# Argo D-4 Javelin: Building the Nike Boosters

**By John Brohm, NAR #78048**

The first two articles in this series covered the modeling of the two adapters that connect the Nike boosters and the Altair X-248 Payload section. One of the goals in those modeling efforts was to try and improve the accuracy of those transition parts over the original model versions.

There remains a third adapter in the Javelin that must be modeled, it being the one that mates the first stage Honest John booster to the second stage Nike booster. I'd like to share with you my build of that rather complicated part, but perhaps before we dive into what is the most complex of the three transitions within the Javelin, we can briefly detour our attention to other parts of the vehicle. In this article we'll tackle the two Nike boosters.

## References

Let's begin by deciding on and declaring our references. We'll continue to reference the NASA and John Langford photos highlighted in the prior articles, and as the build proceeds, we'll pull in other relevant references and prototype photos as needed. We will also rely on a highly-detailed Nike motor drawing prepared by Bob Biedron, and amended by Josh Tschirhart.

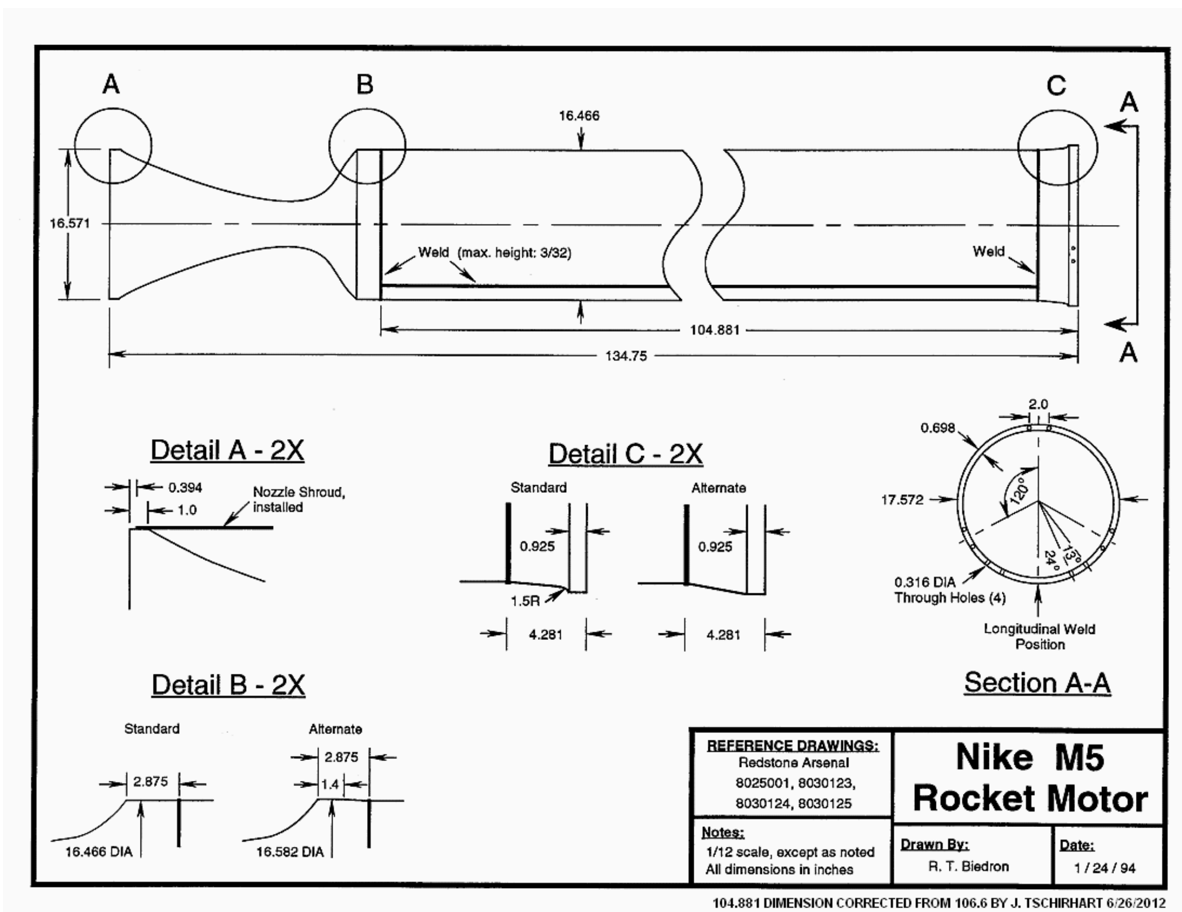



**Figure 1: Nike M5 Motor**

For the fins we'll make use of some standard Nike fin documentation found in Atlantic Research Corporation's Standard Fins product brochure. We will also make use of a drawing by Jon Randolph that details the aft shrouds that skirt the motor nozzle section.

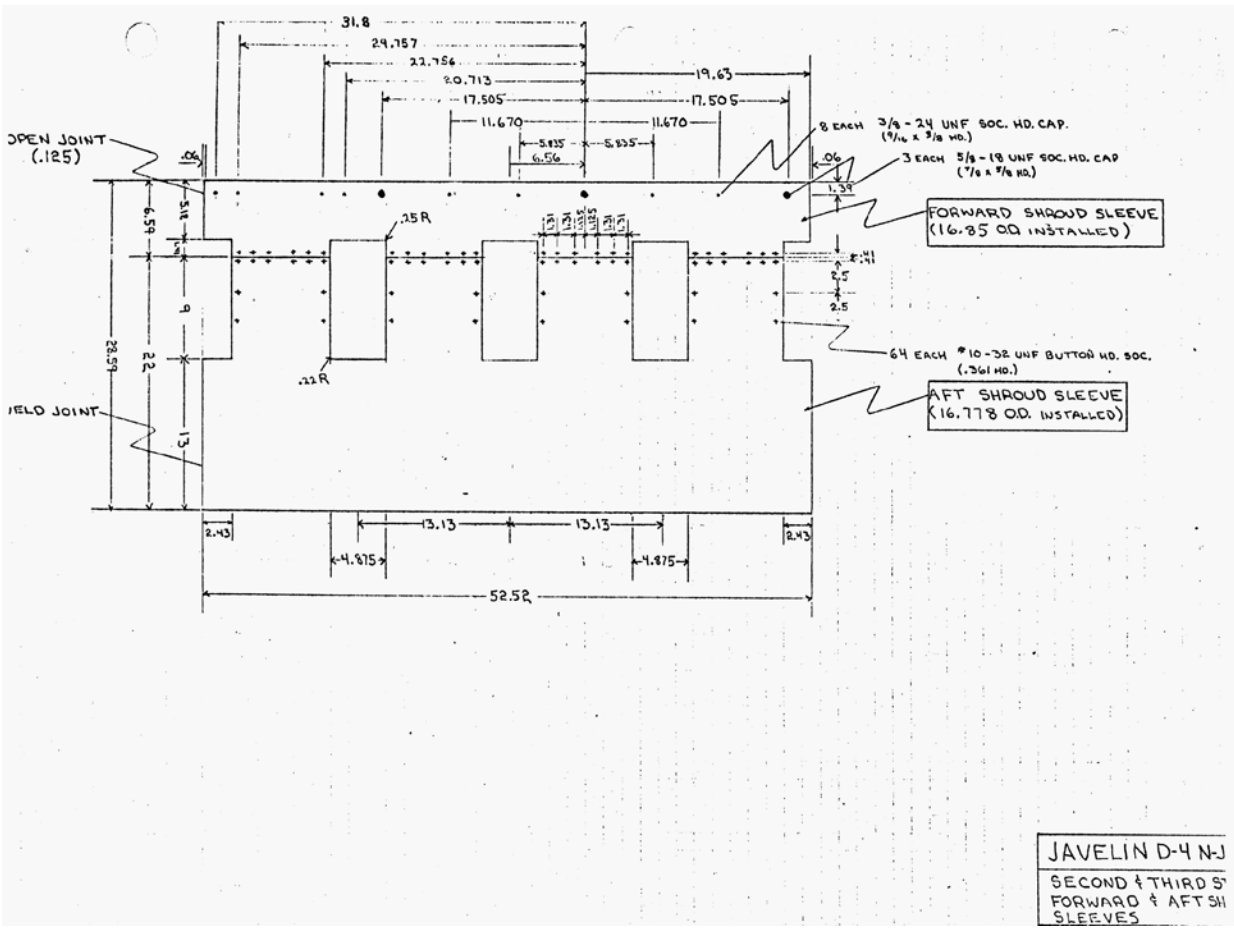



**Figure 2: Nike Motor Aft Nozzle Shrouds**

**(Drawing by Jon Randolph)**

A photo of the real thing helps us visualize a number of these details.

**Photo 1: Nike Aft Nozzle Shrouds and Fin Bolting Arrangement**

**(Photo by Josh Tschirhart)**

Photo 1 details the nozzle shrouds and fin mounting arrangements rather well; it also highlights the motor case and shroud weld lines. A word of caution with respect to the placement of those weld lines on your model – closely check your round reference photo to be sure you have them placed where the photo actually shows them (or at least place them in a location other than where your photo may not show them), as their orientation on the prototypes could vary.

### Things to Fix

As we've seen in the earlier transition articles, it's almost axiomatic that there's always room to further improve the features and fidelity of a scale model. The Nike boosters are no exception; the boosters crafted for the original model were adequate, but could have benefited from some improved precision and accuracy. I wasn't completely happy with the rendering of the forward flange (see Figure 1 above, Detail C, the Standard option), or with the fit of the fin mounting plates and the aft nozzle skirt around these plates. These shortcomings were entirely due to the methods I chose to use at the time, so this rebuild presented an opportunity to tackle these areas with some new approaches.

When I built the original model, I thought a simple approach to seating the fin plates would be to sand their underside to conformally fit the outside of the airframe. However, because of their size (and likely the size of my fingers), I found it difficult to get a consistent curve sanded into each plate, resulting in no two plates actually sitting at precisely the same height on the airframe. Then there was the problem of the sanding technique itself – it was difficult to sand an even trough front to back, as the pressure applied by my thumb was different than the pressure applied by my forefinger. I compensated somewhat by turning the part around halfway through the sand, but it's anyone's guess as to how consistent that approach really was.

Thinking about the fin plate problem, it occurred to me that nothing sits flatter than flat on flat; if one looks at how the prototype was constructed, one observes there is a fin can that's bolted to the motor nozzle section, which includes flat mating sections for the fin plates.

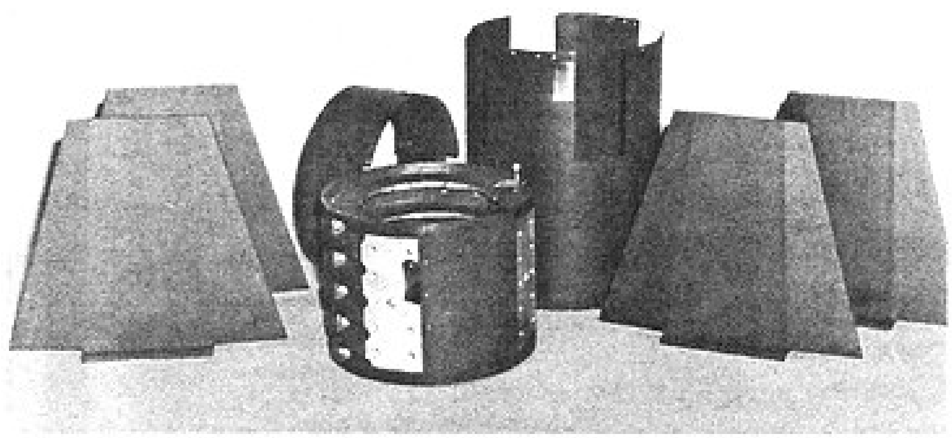


**Photo 2: Nike Aft End Components**

**(ARC Nike Standard Fins Brochure, Page 11)**

This prototype assembly can be seen in Photo 2, above. The fin can is found lower center left, and one can readily see the flat mounting plates the fins are bolted to. So our build strategy for the new boosters will be to replicate those mounting plates within the airframe, allowing the fin mating plates to sit flat.

The issue with the forward flange had to do with the material I chose to use to fillet the underside. I gambled on an epoxy clay, thinking it would give me more working time to shape. And it did, but I found its viscosity to be too stiff to shape precisely. The follow-on problem was the hardness of the clay once cured; it was harder than the Styrene strips comprising the flange, and as result, I ended up with an unavoidably rounded lower edge to the flange as I attempted to file and sand a more consistent shape to the fillet. The solution to this problem was to switch to a softer filleting compound, as we'll see.

Finally, there was the fit of the aft skirt cut outs around the fin plates. Moving to the flat inset fin base plate technique provided a more precise aperture around which I could gauge and cut a precise and even gap for each plate.

Strategy set – let's get started.

**Construction**

Let's begin with the forward flange. Photo 3 presents a Nike forward flange identical to the one found on the two boosters we're modeling from the NASA 71HC362 photo. In Photo 3, we can see that the flange is the standard version, with the radial fillet underneath the flange proper. Looking closely, one can also see the weld seam that mates the flange transition to the motor case.

**Photo 3: Nike Forward Flange**

**(Photo by Josh Tschirhart)**

For our model, the forward flange is built up with standard strips of 0.100" wide Styrene, adhered in place with contact cement. They were positioned 0.090" below the forward edge of the airframe, and once the cement had cured, the built-up flange was sheared with a 150 grit, leaving a flange of the correct scale length.

Photo 3 makes it clear that the outer diameter of the flange sits proud of the transition, resulting in the need for the under-fillet. To create that effect, the flange was built up to the correct underlying diameter, and then a 67# cardstock transition shroud was put in place. A final strip of Styrene was then placed on top, setting the lip for the fillet. As Photo 4, below, shows, the fillet was crafted with Bondo Glazing and Spot Putty, resulting in a fillet that was easier to deal with during the later finishing stages.

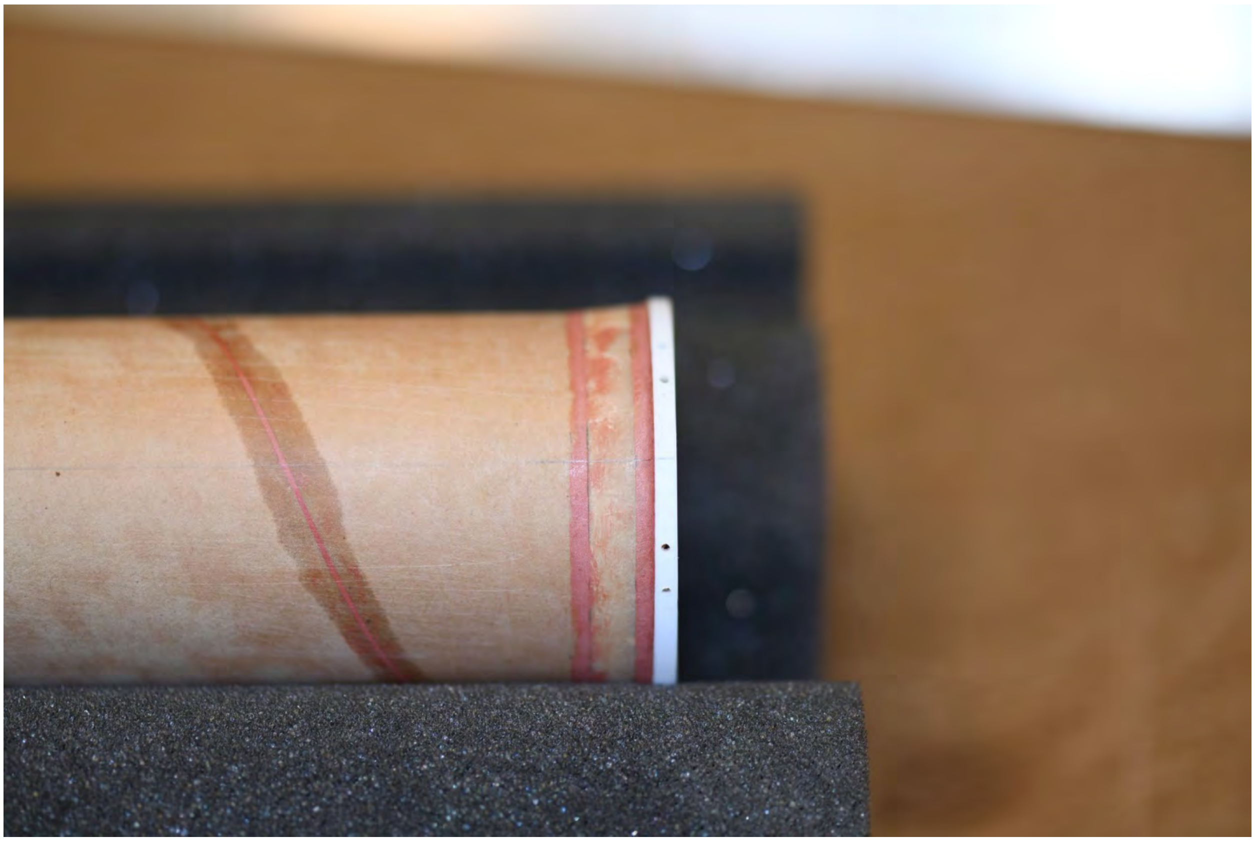


**Photo 4: Native Forward Flange**

It should be noted that I shortened the cardstock transition to take into account the length of the zone that smoothly feathers the edge of the transition into the airframe. It's important to have this area smooth, as we will be placing a weld seam at this location later on. One might imagine that perhaps this isn't all that significant, given that the cardstock is only 0.009" thick. Barely noticeable, one might say. Not so – a little trigonometry highlights the point:

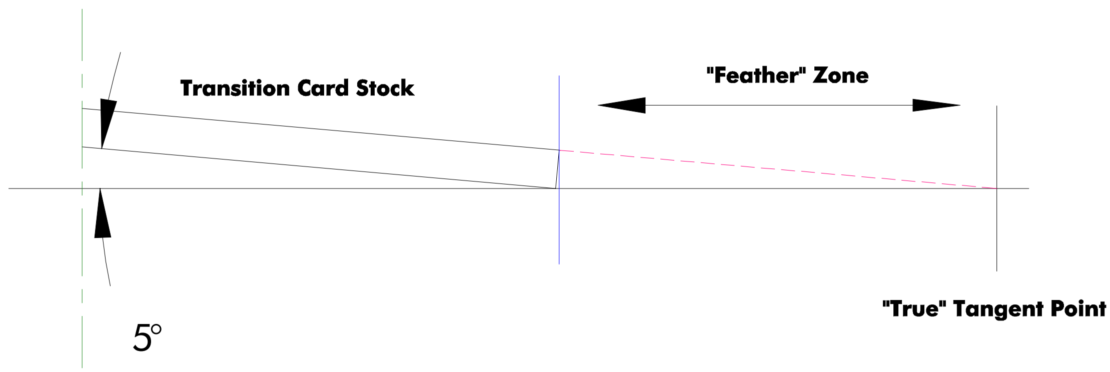



**Figure 3: The Feather Zone**

In Figure 3, I've magnified the interface to make the situation a little clearer, keeping in mind that the illustrated angle is the actual angle of the transition part. We can see that it's the bottom of the cardstock, not the top, that makes contact with the airframe, and that because the cardstock has a physical thickness, it creates a step where it ends. We will need to do some filling and sanding to hide the step, and make this area a smooth extension of the transition. But we also have to keep in mind the overall length of the transition – that distance includes the feathered area, so it must be subtracted from the length of the cardstock shroud.

In my case, I'm using 67# cardstock, and it has a thickness of 0.009". The length of the feather zone is therefore $l$ = 0.009"/Tan 5° = 0.103", which is slightly longer than 3/32", and is therefore very noticeable (note that in my calculation I just used the thickness of the cardstock as the height of the step; in reality, that step height is reduced by the cosine of the transition angle, but because the angle is so shallow, the cosine is 0.996, which is very nearly unity).

We'll subtract this distance from our transition length, print and install the adjusted shroud, and then fill in the area between the end of the shroud and the tangent point with a good sandable filling compound. Once sanded, we'll be left with a smooth, blended transition of the correct scale length, as Photo 4 shows.

**Aft End**

Construction starts with the motor mount. Since we're going to be insetting the base plates into the airframe, we need to "square up" the centering rings so that the base plates will sit flat and at 90 degrees with respect to each other.

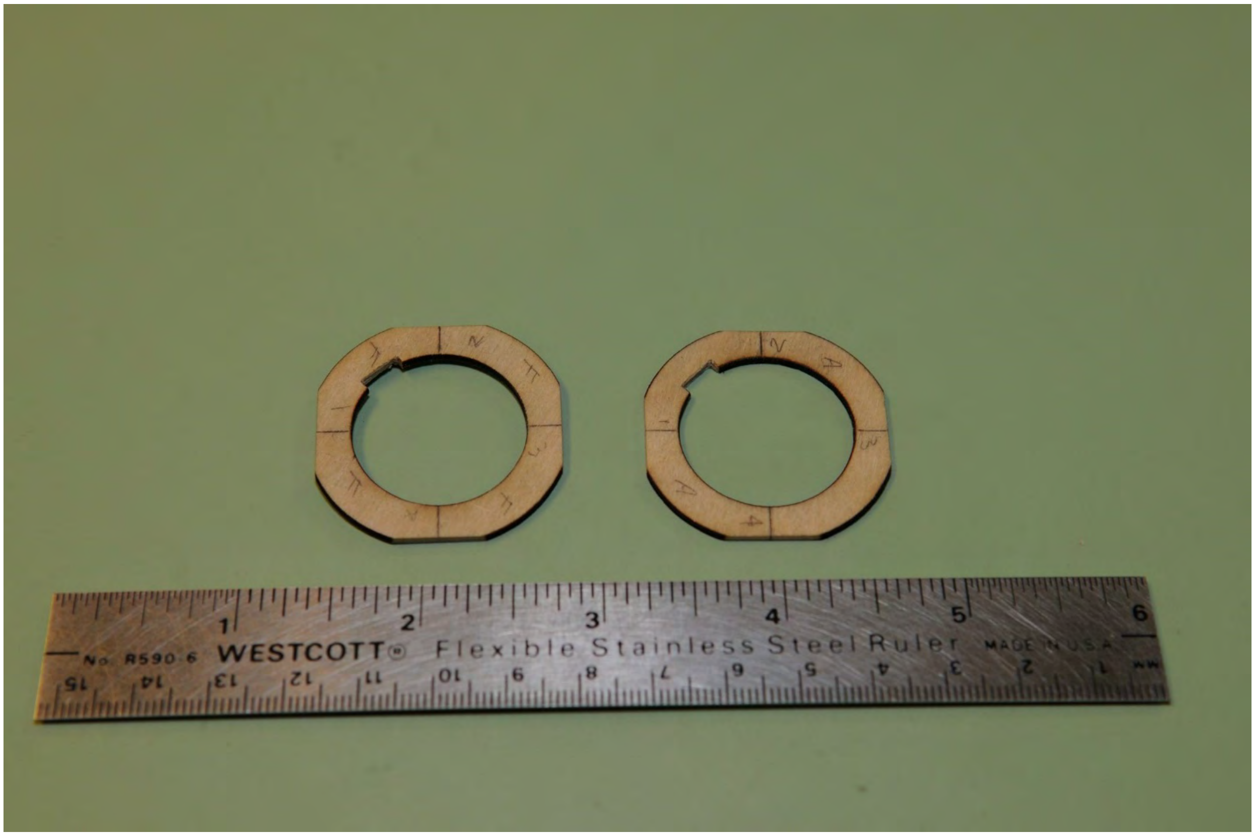



**Photo 5: "Square" Centering Rings**

These are then located at the proper place on the motor mount tube, leaving the appropriate space for the fin tabs.

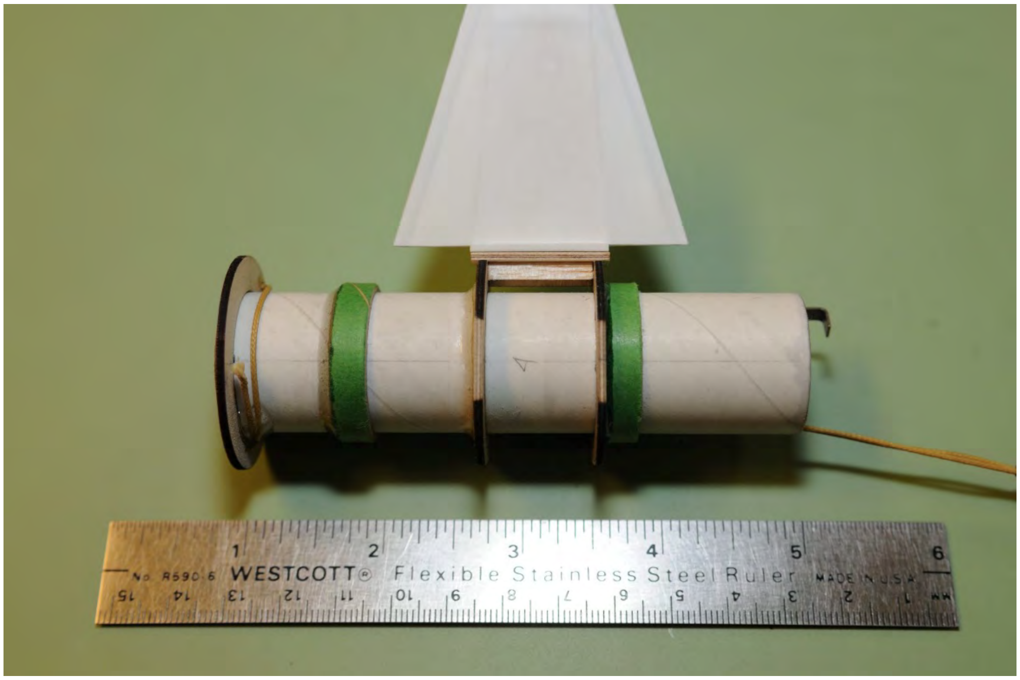



**Photo 6: Motor Mount**

Close examination of Photo 6 shows a trial fit of the base plates that will be inset into the airframe. Those plates are crafted from 1/16" ply, and are slotted to accept the fin tab.

Inset windows are then cut into the airframe at the required locations, and we attempt another trial fit, as shown in Photo 7. Note that the forward skirt has also been temporarily placed for a quick look.

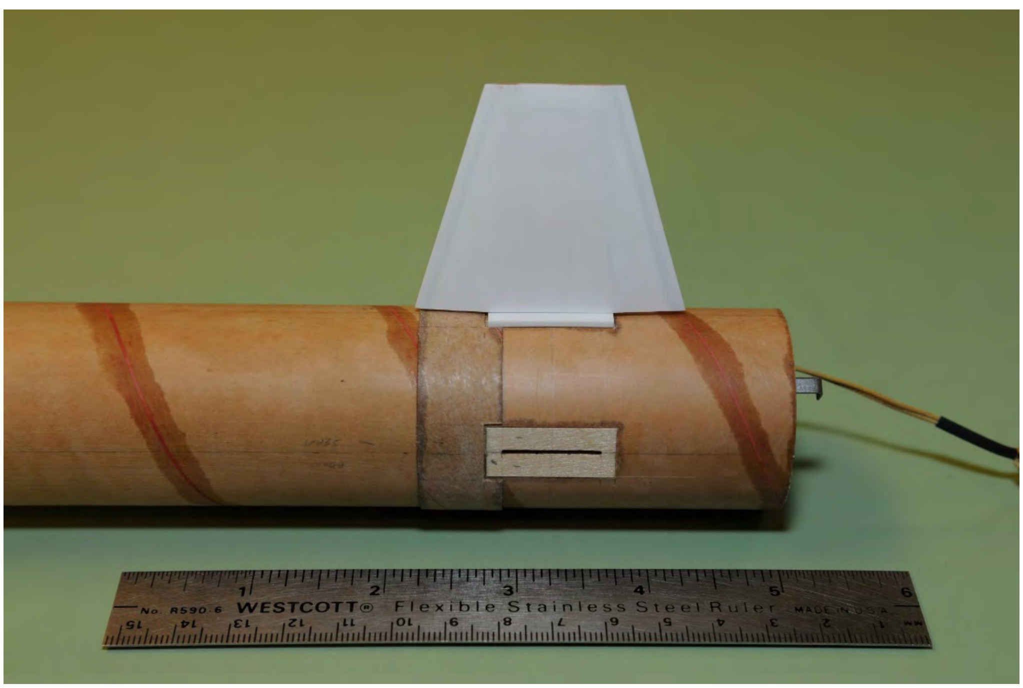



**Photo 7: MMT Trial Fit**

The forward skirt is fashioned from a scaled length of BT-60; it's a nice slip fit over the airframe, and gives us an almost spot-on OD for the part. Satisfied with the inset fit, we move on now to those aft end skirts. For these parts we use the Jon Randolph drawing provided at the beginning of this article in the earlier Figure 2.

The aft skirt is a little more complicated – to get the required OD means we have to build up the skirt in two layers. First a layer of 24# bond paper, followed by a layer of 67# cardstock. Photo 8 shows the result of this effort:

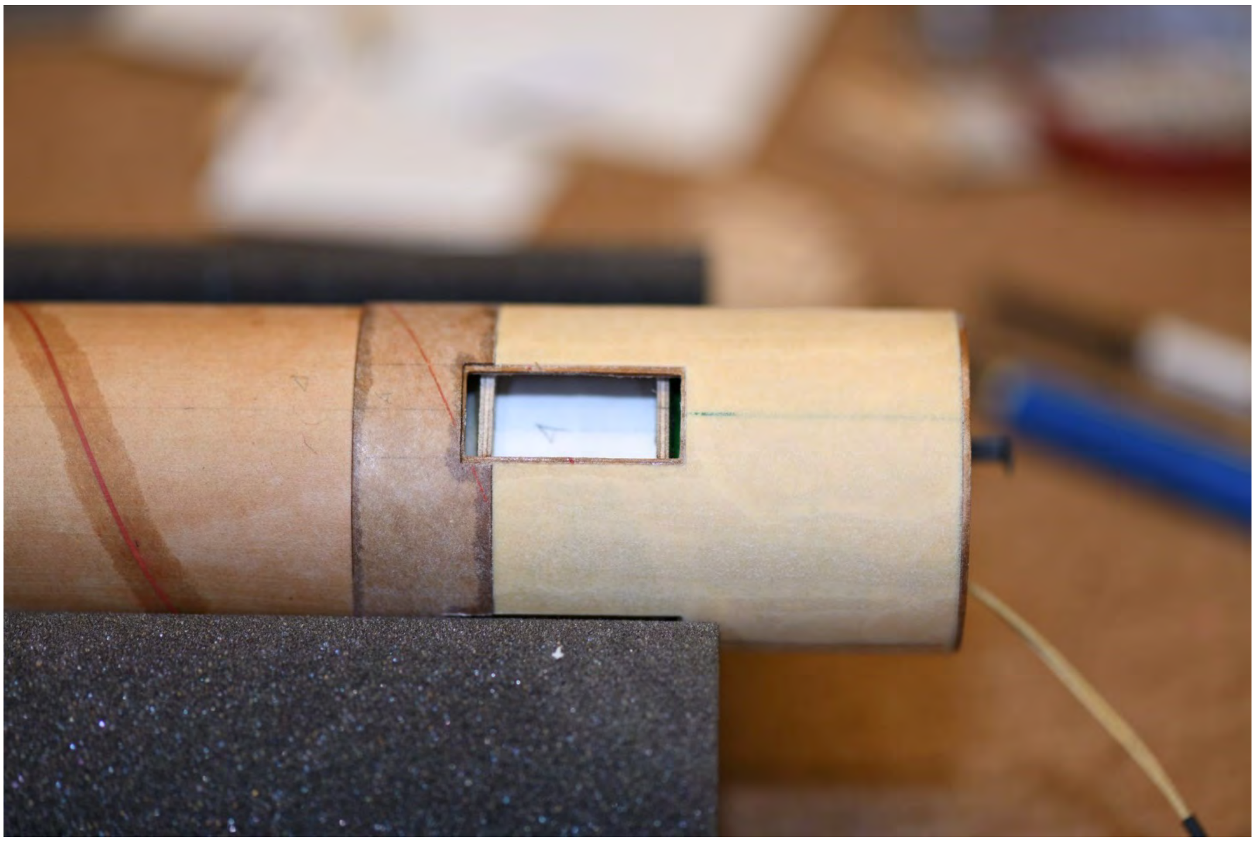


**Photo 8: Aft Skirts**

Another trial fit, checking for alignment:

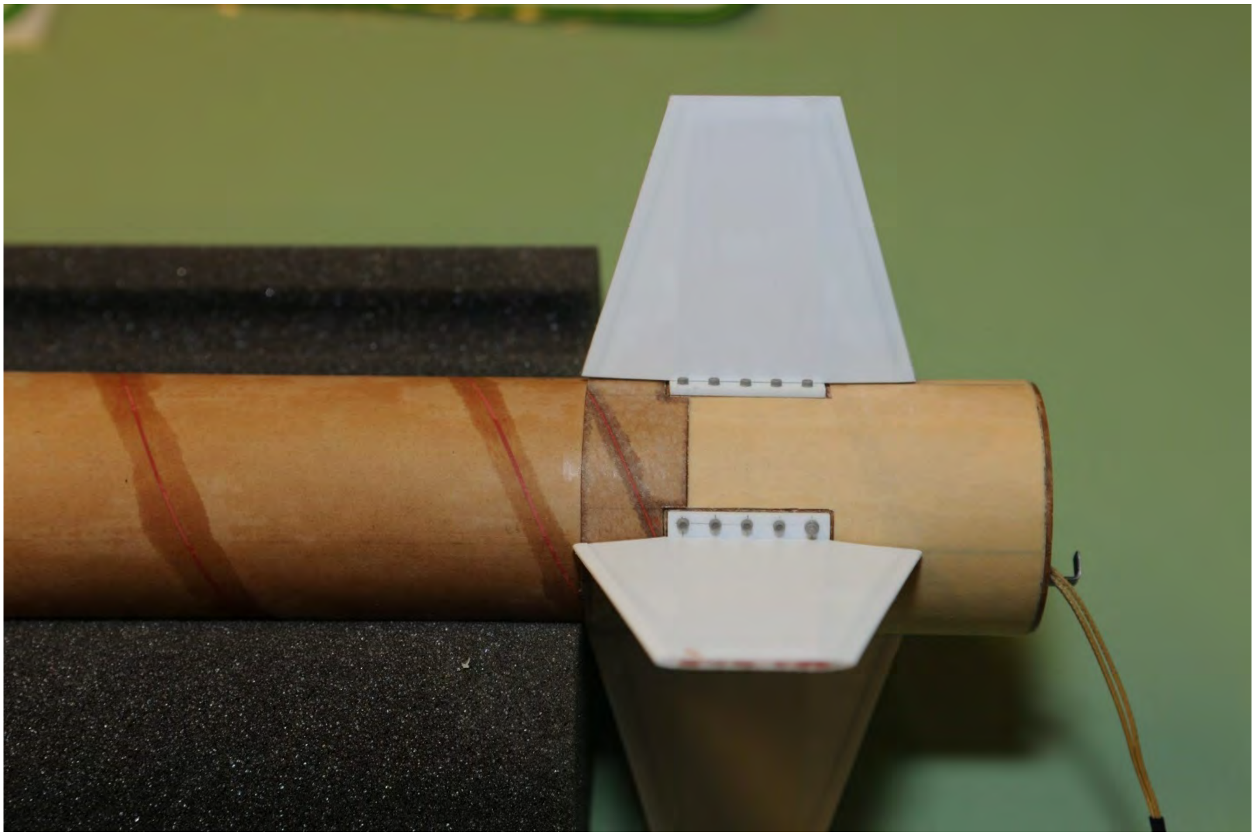
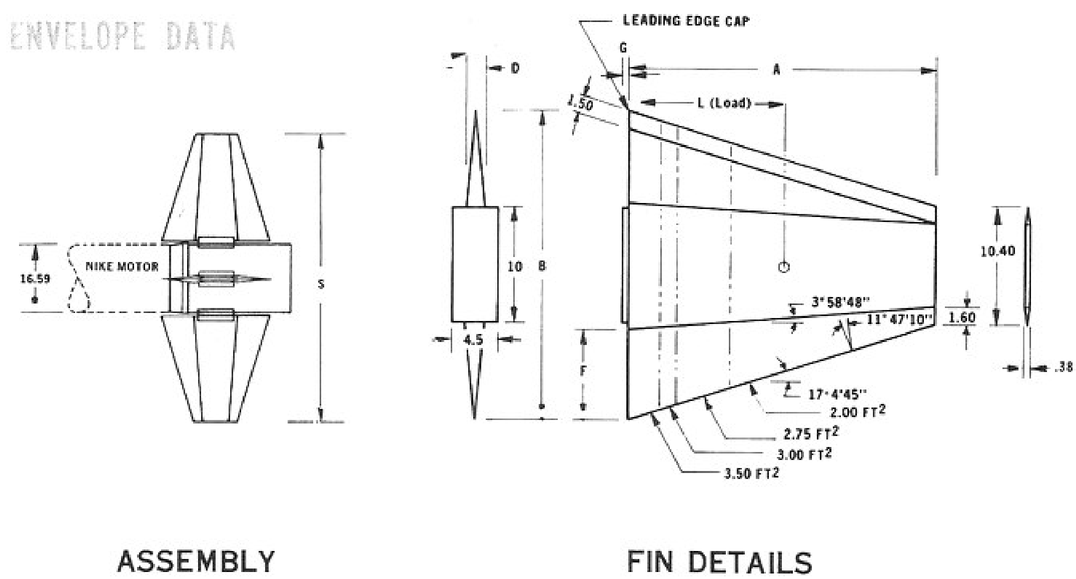


**Photo 9: Final Trial Fit**

Note that none of the surface detail on those aft skirts has been applied yet. This detailing won't occur until the airframe has been primed, as we'll see.

## Fins

ARC's Nike Standard Fin brochure provides the key data for the two fin sizes used on the Javelin; the following Figure 3 provides the relevant excerpt from the document. The 2nd stage Nike used the larger, 2.75 square foot fins while the 3rd stage Nike used the smaller, 2.0 square foot fins. Note that the dimensions for the fin mounting plates are also provided in this drawing.




| PANEL AREA SQ. FT. | A | B | D | F | G | S | ASSY. WEIGHT LBS. | REF. DWG. NO. |
|---|---|---|---|---|---|---|---|---|
| 2.0 | 18.10 | 21.52 | 1.30 | 5.90 | .56 | 53.26 | 93.2 | 14754 |
| 2.75 | 22.80 | 24.41 | 1.45 | 7.02 | .56 | 62.66 | 101.2 | 16145 |

**Figure 3: Nike Fins**

**(ARC Nike Standard Fins Brochure, Page 11)**

We start with a set of 1/32" thick ply cores, the root edges fitted with Styrene strips to serve as a sanding fence for the balsa blanks that are CA'd to each side.

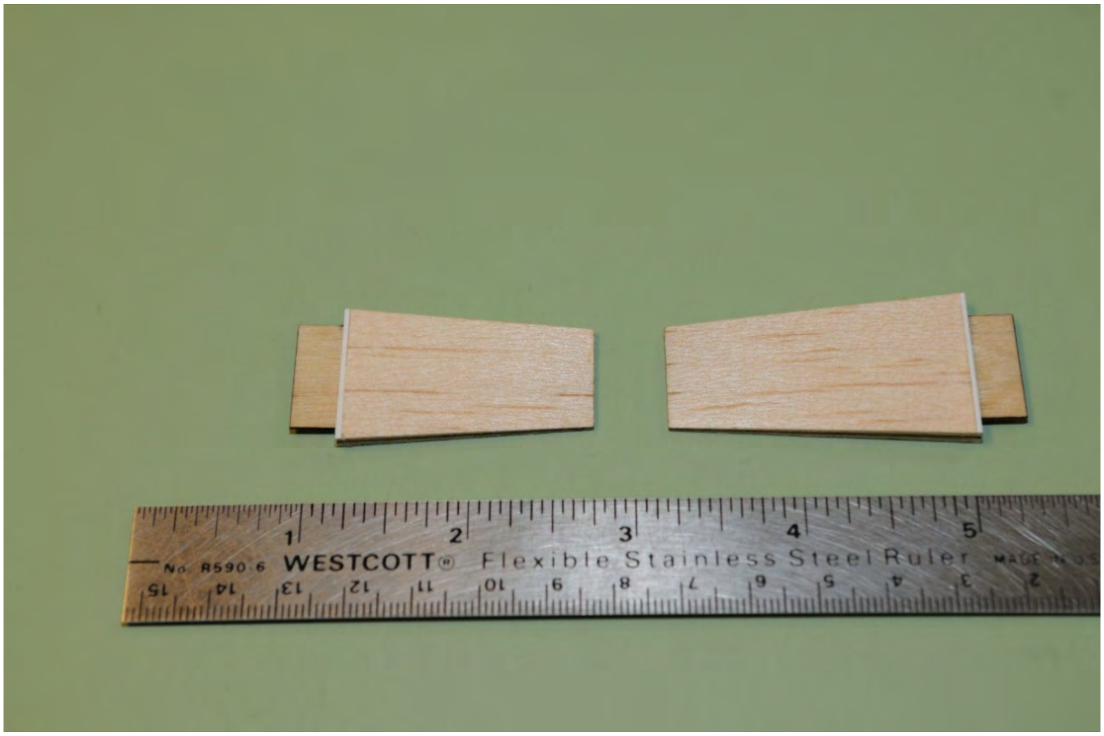



**Photo 10: Sanded Fin Cores**

Styrene sheet panels, 0.010" thick, scaled to size, and bent to the required diamond shape are then CA'd to each core face.

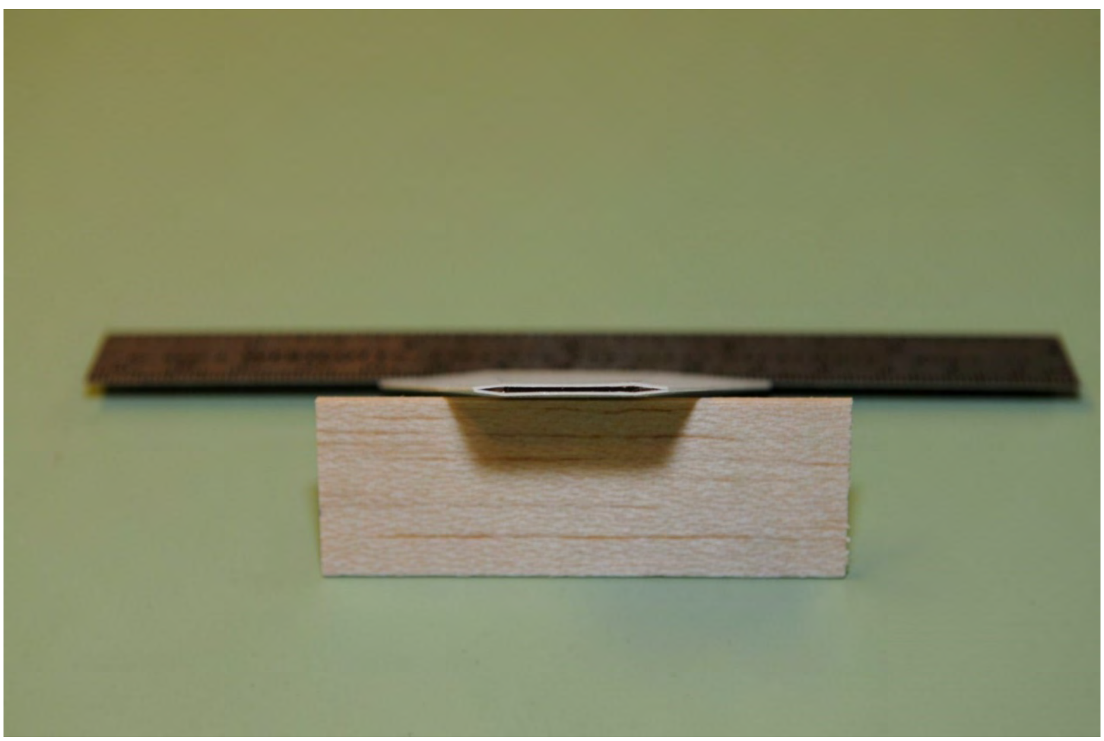


**Photo 11: Diamond Fins**

Leading and Trailing edges are reinforced, glued, and rounded. We end up with a complete set of fins, ready for the next step.

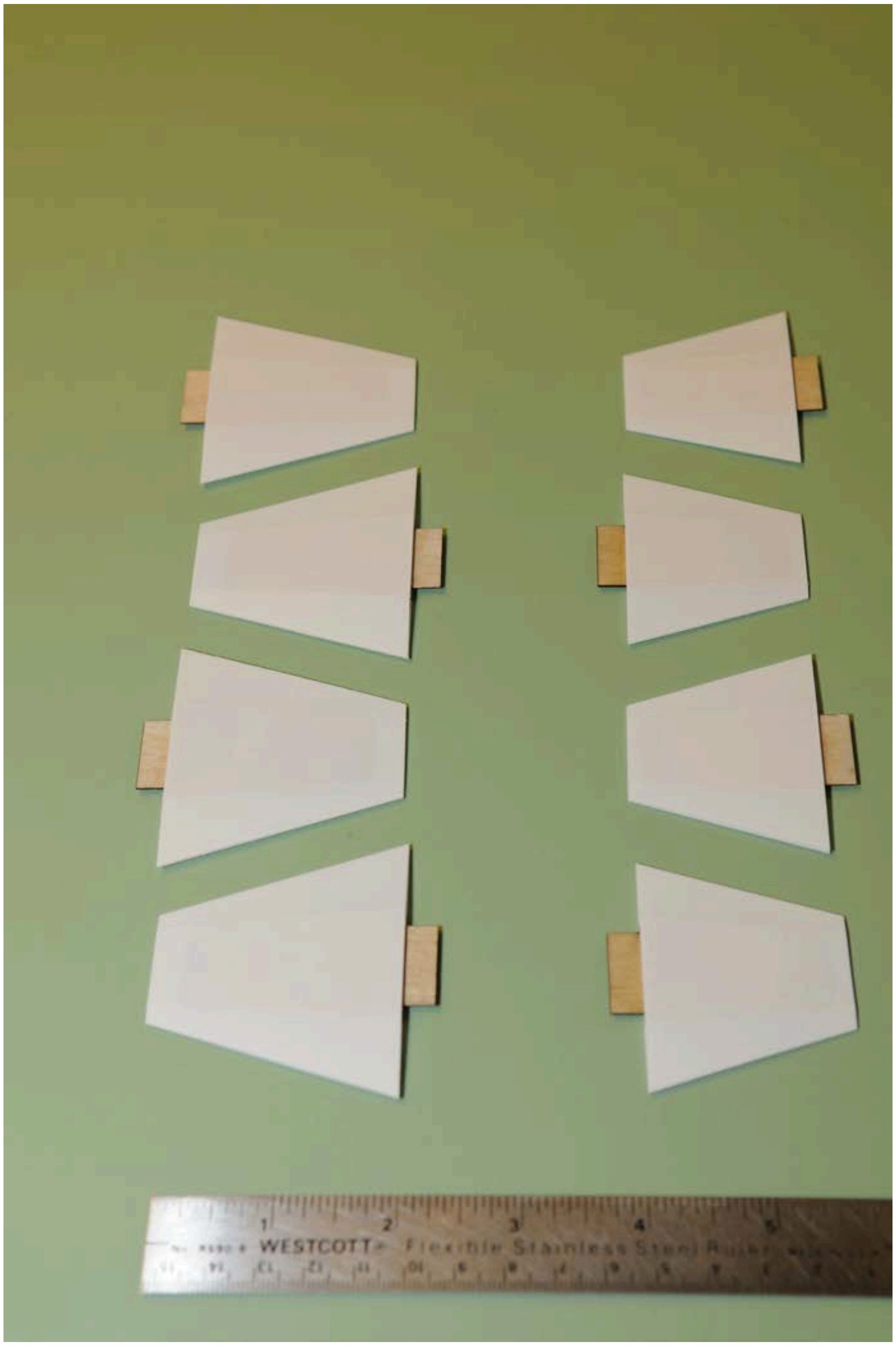



**Photo 12: Fin Set**

Next, we need to add the fin mounting plates. These were fashioned from three layers of Styrene sheet bonded together to arrive at the correct scale thickness. As we saw way back in Photo 1 in this article, the fin mounting plates are distinguished by the mounting bolt detail; to apply these bolt heads in a consistent fashion, I fabricated a jig that held the plate while I cemented the bolt heads in place.

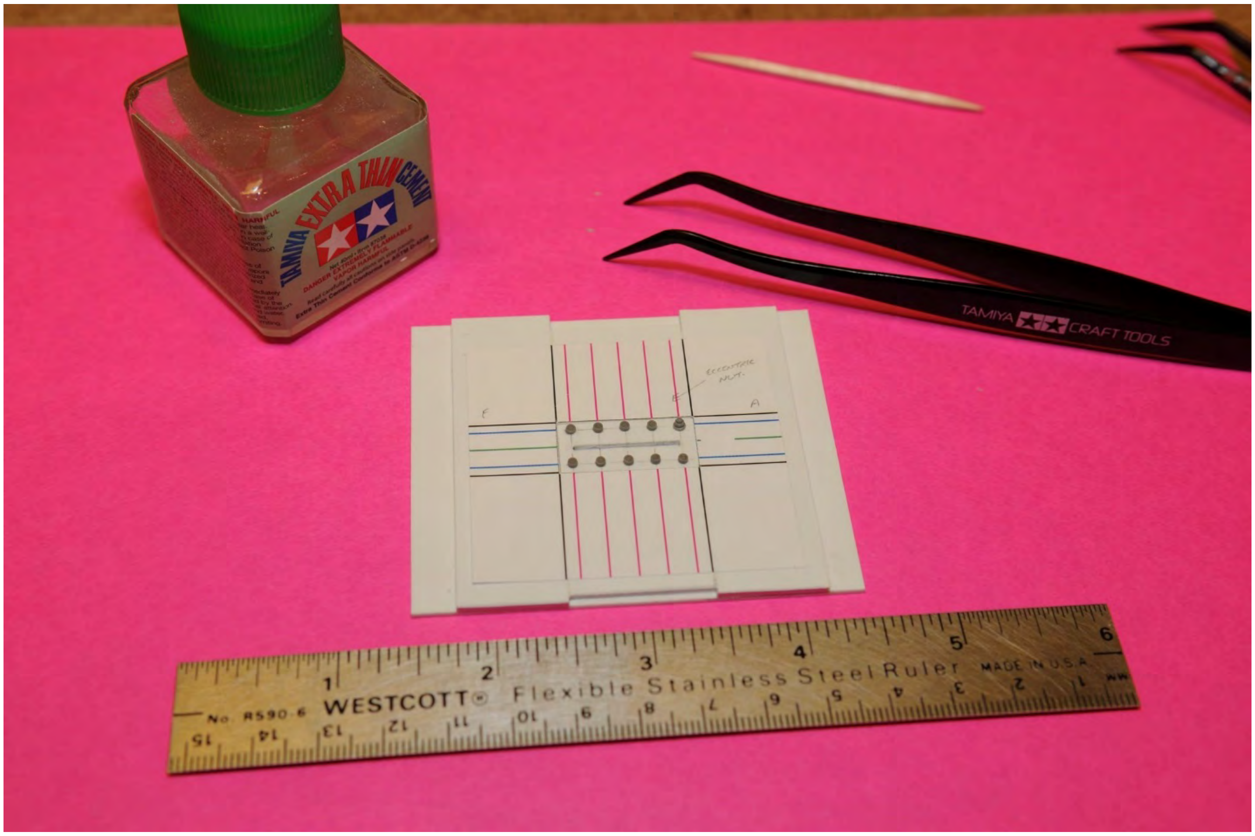



**Photo 13: Bolt Locating Jig**

A few bolt heads later, and we have a complete set of fin plates ready to be installed. Note that these are glued to the inset base plates in the airframe; as the reference photos show, the fin mounting plates are painted the same color as the airframe, and not the color of the fins.

We'll prime each booster at this point, taking care to correct any surface defects, re-priming where necessary. Once satisfied with the surface, we can add the remaining aft skirt fastener detail, and the weld seams.

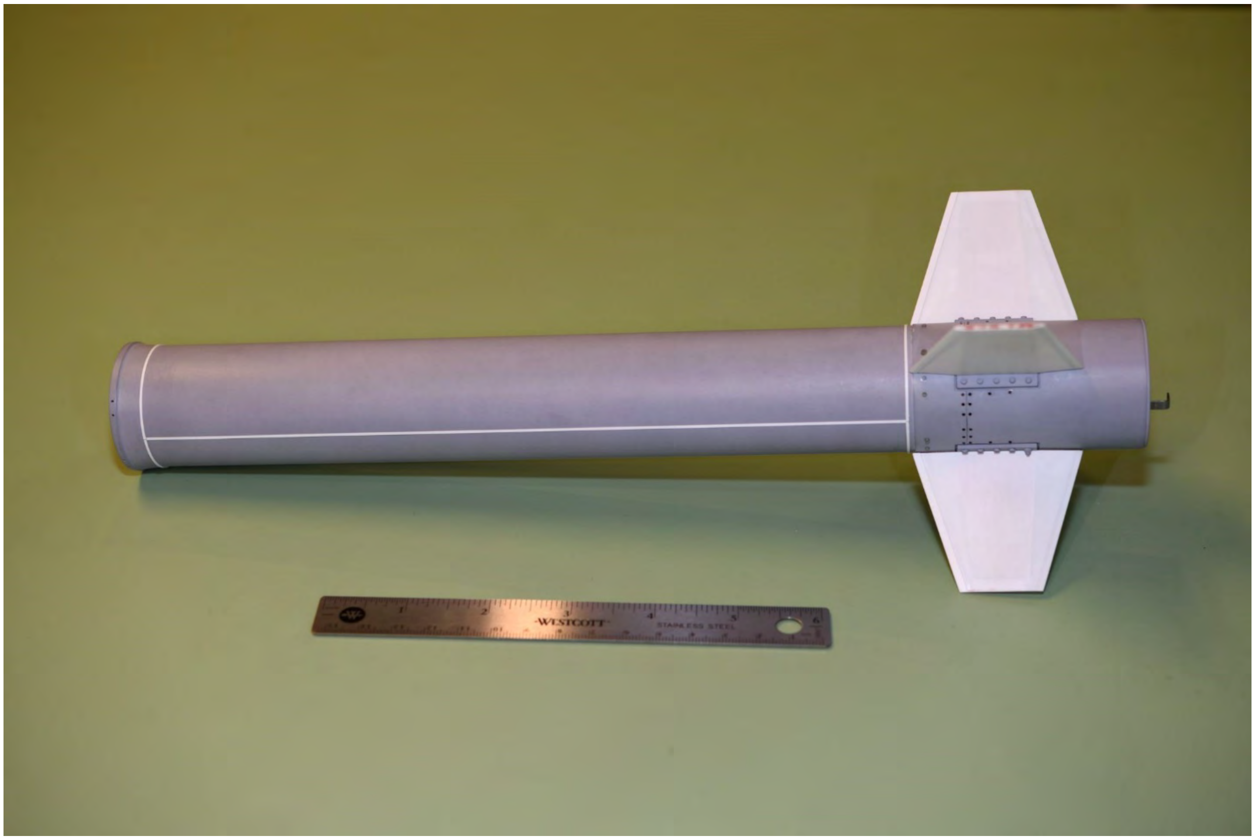


**Photo 14: Final Details**

I fashioned the weld seams out of thin scaled strips of Styrene; the edges were sanded to knock the square edge off. We want the welds to blend into the surface once painted. Time for the color coats, but first, a final detail.

### A Final Detail

It's quite apparent from NASA photo 71HC362 that the Javelin was supported on the launch rail by a launch lug located at or near the forward flange of the 2nd stage Nike booster:


**Photo 15: Argo D-4 Javelin**

**(NASA Photo 71HC362)**

As the photo suggests, there's little doubt a lug was present on the 2nd stage, but it's hidden from view behind the yellow fin of the 3rd stage booster – how exactly was the lug mounted, and how was it finished? Was it painted, or was it left in a primed or natural metal finish?

For the NARAM 59 Javelin, we sidestepped these questions by leaving the part off the model. It can't be judged if it can't be seen. However, in our Javelin rebuild, we'll attempt to tackle the part.

The part itself is well defined in a NASA shop drawing:

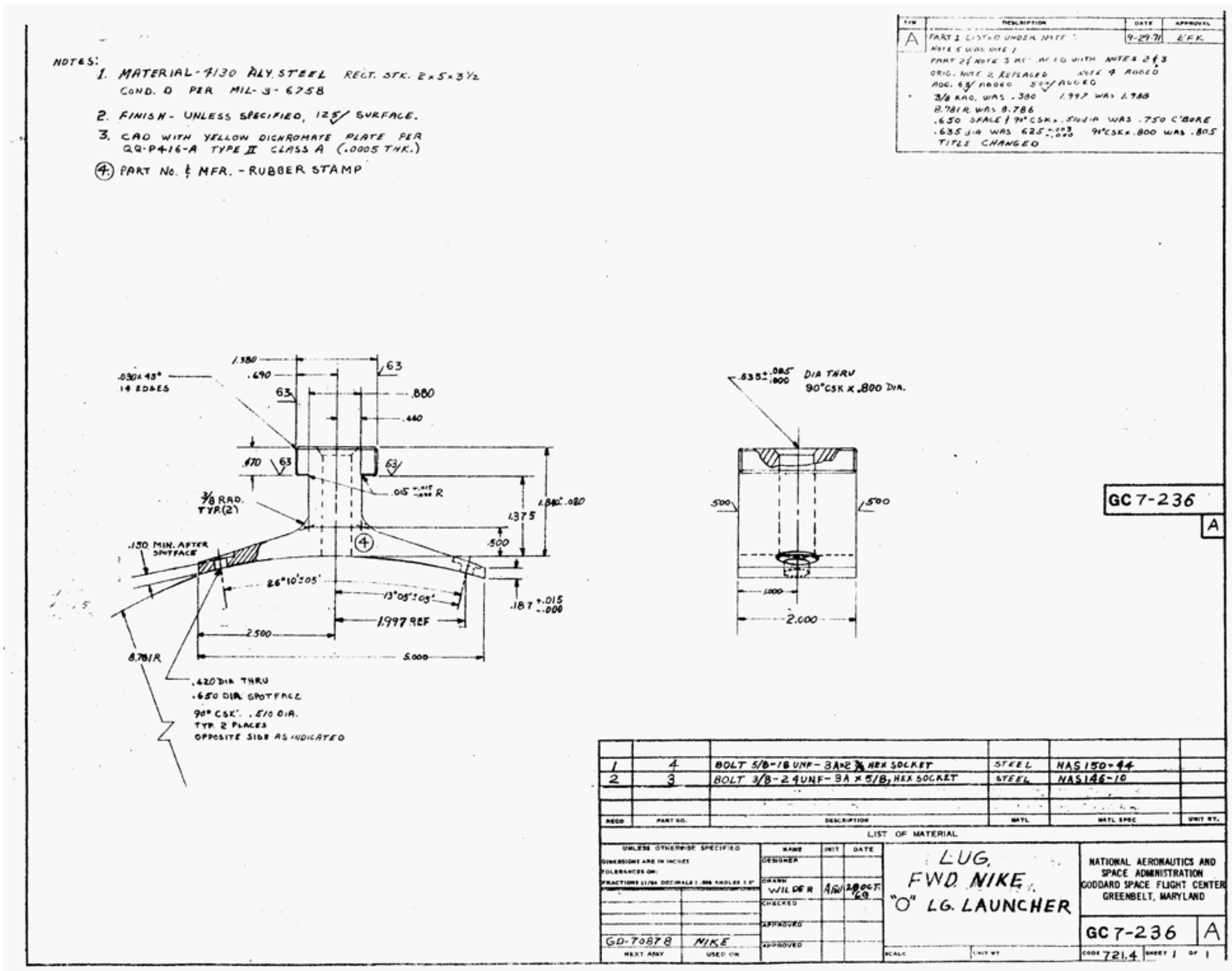



**Figure 4: Nike Booster Launch Lug**

Its orientation on the booster is presented in the Jon Randolph drawing we saw earlier, when working on the Nike-Nike adapter.

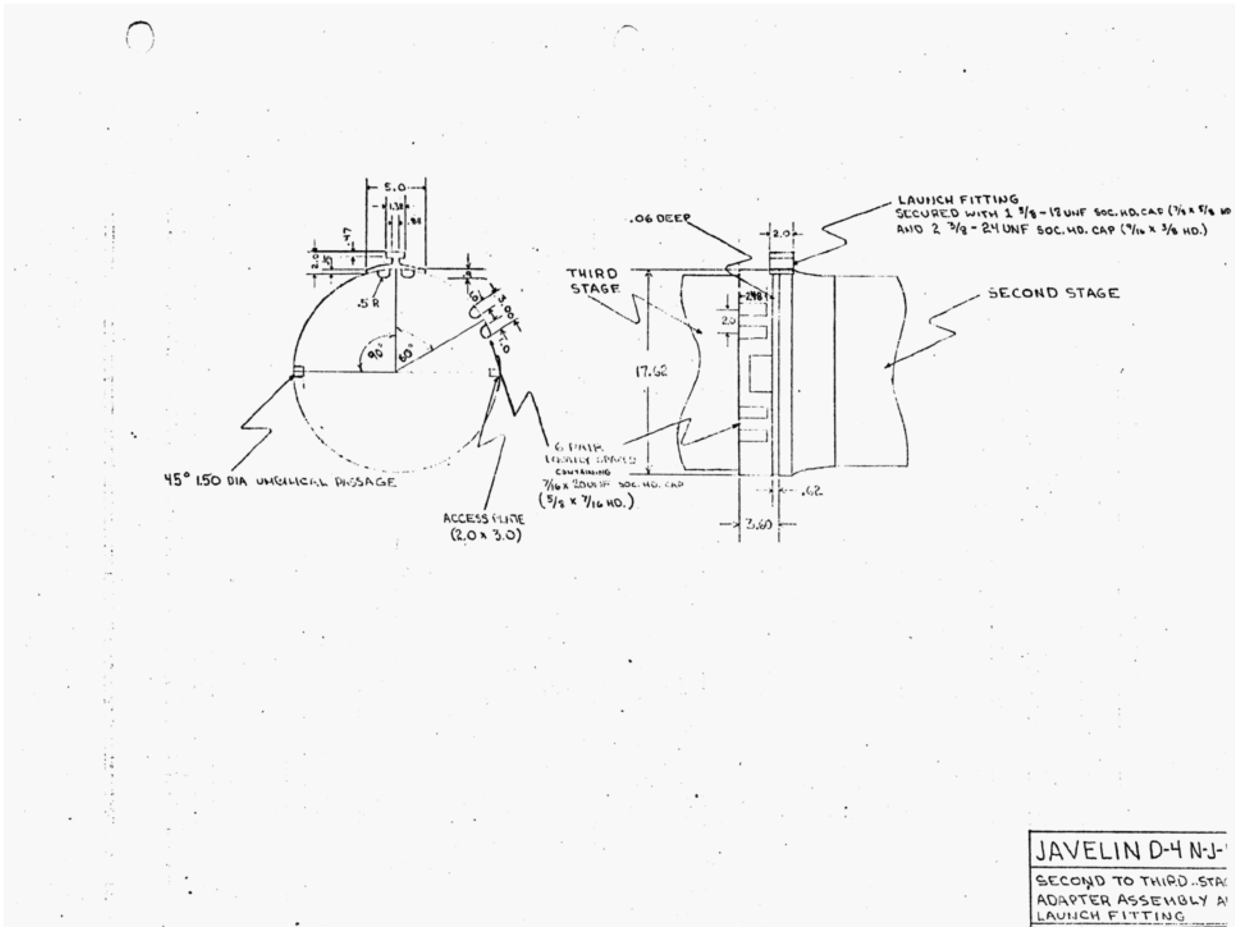



**Figure 5: Nike Launch Lug Location**

**(Drawing by Jon Randolph)**

The drawing is clear, although it's apparent there's an error. The lug is 2" long, while the forward flange is 0.925" long – the lug shop drawing shows the mounting holes to be centered on the part, and if the part were placed flush with the aft edge of the flange (as the Randolph drawing suggests), then the center of the mounting hole would sit just beyond the forward edge of the flange. Clearly not viable. Instead, we can safely assume the part was actually centered on the flange. We'll take that assumption into our build.

As for color, the earlier Langford photo gives us a pretty good idea of the part's final finish. If we revisit the enlargement of that photo referenced in our Nike-Nike adapter article, we can clearly see the launch lug was overpainted with the Nike's airframe color.

**Photo 16: Nike Launch Lug Color**

Armed with this information, we can launch the crafting of our Nike launch lug.

### Construction

We'll build the part from various pieces of Styrene, starting with a 0.010" thick Styrene strip scaled to the correct width. The strip is long enough to wrap most of the way round a scrap length of BT-60; our intent is to build in some curvature into the part so that the finished lug will rest conformally on the Nike's forward flange.

**Photo 17: Lug Base**

Next, we'll fashion the lug web from a pair of scaled pieces of 0.040" thick Styrene, which when bonded together with a dot of Humbrol Poly Cement gives us a very close scale thickness. We'll tack a length of 0.030" x 0.040" Styrene along the top edge of each face with some Tamiya Extra Thin Cement to form the "T".

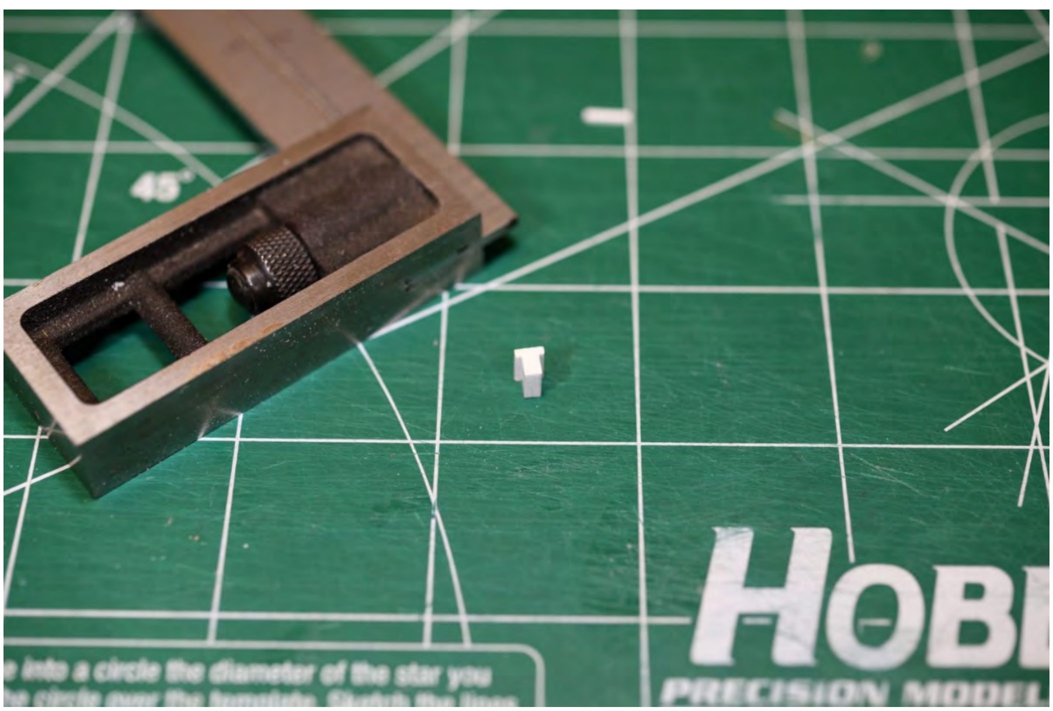


**Photo 18: The Lug "T"**

This assembly is now bonded to the base strip – note in the following photo that I've also marked the limits of the lug on the base strip.

**Photo 19: Base Bond**

Next, we'll install a short thin strip at the base of the "T" on each side; this will be used as a shelf to support the top piece that forms the leg on each side of the lug.

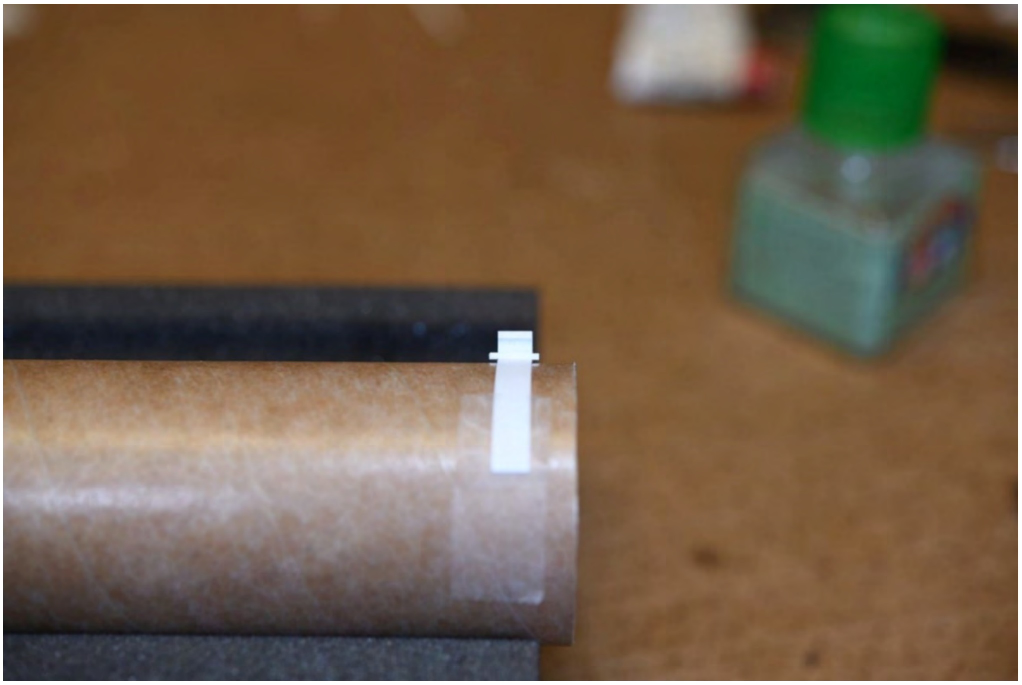


**Photo 20: Top Support Piece**

We'll cement a top piece on each side, fashioned from a scaled piece of 0.010" Styrene. Then the part is removed from the base strip, cutting at the limit marks noted earlier. A bit of trimming and sanding, and we arrive at a native part, ready for finishing.


**Photo 21: Native Launch Lug, Ready for Finishing**

One will note the open voids in the legs; those voids must be filled, but given the thinness of the Styrene, one should avoid a solvent-based filler, as this could deform the plastic. In this case, I mixed some micro-balloons with epoxy, and used the mix as the filler. This mix also imparts some rigidity into the part once cured.

The shop drawing calls out the fasteners used to mount the lug to the Nike forward flange; in the case of the center screw, it scales at our scale factor almost perfectly to the dimensions of an 0-80 socket head screw. So we drill and tap a hole in the center of the lug, and install just such a screw.


**Photo 22: Center Screw**

The two leg screws will be added once the part is primed, but first a trial fit:

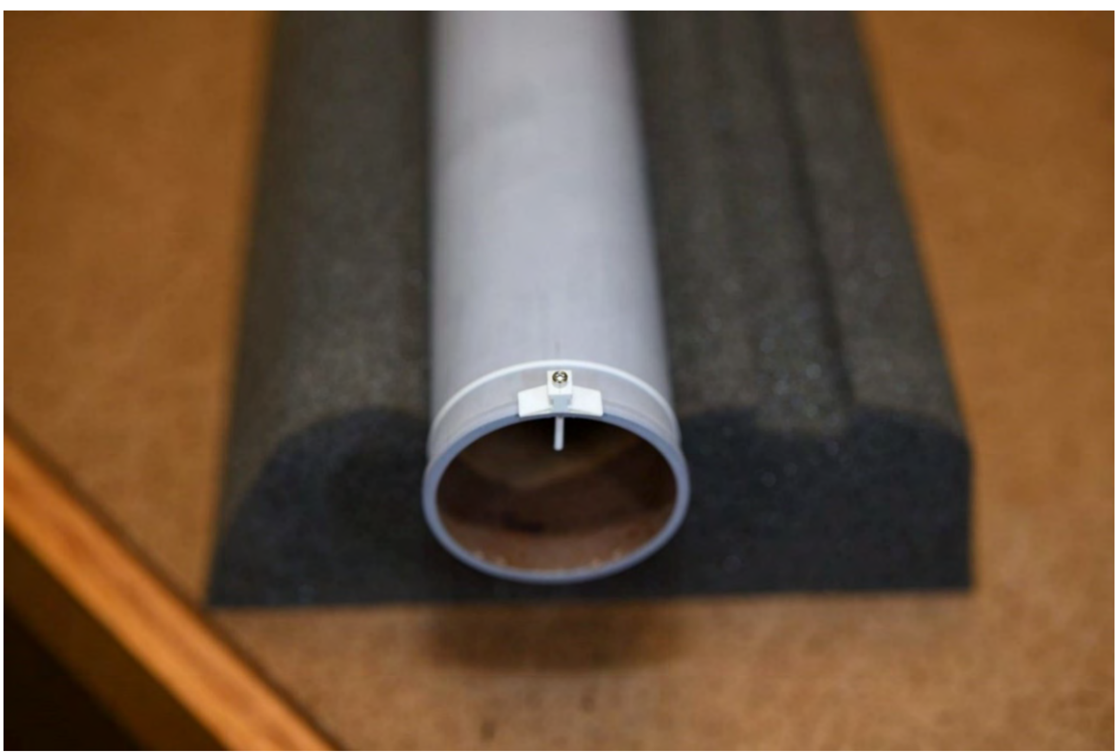


**Photo 23: Trial Fit**

The mounting peg one sees in the photo is a length of Evergreen 3/64" (0.047") Styrene rod, which happens to be a nice press fit into the #56 hole we drilled and tapped earlier to accommodate the 0-80 screw. That peg will be trimmed and glued into place once the lug is primed, leaving us with the final result.

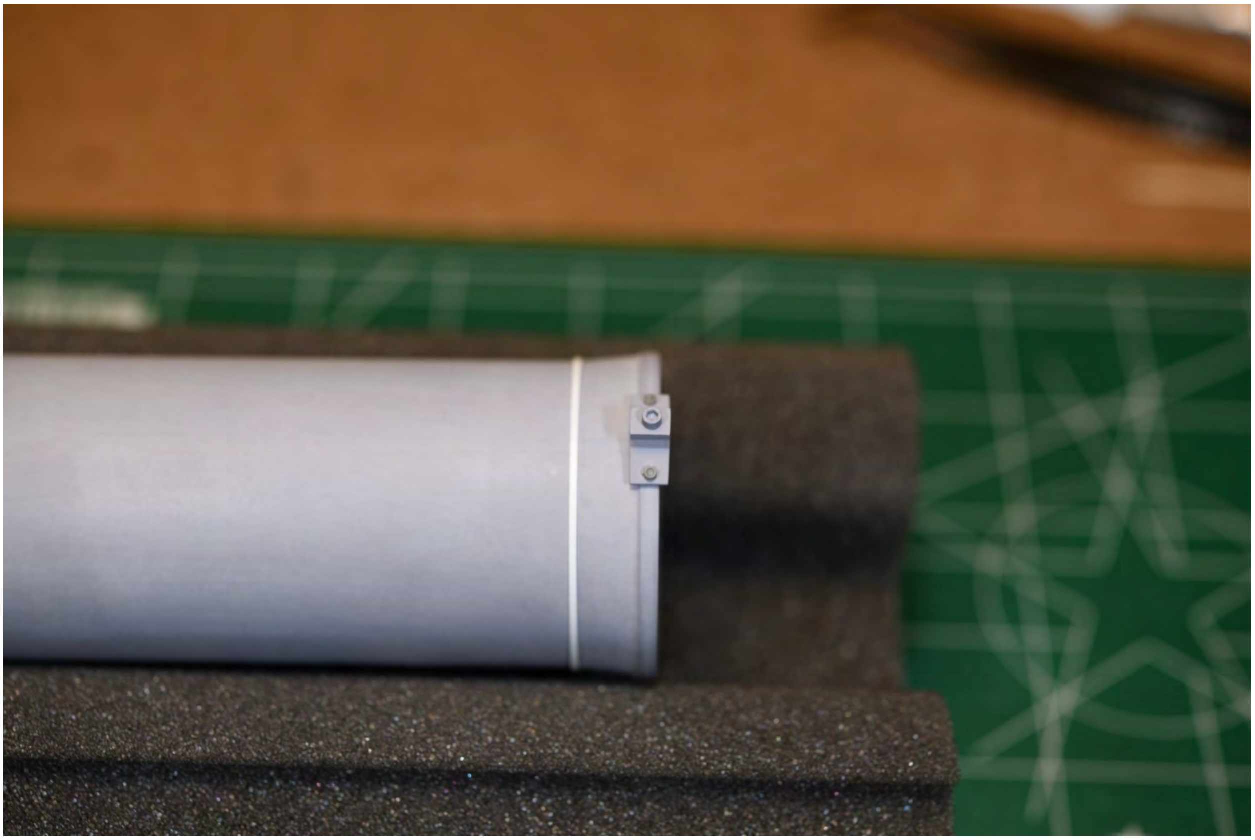


**Photo 24: Launch Lug Installed**

With this, the new second stage Nike booster is complete, and ready for the paint shop.

**Finishing**

We now have two new boosters, ready for paint. They are identical save for the fact the 2nd stage booster has the launch lug mounted on the forward flange, while the 3rd stage booster does not.

A couple of coats of Dupli-Color Artic White provide a perfect blank canvas upon which we can layer our color coats. In the case of the 2nd stage booster, I selected Testors Model Master Go Mango Orange – to my eyes it seemed a fair match to what I was seeing in my reference photos. For the 3rd stage booster, I selected Dupli-Color's Chrome Yellow, again a good match to the reference photos in this case. One will note that in each case, I'm selecting a lacquer – this is my preferred paint medium due to its fast-drying time, its compatibility with wet-sanding, and its hardness once cured.

There remains the matter of the cradle marks. For the original model I elected to whip up some simple bars in TurboCAD, and printed those on Expert's Choice decal film on my laser printer. They were fine in the sense that I was able to blend in the edges of the decals in their application, but not surprisingly, the Scale Judge whacked me a few points because the bars were too crisp, and too dark. Not consistent with what the Judge was seeing in my reference photos. And he was right.

Recalling that sin, I made the effort to fuzzify the marks this time, hoping to arrive at a more realistic representation. I considered the option of airbrushing the marks, but since the Scale Turn In Clock was staring me in the face, I chose the decal route again.

This time I worked up the cradle marks in MicroSoft Word, scaling their size from the photos. I reduced the opaqueness of the black (not so stark), and I softened the edges a few points. Printed them again on Expert's Choice decal film (my preferred film due to its thinness, yet sturdy enough to move around without tearing), making sure to use the greyscale print setting. The result was just about what I was looking for, as shown in Photo 25.

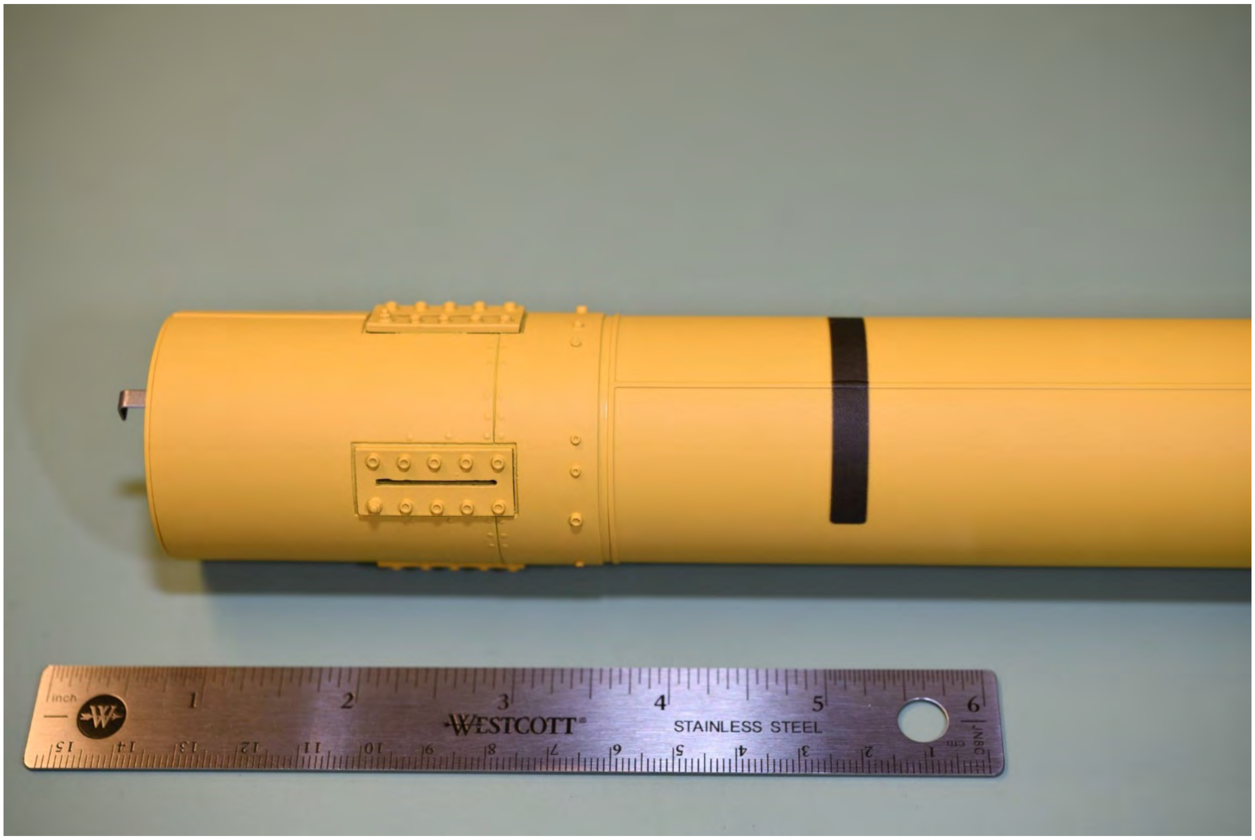



**Photo 25: Cradle Mark**

One is encouraged to zoom in on the photo, above, if possible, which provides a better view of the final cradle mark.

An overspray with Testors Lusterless Flat, and the two boosters are ready to have their fins installed.

## Final Result

Fins installed, some shock cords and final assembly, and we have an accurate 1/10$^{th}$ size (approximately) working three stage Argo D-4 Javelin. An improvement over the original model, thanks to the excellent reference material made available by our good friend Josh Tschirhart of Meatball Rocketry.

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We'll wrap up with a few photos of the completed model. In our final set of articles, we'll cover the research and building of the 1$^{st}$ stage Honest John booster, and that aforementioned and complicated HoJo-to-Nike Adapter.

**Photo 26: 2nd Stage Fin Can**

**Photo 27: Nike-Nike Adapter**


**Photo 28: The Updated Argo D-4 Javelin**