Building the Ogonek Soyuz 7K-OK into Soyuz 4

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Introduction. Those of us who chose to model real space subjects realize that the mainstream styrene model companies don't offer us many options and the kits that are out there are often lacking in accuracy when compared to choices available to someone interested in armor or aircraft. There are numerous specialty kit manufacturers who fill this void with excellent multimedia kits and I have many of these in my collection. However, there are times when the lure of the somewhat easier build (at least given my skills) of a styrene kit appeals to me.

Outside of the mainstream there exists a styrene kit that was produced by Ogonek in Russia of the first generation Soyuz, the 7K-OK. This kit appealed to me due to its 1/30 scale, which would sit nicely next to Monogram's 1/32 CSM, and by the fact that everything I had read about it indicated that it is a reasonably accurate model. As anyone who has an interest in the kit knows, it can be difficult and expensive to obtain. I was able to win a copy in an eBay auction for a price that didn't send me to the poorhouse and it spent the next 12 years lurking in my stash daring me to build it. Since I'm not a collector and never buy a kit without the (best) intention of someday building it, I finally gathered up the courage to pull it out and build it up as Soyuz 4 which was the active vehicle in the first docking of manned spacecraft achieved by the Russians. A short history of the mission can be found at https://nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=1969-004A

What follows is a quick summary my research of the Soyuz 7K-OK, specifically as it relates to Soyuz 4, and the decisions I made during the build as well as a more in-depth description of the build itself. It isn't intended to be a definitive reference, for that I suggest you conduct your own research. I hope you may find my descriptions of the techniques I used and tips I offer based on my experience useful should you embark on a build of the Ogonek kit yourself. Keep in mind that I'm by no means a master modeler but rather just a journeyman infected with AMS who enjoys thinking of different ways to approach a challenge. I include descriptions of some of the trials and errors that arose as I went along.

The three modules making up the Soyuz are referred to by different names in different sources. For consistency, I call them the Orbital Module, Descent Module, and Service Module throughout. I also refer to the top and sides of the spacecraft as if it were flying in a heads-up orientation.

Pre-Build Research. It has been easier to find reference material on the Russian space program since the breakup of the Soviet Union. NASA's Shuttle/MIR program and Russia's participation in the ISS has provided a wealth of photographic documentation of the later generations of Soyuz spacecraft although this isn't that helpful in researching the first generation Soyuz.

While I found the technical descriptions of the 7K-OK variant contained in the references interesting, they didn't help a great deal with the build. Photo documentation of the 7K-OK in these texts, or on the web, is scarce and often of small size or poor quality. This is especially true for actual flight hardware. This is somewhat offset the availability of photographs of museum displays and artist's depictions but these can introduce their own inaccuracies. I found

the photos on the Starbase 1 website of a Soyuz in British National Space Centre particularly helpful. It should be noted that while the page is titled "Soyuz TM" the photos are of a 7K-OK as evidenced by the docking adapter and toroidal tank.

For some unknown reason, I've previously only searched the web for images to use as references. This time around I thought to search YouTube to see if there were any movies of the rendezvous between Soyuz 4 and 5 posted. The following query returned some interesting results that I found useful: https://www.youtube.com/results?search_query=soyuz+4

Having a copy of New Ware's 1/48 scale Soyuz 7K-OK in my stash, I occasionally referred to it as questions arose during my build. As is noted later, the instructions for the New Ware kit helped in a couple of areas and I used some of its parts as reference for scaled-up scratch built details. I found Mike Mackowski's SIM #4 Soviet Spacecraft quite useful as well. It sat on the bench as I was building and I often picked it up to quickly check questions as they arose. Mike kindly gave me permission to include one of his drawings here as Figure 1.

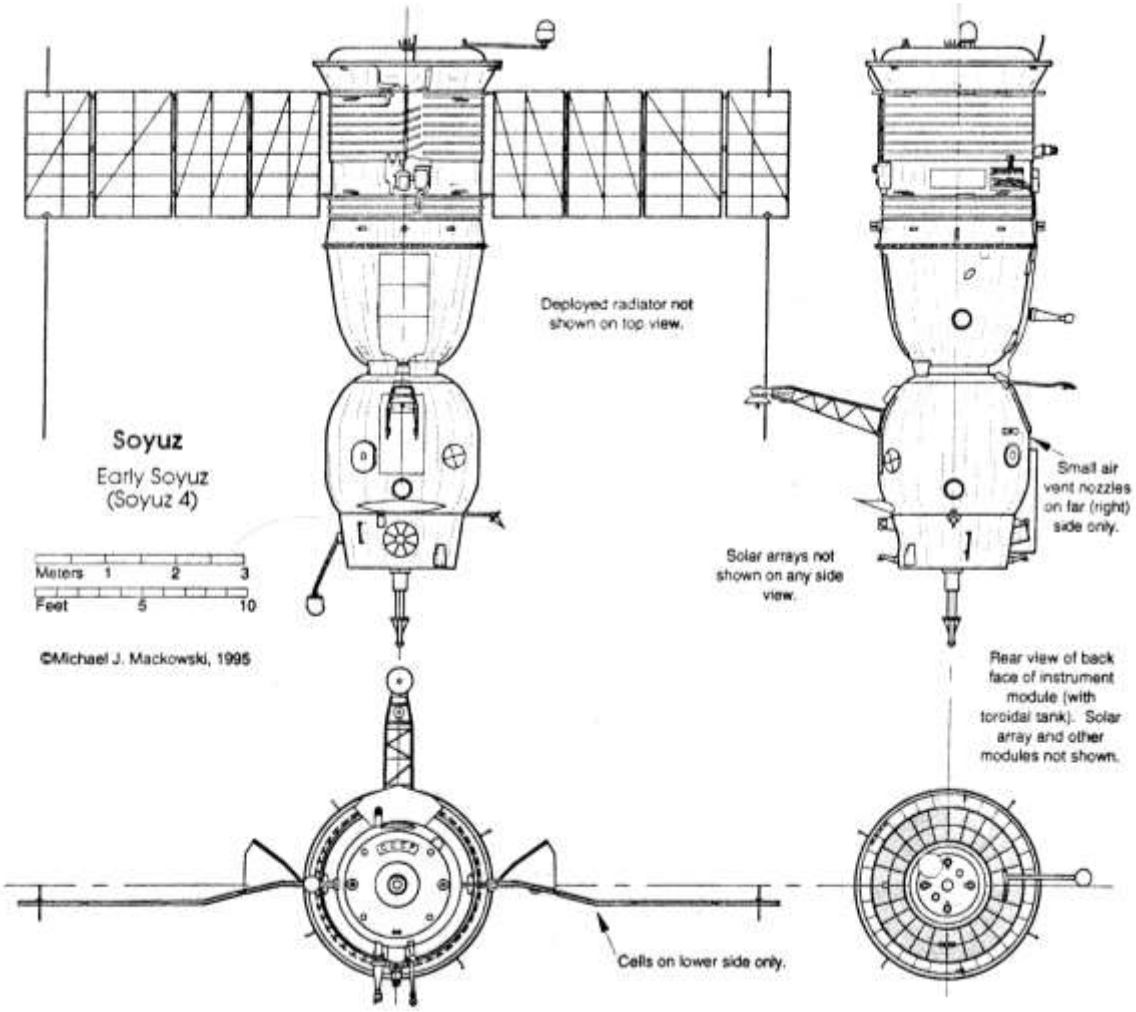

Figure 1, Soyuz 4 Drawing (Michael J. Mackowski, used with permission)

My research showed that my choice of Soyuz 4 as the subject of the build meant I would have to make only minor changes to the kit to end up with a fairly accurate model. However, wading through what I was able to find turned up many inconsistencies on specific details between sources. In cases of conflicting information I'll explain the logic behind the modeling decisions I made during the build.

Initial Out-of-the-Box Impressions. My first impression on opening that much anticipated parcel after winning the auction 12 years ago was concern. Based on the oft-noted flimsy box the kit was packaged in, I was worried about the quality of the molding. A photo of the box art is at Figure 1. For reasons unknown, the box art depicts the ASTP Soyuz not a 7K-OK so don't use it as a reference.

A sealed bag contained two sprues of parts for the spacecraft, three loose parts for the display stand, as well as two separate clear parts (discussed later). A close inspection of the sprues quickly answered any questions on the quality of the parts. The kit was molded in a thick, slightly soft, styrene and the display stand in a slightly harder white styrene. There was very little flash, noticeable mold separation lines, or ejector pin marks that would require cleanup. Exceptions to this are noted where applicable. Figure 3 shows the parts.

Figure 2, Kit Box Art

Figure 3, Parts Sprues (Karl Dodenhoff)

The instructions came on a single Russian language two-sided sheet. Thankfully one side is an exploded diagram showing the placement of each numbered part. The other side has a diagram of the completed model and some numbered lists but I was unable to decipher their meaning. It is important to note that the order in which you assemble the parts is entirely up to you and the way some parts, specifically the solar arrays and display stand, are molded dictate when they should be used. I cover how I handled these cases in the applicable sections below. There is a scan of the instructions on Sven Knudson's modeling website at http://www.ninfinger.org/models/kitplans/ogonek4498.pdf.

Orbital Module (OM) Subassembly. Building up a subassembly of the main OM was very straight forward and didn't require any real decisions other than how much additional detail to include. It consisted of simply joining together the two halves of the main body in preparation for application of the thermal blankets. Next, I applied the thermal blankets to the main body of the OM and the docking adapter frustum separately. I then joined these two pieces once the blankets were in place. I describe the technique I used to model the thermal blankets in a separate section below.

I primed the various bits of surface detail showing through the blankets and the access hatch and filled the small gaps in the thermal blankets between the main OM and docking adapter frustum with Mr. Surfacer 1200 to make that seam less noticeable. Once ready to paint, I sprayed the appropriate colors over the various exposed details and hatch and brush painted the window frames, smaller exposed details, and the thermal blankets. My decision to brush paint the thermal blanket was a good one since it took a concerted effort to ensure coverage in, around, and under the wrinkles. It seemed that each time I looked at the OM I'd notice a little unpainted white area tucked under a wrinkle. I don't believe I could have reached into all those little nooks and crannies with my airbrush.

The docking adapter received the most detailing. The kit part doesn't include the concave depression present on the top of the adapter to provide clearance for the Igla antenna dish when it was folded for launch. I debated on how to add this feature and after a search of my spares turned up unused high gain antenna dishes from a 1/32 CSM, I decided to use one of them. The dish had to be cut to size and the appropriate sized hole cut into the kit part. Figure 4 shows the antenna marked to the correct size. The detail on the part made it easy to keep the part circular and once it was reduced to the correct diameter, the detail was sanded smooth and it was glued into place. The end result may not be deep enough but it at least shows the feature.

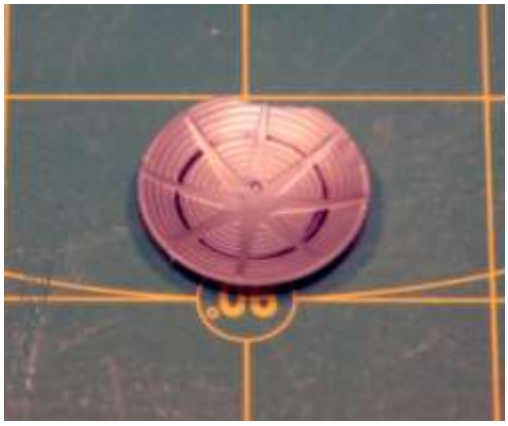

Figure 4, 1/32 CSM High Gain Antenna Marked for Modification.

Compared to the references I was able to find showing the face of the docking adapter, the kit part also lacked detail and the molded-in "CCCP" was too large and in the wrong location. After sanding the lettering smooth, I worked to add the missing surface details around the face of the adapter using reference photos from the Starbase 1 website; screen captures from the YouTube videos of the docking, and the SIM #4 drawings of Soyuz 4.

I cut appropriate bits of styrene tube and square rod to match the details seen and glued these in place. The holes in the tubes were filled with putty and sanded smooth. I also added 16 thin strips radiating out from the base of the probe to match the ribs visible under the thermal blankets and then covered the face of the adapter with foil. Based on a photo on the Encyclopedia Astronautica website and the New Ware part, it was obvious the base of the probe was not round but had flat faces so I sanded the kit part to match. A photo on the Russian Space Web site shows what I believe is part of the capture mechanism on the docking probe, a part depicting this is also included in the New Ware kit. I etched a custom PE part based on the New Ware kit's brass. The New Ware part appears to be oversize based on the photo but I just scaled it up to 1/30 without any changes (this way when I build the New Ware kit it will be consistent with the Ogonek). Attaching this piece necessitated cutting the kit part to graft in the PE. Once the PE was in place, I reattached the top section of the probe and filled the seam with Mr. Surfacer 1200.

At first, I foiled the face of the adapter with the dull side of kitchen aluminum foil to match the color call outs from the New Ware instructions and the appearance in some photos. However after doing so and then referring to the RussainSpaceWeb site for another question, I noticed a small photo in the right margin that clearly showed the face to be covered in green blankets not silver foil. This seemed more reasonable to me since the Russians seem to use so little foil insulation and I dug a little deeper. Going back to the YouTube video, I studied it more closely to see if I could discern the color of the adapter face. I grabbed two new screenshots, one while Soyuz 4 was approaching and one after undocking. I've included these in Figure 5 below.

The approach shot is on the left and the departure shot is on the right. Comparing the two, I believe you can make the argument from the approach view that the face is green as the lighting is uniform and its color matches what is visible of the rest of the blankets. In the departure shot it appears more silver but I believe this to be due to the angle of the lighting and the exposure rather than a reflection of the actual color. Based on this, I decided to go with blankets instead of foil so I added a layer of tissue over the foil and painted it the same color as the rest of the blankets.

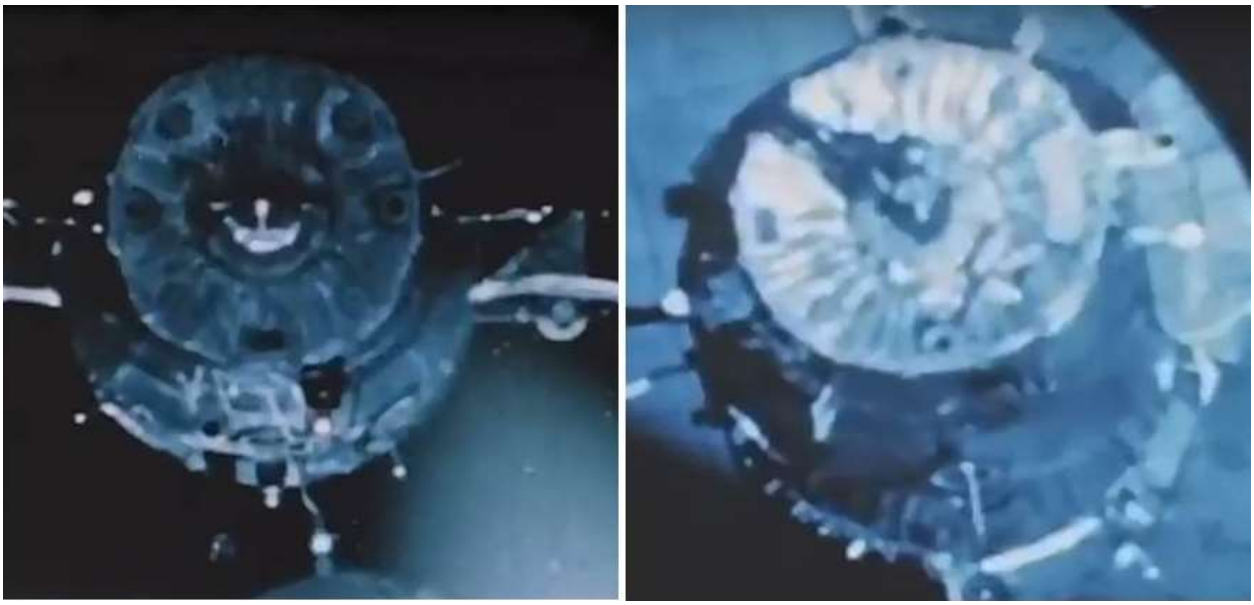

Figure 5, Soyuz 4 Docking Movie Screenshots

The kit provides parts to represent the TV camera mounted on the top and the movie camera mounted on the bottom of the OM. I added "lenses" to these cameras by first drill out about a 1/8 inch hole on the front of the parts with a pin vise, cutting and shaping a bit of clear sprue to fit into these holes, polishing them up, and then adding a little Tamiya clear yellow to them once they were in place to simulate a lens coating. The position of the TV camera on the top of the adapter was moved to its proper place to the right of the centerline. Figure 6 shows one of these cameras with the hole drilled along with the final result.

Figure 6, Adding Camera Lenses

The last remaining details were the missing EVA handrails and the CCCP lettering. For the handrails, a search through my spare parts turned up some railings that could be modified for use. These were attached on either side of the docking adapter. I printed my own decal of the CCCP lettering, applied it to a thin sheet of styrene cut to shape, and glued it in place finishing my detailing of the adapter.

Next, I turned my attention to adding the remaining kit parts and detailing the OM using styrene, parts from my spares bin, and some more custom PE. This is one area I found the kit's instructions lacking since the exploded diagram didn't clearly show where some of these parts attach and not all of them have mounting holes in the body of the OM. In these cases, I used the drawings in Figure 1 from Mike Mackowski's SIM #4 and the artist's depictions on the RussianSpaceWeb site.

The kit part for the docking light has what appear to be the lenses for two lights. Watching the video of the docking, only one flashing light can be seen in the location of the larger of the two of these kit lenses and it appears to be a white light. This light received a similar treatment as the camera lenses but instead of drilling a hole to receive the clear piece, the kit's lens was sanded off. Once again I formed a lens from clear sprue that I polished and coated with future. This time, the back of the new lens was painted chrome silver prior to attaching it. I took a little artistic license with the second light assuming it to be some type of navigation light and coating the kit part with Tamiya clear red.

An oddity about the kit is the fact that while there are two very nicely molded large clear parts intended to provide visibility into the descent module (DM), no clear parts are provided for the porthole windows on the OM (or DM). To remedy this, I used a sheet of clear plastic from some old packaging. I had hoped that I would be able to use my 3-hole paper punch to punch the windows out of the plastic sheet but they were too small to be used. I ended up measuring the opening with a micrometer, drawing a circle of the proper diameter on sheet styrene using a compass, and cutting this circle out to use as a template. After tracing the template on the clear plastic, I cut the windows out by hand. This resulted in less than perfect, slightly oversized, circles so I had to do some sanding to end up with the exact shape and size needed for each window. Once I had the correct size and shape, I fit each window in place.

The Igla rendezvous system components on the OM also received detailing. As visible on the SIM drawing, RussianSpaceWeb website, and the New Ware Kit, there were features to prevent RF interference, a screen just forward of the top window and "interference prevention netting" also on the top side not present on the kit. I custom etched some PE for the screen, painted it, and attached it in place. Next came the "interference prevention netting."

In my first attempt to model this, I cut thin sheet styrene to the proper shape of the netting, painted it a dark tan, applied spray adhesive to the sheet, and then covered it with fabric cut from a pair of my wife's old nylons. This looked great until I tried to glue it into place on the OM.

Due to the OM's curved shape, I couldn't get the sheet to lie smoothly. I settled for a "Plan B" option. Since area covered by the netting appears to have been smooth, and I'd already applied the wrinkled thermal blankets, I masked off the appropriate shape and brushed on a number of layers of Mr. Surfacer to smooth it back out. After a number of coats with sandings in between, I deemed it smooth enough and painted it a dark tan.

The Igla rendezvous antenna also received some detailing. To better match the drawing and photos, I drilled some holes in the side faces of the upper portion of the antenna boom and opened up the rear face leaving a single strut across the middle. I also photo etched a replacement for the kit's antenna dish with a more delicate PE dish. According to the color callouts in the New Ware instructions, the antenna strut should be painted white. However, based on the in-flight movie of the rendezvous it appeared darker and I painted it an aluminum color based on this. A screenshot from the video of the rendezvous showing this is in the top right hand picture at Figure 20 in the section covering the solar arrays.

After attachment of the various remaining kit parts, the OM was complete and ready for integration with the other two modules. Figure 7 shows two views of the completed OM subassembly.

Figure 7, Completed OM Subassembly

Descent Module (DM) Subassembly. Building the DM is the first point where I had to make assembly decisions. One of these was whether or not to include the couches, cosmonaut figures, and control panel. The panel doesn't match the examples I found in my research, nor are several smaller side panels included. Also, the kit only includes two couches and cosmonaut figures. While the Soyuz 6, 8, and 9 7K-OK missions carried a two person crew, I didn't find any reference as to the number of couches actually installed. The remaining early Soyuz missions carried a three man crew with the exception of the Soyuz 1 (solo cosmonaut) and Soyuz 4 and 5 (Soyuz 4 launched with a single cosmonaut and landed with three after the docking and crew transfer with Soyuz 5 which launched with three and landed with one). Additionally, the fact that the two figures are depicted in pressure suits is incorrect. In order for three cosmonauts to fit into the DM of the 7K-OK and 7K-OKS variants, they were unable to wear pressure suits. Launch footage of the two-man Soyuz 6, 8, and 9 missions show these crews entering the spacecraft unsuited as well.

Another related decision is whether or not you intend to model the thermal blankets. If you do decide to include the interior, you may not want to model the blankets since the only way to have a decent view inside is to keep the two large clear pieces provided uncovered.

Even though the parts were incorrect for my chosen subject of Soyuz 4, I decided to include the interior the keep the center of balance roughly the same and since with blankets, you are unable to see the couches or cosmonauts and only the edge of the control panel is visible.

The next decision I made was to make how to display the finished model. The way the display stand attachment points are molded, the stand must be fit into the DM before the bottom heatshield section is attached. This method provides a very secure attachment between the stand and the model and I chose it because of this. The fact that the DM would be covered in thermal blankets aided this decision since I wouldn't have to try and finish the bare styrene and worry about a clean join where the stand attached. Some modifications to the kit parts are necessary if you decide to complete assembly of the spacecraft before attaching it to the stand, these are discussed in the section on the display stand below.

I wanted to modify the DM slightly to alter the display. As molded, the model is displayed as if the Soyuz were flying "wings" level and pitched slightly nose high. As will be seen in the section on the solar arrays, the cells are on the bottom of the arrays and would be hard to see if displayed with the arrays level. I thought I'd roll the Soyuz 45 degrees to make the bottom of one of the arrays more visible. Having decided this, I joined the 2 halves of the DM together and glued the painted over clear pieces in place. I then marked the DM along the lines where the seams of the thermal blankets would run as well as the areas I'd need to cut out to complete my 45 degree roll. Figure 8 shows the unmodified DM with one of the two slots I'd cut out to achieve this roll as well as the locator markings for sections of thermal blanket. The figure also shows the DM dry fitted to the stand to check it was modified correctly

Figure 8, DM Marked for Modification and Dry Fit Test

During the dry fit test, I realized that I hadn't taken the location of the umbilical running from the service module (SM) into account and an arm of the stand would now block installation of that umbilical. Still wanting to roll the Soyuz for display, I taped the DM and SM with the arrays in place together to explore my options. I discovered that if I rolled the model far enough in either direction to clear the umbilical, the end of the low array would hit the ground. I could display model inverted and while I realize that in space up is a relative term I decided to just display it as it came out of the box. Should I decide at some later date to build a custom stand, the thermal blankets will allow me to cut the model from the kit display and easily patch over the old attachment points.

I then began putting on the thermal blankets using a similar technique to that used on the OM. I did this before I attached the heatshield and left enough excess at the bottom to wrap down onto the heatshield after it was installed. Placing the already painted display stand attachment into the slots, I applied a generous amount of cement to the joint at the inside braces then locked it in place by attaching the heatshield and finished wrapping the thermal blankets onto it.

The DM received very little additional detailing compared to the OM. The two windows were glazed in the same manner as the OM. This left only the periscope. The kit part is poorly proportioned. I scratch built a replacement from Evergreen styrene and a bit of clear sprue. I used three tubes of decreasing diameter nested within each other, filled the steps between them with Milliput, and sanded them to the final tapered shape. The head of the periscope was formed from a piece of square rod with a piece of clear sprue squared off to fit into its open center. Before being inserted into the hole, I blacked out the sides and rear of the clear piece using a Sharpie then polished the face and coated it with Future after gluing it in place. Figure 9 is a comparison between the kit part and its partially completed replacement.

Figure 9, Comparison of Kit and Scratch Built Periscope

The DM was brush painted the same as the OM and set aside until I returned to add the "interference prevention netting." Once again, my original idea of fabric covered thin styrene sheet was scrapped in favor of smoothing to appropriate are with Mr Surfacer and painting it. Figure 10 shows some rotated views of the completed DM.

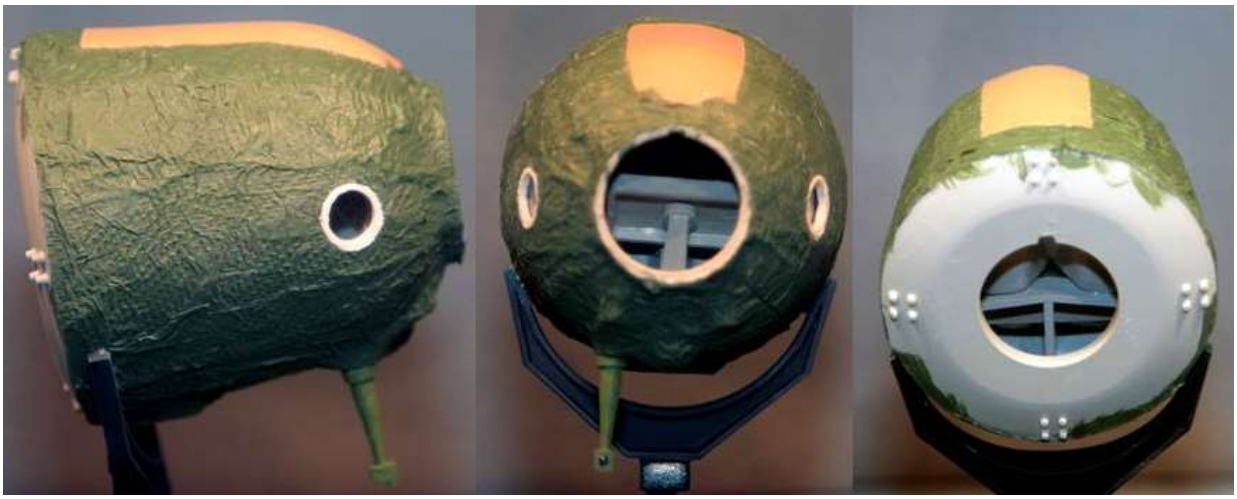

Figure 10, Completed DM Subassembly

Service Module (SM) Subassembly This is another area where the way kit parts are molded dictate the assembly sequence. As molded, the solar arrays must be sandwiched between the two main halves of the SM cylinder when you assemble them. Their attachment tabs are "T" shaped with the top arms of the "T" going inside the SM. Therefore the arrays can't be inserted in the slots after the halves have been joined without modification. The position of the arrays would make it very difficult to clean up the seams through the radiator section of the SM so I chose to modify them by sanding the arms of the "T's" flush to the rest of the tab to allow their installation after the radiators had been painted.

The method of attachment for the un-modified arrays makes for a very strong assembly. I wanted to ensure they'd fit securely after I modified the array. I did this by adding a length of square styrene rod on the inside of the SM flush with the opening of the attachment slots. I placed these supports as closely as I could to the opening of the slot to ensure a snug fit of the arrays once attached. One of these supports can be seen circled in red in Figure 11, the kit supports on the right and the added bit of styrene to the left. This ended up giving me a fairly large surface area to glue the attachment tab on the array to the SM body.

Figure 11, Solar Array Attachment Supports

The kit includes parts for six maneuvering thrusters, three each of which are mounted on the top and bottom of the SM. As molded, these parts are just solid cylinders. Given the scale, I found this unacceptable and carefully drilled these thrusters out prior to gluing them in place.

After several rounds of applying Mr. Surfacer 1200 to the seam, sanding, priming, and checking the results, the main body of the SM was ready for finish painting. I chose to spray the entire cylinder with Testor's semi-gloss white. After this had dried, I applied and painted the thermal blankets on the main body of the SM, the forward ring of antennae, and the aft skirt.

Buildup of the SM also offers the opportunity to do some detailing, mainly on the solar arrays. The arrays ended up consuming a majority of my time and I describe this work in a separate section below.

One of the photos on the Starbase 1 website provided an excellent reference to detail the aft end of the SM. I opened up the nozzles of the main engine and maneuvering thrusters on the kit part then added some thick sheet styrene on the inside of this part to give me some material into which I could drill. Then it was just a matter of drilling, scrapping, and filing out plastic until I

achieved the desired nozzle shapes. Mr. Surfacer 1200 came in handy to smooth these nozzles out. One last bit of detail to correct was the missing indentation near the thrusters and main engine. Although there are some lines of the molded into the part to correctly represent the size and shape of this area, it isn't recessed as it should be. I carefully removed some of the plastic from this area with my Dremel and then slowly scrapped, filed, and sanded away the remaining plastic until I achieved the desired shape. One again, Mr. Surfacer did a great job of filling the imperfections.

All that remained at this point was to insert the solar arrays and join the forward ring of antennas, the main SM body, and the aft skirt.

Figure 12 shows some views of the completed SM.

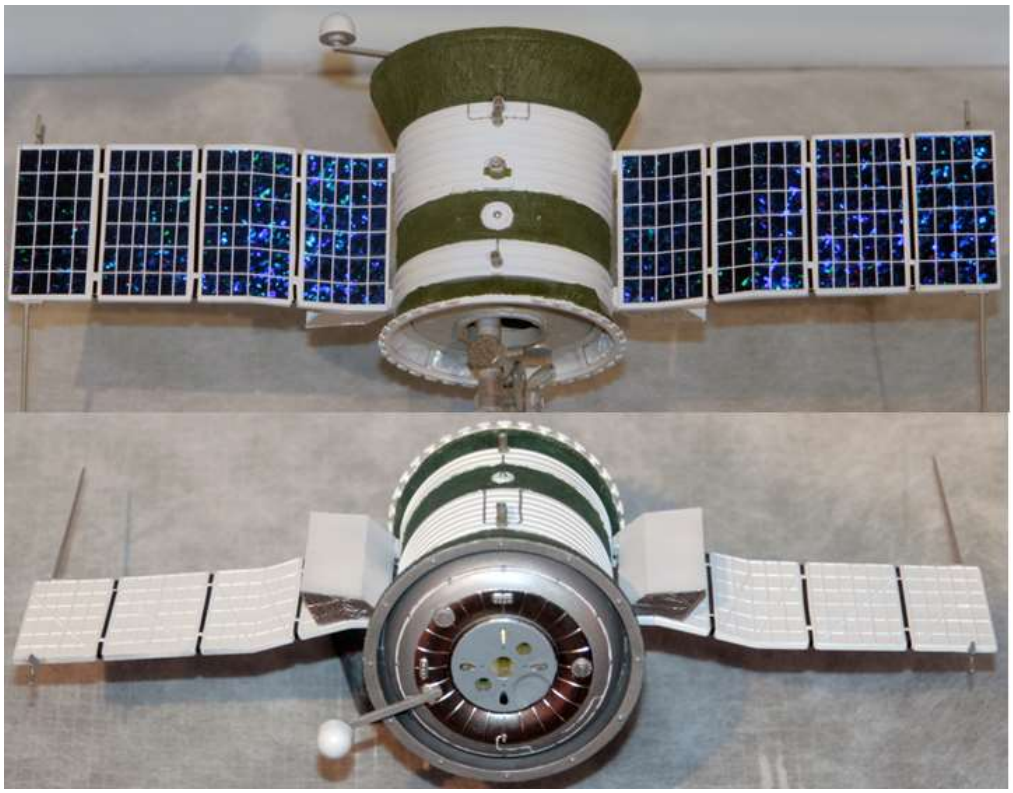

Figure 12, Completed SM Subassembly

Modeling the Thermal Blankets I'm always looking for different ways to model things like solar cells, thermal blankets, etc. It seems that the go-to thermal blanket technique for most real space modelers is to cover the necessary areas with foil to provide a wrinkled surface. While this can yield impressive results, I've never been totally pleased with the texture; it's never really looked enough like a fabric to me. Having read about a build where the modeler used tissue coated with thinned out Elmer's glue to model canvas, I thought I try and see if a similar approach would work for the thermal blankets. Instead of tissue, I thought I'd used a more

durable paper towel. This paper had a slight diamond pattern embossed on it but this pattern seemed to become less noticeable when the towel was wetted. This turned out not to be the case on my model and had to be toned down with limited success later.

In all the reference photos I've seen, the blankets appear to be made up of eight sections and I wanted to capture the appearance of the visible seams. However, to make things a little less complicated, I decided to go with four sections.

I started on the OM but used the same process for all the modules with one exception. First I marked the seam locations on all the modules doing my best to ensure that they'd all line up after everything was put together. Then I traced out the necessary shape to cover that area on the towel and cut out the individual sections. Working one section at a time, I applied Microscale foil adhesive to the marked quadrant making sure not to apply any to areas that weren't getting covered, e.g., window frames. Once the adhesive was tacky, I laid the towel on and tried to add in a few wrinkles as I went. The left-most photo in Figure 13 shows the OM with 3 quadrants covered in this fashion. This photo also shows how the diamond pattern became prominent and that the surface details such as the two bands around the center of the OM stand out through the paper. In hindsight, it would have been easy to sand these minor details smooth before applying the paper to prevent this.

The end result left me indifferent. As mentioned above, the diamond pattern had to be toned down as much as possible and by conforming as closely to the surface of the OM as it was, the paper didn't seem to look as "padded" as the blankets appear in the photos. To correct this, I decided to go ahead and use tissue after all applying it over the paper already on the model.

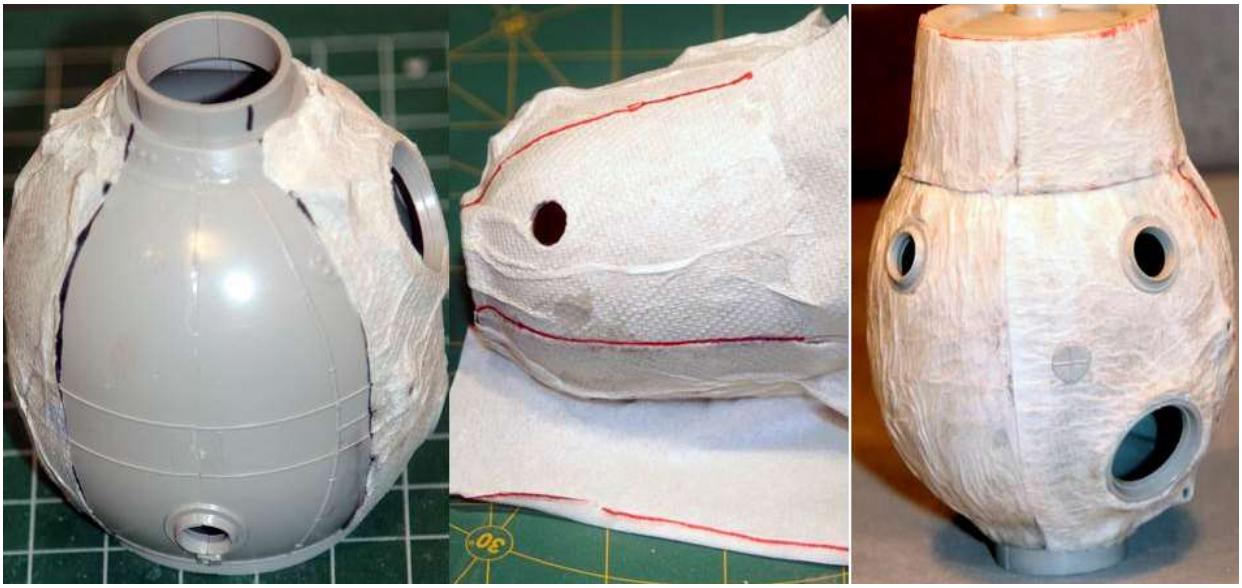

Figure 13, Installation Process for the Thermal Blankets

I followed the same process of tracing out the necessary shapes on the tissue but I made them slightly oversized to allow me to fold the edges over in at what would become the seams. The center photo in Figure 13 shows this on the DM. This time around I used watered down Elmer's to attach the tissue. I brushed it onto the paper already on the model at first just along a seam line. I then placed a section of tissue aligning the folded edge along that line. Once this was in place, I brushed glue over the rest of the quadrant being covered and carefully placed the other folded edge along the line of the adjacent seam leaving excess tissue in the middle. This tissue was gently pressed into place adding wrinkles as I went. Once I'd placed the tissue how I wanted it, I brushed more watered down glue over the entire surface to set it in place. This process was repeated for the remaining quadrants. The final result for the OM is seen in the last photo in Figure 13.

I chose the Vallejo acrylic color "Gunship Green" for the blankets by comparing a picture of the ASTP Soyuz (Figure 14) directly against the Vallejo color chart on my computer. I reasoned a NASA photograph would be best to use since the color balance of the Russian photographs from that period can be iffy. This color is a little less green than is typically chosen by modelers but to my eye, and on my screen, it was a close match although perhaps a little dark. The Vallejo color chart can be found at:
http://cdn.acrylicosvallejo.com/2d567ed91fb58cdc74108685395ac19a/CC070-Rev14.pdf

Figure 14, ASTP Soyuz 19 (NASA)

After painting the OM, the end result didn't quite match up with what I'd expected based on the color chart, perhaps the fact I was painting paper rather than styrene made a difference. However, the end result was close enough but when I get around to building the New Ware kit, I may choose a slightly different shade.

Accurizing the Solar Arrays The solar arrays, although nicely molded, require the most work to correct inaccuracies. The first thing you notice is that there is finely molded detail to represent individual cells on both sides of the array. This is incorrect as the flight arrays on the 7K-OK only had cells on the underside, the top had structural braces. Also, as mentioned in the SM section, the way the arrays are molded with a T-shaped tab means you have to install them when you join the two halves of the SM unless you modify them. I cut the arms of the "T" off of each tab allowing me to finish both the SM and the arrays before joining them

Liking the detail of the molded cells, I figured that I'd finish the undersides with a painting technique I've used before. This consists of applying multiple layers of clear blue over chrome and finishing with a top coat of Alclad Sapphire Prismatic. However, one of the few places where ejector pin marks are present is in an area that would visible and so they would need filling but would still stand out from the molded detail. Figure 15 is a photo of the bottom side of the unmodified kit part with the individual cell detail, antenna attachment points, and ejector pin marks clearly visible. The topside of the array looks the same minus the antenna attachment points and ejector pin marks. I thought long and hard about how I could lose the six pin marks and restore the detail posing the questions to the Yahoo Space Modelers group as well. I received several good suggestions and a generous offer of unused arrays from a member's spares to use as "cell donors" but ended up deciding to go with another previously used technique that would allow me to sand all the detail from the kit part.

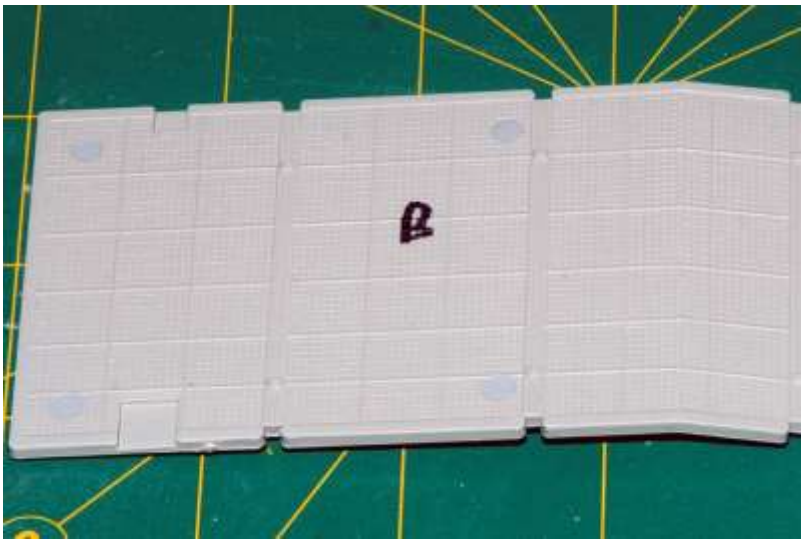

Figure 15, Unmodified Solar Arrays

On my previous build of a 1/96 ASTP, I applied a blue prismatic contact paper I found at Michael's to represent the solar cells. This yielded an acceptable appearance at 1/96 and the size of the individual reflective "flakes" means that the larger the scale of the model, the more realistic the effect making it better suited for a 1/30 model. Also, the hints of green that flash at certain angles aren't present in real cells. Despite these shortcomings, I believe using this paper yields an impressive result.

My original thinking was to sand the fine individual cell detail in between the thicker raised lines on the part smooth, finish paint the array white, and then cut and place individual pieces of the paper to fit in between the thicker lines. I reasoned this would allow me to keep the white lines between groups of cells. However, after removing the detail from a couple of sections I realized that preparing the 144 individual sections and cutting the same number of approximately 9x8 mm squares would be a very time consuming process introducing a lot of opportunities to mess up. In the end, I decided to sand all the detail smooth, cut and place a single large rectangle of the paper on each panel, and devise some other method of adding the white lines between groups of cells. To minimize the amount of handling I would be doing after finishing the cells, I turned my attention to the topside of the arrays leaving the cells until end of my work on the arrays.

The first order of business was to determine the pattern of the bracing struts on the topside and I soon discovered that there is no single definitive reference. The one consistency is that all the references I could find showed five struts running from inboard to outboard one each array. The remaining details, while similar, differed from source to source.

The SIM #4 drawing shows a single diagonal strut on each of the two outboard panels and two diagonal struts on each of the inboard panels. The drawing on the Encyclopedia Astronautica website depicts only a single diagonal strut on the inboard most panel but matches the SIM #4 drawing for the remaining panels. Photos of a museum display on the Starbase 1 website show this inner most panel to have the two diagonal struts but the orientation of the strut closest to the spacecraft is slightly different than the SIM #4 drawing. The layout of the struts on the PE in the New Ware kit offer yet another configuration option omitting the diagonal on the outer most panel and including only 1 diagonal on the inboard panel as in the Encyclopedia Astronautica drawing. I decided to go with the configuration in the SIM #4 drawing with the inner most panel slightly modified to more closely agree with the museum display photo.

A closer look at the SIM drawing also showed that the last panel on either side was a little shorter than the other 3 while all 4 panels on the kit part are of equal length. This was consistent across sources. My research indicated that the arrays spanned 32.2 feet (9.8 m). This would equate to 12.88 inches (32.7 cm) at 1/30 scale. Figure 16 shows the actual span on the model is 13.25 inches (33.65 cm) meaning model is .37 inches (9.4 mm) oversize. By cutting a 4.7 mm slice out of the last panel on each array, I'd correct the minor inaccuracy in span and more accurately reflect size of the panels relative to each other.

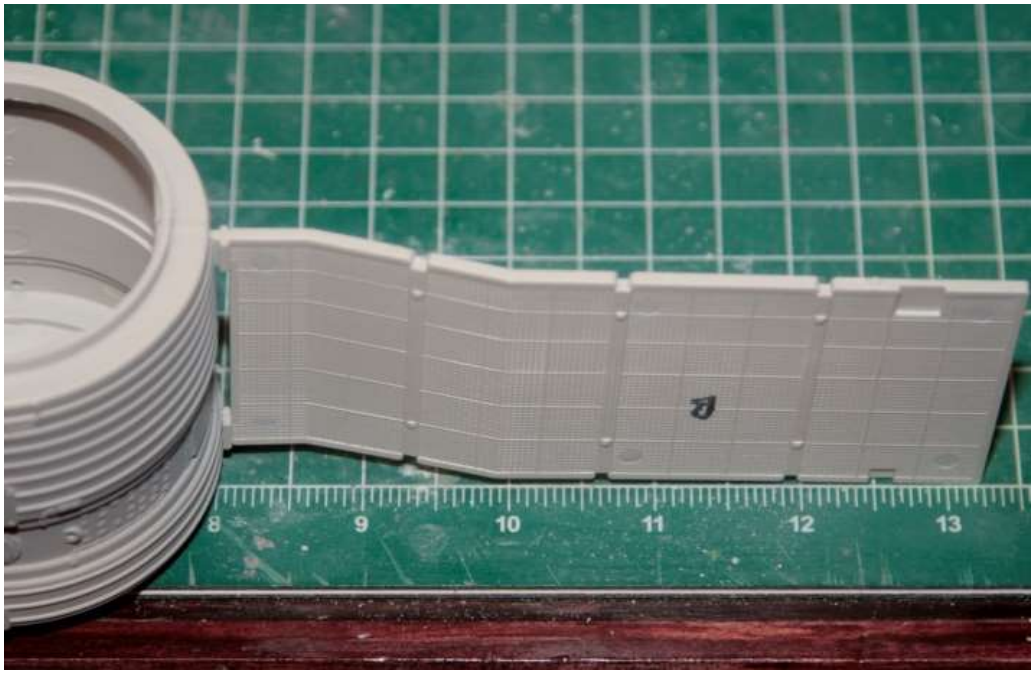

Figure 16, Measuring Length of Unmodified Arrays

As can be seen in Figure 15, there are two recessed areas on the last panel where the antenna parts are attached. The smaller of the two measures almost exactly the 4.7 mm needing removal. I decided this would be a good area from which to remove my slice using the recess to help ensure I marked parallel lines. Once the cut was made and the panel spliced back together, I needed to fill that seam and finish sand the surface of all the panels prior to applying the bracing struts. I also had to consider the eventual attachment of the antennas now that I had removed the recessed area. Instead of trying to recreate the recesses and attaching them as is, I removed the tab from the antennas before attaching them to the finished array with CA glue.

I debated long and hard between different ways to add the bracing struts. The best I could determine from the reference photos, there was a network of what I'll call main struts which extended an equal height above the surface and a second network of thinner struts that didn't extend as high.

One of the options I considered was to use styrene strips. This offered the advantages of being fairly inexpensive and easy to apply. However, since they would necessarily be very thin and flexible, I'd have to pay close attention keeping them properly aligned. The way the struts interconnect meant I'd have to cut a lot of small lengths and attach them between the longer runs, a time consuming process. Also there would inevitably end up being small gaps at some of these intersections that would require filling.

The second option I considered was using photo etch brass. The advantage here was that I could

generate the artwork for each panel as a whole, there would be no gaps between intersecting struts to fill. This advantage was offset by numerous disadvantages, most significantly cost. Although I have the Micro Mark PE kit and could do the etching myself, the brass, photo resist, and chemicals aren't cheap. This was magnified by the fact that a single sheet of brass wouldn't give me the amount of vertical relief I wanted. A sandwich of two sheets would work but it would mean etching 16 individual panels. Not only would this be a time consuming process it would increase the cost and mean a lot of futzing around with noxious and caustic chemicals.

I chose to go the styrene strip route figuring that if I wasn't happy with how it turned out I could remove what I'd put on, finish sand the panels once again, and try the PE option.

For consistent reference I'll refer to braces running along the length of the panel as horizontal braces and those running the width of the panels as vertical braces. After penciling in the proper location of all the braces, I started out by cutting Evergreen 0.015 x 0.030 (0.38 x 0.76 mm) strips to length to define the outside edges of each panel. Then using the same size strip, I added the vertical brace inside of the panels followed by the diagonals. Switching to 0.010 x 0.020 (0.25 x 0.51 mm) strip, added the five horizontal braces to each cell.

As can be seen in the references, there are a number of thinner braces running both horizontally and vertically and I debated on whether or not to add them as well. One of the things I was concerned about was eliminating any of the slight glue marks left no matter how carefully I brushed the Ambroid Pro Weld glue. The space between the braces would be pretty small and difficult to sand smooth. Additionally, I'd be dealing with a lot of short, thin strips that I'd have to make sure all aligned. Eventually I gave into AMS and added these braces as well using 0.010 x 0.020 strips. Figure 17 compares the size of the stock part to a partially completed modified array with the thicker braces in place.

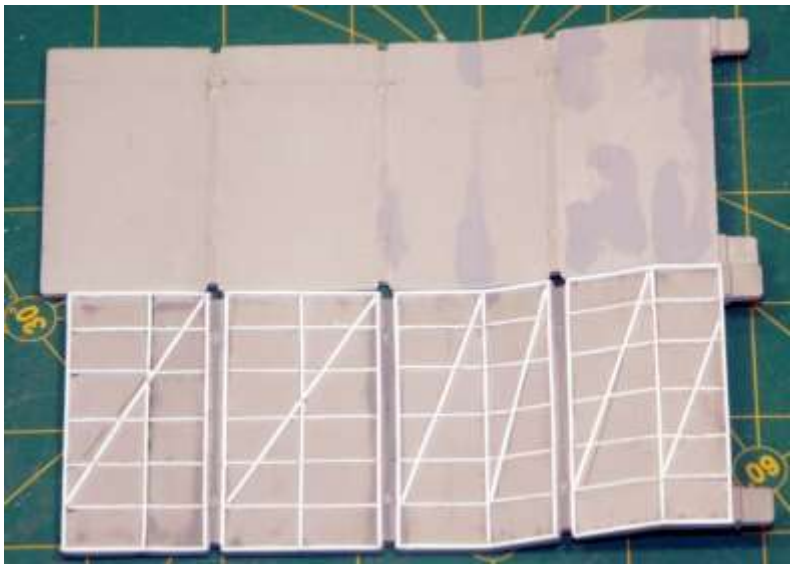

Figure 17, Comparison of the Stock and Partially Modified Topside of a Solar Array

Turning to the cells on the underside, I cut rectangles of the contact paper to the proper size and applied them to the array. This left only the addition of the white lines separating groups of cells. In his article in the IPMS Journal, Doug Jones described using Pactra Trim Tape on his build. However a visit to my local hobby shop and a web search for some of this white tape turned up empty, the trim tape has been discontinued. Then I thought automotive pinstripe tape could work and was able to track down an option that was priced reasonably enough that I went ahead and bought some to try. However, the thinnest I could find was 1.5 mm wide and this turned out to be too wide for my use.

While at my local shop, the owner suggested using white decal stripes. Microscale carries stripes of various widths down to 1/64th of an inch (0.4mm) so I ordered a couple of sheets of various widths. One last option I considered was to mask and paint the stripes thinking that the dark blue of the paper would show through the decal a little. I decided to do a test coupon to compare the results of painting and decaling. I also thought that the prismatic paper might be a little too light so I took advantage of the opportunity to coat some of it in Tamiya clear smoke to see how it would look if I darkened it up some. Figure 18 shows the resultant test coupon with the painted stripes on the left side, the decaled stipes on the right, and the right side of each half darkened with the Tamiya smoke. Although the edge of the carrier film was visible, the decaled stripes gave an obviously superior result and it was the method I chose. Although I preferred the appearance of the darkened paper, I decided not to apply the Tamiya smoke on the model since I was unable to obtain a smooth finish when I applied it by brush or airbrush. Spraying acrylics is an area I've got to improve on, I think it's a matter of getting the air pressure right.

Figure 18, Solar Cell Test Coupon

To model the solar cells, I cut and applied rectangles of the contact paper then applied the white decal stripes in the same pattern as the braces on the topside (with the exception of the diagonals). The last step was to add black decal stripes to the spaces between the panels. The final results are shown in Figure 19.

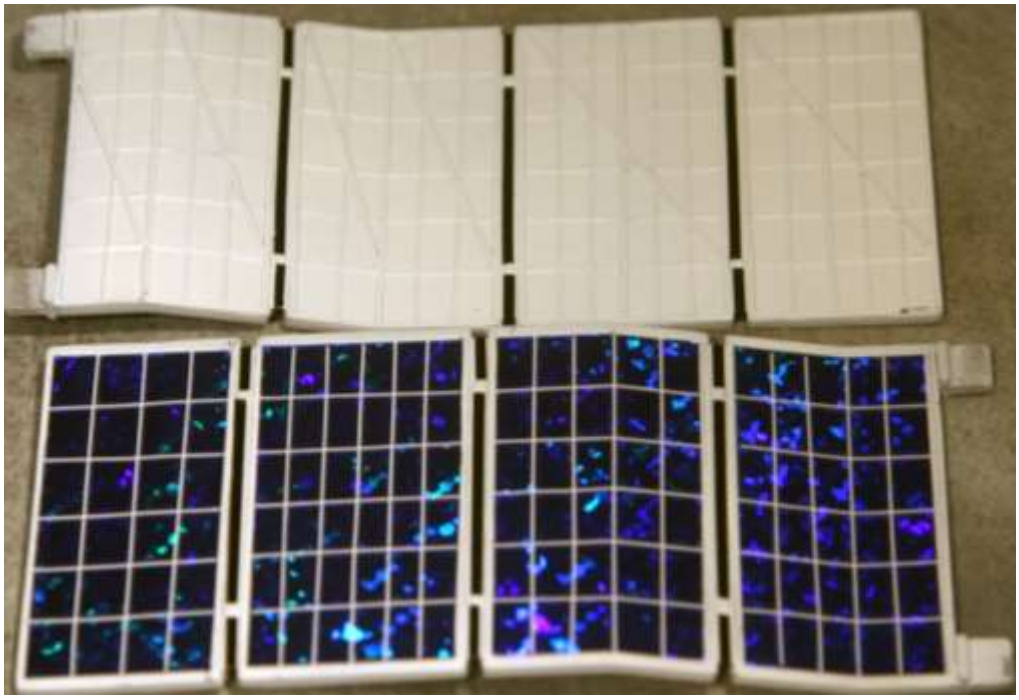

Figure 19, Completed Solar Arrays

One last item needed to be added to the arrays to complete them but I haven't been able to find any reference that describes exactly what they are. The SIM drawing describes them as radiators. I etched PE parts for these and then had to work out how to model the sides that extend down from these "flaps" to the panel below. Once again I couldn't find a definitive reference to show if these sides where present on both the fore and aft of the "flaps" or what material they may be. I've seen them modeled with gold foil but I wanted to see if I pin it down better myself.

A couple of artist depictions of a 7K-OK on the Russian Space Web site clearly show these sides present on the fore of the panel and they are shown as light gray or silver in color. With a little imagination you can infer from one of these that they are a foil material. Next I studied the YouTube video of the actual rendezvous again and grabbed a couple of screenshots which are at Figure 20. These again clearly show the sides present on the fore of the panels and that they are light gray or silver in color (although it's difficult to tell in the lighting conditions). Also I believe it is possible to make out a side on the aft of the panel as well from the screenshot on the right.

Also in Figure 20 is a NASA photograph of the aft end of the ASTP Soyuz. This clearly shows a side curtain on the aft of the radiator. The lighting conditions in this photo make it obvious that this side is silver in color and appears wrinkled. Although the arrays on the ASTP Soyuz are of a different configuration than on a 7K-OK, I figured it was a safe assumption to make that the "flaps" on Soyuz 4were made of a sliver foil given how slowly the Russians tend to evolve their spacecraft and the lack of definitive proof otherwise. I cut side curtains of the proper shape from thin sheet styrene, glued them to the radiator panels, and covered them with kitchen aluminum foil prior to attaching them to the finished arrays.

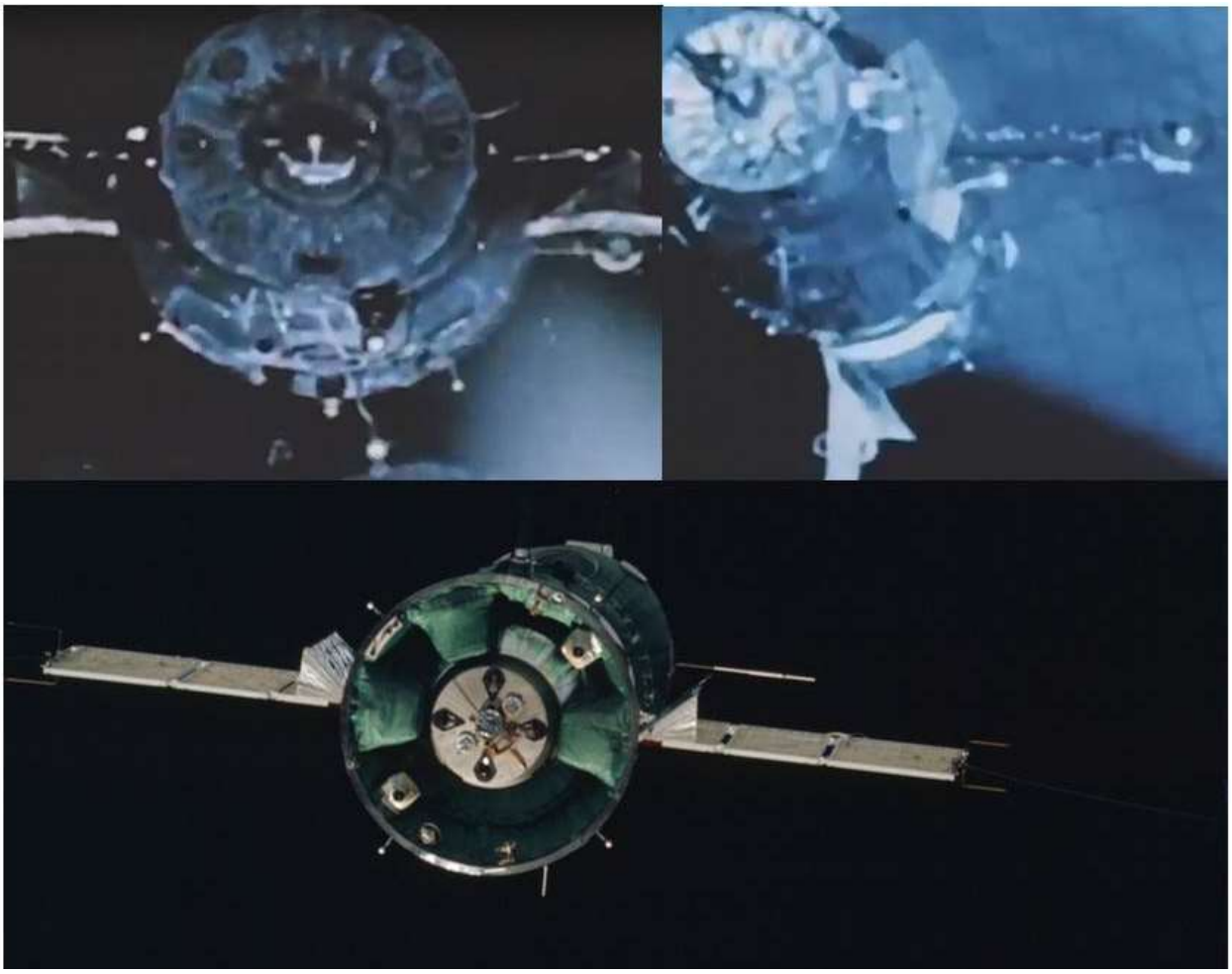

Figure 20, Screenshots of Soyuz 4 Arrays, NASA Photo of ASTP Soyuz

Display Stand Assembly and Finishing The parts of the display stand required the most clean up prior to assembly. It was apparent that on my copy the mold halves where slightly misaligned leaving a rather significant "step" along the mold separation on the two upright parts of the stand. There were a few sink marks on these two parts as well. These issues can be clearly seen in the photo of the parts at Figure 21. It took quite a bit of scrapping and sanding to smooth this prominent seam out as well as the application of some Milliput and Mr. Surfacer 1200 to clean

up the sink marks and gaps present when the two upright braces were joined and where they attached to the base. After a few rounds of filling, sanding, and priming, I finish painted the assembled parts

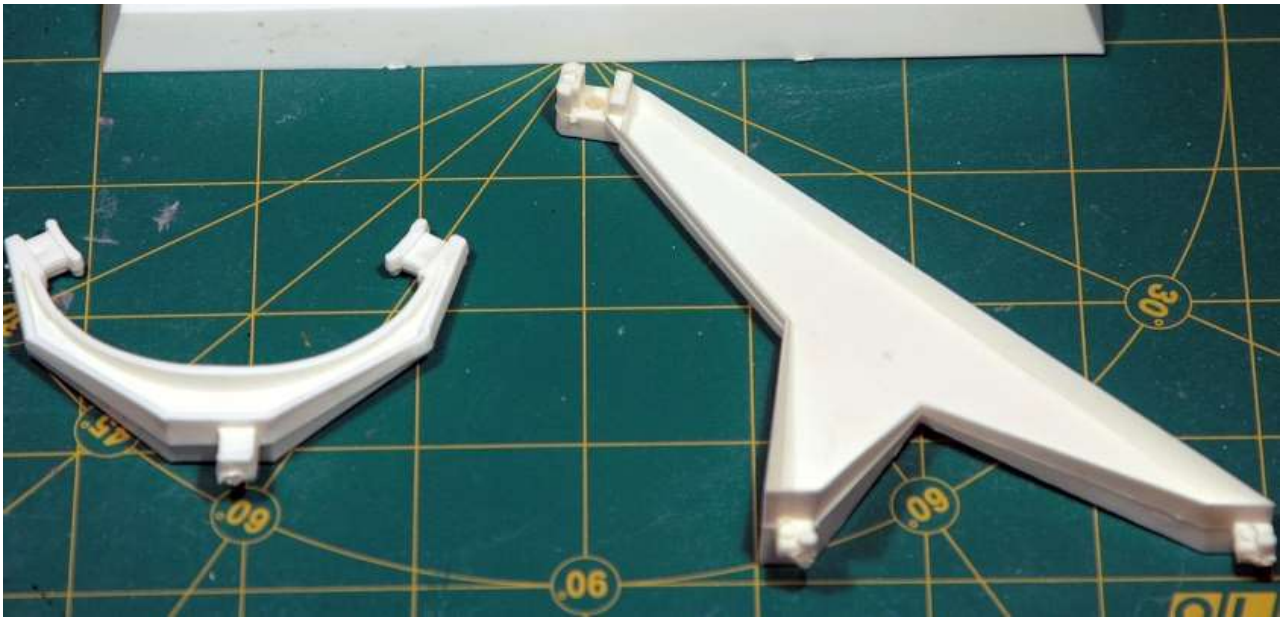

Figure 21, Display Stand Parts

As can be seen in the parts photo in Figure 2, the base of the stand has raised lettering. I'd considered dry brushing these but have never been very good at the technique so I decided to sand these off of the base and make a decal of the mission patch instead.

Of particular note on the "U" shaped brace in Figure 21 are the "T" shapes where the brace attaches to the DM. These fit inside the DM and provide for a very secure attachment once the heatshield is in place. If you chose to complete assembly of the model before attaching it to the stand, the arms of the "T's" must be removed to allow the tabs to slot in place. I wouldn't recommend this as I believe it may not prove strong enough. This led me to completing and attaching the stand as I was building up the DM subassembly

Final Assembly and Finishing Final assembly was very straight forward since the three individual modules where completed with the exception of the umbilical between the SM and OM. The addition of all the detailing to the SM added a fair amount of weight, especially in aft end. In addition, the thermal blankets added to the DM prevented the two from fitting together as snugly as the unmodified parts would. To ensure a strong bond between these two modules, I used a generous amount of 5-minute epoxy. Although the detailing added to the OM also increased its weight, the mating surfaces still came together well and this module was glued on using good old fashioned tube styrene cement.

Once the three modules where joined the last remaining task was to thread the umbilical between the two arms of the display stand and glue it into position. Figures 22-24 provide a number of views of the completed model

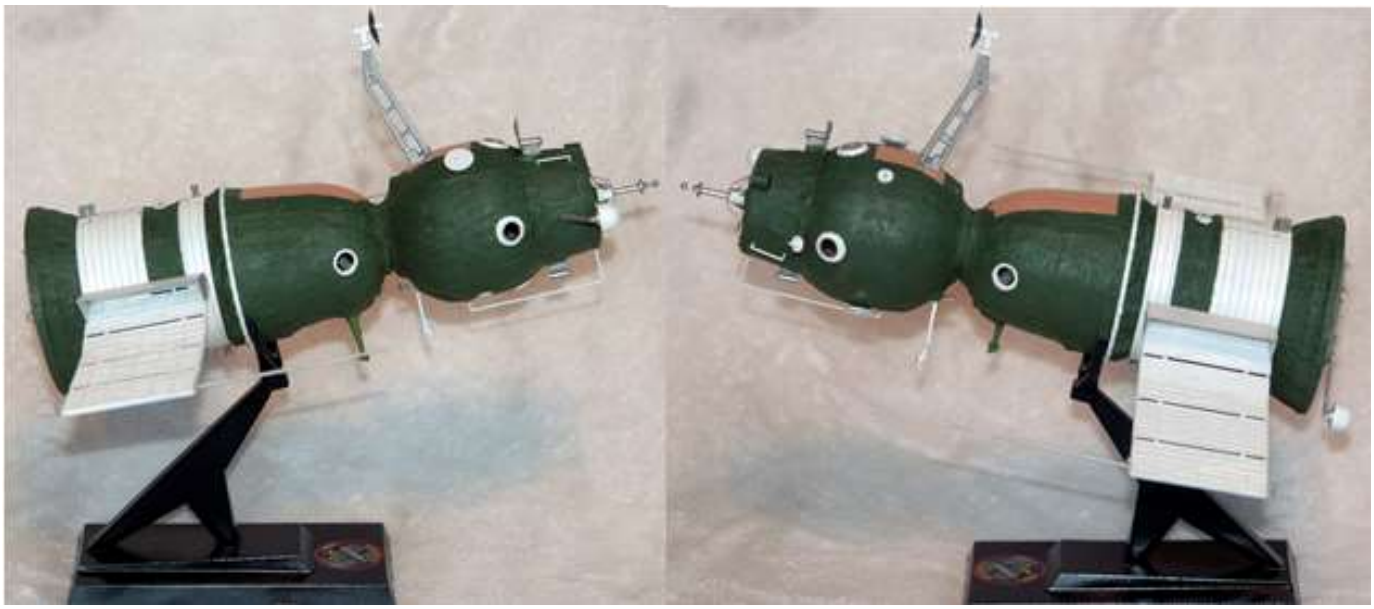

Figure 22, Completed Model, Port and Starboard Views

Figure 23, Completed Model, Fore and Aft Views

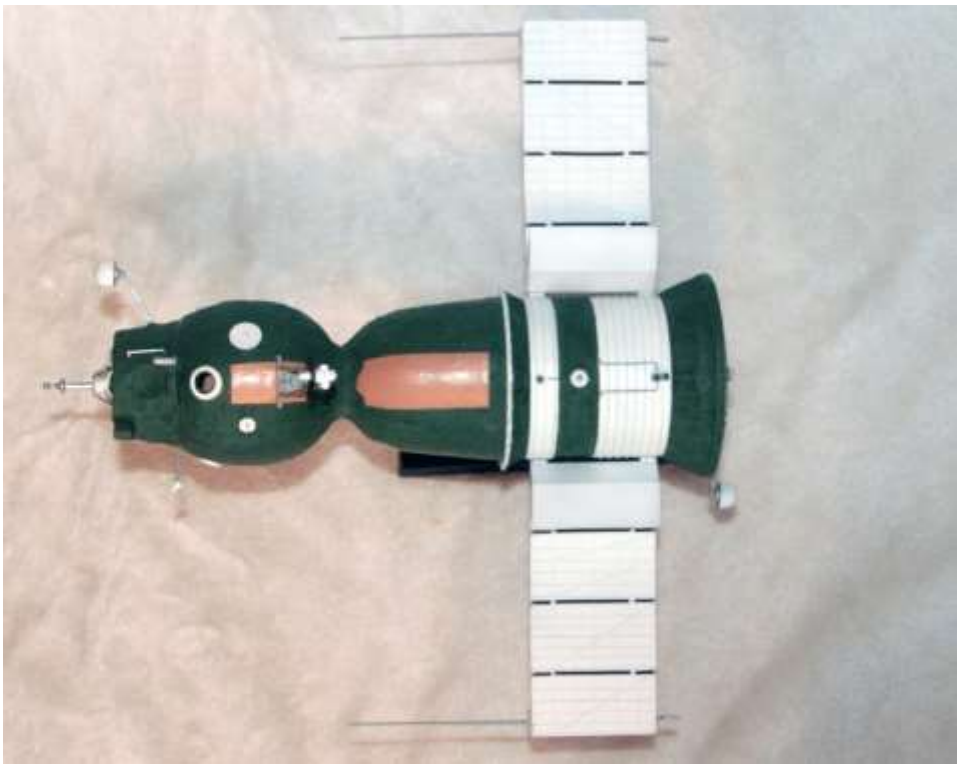

Figure 24, Completed Model, Top View

Summary I am pleased with the end result, especially given the anxiety caused by deciding to build such an expensive and hard-to-find kit. I continued to gain scratch building and detailing experience and even though my still journeyman skills would never win me any awards, I wouldn't be ashamed to enter the model at Nationals were I to attend. I also came away with more organized research skills and build planning but I still need to think through some of my detailing more prior to jumping straight into it. A little more experimentation like that I did with the solar cells before committing to a chosen technique would cut down on the fits and starts. In addition, thoroughly researching and planning the detailing I intend to do before I start would allow me to make sure I do things in a logical sequence. I tend to jump into the build too quickly, partially complete something and then see some new detail I'd like to add that would have been easier to do before I'd finished as much as I had.

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