Crafting a Complex Transition – Part II

By John Brohm, NAR #78048

In the last article our narrative ended with a photo of the new, updated, and completed X-248 Payload Adapter for our 1/10th size Argo D-4 Javelin. The next step for that part of the model is to finalize the payload section and its nose cone, using the same finishing steps as the original model. But before we do all that, there's another adapter that's in need of attention. We're referring to the Nike-Nike 2nd/3rd stage adapter, and this article tackles the accurizing of that transition part.

References

Unlike the payload adapter, which, as we saw in the previous article, is a conically-derived transition, the Nike-Nike adapter presents itself externally as a short cylinder, and so at first blush one should imagine that modeling this part would be rather straightforward. And one would be right, if one was to dismiss much of the detail this part brings to the table.

There were at least two types of Nike-Nike adapters, a long one (3.6" long), and a shorter one (1.88" long). An example of the short one can be seen in the following photo:

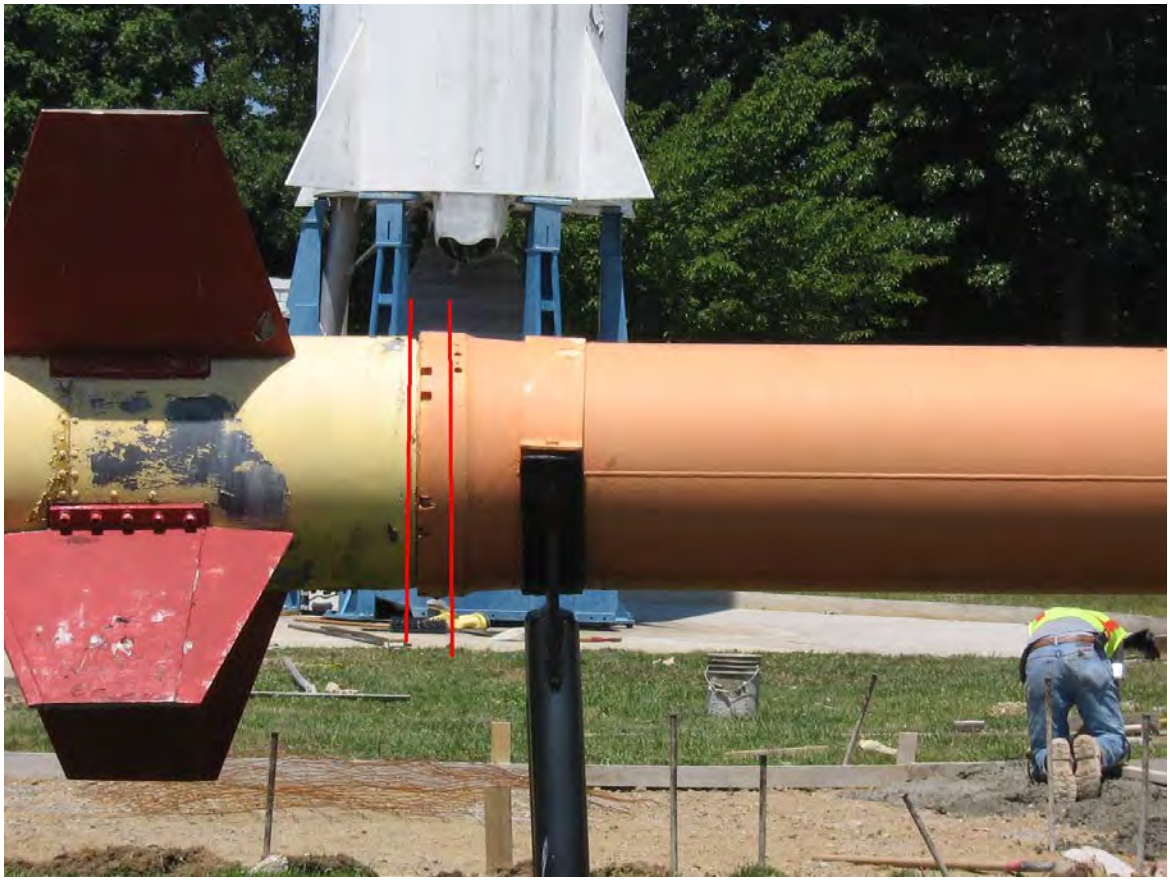

Photo 1: Nike-Nike Adapter

(Photo by Josh Tschirhart)

The Nike adapter is the orange section between the two red lines, and as can be seen, it bolts to the forward flange of the Nike stage preceding it. There are six pairs of mounting bolts equally spaced about the adapter, and each pair is located in a set of bolt access slots as one sees in the photo. A closeup view, as follows:

Photo 2: Nike Adapter Mounting Bolt Access Slots

(Photo by Josh Tschirhart)

Based on their appearance in the photo, one might imagine those access slots are square in shape; yet in fact, they're not. Rather, they are round counterbores, and this can be seen more clearly in the following photo:

Photo 3: Nike Adapter Mounting Bolts

(Photo by Josh Tschirhart)

When I crafted the Nike adapter for the NARAM 59 model, I had used these photos as part of my reference package, together with an adapter blueprint prepared by Bob Biedron, a noted former WSMC and Javelin scale modeler. We can see the part as crafted for my original model in the following photo - it's the olive drab section between the two Nike stages:

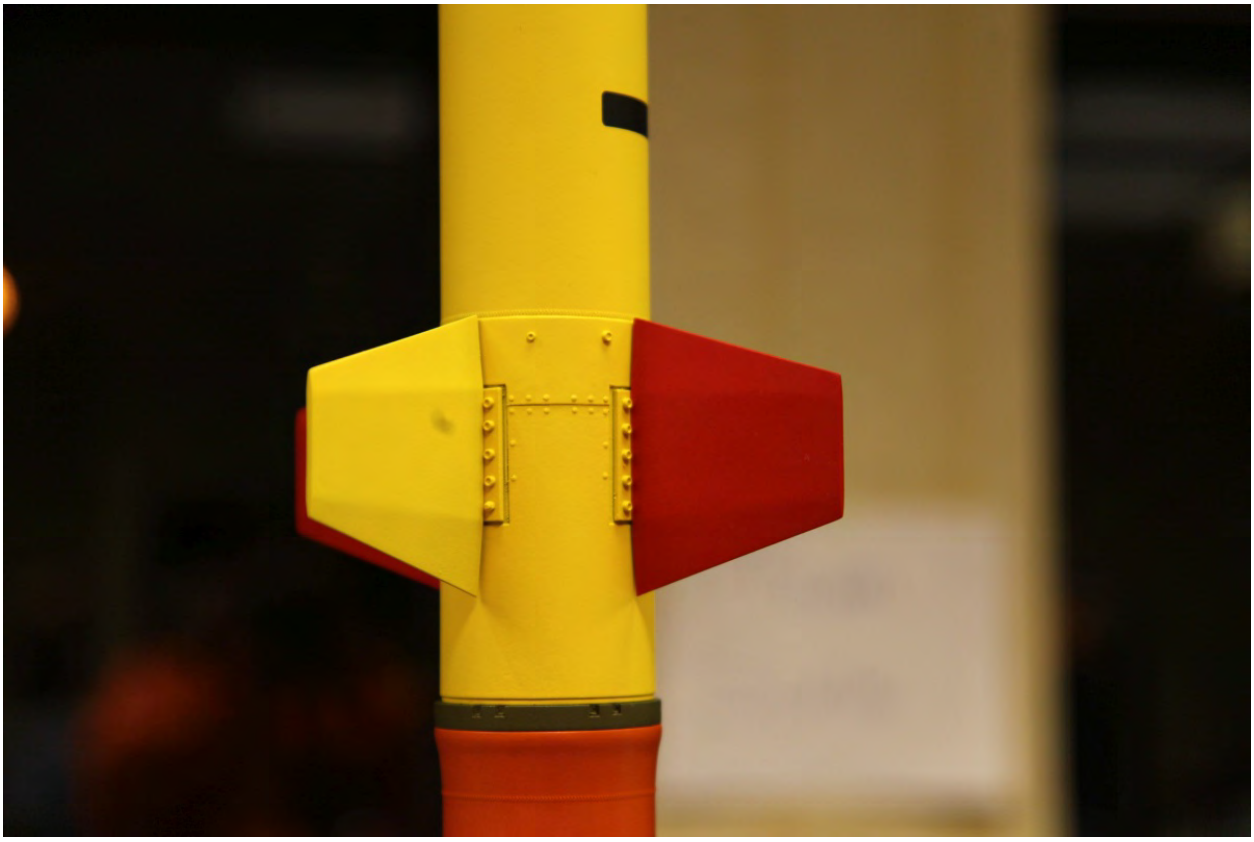

Photo 4: Nike Adapter

(Photo by Chris Taylor)

The model's part was painted olive drab, as the round I was modeling was the one captured in NASA photo 71HC362. While hard to see, close examination of the following photo, NASA photo 71HC362, shows that the Nike-Nike adapter used in that prototype round was also painted olive drab.

Photo 5: Argo D-4 Javelin

(NASA Photo 71HC362)

So superficially, no problem – we had documentation, we had a part with six pairs of mounting bolts and slots, and the thing was green. Why re-work the part?

As it turned out, there were a couple of reasons why. The first had to do with the fabrication of the original part. I wasn't really happy with the way it turned out, as it was difficult to cut those access slots in a round shape. The adapter was built up with Styrene strips placed around a short section of JT-60 (recall that JT-60 is the size of the Nike airframe at this scale factor) that would then just slide into place over the coupler, but I found that attempting to drill the bolt access counterbores was virtually impossible due to significant bit wandering. I ended up cutting the slots by hand, using an Xacto knife, crudely attempting to "round' each slot in the process.

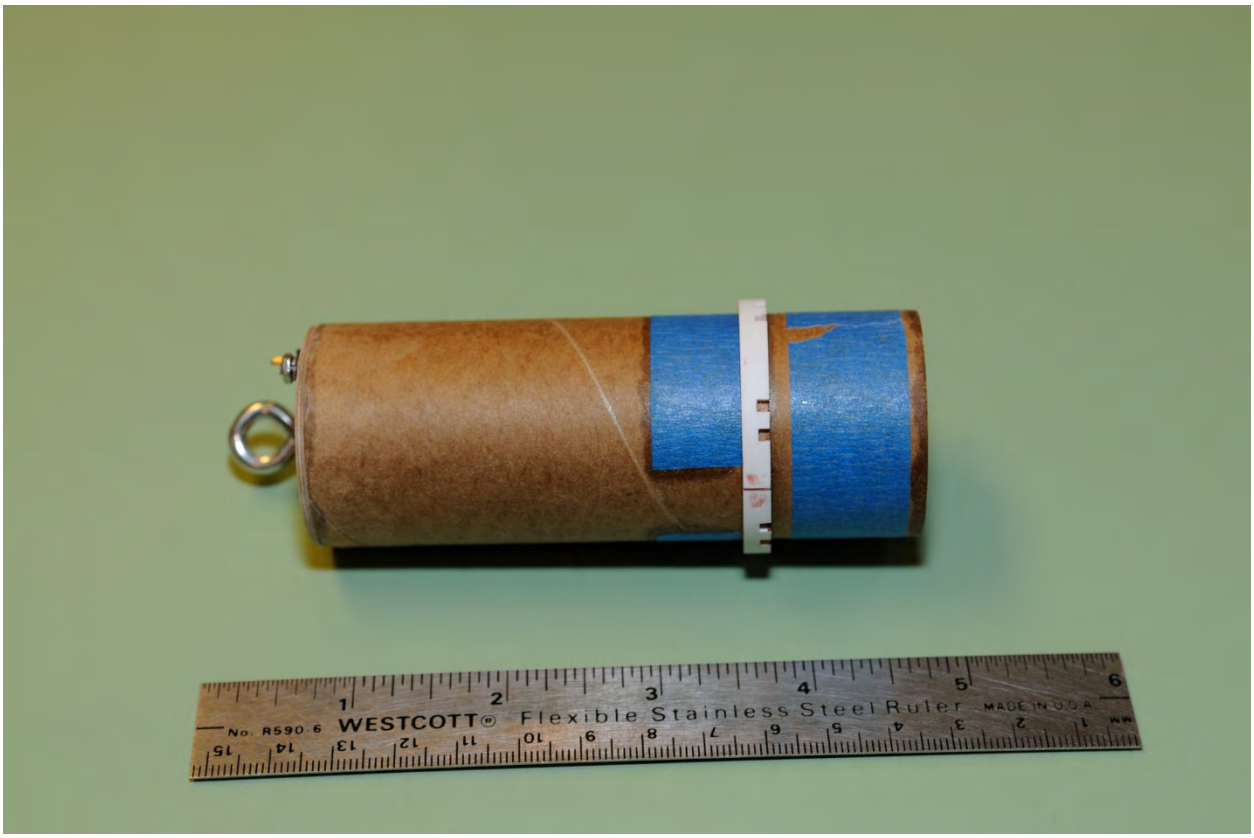

Photo 6: Native Nike Adapter for the Original Model

Despite my best efforts, the slots ended up more square than round. And since the ring had been built up on a section of JT-60, I didn't get the proper scale radial depth for the slots either. Nevertheless, with the turn-in deadline looming, the bolt heads were installed, the part was painted, and I then directed my unbridled anxiety towards other unfinished parts of the model.

The second problem was a little more dramatic – it had turned out that I had modeled the completely wrong part. Further research revealed that the round in NASA photo 71HC362 used the long adapter, not the short one. A photo buried in John Langford's Javelin photo collection (Photo W-70-277) shows the same round, but in launch attitude. This permits us to see the adapter more directly, without the severe parallax apparent in NASA photo 71HC362.

Photo 7: Argo D-4 Javelin

(Photo W-70-277, John Langford Collection)

Some magnification will help to make the point. We'll compare the adapter in the NASA/Langford photos with the adapter deployed in the round that Bob Biedron documented. The Biedron round is NASA 8.25 GA/GI, and is the one depicted in Peter Alway's Rockets of the World: A Modeler's Guide, 1st Edition, pages 167-170.

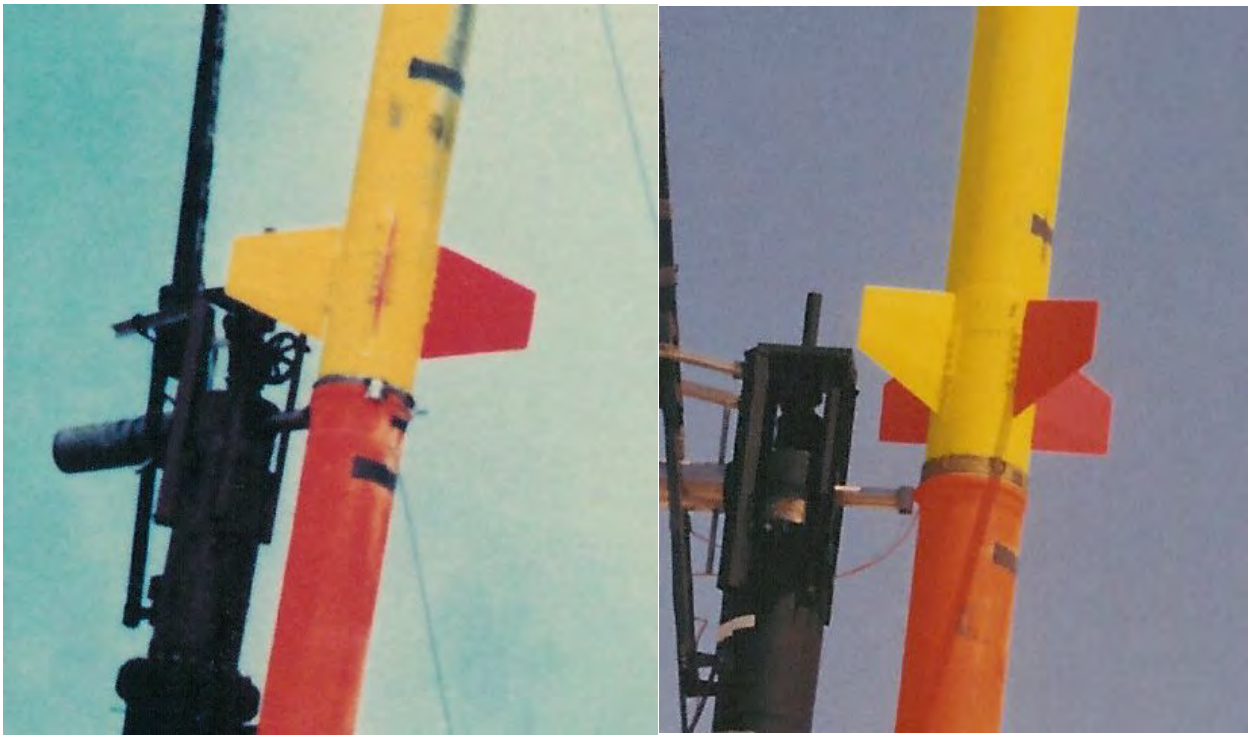

Photo 8: Biedron Javelin Round 8.25, Left; W-70-277 (Langford), Right

Close examination reveals that NASA Round 8.25 quite rightly used the short adapter, but the round in the NASA/Langford photo is the longer one. One can see that it's about twice the length of the adapter displayed in the Biedron photo. This was a detail, but an important detail, that I had completely missed in my rush to complete the original model.

Fortunately, we have both a drawing and a photo for the long adapter, and this rebuild exercise provides the opportunity to use this data.

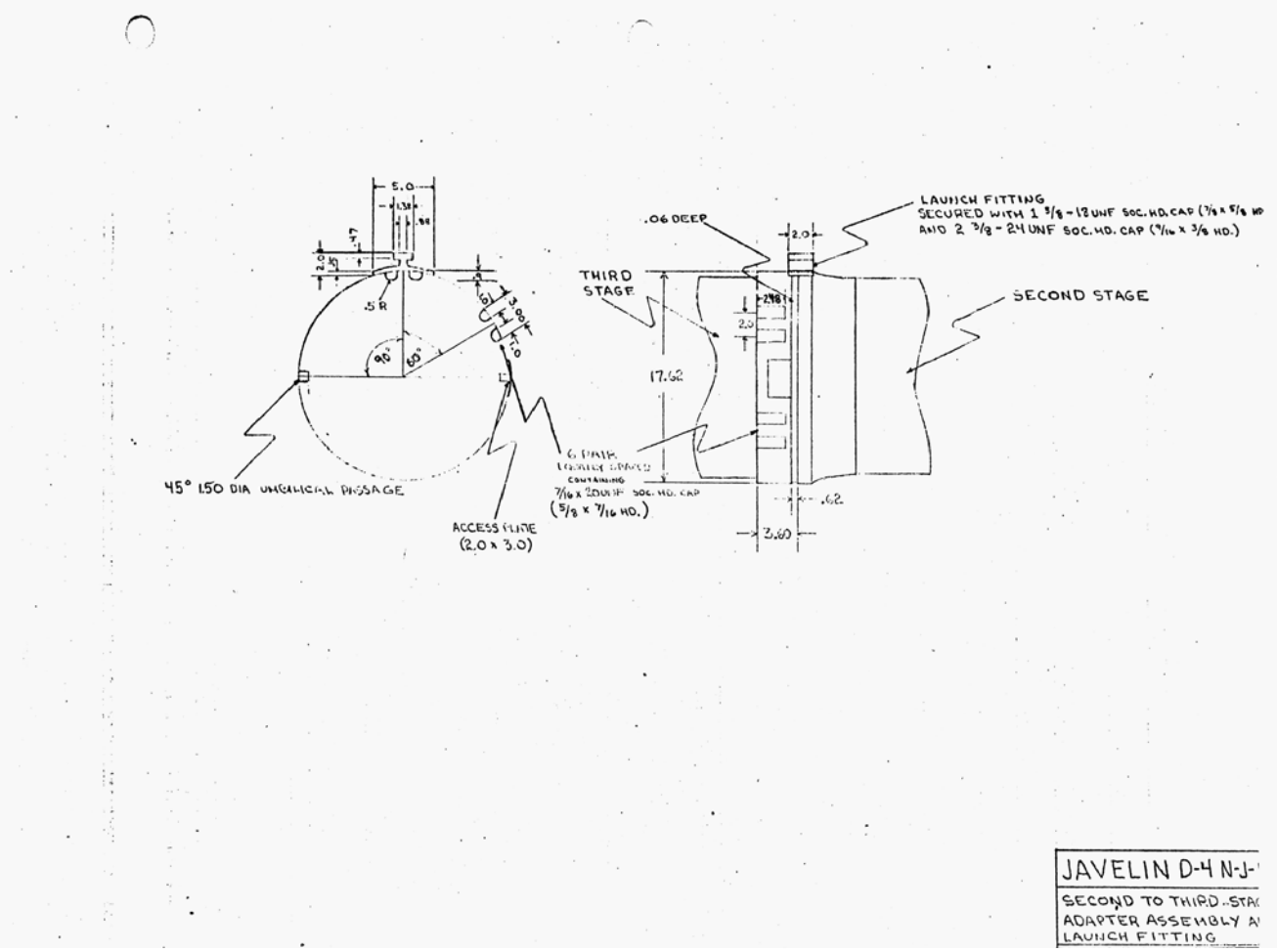

Figure 1: Nike-Nike Adapter, Long Version

(Jon Randolph Drawing)

In this rebuild, we'll use the Randolph drawing to fashion the longer part, and instead of building up the part from Styrene strips, we'll machine a solid master and then use this master to create a mold from which we'll resin-cast the model's part. This approach will eliminate the difficulties associated with cutting/drilling those bolt access slots, and will allow us to arrive at a more accurate part.

Part Design

It's important to note that, unlike the short adapter, the long adapter had bolt access slots that were not fully counterbored, but rather had tangent sides (i.e.: they were "U" shaped). The Randolph drawing shows this, as does the following photo of an actual prototype long adapter:

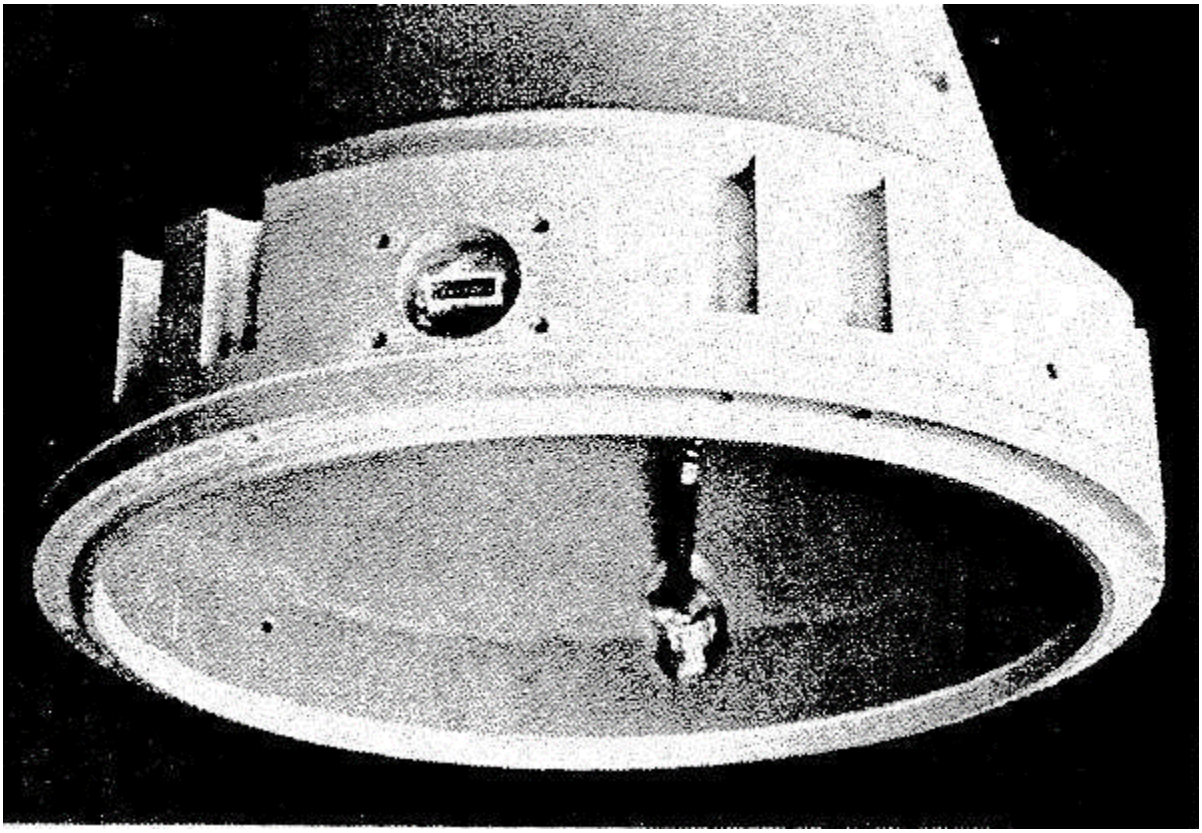

Photo 9: Nike-Nike Adapter, Long Version

(ARC Standard Components Catalog)

The Randolph drawing also indicates a couple of other surface features on the external face of the adapter, and the photo above highlights these as well – the rectangular access panel (shown removed in the photo), and the umbilical port sitting opposed to the access panel. The photo makes clear that the access panel sat proud of the external surface (there is no observable inset in the face of the adapter that would permit the panel to sit flush), and the umbilical port was bored 45 degrees inclined and parallel to the longitudinal axis of the part. These are details we can easily add to the model's part once cast.

Recalling that our scale factor for this model is 10.32, we can quickly calculate the part's outer diameter – 1.707". It's not a particularly large part, so to get the kind of tolerances we need we'll precision-machine the master from 6061-T6 aluminum. After a bit of CAD work, we arrive at a virtual model for the master:

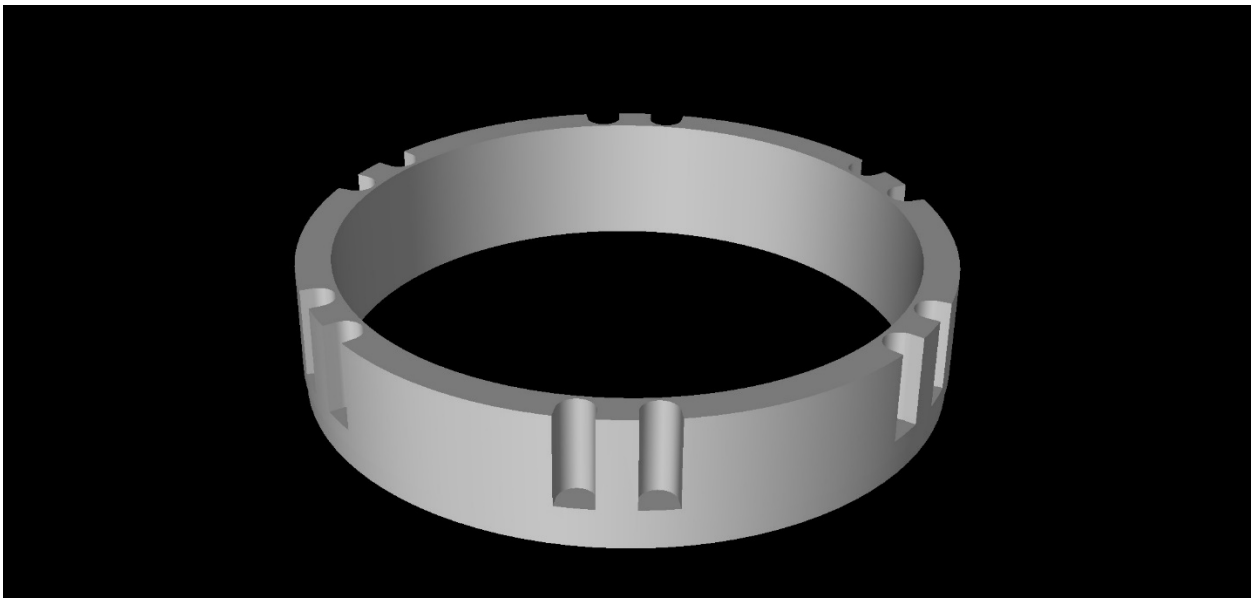

Figure 2: Nike-Nike Adapter, Top View Oblique

Figure 3: Nike-Nike Adapter. Bottom View Oblique

The part is sized with an inner diameter that will permit it to slide into position on the underlying coupler, negating the need for that section of JT-60 the original model used; eliminating that support thickness allows us to get to an almost exact scale radial depth for those bolt access slots. Note in the bottom view the underlying channel machined into the aft end of the part, just as the drawing calls for, and as the prototype photo shows. With the drawing and 3D CAD file prepared, off to the machinist to have the master part made.

Fabricating the Adapter

Eventually the master part arrives at the shop, and we take the opportunity to inspect it:

Photo 10: Adapter Master

Looks good, and it seems to fit the coupler very well:

Photo 11: Trial Fit

We fashion a mold box out of 0.030" sheet Styrene, sized to accommodate the part, and once the mold has cured, we cast the part with resin. I'm using the Alumilite brand of molding and casting products here, but any good quality casting set will do the job.

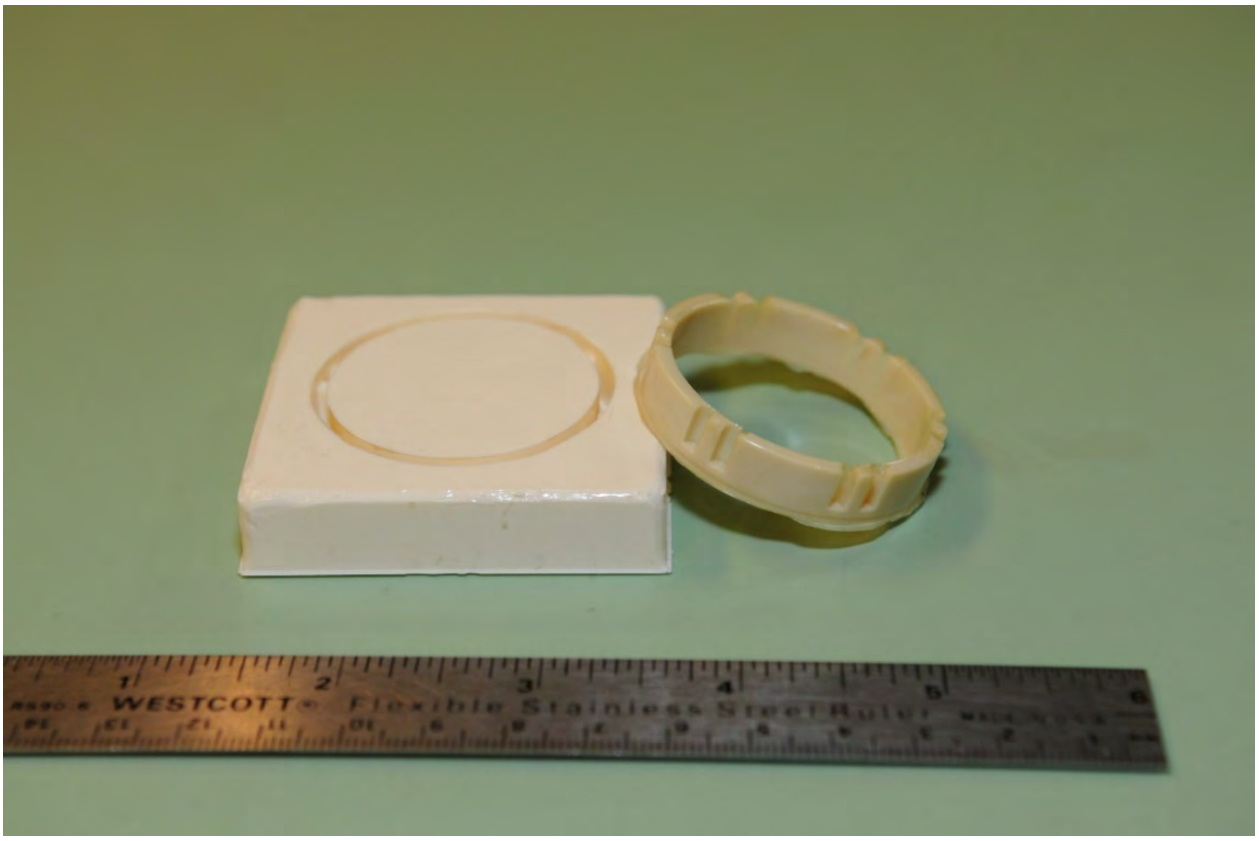

Photo 12: Mold and Part

I found that I had to use a Monoject 412 plastic syringe to properly pump the resin into the narrow confines of the mold; about six cc's of resin was needed for the pour. I also found that, due to the thin nature of the part, the curing time was much longer than the time used by the remaining resin mass in the mixing cup; the mass in the mixing cup only needed a couple of minutes to harden up. Accordingly, I had to leave the poured part in the mold for about an hour before I was confident it could be removed without deformation.

Not surprisingly, the molded part presented a bit of flash to clean up and some air bubbles to fill, but in the main the resin cast part turned out fairly well. We'll trial fit this one also, and as the following photo shows, the fit is also quite good:

Photo 13: Native Part Trial Fit

Looking closely, one can see just how thin the bolt access slot back walls are (i.e.: the very back of the "U" shape slots that rest against the coupler); this area of the part is only a few thousandths of an inch thick. It would seem the casting is delivering on the scale tolerances we need for this part.

Before we fix the part to the coupler, we'll first add the access panel and the 45-degree umbilical connector passage. We'll fashion the access panel from a scaled piece of 0.010" Styrene sheet and adhere it with some Tamiya Extra Thin cement:

Photo 14: Adapter Access Panel

Next, we'll locate the hole for the umbilical passage, and we'll drill that with a #27 drill bit – almost exact scale diameter for the model. We don't have a front view of the umbilical passage, but since this is a plug connector that needs to separate at launch, we can assume the receptacle connector is permanently mounted to an internal bulkhead inside the passage. We'll fashion a bulkhead out of Styrene sheet, and cement that in place.

Photo 15: Umbilical Passage

We'll add the connector and mounting nut after the adapter has been painted. So with that, our Nike-Nike adapter is now ready for some primer. Off to the paint shop.

Finishing

Voids were filled with Bondo Glazing and Spot Putty, and then sanded smooth. The part was then primed with Rustoleum Automotive primer, and once cured, remaining divots and defects were filled with Squadron White Putty. A final sanding, followed by another primer coat, and the part was set aside to dry.

It's at this point the mating bolt heads are added to the bolt access slots. The prototype used socket head bolts that had a 5/8" head diameter; at our scale factor, that works out to a diameter of 0.061" on the model, or 1.54 mm. We happen to have some miniature styrene socket heads 1.5 mm in diameter – close enough – and we'll use these. We also need to add an underlying washer to each bolt head, and to represent these, we'll punch out some Styrene disks 1.9 mm in diameter. Each bolt head and washer were tacked together with Tamiya Extra Thin cement, and then tacked into place on the Adapter with a dot of Humbrol Poly Cement.

Photo 16: Ready to Install

The part is now ready to be mounted onto the coupler, and it's here the part will receive its final olive drab color coat. But before we do that, we mustn't forget that this coupler/adapter assembly is also the home for the staging electronics and battery that ignites the 3rd stage. Since this fitting work will require a lot of coupler handling, we'll install and paint the adapter after the staging package has been completed.

Staging Package

The Staging Package is built around a PerfectFlite MiniTimer 4; this is a compact and reliable timer-staging unit that we've used in all of our multi-stage scale models, and we've yet to experience a staging failure. Our staging power source is a 280 mAhr LiPo battery, the largest and most energy-dense package that will fit in the available space.

External connections are made available for the igniter leads and for an on/off shorting plug; we like to use a simple two pin Deans micro plug as the on-off switch, the forward pins shorted to make the circuit. These miniature connectors ensure maximum current delivery in a small, compact space.

Construction begins with a 1/16" thick ply sled. The sled is permanently mounted to the aft bulkhead, the aft bulkhead fitted for the Deans connector and a #8 eyebolt to which we will attach our recovery appliance.

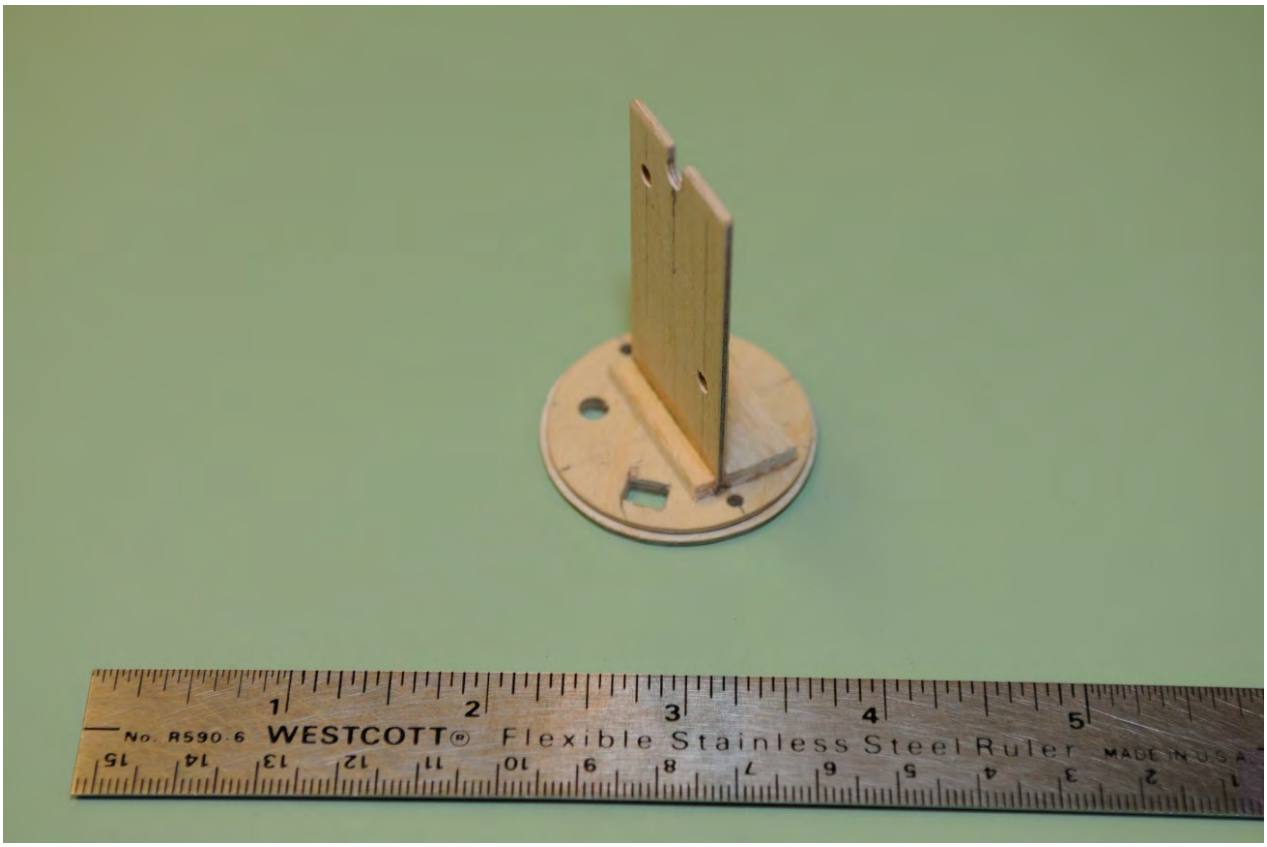

Photo 17: Electronics Sled

With some assembly and wiring, we arrive at the completed Staging Package as seen in the following photo:

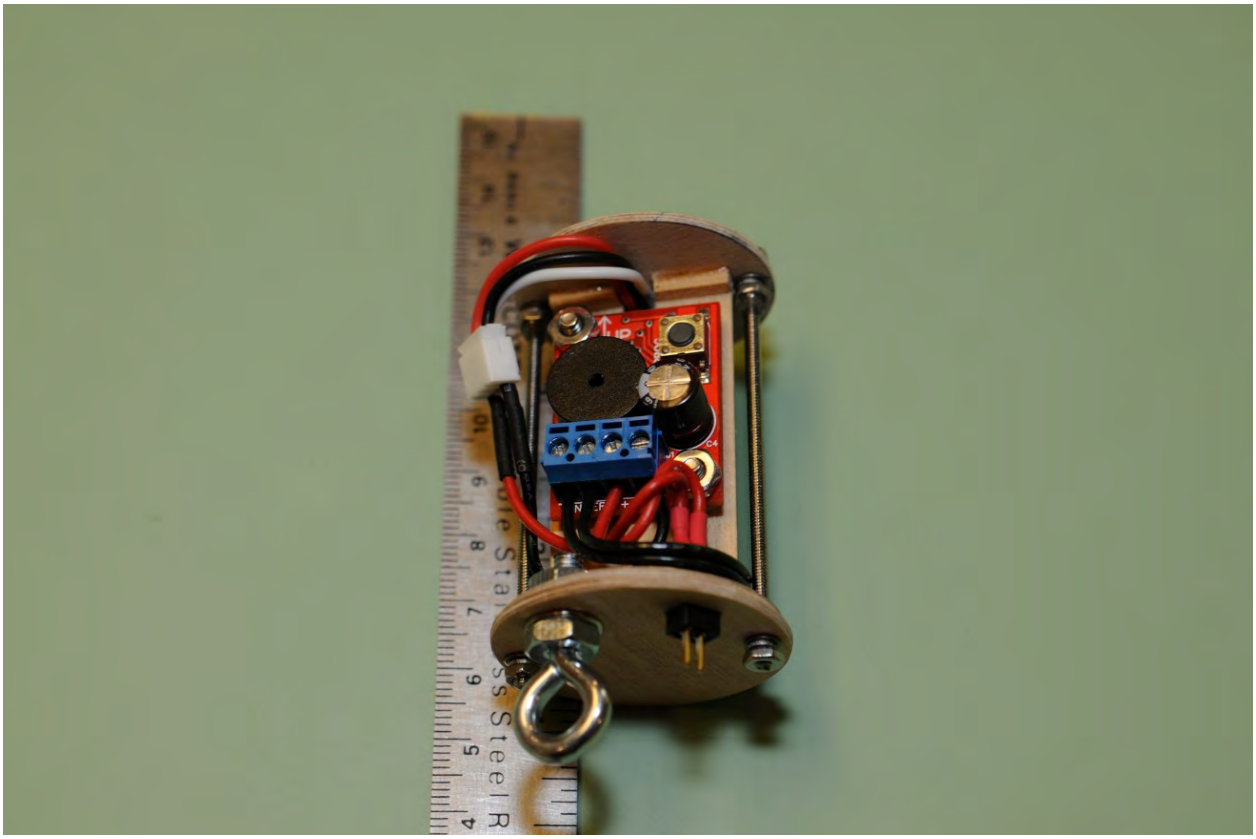

Photo 18: Staging Package

Note the use of two 2-56 all-thread rods to tie the package together. Ejection forces, combined with the mass of the staging package, create too much inertia to rely on glue joints alone, and so the all-thread ensures that everything lands in one complete piece.

The forward bulkhead is epoxied in place on the forward side of the coupler, and is located a sufficient distance back from the aft end of the 3rd stage to leave room for the 3rd stage motor end, igniter and igniter leads.

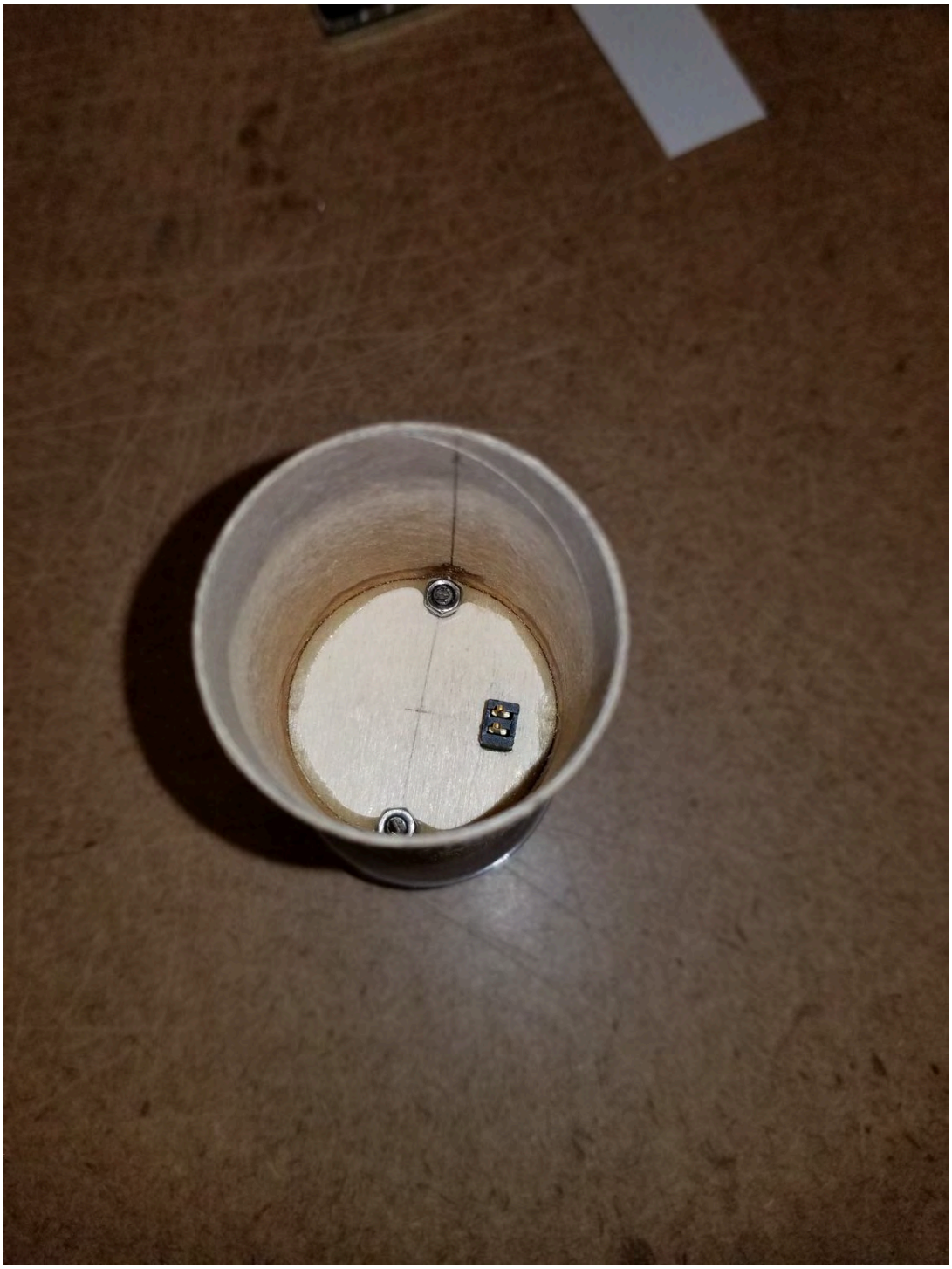

Photo 19: Forward Bulkhead, Top View

The forward bulkhead is supported underneath by a pair of coupler tubing sections, cut to fit and epoxied in place so that there is a secure brace for the forward bulkhead to bear against once the aft bulkhead is bolted in place.

Photo 20: Forward Bulkhead, Aft View

The Staging Package is removable from the aft end of the coupler; when bolted together, the package is solid, sealed, and secure. One just needs to remember to insert the shorting plug out at the pad to activate the timer when preparing to fly!

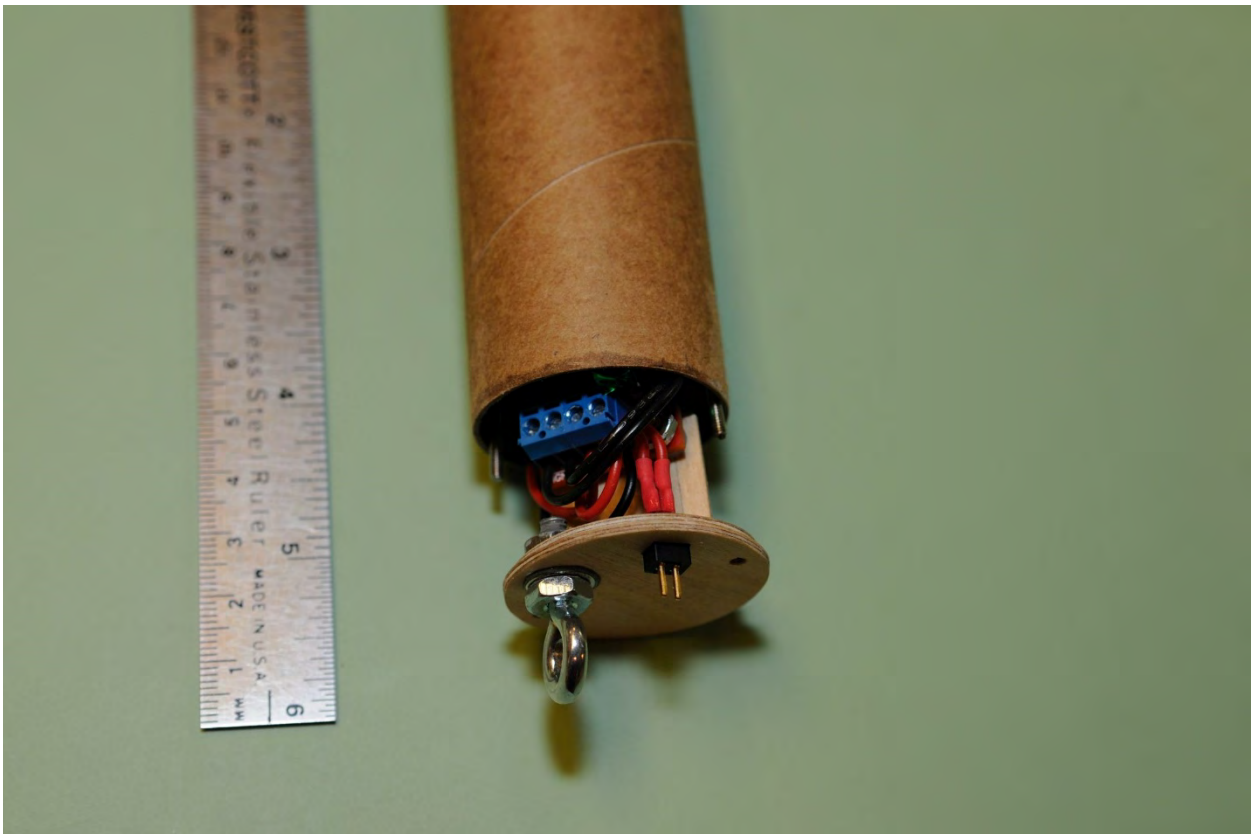

Photo 21: Removable Electronics Sled

With the Staging Package now complete, we can install and paint the adapter.

Wrapping Up

The primed adapter is moved into place on the coupler; its location is 1" aft of the forward end of the coupler. A very thin layer of epoxy is used to fix the part in place.

Once the epoxy has cured, the assembly is masked and then shot with a couple of coats of Model Master Olive Drab.

Photo 22: Painted Adapter

Waiting for the paint to dry provides the opportunity to prepare the umbilical connector. We'll do the same as we did for the umbilical connector on the X-248 Payload Adapter; we'll fashion an hexagonal mounting nut from a piece of Styrene, and we'll use a socket head bolt head to represent the connector. Some glue and silver paint, and we have an umbilical connector ready for installation.

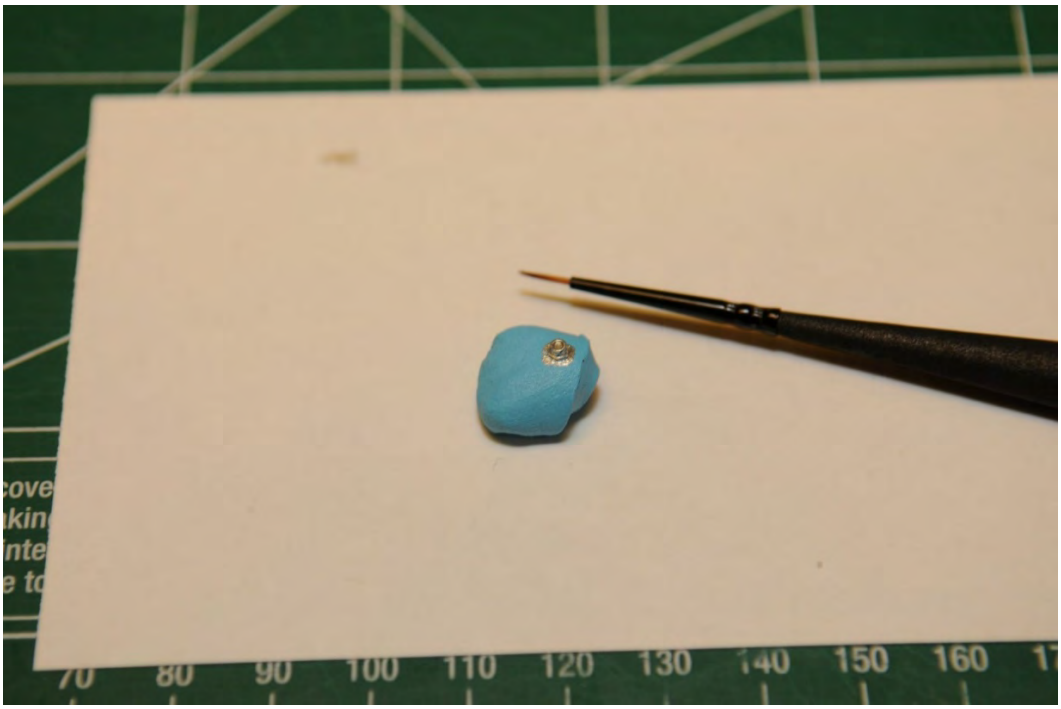

Photo 23: Umbilical Connector

A dot of Humbrol Poly Cement, and the umbilical connector is set in place.

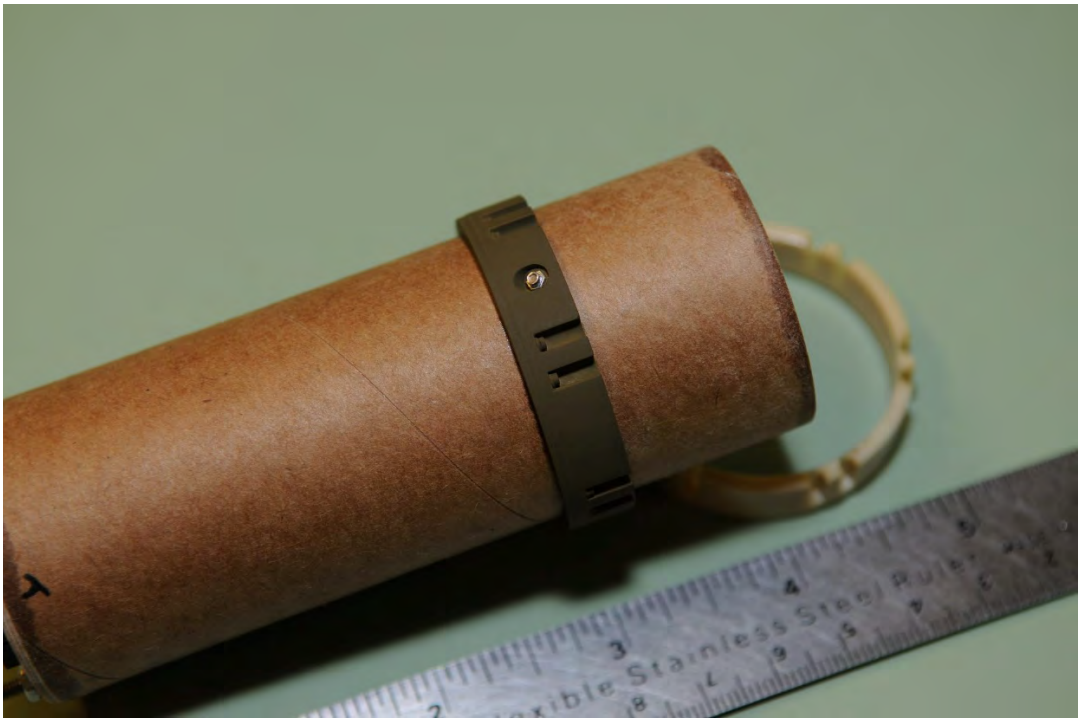

Photo 24: Umbilical Connector Installed

And there you have it, an accurized Nike-Nike adapter, and one properly sized for the round we're modeling.