# MOLDING LARGE SCALE MODEL TIRES

**Introduction**

One of the challenges in scratch-building scale models is making appropriate tires. Properly sized, properly scaled, historically accurate tires are very hard, if not impossible to find, so often the only viable option is to make your own. This was the case when I started building a model of a 1935 Austin Seven Ruby.

The Austin Seven was a small inexpensive vehicle designed to bring motoring to British working families. It was produced in large numbers between 1922 and 1939.

You can find more details about the Austin Seven and the reasons for building this particular model at [www.jrhscalecars.com](http://www.jrhscalecars.com).

Austin Seven tires are small and narrow.
Just how small can be seen in the picture below. It shows the Austin Seven wheel and tire in front of the wheel and tire from Pocher's Rolls-Royce Phantom II kit.

**Prototype Tire**

At the time of manufacture, the Austin Seven Ruby used a tire designated as 4.00 x 17.
This means the tread width was 4.00" wide and the wheel had a diameter of 17".
The standard tire profile was 80%, so the wall height was 3.2" and the overall tire diameter 23.4".
The tread pattern I intended to use is a vintage tire design that is currently available to Austin Seven owners.

**Making The Tires – Approach**

The most obvious way to make the tires was by resin casting.
The process begins with making a 1:8 scale master model of the tire. The master is then used to make a silicone mold of the tire. The mold is made in two parts so that the master can be removed once the mold parts have cured. With the master removed, a urethane rubber liquid is poured into the space vacated by the master and the rubber allowed to cure. The mold is split open and the molded tire removed. These last two steps are repeated each time a tire is made.

**Challenges**

There were a number of challenges to resin casting the tires:

1. How to make a realistic model of the tire?
2. What was the best cross-section profile for the tire? Some flexibility in the tire wall was desirable so it would bulge out slightly at the bottom, just like the prototype tires. The tire profile would also affect the ease with which trapped air could escape the mold and the molded tire could be extracted, so that had to be considered.
3. Since the tire is symmetrical, where should the mold split line be? The default answer is in the middle of the tread. But the mold halves would be of silicone, so some misalignment of the two halves was a real risk.
4. What material should I use for casting the tires? Obviously, rubber was the first choice, but what hardness to use?
5. What was the best way to get the liquid rubber into the mold? And what was the best way to vent out the air as the mold filled. Both the fill point(s) and the air vent would leave material that would need to be trimmed off. Where, then, to place those points?

**Master Tire Model**

There are several ways to acquire a tire model that can be used as the master. The easiest way is to copy an existing model tire, if one is available. Or, if the tire is simple enough, the tire can be built by hand or turned on a lathe. For the Austin Seven, however, I wanted to capture the detailed tread pattern of an historically accurate tire, so 3D printing was a good way of doing that.

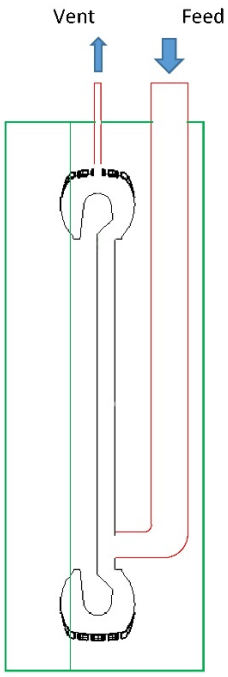
I used Rhino 5.0 CAD software to draw the tire and then had the tire printed by a commercial service. Since it's a relatively simple drawing, it's possible a free CAD programs such as SketchUp could also be used to draw the tire model, but I haven't tried it. Here's a picture of the tire drawing:

The 3D printing would be done by Shapeways (www.shapeways.com) using their Ultra Detail acrylic material. This provides relatively smooth surfaces while preserving all of the nub detail. Very little cleanup of the model would be required after it had been received.

**Molding Setup & Casting Process - Overview**

After a couple of unsatisfactory experiments with feed points and rubber hardness, I settled on using Smooth-On's ReoFlex 50 urethane rubber (www.smooth-on.com), a Shore Hardness 50 rubber that doesn't need vacuum degassing. I also had the master tire printed with a flange across the inside of one of the tire walls. This way, the liquid rubber could be fed into the bottom of the flange. The rubber would flow down into the bottom of the mold, then up and around the mold before venting out at the top of the tire.

Here's a cross section through the master tire and the mold showing the feed and vent tubes (red) as well as the outlines of the molds (green). The mold split line will be at the edge of the tire tread to minimize any issues if the two halves of the mold are slightly mismatched.




The feed flange avoids having to place a feed point on the outside of the tire where the trim point will be a visual distraction.

The tire and flange cross-sections shown here are accurate. Combined with the Shore Hardness 50 rubber, the tires will take on a slight bulge under the weight of the chassis and body. Just like the prototype.

For reference, the Pocher tires have a Shore Hardness of between 50 and 80, depending on where you measure them.

When making the two parts of the mold, the tire and tubes assembly is turned on its side and supported inside a foam-board box. The larger half of the mold, containing the tubes, is poured first.
Two 3/16" dia holes (not shown) are drilled through the flange to allow the air underneath the flange to escape when pouring the silicone mold material. Once the air has escaped, the holes are plugged and the silicone allowed to flow up to the split line. Once the first part of the mold has cured, and the surface sealed, the second part is poured. As you can see, the inner profile of the tire is such that air can escape from the inside of the tire carcass and not be trapped.

The tire rubber is cast vertically, as shown in this cross-section. Resin is fed into the bottom of the flange through the feed tube (large arrow). Resin then flows down to the bottom of the mold and then up the sides displacing the air upwards and through the small vent tube at the top of the mold (small arrow).

A more detailed, step-by-step, description of the process follows.

# STEP-BY-STEP: MOLD CONSTRUCTION & CASTING

**Mold**

This is the tire model

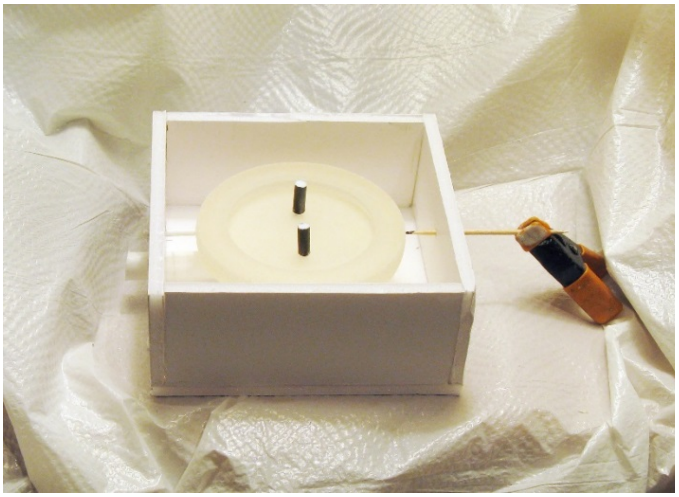
For reference, the flange is 2mm thick.
The channels between the nubs are approx 1mm wide. They are slightly over scale to ensure they are effectively filled by the silicone. The high fidelity 3D printing process allows for text to be added to the tire.

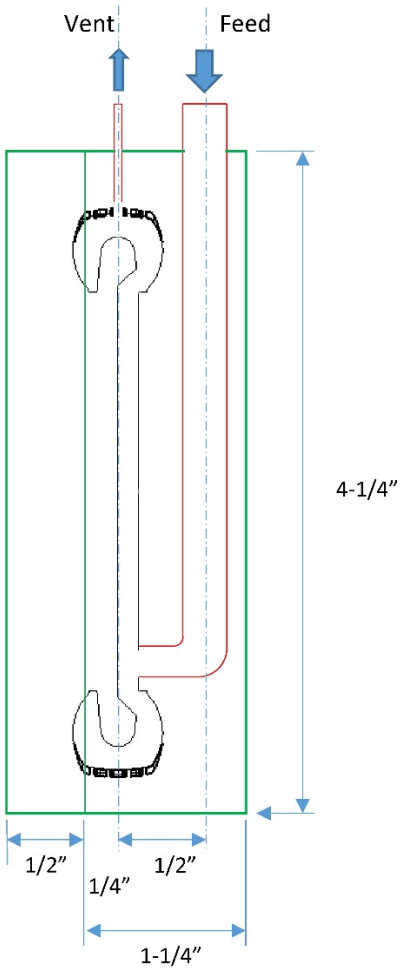
- Once you have a tire model add the fill tube and vent tube:

A 3/16” dia. vent tube is enough to vent the air without risking collapse.
Drill a hole through the center of one of the tire nubs for the tube. It should be on the opposite side of the tire from the tire text. Then, when the vent tube is cut off the tire, and the tire text is upright, the trim mark will most likely be hidden underneath the tire.
Next add the 7/16” feed tube. A large feed tube facilitates flow of the rubber. The goal is to get the rubber down to the bottom of the feed tube without creating an airlock, which would slow filling. Bigger is definitely better.
The tube should be glued to the flange near the tire wall, as shown above.

**Mold Box**

- Construct the mold box from 3/16” foam board.
- Allow 1/2” mold space around the tire to give the mold stability when casting.
- Drill two 3/16” dia holes through the flange on either side of the centerline. These let air escape from under the flange when filling the bottom part of the mold.
- Mount the tire in the box horizontally, feed tube down.






**Mold Release**

- Once the tire position is set, remove the tire and, with a soft brush, apply mold release to the underside of tire and over the flange. (I used Ease Release 205 from Mann Release Technologies … www.mann-release.com.)
- Put the tire and tube assembly back in place.

**Silicone Mold – Casting The Bottom Part**

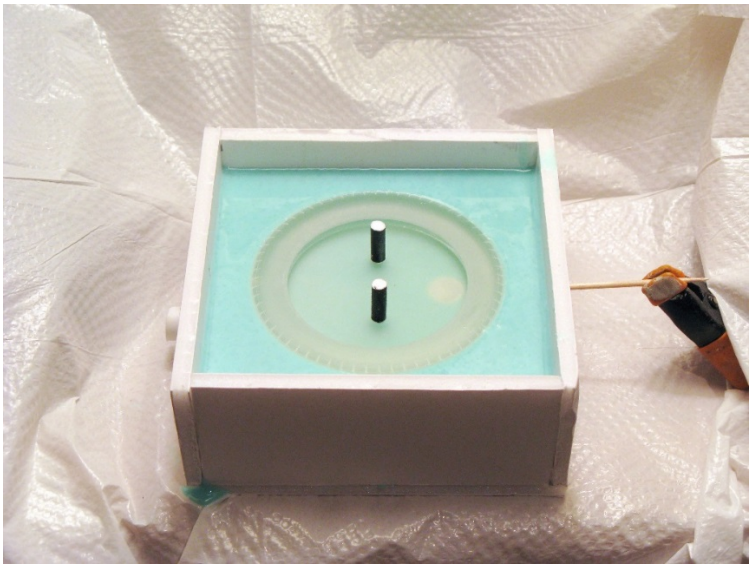
The mold is cast from Smooth-On's Mold Star 15 platinum silicone.
Mold Star 15 is a two part material, the two parts mixed in equal quantities. Working time (pot life) is 50 minutes and cure time about 4 hours.

For the Austin Seven tire, the simplest way to calculate the amount of silicone needed for the bottom part of the mold was to take the height to the upper edge of the nubs (1-1/4"), which was the fill height, times the area of the inside of the mold (4-1/8" x 4-1/8"). This was 21.3 cu. in, or 354ml. Since the specific volume of the silicone is 23.5 cu. in. per lb, 0.9 lb of silicone was needed. Because the flange and tire take up some space, the cast would actually need somewhat less than this. Half of this quantity is needed from each of the two parts.

The steps are as follows:

- Follow the manufacturer's mixing instructions, especially with respect to thoroughly mixing Part B.
- Let Part B stand for at least an hour to help degassing.
- After mixing Part A and Part B, let the silicone sit for 5 or 10 minutes to help any air in the silicone escape. A gentle, very slow swirling of the material in the mixing cup will also help eliminate air bubbles.

- With the two holes in the flange open, slowly fill the bottom part of the mold by pouring the silicone into one corner of the mold box. A slow pour over the edge of the mixing cup also helps release any entrapped air in the silicone.
- When the silicone starts to flow up into the two holes (and the air under the flange has completely escaped), plug the two holes with short 3/16"dia styrene rods.
- Then continue filling the mold box until the silicone reaches the top edge of the tire tread:



- Allow the silicone to cure for at least 4 hrs.

**Silicone Mold – Casting The Top Part**

- Remove the two small plugs from the flange.
- Apply mold release (e.g. Smooth-On's Ease Release 205) to the surface of the tire model, especially the undercut. Any exposed silicone has to be carefully coated as otherwise the new silicone will stick to it.

For the top part of the mold the volume of silicone needed was calculated by taking the height from the midpoint of the tire tread to the top of the mold box (3/4") times the area of the inside of the mold (4-1/8" x 4-1/8"). This was 12.8 cu. in, or 215 ml for this particular mold. The specific volume of the silicone is 23.5 cu. in. per lb, so just less than 0.6 lb of silicone is needed. Again, half of this quantity is needed from each of the two parts.

- Follow the manufacturer's mixing instructions and, after mixing Part A and Part B, let the silicone sit for 5 or 10 minutes to help any air in the silicone escape. A gentle, very slow swirling of the material in the mixing cup will also help eliminate air bubbles.
- Slowly pour the silicone into one corner of the mold box. Tilt the mold up slightly at the back to allow the undercut to fill at the front first. This will help push the air out towards the top.

Here's the mold box after the bottom half of the mold has been poured.
(The shadowing on the top of the mold is from a lamp standard in the background.)

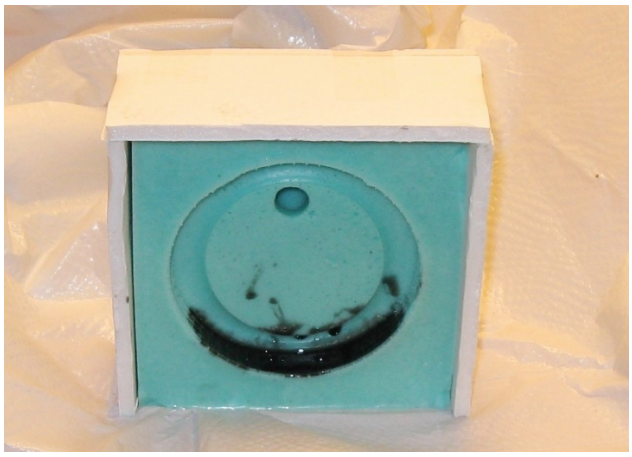
- Allow the silicone to cure for at least 4 hrs and then remove the mold from the mold box.
- Separate the two parts of the mold and remove the tire model and tubes. Carefully ease the thinner, upper mold away from the tire so as not to damage the silicone that has filled the undercut.

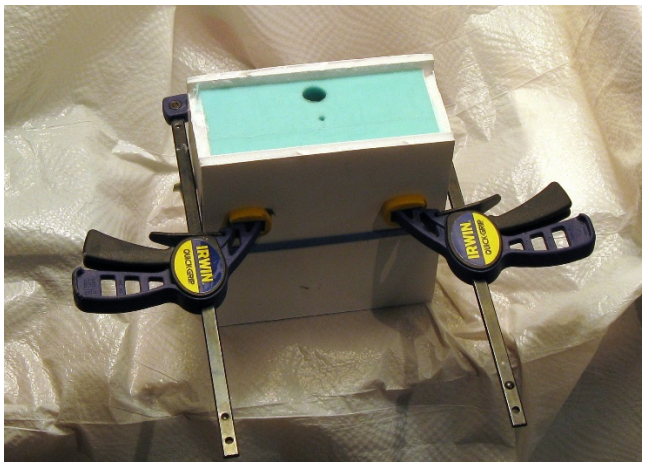
Here are the two parts of the mold … note the detail and consistency of the tire tread:

**Casting The Tires**

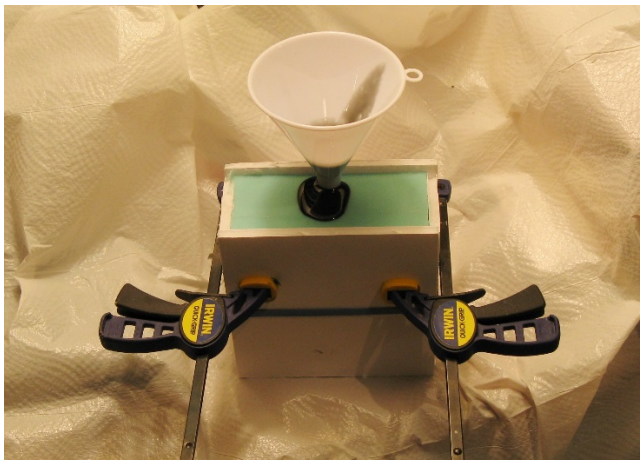
- Casting of the tires can be done using Smooth-On's Reoflex 50 urethane rubber; another two part material. The Austin Seven tires require about 60 ml of material per tire, equally split between Part A and Part B.
- To get a dark gray tire, tint Part B by adding 50 drops of Smooth-On's UO urethane colorant to 2 lb of Part B.
- Begin by covering the inner surfaces of the two parts of the mold with mold release (Ease Release 205).
- While the mold release is drying, thoroughly stir the contents of Part B and Part A according to the manufacturer's instructions. To the extent possible, try to minimize the amount of air trapped in the resin.
- Pour Part A into the mixing cup and allow to stand for an hour to help remove bubbles.
- Mix in Part B and let the rubber sit for 5 or 10 minutes to help any air in the silicone escape. Again, a gentle, very slow swirling of the material in the mixing cup will also help eliminate air bubbles.

- Paint some of the rubber onto the tire treads, especially those that will be at the top of the mold. This will minimize the likelihood of trapping air in those treads (see the picture below … note that the mold is upside down in this picture)
- Re-assemble the mold in the box with the feed tube upwards. The box will help keep the shape of the mold.
- Clamp the long walls of the box lightly in place (as shown on the right).






- Slowly pour the rubber mix into the mold. A slow pour helps air in the mold escape and also minimizes any air bubbles in the resin. I slightly separate the tops of the two molds about halfway through the pour to help the majority of the air escape. Once the rubber is well up the mold I let the two halves go back together again.
- Keep on pouring and when the rubber emerges from the vent hole, stop the resin pour. Subsequently, a gentle squeeze and then slow release of the mold walls will ensure any remaining trapped air is expelled.

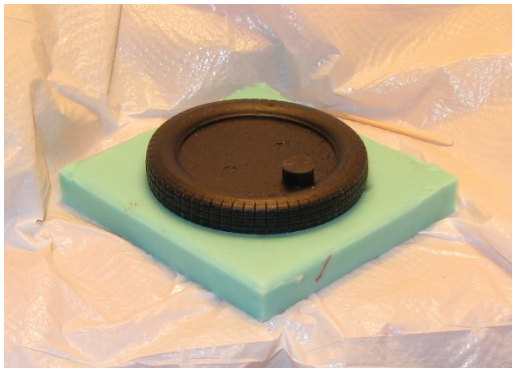



- Allow the rubber to cure for at least 16 hrs before attempting to de-mold. 24 hrs is better.

**De-molding**

- Remove the funnel and clamps and then remove the mold from the mold box.
- Cut away any excess rubber from the top of the mold
- Slowly peel back the edge of the larger part of the mold freeing it from the tire tread. Do this around the complete tire.
- Then fold the mold back so that the feed tube can be cut (see below)

- Cut the feed tube and remove the mold. The rubber in the vent tube should just pull out. Remove the rubber in the feed tube by pulling the cylinder of rubber down and out.
- The tire is now only attached to the smaller part of the mold.



- Carefully peel the tire out and up over the undercut of the mold. Do this carefully so as to not tear the tire wall:

- Once the tire is removed from the mold, cut the flange away from the bottom of the tire wall. First use a cut perpendicular to the side wall. Then trim back the remains of the flange so the bead of the tire is the same on both sides.

- The trimmed tire can now be mounted on the wheel.

**Cost**

The minimum quantity of urethane rubber that Smooth-On sells is 2 lbs. It is good for at least a dozen tires of this size. Based on that 2lbs, in 2014 the total cost came to approximately $80, excluding the cost of the tire model.

- Silicone mold material … $30
- Mold release … $15 (this is for a pint, way more than is needed for this application)
- Urethane rubber … $30
- Miscellaneous materials (foam board, funnel, mixing cups) … $5.

The mold is, of course, a significant investment (and the tire model, too, if it is 3D printed). However, once that is made, the variable cost for each tire is quite small; roughly $5 depending on how many tires you make.
Clearly, it's important to get the model right and then the mold. Mistakes after that aren't very expensive.

**Summary**

Creating tires for large scale automobile models can be a challenge.
However, the process is within the skills of an experienced model builder and, hopefully, this note will help.
Happy modelling!