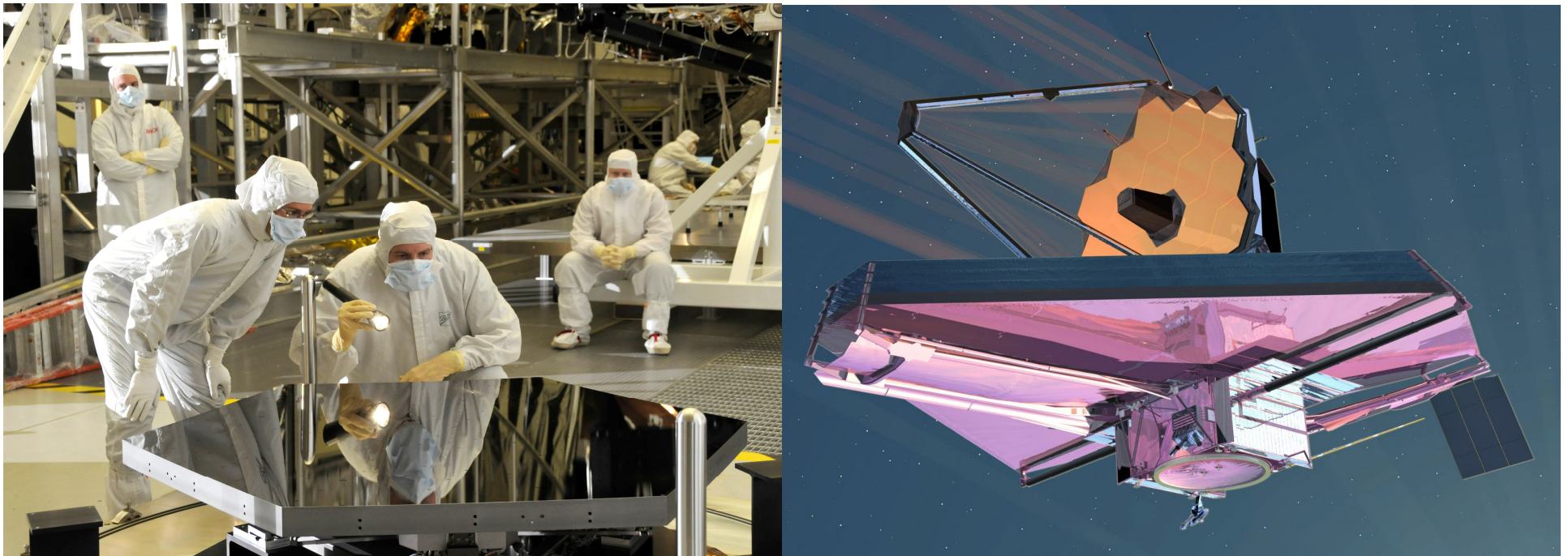


The James Webb Space Telescope (JWST) is a large, infrared-optimized space telescope, scheduled for launch in 2014. JWST will find the first galaxies that formed in the early Universe, connecting the Big Bang to our own Milky Way Galaxy. JWST will peer through dusty clouds to see stars forming planetary systems, connecting the Milky Way to our own Solar System. JWST's instruments will be designed to work primarily in the infrared range of the electromagnetic spectrum, with some capability in the visible range.

JWST will have a large mirror, 6.5 meters (21.3 feet) in diameter and a sunshield the size of a tennis court. Both the mirror and sunshade won't fit onto the rocket fully open, so both will fold up and open once JWST is in outer space. JWST will reside in an orbit about 1.5 million km (1 million miles) from the Earth.



JAMES WEBB SPACE TELESCOPE
1:48 scale

21.3' (6.5m) dia mirror
<http://www.jwst.nasa.gov/>

James Webb Space Telescope – 1:48 scale

Assembly

Where it is not obvious, black arrows indicate cuts. Red arrows indicate fold lines. You'll need 10 sheets of paper & 9 of cardstock.

1: SPACECRAFT BUS

1. Score all fold lines then cut out **Spacecraft Bus**. Fold the sides up (toward the printed side) for form a box, then fold the outer portions (labelled “fold up”) the opposite way – toward the printed side. This will give you two large and two small tabs that will be used to fasten the bus to the bottom of the sunshade stack.

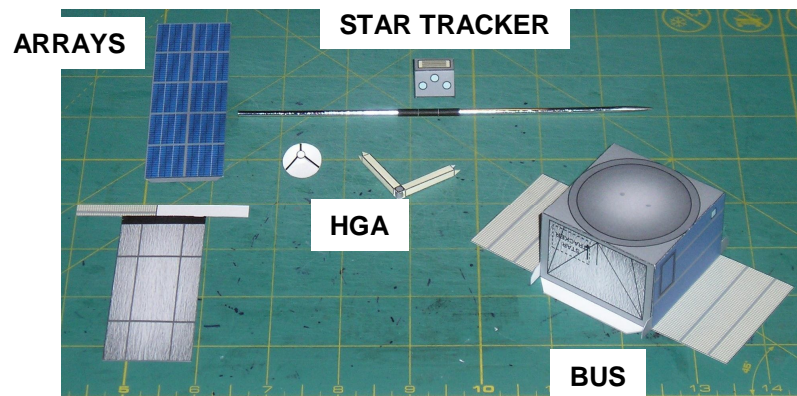
2. Score all fold lines then cut out the **star tracker**. Fold the main part into a box and secure using the tabs. Roll the black rectangle (**star sensors**) into a cylinder, overlapping to the dotted line, and glue. When dry, cut off one end of the cylinder along the white line –this will form the center barrel of the star tracker. Cut the remaining black cylinder in half at a 45 degree angle to form the two outer, angled barrels. Glue the center barrel to the star tracker on the center blue circle. Glue the outer barrels to the remaining circles aimed outward (see pictures of JWST). You have the option to roll the barrels from plain bond paper which is easier to make (see page for sunshade #5). Apply glue to the edges of the completed star tracker and attach to the side of the bus where indicated with the barrels pointed away from the spacecraft (direction of arrow).

3. Score all fold lines and cut out the **HGA** parts. Form the **primary reflector** into a shallow cone, overlapping to the dotted line and glue. Fold the three legs of the **secondary reflector** down into a tripod and glue to the concave surface of the primary reflector. Roll the small rectangle of the **HGA mount** into a short cylinder, overlapping to the dotted line, and glue. Fold up each arm of the mount arm into a rectangular beam and glue – making an L-shaped assembly. Two corner tabs will overlap – glue them together to fix the shape. Apply glue sparingly and insert the short cylinder into the “elbow” of the arm to finish the joint. Spread the two tabs on the end of the arm marked “dish end” and glue the HGA reflector assembly in place. Set aside for later final assembly.

2: SOLAR ARRAYS

1. Score the fold lines on the **solar arrays** and cut them out. The long array will be attached to the bus opposite the star tracker and the shorter array (actually a momentum flap) will be attached to the outer ends of the sunshield support booms on the same side (see pictures).

2. Fold your arrays in half along the scored line and glue to make two-sided parts. Set aside for later final assembly.

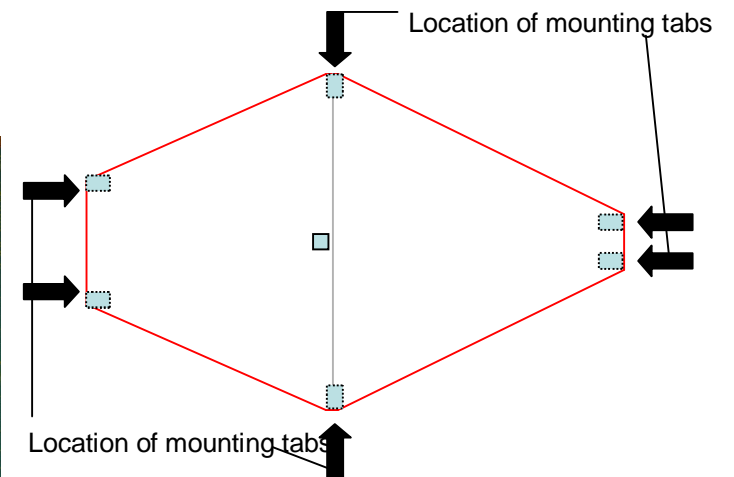
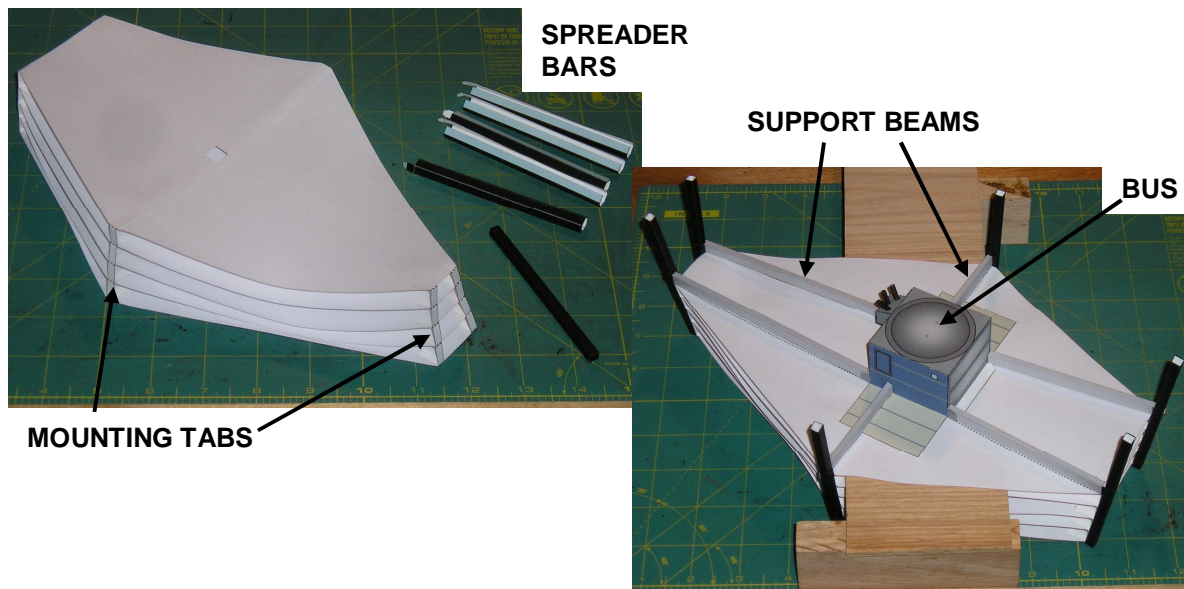


James Webb Space Telescope – 1:48 scale

Assembly

3: SUNSHIELDS

1. Cut along edge of each **sunshield**; cut out ten parts to make five sunshields. Cut out the small blue square that will end up in the center of each sunshade.
2. Score along the fold lines and cut out the **sunshield mounting tabs**. Fold each tab into a “C” shape.
3. Start with sunshield #5 (bottom) and glue one leg of a tab to each corner of the shield on the unprinted side of the sunshield (you will need the alignment lines to attach the bus and structure later). Carefully glue sunshield #4 on top of the tabs, keeping it aligned with the edges of sunshield #5 and making sure to line up the fore end with the fore end of the one below.. Repeat for the remaining sunshields, keeping the stack aligned.
4. Score the fold lines and cut out the **sunshield spreader bars**. Fold them into long, rectangular beams and glue using the blue side (folded inside) as a tab to secure the beam. Then, fold down the end cap and glue. The capped end will be the top of each bar.
5. Apply glue to the outside of one set of sunshield mounting tabs and glue the spreader bar in place, aligning the top of the bar with the top of the sunshade stack (smallest, #1 sunshade is on top) and keeping the spreader bar aligned straight with the tabs. Repeat for the remaining spreader bars.
6. Attach the **spacecraft bus** to the bottom of sunshield #5. Turn over the sunshield stack and find the rectangle marked on the bottom; the bus will attach here. When positioned correctly, the star tracker will be facing the narrowest end of the sunshields. Apply glue to the tabs on the bus and glue in place to the sunshields. It may help to use something flat between the bottom two sunshields to help press the sunshield surface to the tabs on the spacecraft bus.



James Webb Space Telescope – 1:48 scale

4. SUNSHIELD SUPPORT BEAMS

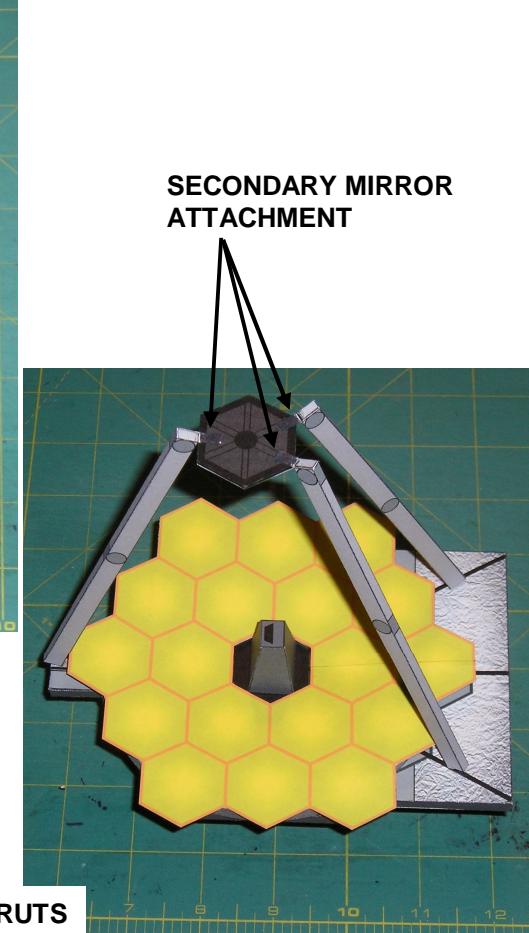
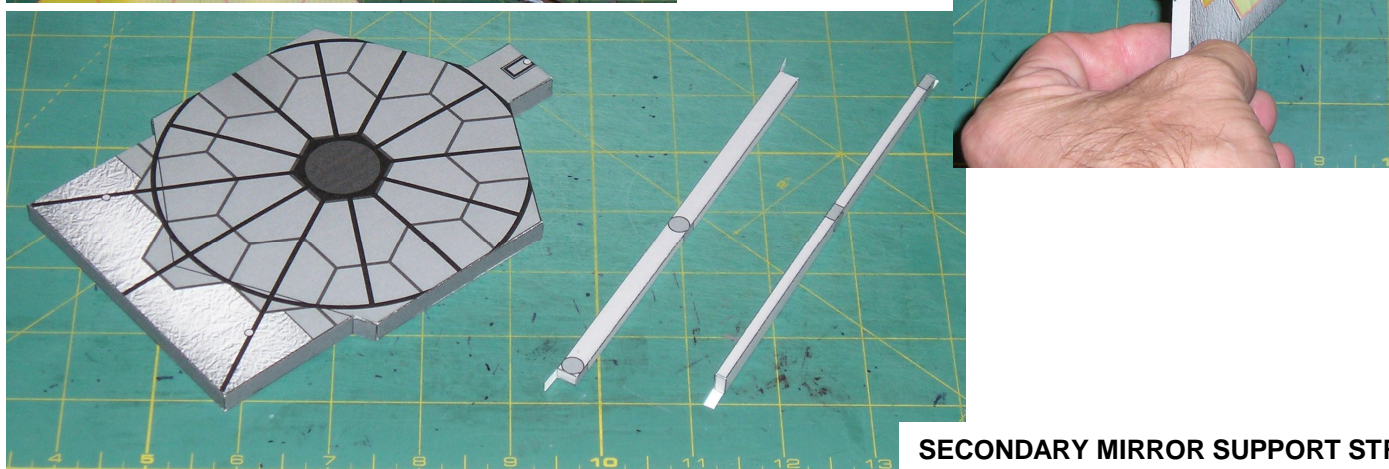
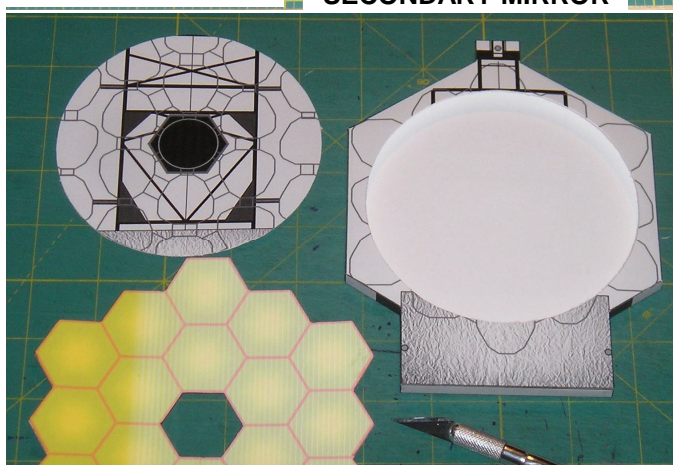
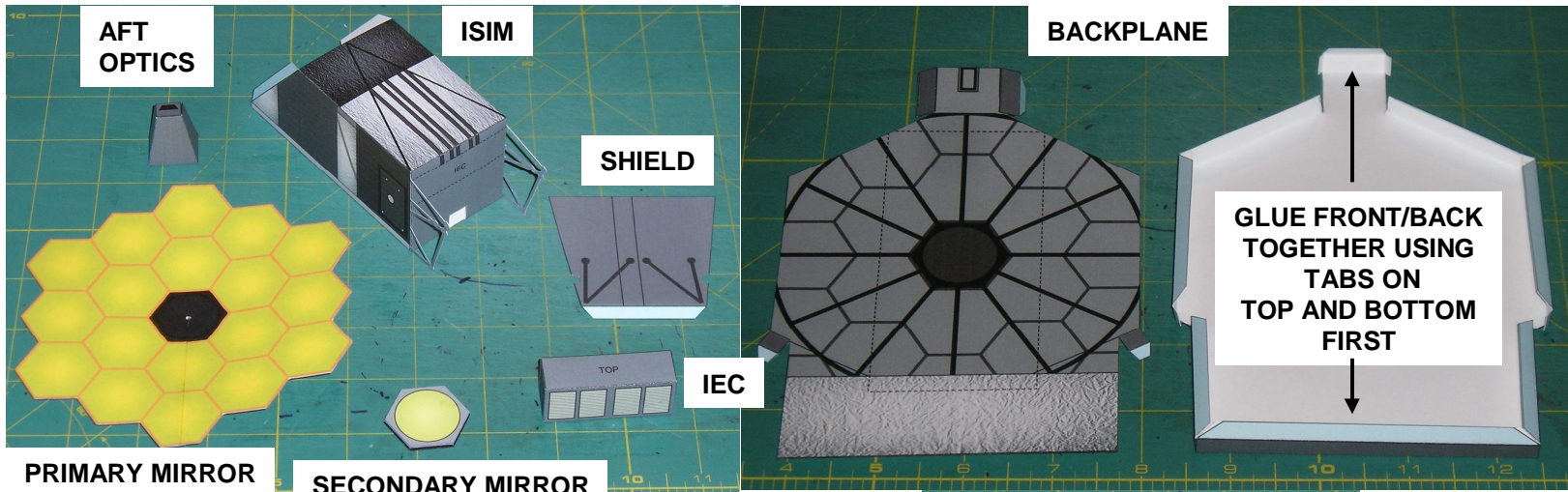
1. Score the fold lines and cut out the **support beams**. Do not score or bend the black tabs on the ends.
2. Fold and glue each part into a long rectangular beam, securing the assembly with the long blue tab.
3. Locate the dotted lines running from the spacecraft bus to the spreader bars on the bottom of the sunshade assembly. These show you where to place the support beams. Match the support beams to the appropriate lines by length – short ones on the sides; medium ones toward the fore end of the sunshields; longest beam toward the aft end of the sunshields. Carefully spread the black tabs on the end of one support beam and slip them around the spreader bar. Trim the other end of the support beam so it fits tightly against the spacecraft bus.
4. Apply glue sparingly to the inside of the tabs on the support beam, the narrow side that will fit against the sunshade, and the end that meets the bus then glue in place.
5. Repeat for the remaining support beams. The fore and aft support beams will also be supported by the gray brackets on the side of the bus – glue those beams to the brackets.

5. CENTER SUPPORT BOOM

1. Score the lengthwise fold lines and cut out the **center support boom**. Fold the support boom into a square beam and glue using the long blue tab.
2. Insert the center support boom down through the square hole in the center of the sunshades until it bottoms against the spacecraft bus, ensuring the boom stands straight up and down.
3. Pull the boom up enough to apply glue to the bottom, then push it back down to secure it firmly to the bus – again, making sure the boom stands straight.

6. ISIM (INTEGRATED SCIENCE INSTRUMENT MODULE)

1. Score the fold lines and cut out the **ISIM**, the **instrument shield**, and the **ISIM Electronics Compartment (IEC)**.
2. Carefully cut out the two blue squares on the ISIM. The square in the back panel has a dotted line and red lines around it. Carefully score along the dotted line and cut only the red lines to make a bracket that will fold inward and slip over the center support boom.
3. For a more detailed – and fragile – model, cut out the white areas inside the mounting truss on the bottom of the part.
4. Fold the part into a box shape and glue.
5. Fold the IEC into a box and glue. Glue the top of the IEC to the bottom of the ISIM where indicated, using glue sparingly to attach the sides of the IEC to the mounting trusses.
6. Bend the tabs on the sloped top edges of the ISIM inward, bend the tab on the instrument shield downward. The shield's tab will slip inside the ISIM lower edge and the shield will attach to the tabs on top of the ISIM. **Do not attach yet**, the instrument shield will be attached later during final assembly.



James Webb Space Telescope – 1:48 scale

7. PRIMARY MIRROR

1. Cut out the **front** and **back of the primary mirror**. Carefully glue them back to back.
2. For a more detailed model: cut out the front and back of the primary mirror then make a slit from the center of the mirror parts to the bottom edge. By overlapping the cut edge very slightly you can form the mirror front into a very shallow cone – secure with a little glue. Form the back of the mirror over the front to ensure they have the same shape, then glue the overlap on the back part to hold its shape; then glue the two pieces together. You can increase the 3-D aspect of the mirror by cutting one or more layers of thicker card (from a cereal box, for instance) and forming additional layers to glue between the front and back faces of the mirror.
3. Score the fold lines and cut out the **front** and **rear** of the **backplane** mirror support. Fold all the tabs inward and secure those tabs on the front of the backplane. When gluing the front and rear of the backplane together, place the front part face down on a flat surface to keep the assembly straight. Carefully place the rear of the backplane in place and glue it to the front using the tabs on the front part. **Glue the long tab at the bottom first, then the small tab at the top – ensuring the parts stay flat.** This will establish a straight reference for the part. Then glue the upper diagonal and lower vertical tabs, finishing with the outside tabs. When the glue is dry, fold the remaining tabs on the rear of the backplane into place and glue to complete the assembly.
4. Score the fold lines and cut out the **aft optics system**. Fold the part into a tapering rectangular prism and secure the edges with the tabs. Fold the tabs on top inward and secure the top.
5. **Detailed mirror.** If you've made the curved mirror – carefully cut out the black center hexagon of the mirror. Cut out a circle on the front of the backplane, following the gray dotted line. Color the center part of the inside of the backplane with a black marker. Carefully set the mirror into the hole in the backplane to check the fit and ensure you've colored all of the inside of the backplane that will show. Apply glue to the edge of the hole and put the mirror in place – ensuring the mirror is centered and correctly aligned – refer to the pictures as needed. Glue the aft optics system in place, centered in the opening in the primary mirror array.
6. If you've made a **flat primary mirror**, simply glue it in place to the front of the backplane – ensuring the mirror is centered and correctly aligned – refer to the pictures as needed. Glue the aft optics system in place in the black center of the primary mirror – refer to the pictures as needed.

8: Secondary Mirror with Support Struts

1. Score the fold line and cut out the **secondary mirror**. Fold the part and secure to make the two-sided part.
2. Score the fold lines and cut out the **secondary mirror support struts** (3 parts). Fold them into long, rectangular beams and secure. Fold the ends closed using the small rectangular, tabbed pieces and secure – leaving the long, skinny rectangular parts sticking out. These will be used to attach the struts to the secondary mirror and back plane.

James Webb Space Telescope – 1:48 scale

FINAL ASSEMBLY

1. **ISIM to Mirror/Backplane.** Carefully fold the attachment bracket in the center of the plain gray side of the ISIM inside so it's out of the way. Apply glue to the ISIM and attach the plain gray side to the rear side of the backplane/mirror assembly – centered using the dotted lines on the backplane as reference.
2. **ISIM/Mirror to center support boom.** Carefully slide the ISIM/Mirror assembly over the center support boom to check the fit – the mirror should face the forward end of the sunshades (same side as the star tracker and opposite the solar array. The boom passes through the square hole in the bottom of the ISIM and the hole in the attachment bracket. Trim the top of the support boom if needed. The bottom of the backplane should be slightly above the surface of the top sunshield. Apply glue to the bottom of the center support boom and glue it to the bus. Apply glue to the inside of the ISIM where it contacts the boom to glue it in place.
3. **ISIM top/instrument shield.** Fold the tabs on the top of the ISIM inward and glue the instrument shield on top to close the assembly. Trim the top edge as needed to get a good fit.
4. **Secondary mirror assembly to Mirror.** Using the small gray tabs, glue the secondary mirror support struts to the gray dots on the back of the secondary mirror. The struts should be aligned radially, with the narrow sides inward and the struts outside the secondary mirror. The yellow face of the mirror will face the primary mirror, with the tabs reaching around to secure the secondary mirror. Glue the other ends of the struts to the small gray dots on the front of the backplane/mirror assembly. Refer to the pictures as needed.
5. **Solar panels.** Turn the model upside down to expose the spacecraft bus. Use the tab on the longer solar to glue it to the spacecraft bus, positioning the panel at the edge of the bus (away from the sunshields) on the side opposite the star tracker. The gold side of the solar panel faces the sunshields, blue side out. For the remaining panel, fold the white section up then fold the gray tabs on the ends of that section inward to make the mounting bracket. Position the bracket between the sunshield support beams at the wide end of the bottom sunshield. This panel will extend away from the sunshields with the lighter side facing the spacecraft bus. Refer to the pictures as needed. Glue in place.
6. **HGA.** Spread the four small tabs on the end of the HGA mount and glue it to the side of the spacecraft bus over the small blue square. If you're going to display the model standing on the spreader bars, point the HGA antenna fore or aft so it will be clear of your display shelf. If you are going to hang the model, the HGA should point down and away from the spacecraft as that's where the Earth will be when the telescope is established in its orbit at the L2 Lagrange point.

DISPLAY

The model can be displayed standing on the sunshield spreader bars or hanging freely. The model can be hung from a thin line passing through the top of the backplane; another line to the end of the model will ensure it hangs level. If you hang the model, you may want to trim the sunshield spreader bars so they extend only about ½ inch below the bottom sunshade. If you display the model standing on the spreader bars – a ½” thick support under the spacecraft bus will prevent the model from sagging over time.

A model of the **Hubble Space Telescope** at the same, 1:48 scale can be found at <http://hubblesite.org/> so you can build the set.

