be very well worthwhile especially as the first test piece was a complete disaster. I applied the gel coat too thickly, didn't allow enough time for it to set up properly and then laid down a second coat too soon. The end result was a severely wrinkled, unusable surface. The second test piece was much, much better. The difference was that I was much more careful and patient.

I didn't have spray equipment so both gel coat and resin would have to be painted on. Given that, here's what seemed to work best:

- Get organized!
  - Resins are messy and begin to set up (slowly at first) once the catalyst has been added. So you want to have a good routine. It's another good reason to practice.
  - Assume that each time you mix and apply resin you'll end up throwing away the mixing cup, mixing stick and brush. So buy disposable materials. I used popsicle sticks for mixing and the cheapest bristle paint brushes I could find.
  - I tried using vinyl and styrene mixing cups (the kind you typically use in bathrooms) but the resin just melted out the bottoms. What worked well were the very small 'Ziploc' food storage containers available at stores like Wal-Mart or Target and in supermarkets. They are still relatively inexpensive but have smooth sides and don't react with the resin.

- Mix well
  - Measure out the amount you need using a digital kitchen scale. It doesn't have to be a big scale, just accurate. For the body shell I never needed to mix more than 8oz of gel coat or resin at one time.
  - Carefully add in the right amount of MEKP (Methyl Ethyl Ketone Peroxide). Typically this is 2% for gel coat, 1% for resin. I used only 1.5% for the gel coat but stuck with 1% for the resin. The gel coat took longer to cure, but the working time was, conveniently, longer.
  - Mix thoroughly, and I mean thoroughly. MEKP is colorless so it's virtually impossible to see how well it is mixed into the resin. If in doubt, mix for a bit longer. Make sure that any resin on the side of the cup is also mixed in well.
- Apply multiple thin gel coat layers … at least, that worked best for me.
  - Each gel coat layer should be thin … just enough to wet and cover the surface. A thin layer minimizes the risk of wrinkling the previous layer and also helps the gel coat stick to vertical surfaces without running or dripping.
  - Work relatively quickly otherwise the gel coat will begin to setup in the mixing cup.
  - Let each layer cure for three to four hours. Don't shorten this time. The side of the laminating gel coat or resin layer that is exposed to air is designed to remain tacky as it cures. This provides a good mating surface for the next layer. Waiting three to four hours ensures you will still get a good bond but won't completely soften (i.e. wrinkle!) the previous layer.
  - Tip the shell mold on its side or end so that the resin vapors can escape the mold. They are heavier than air and will otherwise sit in the bottom of the mold, extending the cure time.
  - Lay down the next thin layer. Try to get an even surface. Again, wait three to four hours.
  - If necessary, repeat the routine and lay down another layer of gel coat. I found out that two or three layers were enough. Again tip the mold to let the vapors escape.
- Be patient
  - By now you'll have figured out it's largely a process of hurry up, and wait. But it also means that, ideally, you should plan to do all the layup in one day. I like to start early, say at 6.00am, and then work in roughly four hour intervals; approx. 30 minutes of application and 3-1/2 hrs of curing. That gets me five 'layers' by 10.00pm; two gel coat and three resin/fiberglass.
- With the gel coat cured, begin laying in the fiberglass by first painting the gel coat with resin. Then lay in the mat and stipple the mat into place.
  - The generally suggested method of laying in fiberglass mat is to paint the mat with resin on a work surface and then lay the impregnated mat into place in the mold. However, the surfacing mat I used was very thin and easily absorbed resin. Painting the resin on a work table and then laying it in the mold proved to be impossible. The mat became very soft, tore easily and flopped all over the place. It was much simpler, and just as effective, to paint a layer of resin onto the gel coat or previous reinforcing layer, lay in the dry mat, stipple the mat into the resin and, as necessary, add more resin. The mat absorbed the resin extremely well and conformed easily to the mold contours.
  - Mixing the resin is essentially the identical process that was used for the gel coats but, in this case, the catalyst ratio is 1%.
  - To the extent the resin lets you, take your time with this process. Make sure the mat completely absorbs resin and that the mat bonds with the underlying layer.
  - Stipple or roll out any air bubbles. This is important, especially in the corners. I used rollers specifically designed for this work. They are typically available from the fiberglass or resin supplier. Get the smallest diameter you can.
- Lay in the second surfacing mat layer right after laying in the first.
  - Mix another batch of resin.
  - Place the second surfacing mat layer on top of the previous fiberglass/resin layer, add some new resin and gently stipple the new mat into place. Don't overdo the resin, you need just enough to soak the new mat and bond it in place.
  - Again roll or stipple out any air bubbles.
  - Tip the mold as before and then wait three to four hours for the resin to cure both mat layers.
- Lay in the first cloth layer, followed by a surfacing mat layer.
  - Mix another batch of resin and paint the cured surface with the resin.
  - Lay down the cloth and stipple it into place adding more resin as necessary.
  - Again roll or stipple out any air bubbles.
  - Once done, mix another batch of resin.
  - Lay in surfacing mat and stipple it into place adding more resin as necessary.
  - Tip the mold and wait three to four hours for the cloth and mat layers to cure.

- Finally, lay in another cloth layer, followed by a surfacing mat layer.
  - Repeat the procedure described above.
- The last step is to seal the resin/fiberglass surface by applying a final thin coat of resin which has surfacing wax or similar additive mixed into it. Surfacing wax (www.uscomposites.com) migrates to the surface as the resin cures and creates a barrier to air. This lets the resin completely cure creating a sandable tack free surface. Add 2oz of surfacing wax per gall. (128oz) of resin.

Below left is a picture of the test piece. Clearly visible are a couple of wrinkles from the process, but the other 'irregularities' are just imperfections on the surface of the mold mirrored in the gel coat.

The picture on the right shows a cross-section through the layers. The two gel coat layers, then two layers of mat, a cloth, a mat, another cloth and a final mat, came out to just over 2mm. Not only was it more rigid than I had hoped, the thickness was on the low end of my expectations. Perfect!!

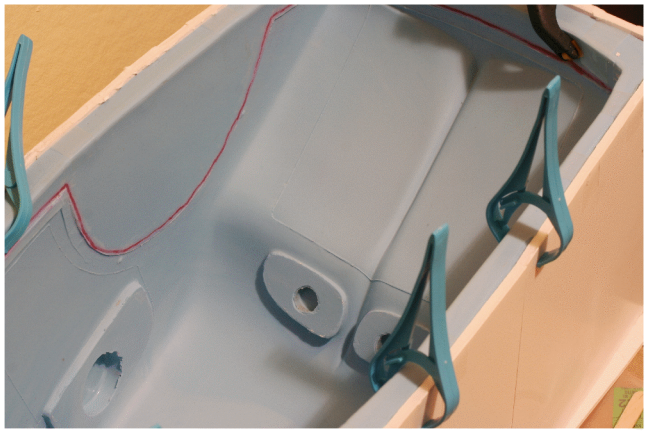
**So Now For The Real Thing!!**

**DAY 1**

**Preparing the Mold**

The first step in preparing the mold was to remove any excess silicone flash. I used very sharp toe-nail like clippers to trim the flash. Then I cleaned the mold. WD-40 (or gasoline) works quite well for cleaning the silicone, but it is something you'll want to do outdoors.

Here's the mold ready for the layup process. The red line is just a marker to remind me where the edge of the shell will be.



**Fiberglass Pieces**

I wanted to do all the layup in one day. With that in mind, I cut out all the pieces of fiberglass mat and cloth beforehand. To me, the obvious way to build the shell was to use three pieces … two side pieces and a long trunk/roof/front window piece. The pieces would overlap about ½" to ¾" at the point where the roof curves into the side pieces. This would strengthen the roof edge yet still keep the side walls relatively thin. Templates were made directly off the mold using tissue paper. Since the mat and cloth are relatively thin I was able to stack up multiple pieces of mat and cloth for the side pieces, place the tissue paper on top, clip or staple all the pieces together and cut them all out in one go. I was able to do the same thing for the long center pieces. But, be warned, you need to have very sharp scissors!!

**DAY 2 & 3**

**Timing**

The overall process took most of a day, although only three to four hours were actual preparation and application time.

Here's my rough timing …

| Time | Step | Prep Time (mins) | Application Time (mins) | Cure Time (mins) |
|---|---|---|---|---|
| **Day 2** | | | | |
| 6.00am | • Gel Coat 1<br>  ○ 3 oz gel coat + 45 drops MEKP | 5 | 15 | 210 |
| 10.00am | • Gel Coat 2<br>  ○ 3 oz gel coat + 45 drops MEKP | 5 | 15 | 210 |
| 2.00pm | • Surfacing Veil Mat 1<br>  ○ 3oz resin + 30 drops | 5 | 15 | 180 |
| | • Surfacing Veil Mat 2<br>  ○ 3oz resin + 30 drops | 5 | 15 | |
| | • Roll out air bubbles | - | 10 | |
| 6.00pm | • Standard cloth<br>  ○ 4oz resin + 40 drops | 5 | 15 | 180 |
| | • Surfacing Veil Mat 1<br>  ○ 3oz resin + 30 drops | 5 | 15 | |
| | • Roll out air bubbles | - | 10 | |
| 10.00pm | • Standard cloth<br>  ○ 4oz resin + 40 drops | 5 | 15 | 180 |
| | • Surfacing Veil Mat 1<br>  ○ 3oz resin + 30 drops | 5 | 15 | |
| | • Roll out air bubbles | - | 10 | |
| **Day 3** | | | | |
| Any Time | • Resin seal coat<br>  ○ 2oz resin + 40 drops MEKP + 40 drops surfacing wax | 5 | 15 | 180 |
| | | | | |

**Removing The Shell**

After the final seal coat had been applied, I turned the mold on its end and then left the mold and shell sit for three days in a warm room. The time and temperature ensured there was complete curing of the resin.

To release the shell, I simply removed the tape that held the reinforcement walls of the mold in place, pulled the walls back and then gently worked the silicone mold away from the shell walls. With just a little coaxing, the shell came away easily from the mold.

**Trimming The Mold**

The last step was to cut away the excess fiberglass and resin from around the shell. I used a Dremel tool and rotary saw blade to first trim the edges of the shell close to the finished edge I wanted. The only problem with the saw blade was its tendency to 'run away'. By the time I was done, my arm was pretty tired so I waited until the next day before using the Dremel and a burr-type grinding head to carefully remove the remaining excess material.

Here are a couple of pictures of the trimmed shell …

The doors and trunk still need to be cut out but the mold and gel coat nicely carried over the scribe lines from the original balsa wood shell so there shouldn't be a problem. There's also other finishing work to do including preparation of the gel coat surface for painting. Nevertheless, I'm happy with the shell: it is what I hoped it would be.

Likely as not, I'll make another shell for insurance purposes (and possibly a second model) but at least, now, I know this approach will work.

**Summary**

I started Vol. 1 with a simple question:

"What's the best method for scratch building a body for a large scale model car?"

Brass would be ideal, if you have the skills. I didn't.
3-D printing is the coming revolution. It's great if you have experience with CAD, but I didn't and I wasn't yet ready to invest the time to get up the learning curve.

That pretty much left resin casting and fiberglass.
Both have their strengths and weaknesses. In the end, though, I used both!

Hopefully, then, these two volumes will help you think through which method will work be best for you.

Happy modeling,

John Haddock

**Acknowledgements**

Once again I was helped by the worldwide resources of the Internet. And, once again, Ken Krausfeld was singularly helpful, providing advice based on his own hands-on experience with laying up fiberglass. For all those inputs, I'm extremely grateful.