RESIN, FIBERGLASS AND BALSA MODEL CAR BODIES
Vol. 1

Introduction

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

That was the question I faced as I set out to make a 1/8th scale model of this streamlined, teardrop fendered, 1932 Rolls-Royce Phantom II with coachwork by Figoni & Falaschi.

Although the chassis was coming from a Pocher 1/8th scale kit, virtually everything related to the body, including the floor and seats would have to be scratch built.
How then to start?

I did have several photographs of the car but, unfortunately, no body drawings. Nevertheless, using the photographs and the chassis dimensions, I was able to make preliminary outline drawings. But, I was still going to have to sculpt a model of the exterior of the body to make sure that it was not only faithful to the shape of the prototype, but also that it would fit the chassis. How I would sculpt the body would be a factor in the decision as to which method I used for the body construction.

Narrowing the Field

Cast resin, fiberglass, brass and wood are all long-established methods for making model car bodies. More recently, prototype (3-D) printing has become available. I even experimented with a plank-on-frame approach using thin styrene strips. That method also worked, but it proved to be very time consuming.

Brass would be ideal. It's thin, strong, and relatively easy to form and solder (with the right tools). And a brass body, properly done, is a thing of beauty. But I had very little experience with brass forming and none whatsoever with forming the complex, deep-drawn shapes of the fenders. I would also need hard wooden bucks over which to form the brass shapes but Dremel tools were the extent of my wood forming equipment. It was tough to see how I could easily experiment with the fender shape. That did it for brass.

In my mind, wood wasn't really viable since both the exterior and interior were going to be modeled. As a result there would be quite a few thin sections, especially the doors, and I had lots of concerns about the fragility and long term stability of thin wood sections.

The styrene plank-on-frame method was eliminated simply because it would be too time consuming. However, I did make the front apron using this method. But that's another story.

At first sight, prototype or 3-D printing looked very attractive. It's a very clean, elegant approach, particularly if you only want one or two copies of a part (as was the case). And, over the past ten years, the cost of printing parts has dropped considerably. Nevertheless cost is still an issue. The body shell alone would be about $400 (in mid-2010) and each of the front fenders only a little bit less. The total cost of over $1,000 was significantly more than what I wanted to pay. The other major issue was that the machines print from an STL file. The STL file is a straightforward translation of a computer-aided design file, and although I have traditional drafting skills, I would have to learn CAD and invest in CAD software. Either that or have someone produce the CAD drawings. And to make it a little bit more complicated, the complex shape of the fenders effectively eliminates a number of CAD programs. The idea of learning

CAD was attractive, especially as, in theory, I would be able to make sure everything fit and the shapes and lines were correct without ever leaving the computer. But I decided this wasn't the time!!

That left resin casting and fiberglass

Resin, Fiberglass or Both?

I figured the front fenders were going to be the biggest challenge. First, the fenders have big swooping contours with deep undercuts for the wheels. Second, the inside edge of each fender would be stepped so it could clear items attached to the chassis and also rebated in order to allow a brass chassis rail cover to be attached. Third, because the fenders flow into, and are an integral part of, the running boards I wanted to make each fender and running board in one piece. Lastly the running boards have side walls and I wanted them to be just 1mm thick.

One other important factor came into play – molds. Both resin and fiberglass need molds. Typically, for resin casting, it will be a split mold made of silicone. Once the master is removed and the two parts of the mold put back together, filling the void with resin will, of course, yield a one-to-one copy. The shape of the master can be quite complex and, using the appropriate resin, wall thicknesses of 1mm are possible.

For fiberglass, the first step is to create a female (or outer) mold of the master. Once that is done, a gel coat is laid down on the inside of the mold, followed by a mixture of fiberglass and resin. This creates a replica of the original outer surface.

Fiberglass is messier and smellier than resin casting and better suited for large surfaces with relatively modest curves and corners. Different wall thicknesses can be built up by laying down multiple layers of glass mat or cloth, but it is less precise than resin casting. Cast resin is also better suited for tight corners and deep valleys. Since that was the nature of the front fender, I chose to go with resin casting.

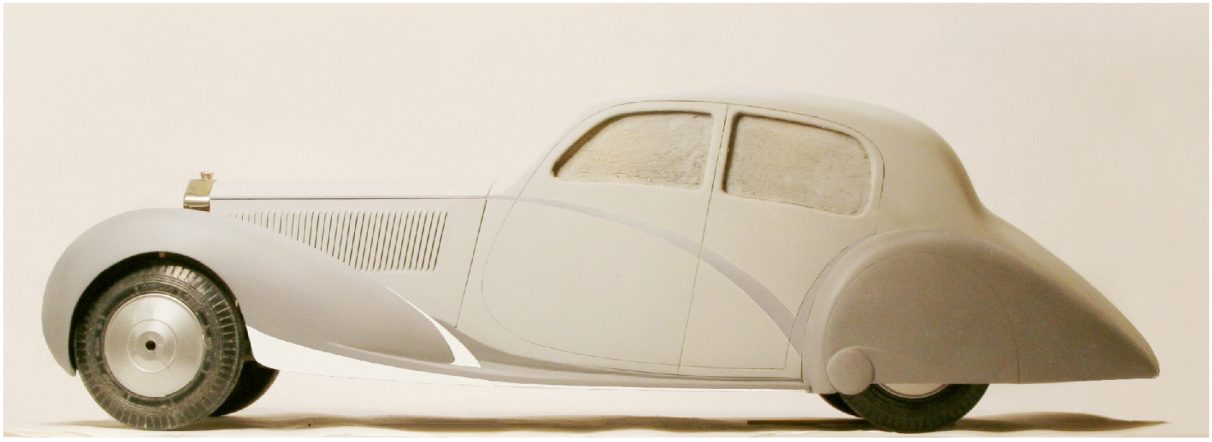
It would be a different story when making the body shell, but more on that later.

Making the Master

For a couple of reasons I chose to use balsa wood to make the masters for the fenders. First, it's easy to shape and the shaping can be done with just craft knives, Dremel tools and sandpaper. This was important since, in order to get the right lines, I was going to have to experiment with the shape of the fenders. Second it's lightweight, so it would be relatively easy to test mount the fenders to the chassis when checking the shape.

Its weakness is that the large porous grain structure makes it relatively fragile so thin sections have to be made with care. And, as I found out later, you need to do a good job sealing the finished shape otherwise the silicone mold material will tend to 'grab' the grain. Despite all that, the process worked well.

The following photograph shows the model with balsa fenders (front and rear) and a balsa body.



The rest of this note describes the sequence of steps I used to make the fenders and body.

Fender Sequence

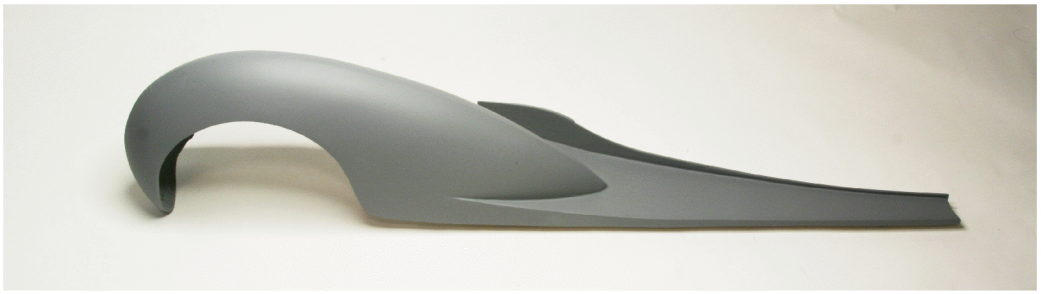
- I began by making paper and card templates for various profiles of the finished part.
    - A handful of templates of the key cross-sections was sufficient.
- Outline drawings and the templates were used to select balsa wood blocks that, assembled together, would be big enough to envelope the finished shape.
- The blocks were then cemented together (using Elmer's Glue-All).
- With the templates as a reference, the assembled blocks were first milled / carved to the rough outside shape of the fender. After confirming I was on the right track, I carefully carved and sanded the rough shape until was very close to the finished external dimensions I wanted.
- After further checking of the dimensions and the flow of the shape, more sanding (400 grit) was used to get to the final shape.
- If I needed to add back material (and I did) I used auto body filler. After some web-based research I settled on a two-part polyester filler called Metal Glaze® made by Evercoat (www.evercoat.com). It flows easily and can be sanded to a very smooth surface. It will also hold a fine edge. The filler will adhere to, but not bond with styrene so you can use styrene sheets to make formers. Working time is just a few minutes so I would typically mix just a small quantity at a time. The resin and hardener were thoroughly mixed in a small plastic bathroom cup using a wooden stick (tongue depressor) both of which could be thrown away after use. Evercoat makes a wide range of professional body fillers so you can choose the one that best meets your needs.

- Once the outside profile was set the underside of the fender was milled and carved, reducing the walls to approx. 1/8th inch.
- Where the balsa was strong enough, I continued to shave away material until wall thicknesses were about 1/16th in. This is a judgment call. Wherever possible leave walls thicker rather than thinner.

- Once the carving and sanding was complete, the external surface was sealed with wood sealer
    - Michael's sells a very good wood sealer; Folk Art Sanding Sealer.
    - It's also available from www.plaidonline.com
- Once the sealer had dried, the surface was sanded to remove any raised wood.
- Then re-sprayed with sealer.
- And this second coat lightly sanded.
- Any large holes, gouges or scratches were filled with Squadron Putty or some of the polyester body filler.
    - Squadron putty is readily available from most hobby stores and, since it can be used straight from the tube, it's very convenient. However, because it is relatively soft and porous, it is fragile and sharp edges are easily damaged. The auto body filler was a much better choice for filling edges.

In this picture, the blue-green areas are Evercoat filler and the beige areas Squadron putty.

- The outer surfaces were once again sanded smooth.
- And then filler primer sprayed on the outer surfaces. The filler primer will fill any small remaining irregularities.
    - My preference is to use Dupli-Color Filler Primer (FP101). It is fast drying and easy to sand. Where it is needed, you can apply several successive layers. Each layer should be relatively thin. Advance Auto Parts carries it or check out Dupli-Color's website (http://duplicolor.com) for places to buy it.
- Next the outer surface was wet sanded, and, if necessary, re-sprayed with filler primer and wet sanded again until the desired surface profile and uniformity was achieved.
- The finished, sanded primer was then coated with Primer Sealer. This ensures a smooth non-porous surface. I use Dupli-Color's Primer Sealer (DAP 1699)
- A light wet sanding gave the Primer Sealer a very smooth finish.
- I re-sprayed and re-sanded with primer and/or primer sealer until the surface was exactly right. It was easier to get the master right than do a lot of remedial work on the castings.
- At this point I had a uniform, very smooth finish in which any imperfections were clearly visible. If the surface wasn't to the standard I wanted, I took a deep breath and repeated as many of the earlier steps as necessary.



- I now have a surface that would be an excellent master for making a resin mold.

- The next steps were to finish carving and sanding the inside surfaces.
- If the inside surfaces are going to be visible then you should follow the same procedure as above. If not, (and mine weren't) it is only necessary to remove as much excess material as possible.
    - I used burr type tools (first rough and then fine) to remove the balsa wood. I found that traditional wood carving tools didn't work that well unless they were very, very sharp. The burr tools were easier to use, but wield them with care, they can remove a lot of material very quickly even at the lowest Dremel speeds!!
- Dry sanding with medium grit sandpaper provided the final desired finish.
- The uncoated wood was then sprayed with wood sealer (being careful to protect the primed surface of the exterior surfaces).
- After that the sealed surface was lightly sanded to create a relatively smooth finish.
- I then re-sealed and lightly re-sanded until I had an acceptable finish.

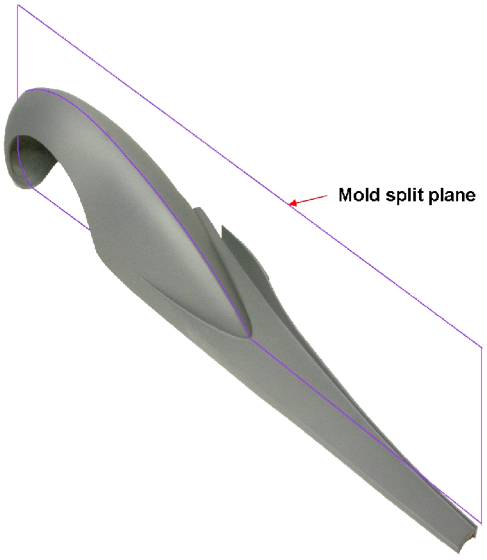
Resin Casting

Once the balsa fender was finished I could set about making the molds for resin casting.

The first challenge was to decide the split plane for the silicone molds. There were a couple of options:
Option a) was a split plane along a vertical line through the apex of the fender.

Essentially this splits the mold into two halves (left and right). My thought was that I could peel the top of each mold away from the top of the fender and then pull the mold down and away from the deep undercut.

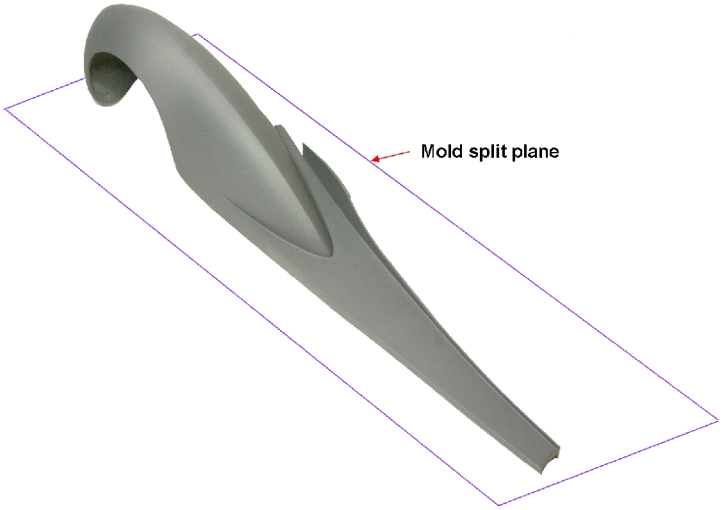
The molds would be cast with the fender on its side and the split plane horizontal. The fender would be suspended off the side wall of the mold box.



Option b) was a split plane horizontally along the bottom side of the running board.

The top mold would essentially drape the outside of the fender and be designed to simply pull up and off the fender. The bottom mold would take care of the underside of the fender and its deep undercuts. Since the bottom of the running board isn't flat, the fender would have to be mounted on a low wall with the top of the wall conforming to the shape of the underside of the fender. Inserts would be needed to fill the wheel arch and the inside edge of the fender.

The top mold would be poured first. Then the platform walls and inserts would be removed, the top mold (with the master) turned upside down and the bottom mold poured into the cavity.

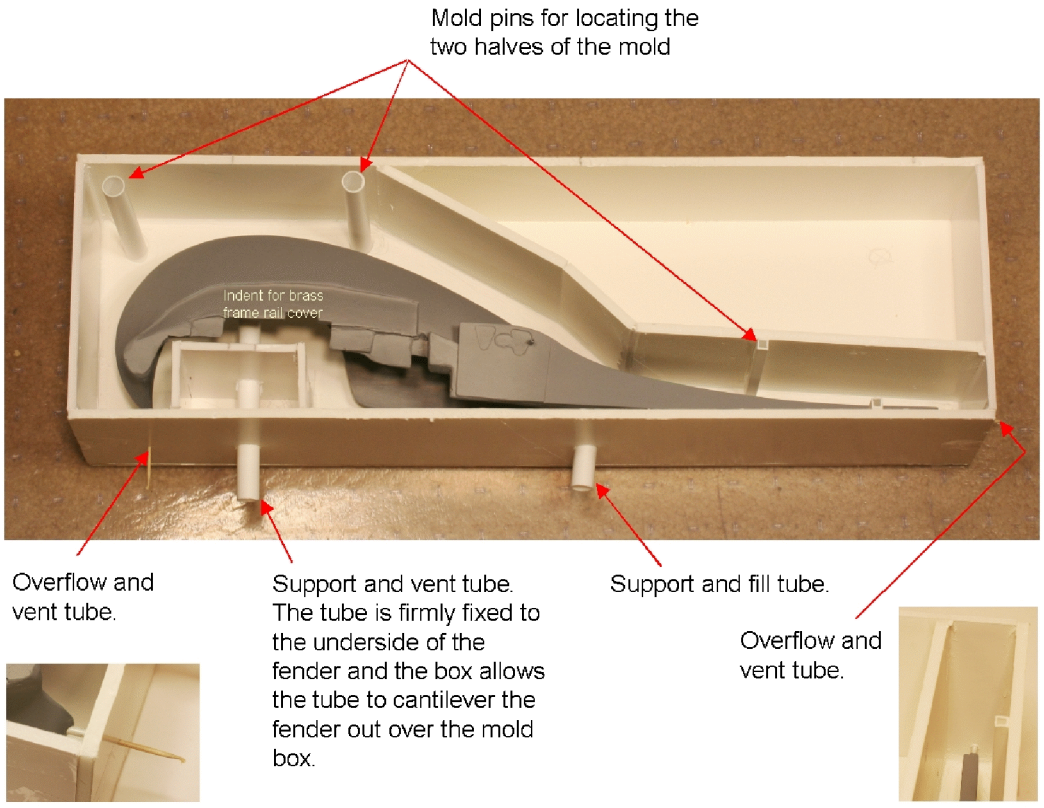


For the front fenders I chose to go with Option a) based on a number of factors:

1. How easily I could support / suspend the fender so the silicone could easily flow around it
2. How and where I would set up the fill channel for the resin and the vents / overflows so any trapped air and excess resin could escape.
3. How I would support the molds so that they were rigid enough when casting to ensure the cast parts were the right shape.
4. How I would remove the master and, subsequently, the cast parts from the molds.
5. How I could best minimize the amount of silicone being used.
   Good silicone mold material is expensive … roughly $0.50 / cu in in 2011 (a pound of silicone is approx. 22 cu in). The silicone for each fender came to about $100 so it's worth thinking about. The manufacturer recommends a minimum ½" mold thickness around a part, but other than that the other factors, listed above, come into play.

For the rear fenders I used Option b), but more on that later.

Here's how I set up the front fender.



Bottom Mold

After the fender was mounted in the box, the first step was to pour the bottom mold. But before I started, I made a rough calculation as to the amount of silicone I would need. With a little care you should be able to get pretty close. My plan was to wait at least a day after pouring the bottom mold before I poured the top mold. So any excess from pouring the bottom mold would have to be thrown away. Based on my setup, the bottom mold would need just under 4 lbs and the top mold would need 6 lbs. Fortunately that meant I could mold each fender out of a single gallon of resin (which is 10 lbs).

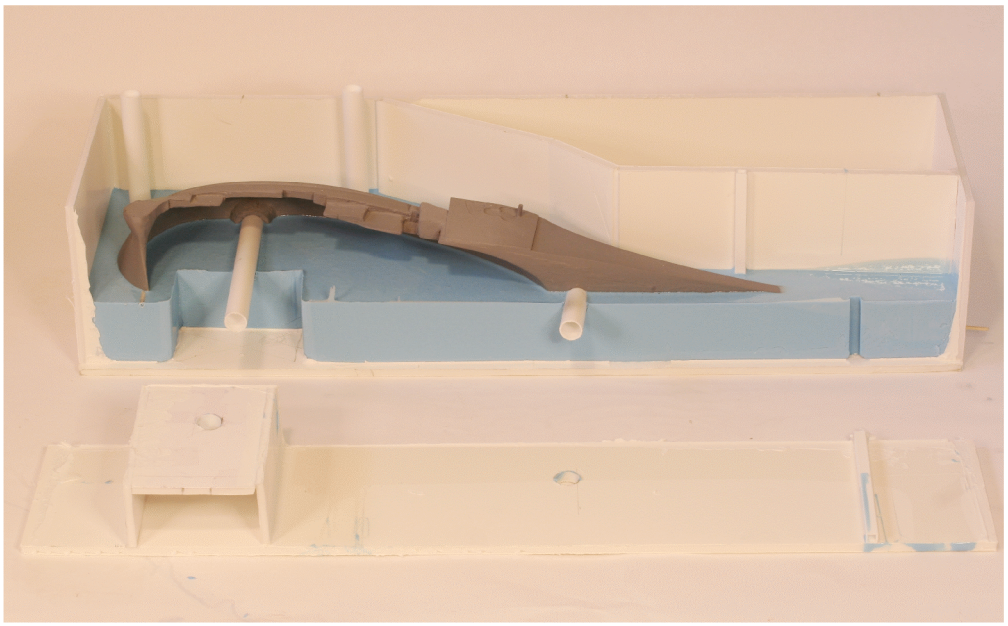
I used Smooth-On's Mold Max II silicone. It has low shrinkage (critical for a long part like the fender), high tear strength (very important when de-molding parts with deep undercuts so as not to tear the mold) and a relatively long set-up time. The long setup time was useful since the catalyst has to be mixed in well with the silicone and it's a relatively tedious process. Follow the manufacturer's instructions and make sure the silicone on the side walls is thoroughly mixed in. Try to stir horizontally and avoid folding the silicone in on itself. This will minimize the amount of air trapped into the material.

Once thoroughly mixed, I poured the mixed material into the box along the wall facing the bottom of the fender and let it pool so the silicone built up and over the edge of the fender. This helped keep the fender in place as the silicone spread out and built up under the rest of the fender. Pour slowly – it will help reduce the number of bubbles in the mold.

I poured the bottom mold one evening and then worked on pouring the top mold the next evening.

Once the bottom mold was poured, the first step was to remove the side wall facing the bottom of the fender. That was necessary so that I could effectively and completely coat the bottom mold surface with mold release. The mold release is very important to make sure the upper mold doesn't stick to the lower mold. I used Ease Release® 205, a brushable mold release made by Mann Release Technologies (www.mann-release.com). You need to be thorough about this step. I had originally used a spray on release but, subsequently, I had problems separating the molds. The switch to a brushable type solved the issue.

Here's a picture after the bottom mold had been poured and the side wall removed.



Top Mold
I mixed the resin and catalyst for the top mold following the same process as for the bottom mold. Again I poured the mixed material slowly into the mold box. This also helped make sure I didn't trap any air under the fender. The mold was left to cure for 24 hrs.

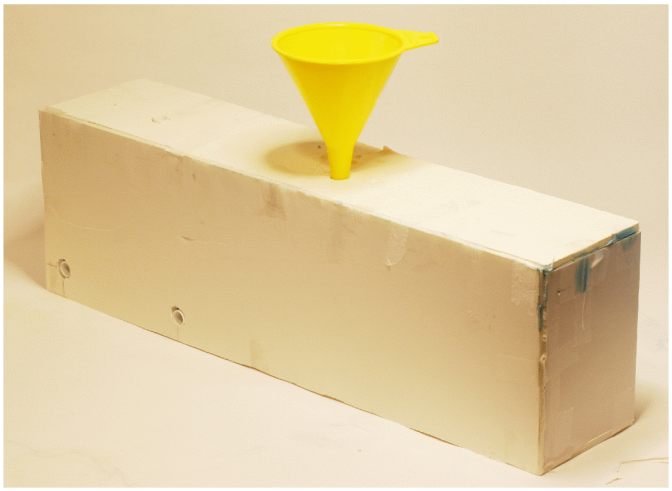
Once the mold had cured, the side walls of the box and the locator tubes were again removed.

Separating the Molds
The first step was to release the two molds from the side walls of the box. To do that, I worked around the mold, easing the mold away a bit at a time. Each time I went round I went a little deeper down the side of the box. Eventually the two molds came free (as one piece).

Next, it was necessary to find the split line between the two molds and begin carefully separating the top and bottom molds. Ideally you can make the split with a fingertip but you may need to encourage the separation with a sharp knife!! If so, do this with care since you'll want the two molds to mate together well when you cast the fender.
Once the two molds were separated, I pulled the bottom mold up and over the fender top and then pulled/pushed down on the mold to release it from the undercut. It's worth taking your time over this step; easing, rather than forcing, the separation. Since the fender had such steep undercuts, it was hard not to damage the balsa fender. The exercise was then repeated with the other half of the mold.
At this point I had the two halves of the mold free and clear of the fender. They were cleaned thoroughly, the pour and vent tubes cleared and any silicone flash removed.

Casting
The first step was to put the two molds back together and replace any pins or location tubes. In particular, I made sure the two halves were properly mated together.

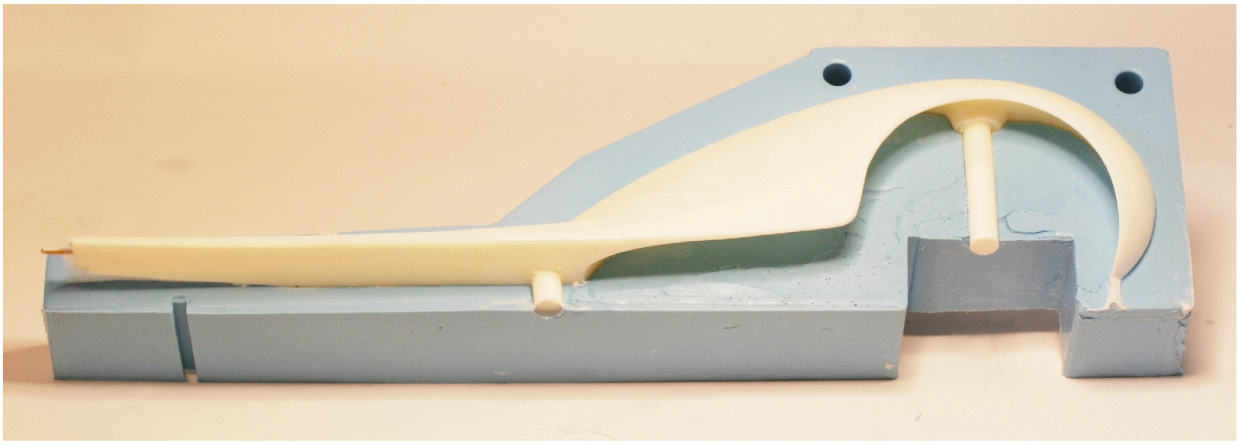
The original mold box (with a couple of damaged walls replaced) was used to support the molds and hold the two halves of the mold together. You don't want resin leaking out between the molds! The mold box was turned over so that the pour tube was facing upwards and the outer ends of the vent tubes were near the highest point of the part.
On later pours I found I could dispense with the sides and top of the mold box and just lightly, and evenly, clamp the two halves together.



The resin was mixed in a disposable plastic bowl and according to the manufacturer's instruction. Again, I made sure the resin and catalyst were completely mixed. I used Smooth-On's TASK 4, a low shrinkage slow cure urethane resin. Set up time was 20 minutes; plenty of time for the resin to be thoroughly mixed and slow poured into the molds. You can buy the resin directly from Smooth-On (www.smooth-on.com).
Once the air was out of the vent tubes at the end of the fenders, I plugged them with short styrene rods and made sure there was enough resin in the fill tube to keep the mold cavity full.
Then the resin was left to cure for 24 hrs.

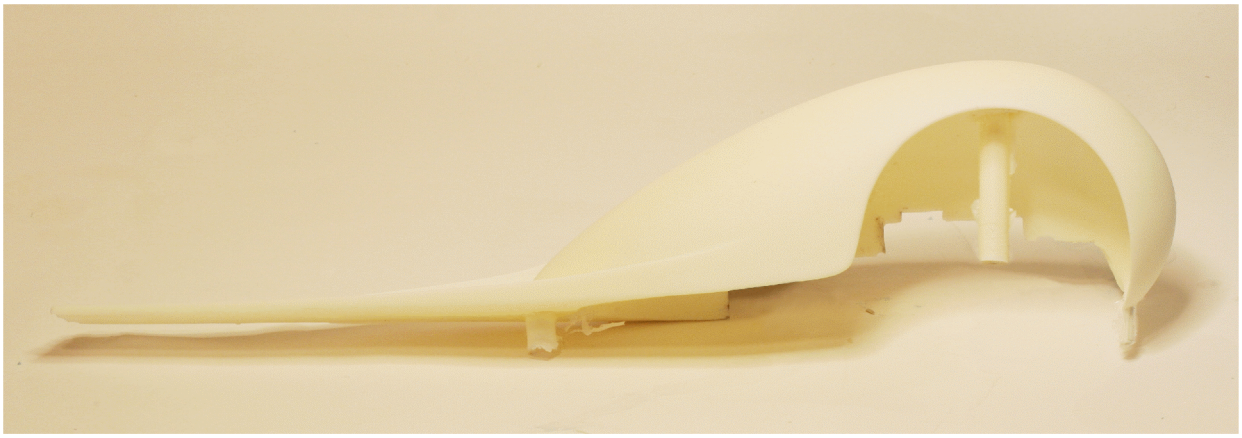
Once the resin had cured, the molds were removed from the box and the locator pins removed.

The lower mold was removed first, in a similar manner to removing the master from the molds.



The upper mold covered the side wall of the running board so was more awkward to remove. Removing it after the lower mold was out of the way made most sense.

Finally, the last mold half was removed.



Everything had worked out!! It was time to exhale!!

The resin casting turned out better than hoped. The resin is strong, even on the side wall of the running boards where the resin thickness was 1mm in places, and yet it captures lots of detail.

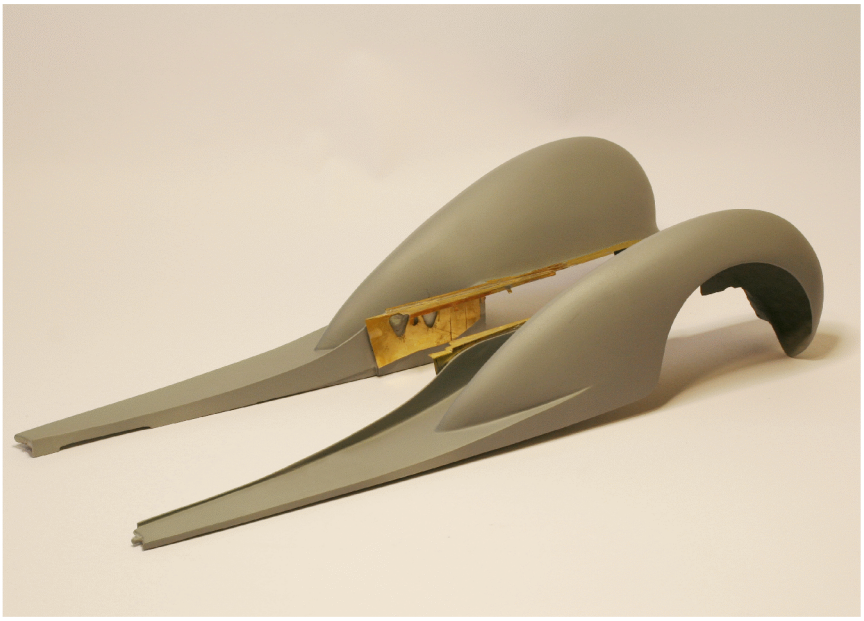
Cleanup and Sealing

Sawing off the fill and vent pipes was straightforward as was removing the flash. I then did some final milling, using my Dremel tool, to remove the last of the excess material from the fill and vent tubes.

Once the casting was cleaned up I sprayed it with resin sealer. Unless the resin is thoroughly cleaned it is likely you will have places where primer or paint won't stick. I had mixed results with resin cleaner on the seats and so, on the fenders, I switched to using a spray on sealer. I used Resin Spray from Castin Craft (www.eti-usa.com) with very good results. It's a multi-purpose clear gloss finish / sealer.

Next, the chassis rail cover was attached to the fender and Metal Glaze filler used to finish the fender profile. Once the filler had been sanded smooth to the right profile, two coats of Dupli-color filler/primer were applied, followed by wet sanding with 400 grit sandpaper. A final coat of Primer Sealer set the fenders up for painting.

Here are the left and right front fenders, after the Primer Sealer had been applied. The brass frame covers have yet to be finished:



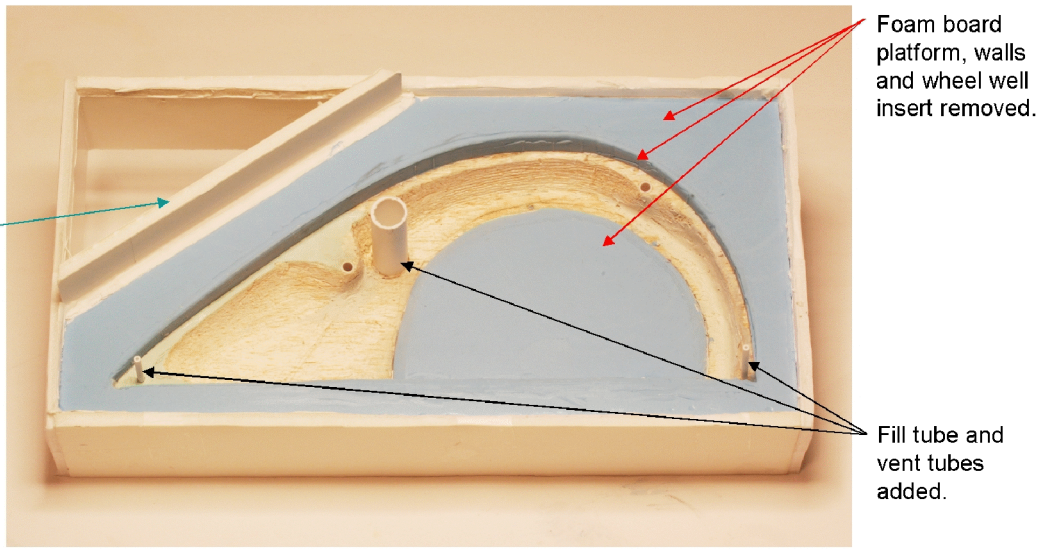
Rear Fenders

The same overall process was now used to make the rear fenders. However, since the back side of the fender was relatively flat I chose to use Option b) for the split plane and place it on the outside of the fender. Any flash would also be on the outside edge of the fender which would work better cosmetically.

The first step was to mount each fender on a low foam board wall (about ½" high) that ran completely around the fender. The top part of the wall was contoured to exactly match the back of the fender and lightly glued and caulked in place. The wheel well was then filled in from behind with another piece of foam board and the total assembly lightly glued to a foam board platform. Walls were added to the platform so that the top of the walls was about ½" above the highest part of the fender.

The mold box was then filled completely filled with silicone up to the top of the walls.

Once the silicone had cured (overnight), the box was turned upside down, the original platform removed and the low walls under the fender removed. A fill pipe and two vent pipes were then added.

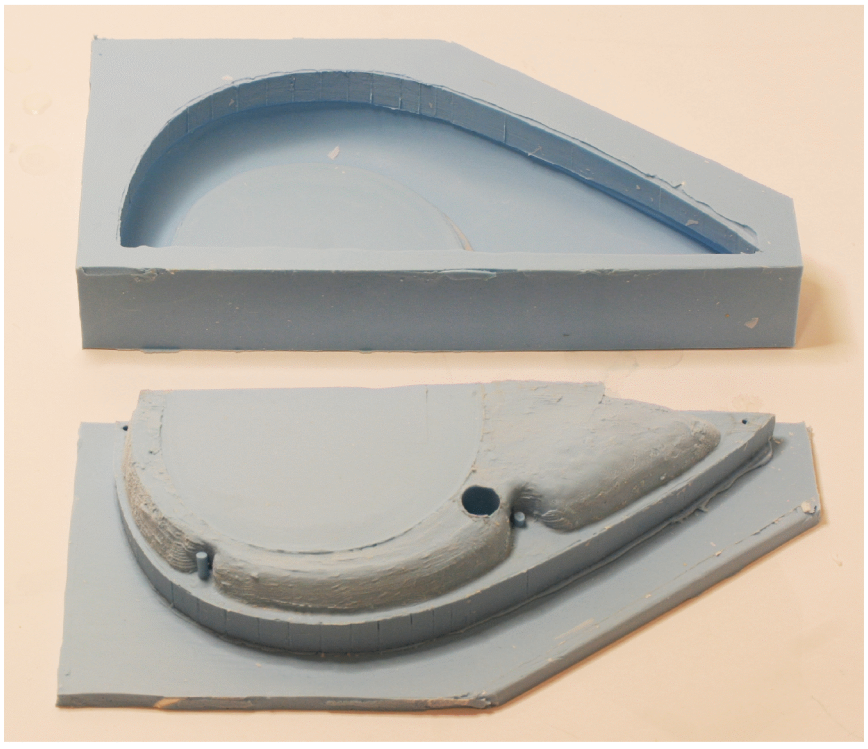


The exposed silicone surface was brushed with mold release (two coats) and, once it had dried thoroughly, the second part of the silicone mold was poured into the box and allowed to cure overnight.

Once cured, the upper mold was removed. This had to be done with some care since there were two, 1/16'" dia holes for mounting pegs on the back of the fender and these were now filled with silicone and were part of the mold.

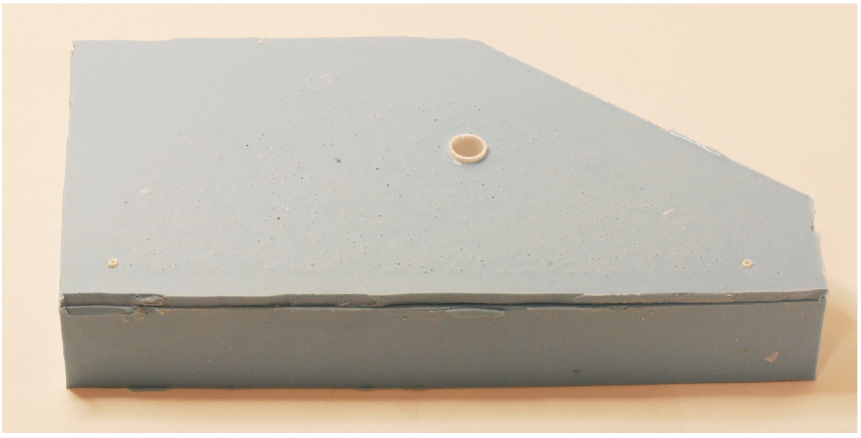
Once the upper mold was out of the way the foam board walls were taken off and thrown away. The balsa master (together with the fill and vent tubes) could then be (carefully) removed from the lower mold.

Here are the two halves of the mold:



Casting the Rear Fenders

Re-assembling the two parts of the mold prior to resin casting was straightforward.



And a slow, careful pour of the resin was equally straightforward. I used the same TASK 4 resin that I had used for the front fenders and the resin was, once again, allowed to cure for 24 hrs.

De-molding was not a problem although it should be done with care so as to not damage the silicone molds. The master included several small holes that would accept mounting pins during assembly. These holes were translated into small silicone pillars on the mold and they can be broken easily. Very little cleanup of the cast fender was needed other than cutting off the fill and vent tubes. There was only a small amount of flash and the surface quality was excellent.

These are pictures of the fenders after light sanding and spraying with filler primer.

Takeaways

In all of the above, three things stand out.

- Resin casting is excellent for any parts that need dimensional accuracy and/or have a lot of complex features. There is a wide choice of resins available so, for this application, it was possible to find a slow setting, low shrinkage resin with high strength in thin sections. It was definitely worthwhile checking out the manufacturers' data sheets.
- Mold design is important … for both cost and casting reasons …
    - Large silicone molds for resin casting are expensive. The silicone for the two front fenders (left and right) cost about $200. By comparison, each foam board box (to contain the mold) cost less than $10 and the resin for each fender was less than $20.
    - You need to be sure that the fill and vent tubes will allow the mold to be filled properly. This is especially the case if you have thin wall sections. They are hard to repair, so plan with care!
- Proper preparation of the master will save a lot of time later. This is nothing new, but it is particularly true if you plan on making more than one copy. Silicone will faithfully mirror every imperfection!!

Next

Once the fenders were complete my focus could shift to the body shell. This is the focus of Vol. 2.

John Haddock

Acknowledgements

My own initial, hesitant steps were supported by a number of excellent articles on the Internet. For that I'm thankful. But in the preparation of this note, Ken Krausfeld was particularly helpful, both in reviewing drafts and offering suggestions for improvement. Thanks, Ken.