

Hubble Space Telescope Expert Model — Exterior



Directions

Downloads, patterns, and other information at: www.hubblesite.org/go/model

Materials:

- The patterns and instructions, which can be downloaded at www.hubblesite.org/go/model. The pattern pieces should be printed onto 32-lb paper. (You may want to have extra printouts handy in case you need them.)
- Cardboard (the weight of a cereal box is good)
- Glues: White or clear craft glue, gluestick (permanent), and superglue
- Good scissors
- A sharp craft knife with extra blades
- A metal straightedge and/or ruler
- A cutting board or similar surface

Optional (but very helpful) materials:

- Tweezers for handling small pieces
- A small paintbrush for applying glue
- Flat-edged toothpicks for applying glue and superglue
- Thin dowels and/or tapestry needles to help roll up thin tubes
- Clear spray-on sealant to protect the finished model

Before beginning construction:

1. Read all instructions carefully!
2. Have all of your materials ready.
3. Make sure a responsible adult is nearby to help out if necessary.
4. Glue all the pages that require it onto cardboard and paper ahead of time, so they can dry. If they curl up when drying, press them under heavy books.

Construction tips:

- Read through all the directions first and make sure you know where all of your materials are and what you will need to do.
- Always follow safety precautions when using a sharp blade, like the one on a craft knife.
- Have extra blades available and safely stored until you need them. Change the blade whenever it starts to become dull; a sharp blade cuts more easily and is safer to use. Dispose of used blades safely.
- Don't cut out pieces until you need them, so you can keep track of them. You can also lightly pencil the piece numbers on the backs. Pieces are numbered and labeled in the recommended order of assembly.
- Score fold lines before cutting out the pieces. This will make it much easier to fold the flaps later. Draw the edge of a narrow but not sharp object — like a butter knife or a small flathead screwdriver — along the dotted lines to make an indentation. Use a ruler to make sure your lines are straight. Alternately, you can use the “dull” side of a craft knife, with a very light pressure so you don't cut through the paper. Fold lines that are on cardboard require heavy scoring: use the point of the scissors or a craft knife to lightly cut along the line, just enough to make a small groove, but not going more than halfway through the cardboard.
- Fold the pieces and try to fit them together at least once before applying the glue.
- Very small folds are easier to make with a pair of tweezers.
- Keep your hands and your workplace clean and clear of scraps to prevent accidents and errors.
- Protect your work surface with scrap paper, especially when gluing.
- Keep your hands clean, so you won't get glue or fingerprints on your model.

Construction tips continued:

- When using white glue, apply in a thin coat with a flat toothpick or a small paintbrush. If you wait a few seconds for it to become “tacky” it will stick more easily.
- When using superglue, follow all the safety precautions on the label. Be VERY careful not to get any on your hands or skin, and do not touch pieces that have had superglue applied for several minutes, to be sure it is dry.
- Only use as much glue as is needed to cover the surfaces you’re connecting with a thin layer. Too much glue may end up on your hands or on the surface of your model.
- Be careful using sharp scissors and blades. Have a responsible adult nearby to help you if you need assistance.
- When gluing two flat pieces of paper together, use as little glue as possible. The glue stick is very helpful for this.
- Unless otherwise indicated, allow the glue to dry before going on to the next step.
- Take your time and be patient!

About the designer

Ton Noteboom describes himself as a “space age kid.” Growing up in the Netherlands, he followed the progress of the space program, hearing about Sputnik on the radio, and watching Neil Armstrong take his first steps on the Moon. But what really fascinated him was the technology – the technology that got the astronauts to the Moon, the technology that brought the journey back to people around the world.

“The force of the rockets, the hardware part – that was what interested me,” he said. “It was amazing to see pictures on the television screen, especially in that time, that came all the way from the Moon.”

He got his first cardboard model of a boat when he was 11 years old, as a present from Sinterklaas, the Dutch version of Santa Claus. The model joined his already extensive collection of plastic models, but after a short time that phase gave way to a period of model-train building that he shared with his father. And that was it until the day about five years ago, surfing the Web, that he started finding plans for elaborate paper models online.

Lured by nostalgia, and with both training in silversmithing and job experience in construction engineering under his belt, Noteboom thought he’d give the paper models another shot. “I said, ‘Well, let’s try it,’ and it stuck,” he said. When he couldn’t find a model of the Saturn V rocket, he decided to design his own. “I didn’t start with an easy one,” he noted wryly. “You just put your teeth together and go. It took a lot of patience, paper, ink and time. It’s fascinating to see a model taking shape.”

His love of technology and engineering is evident in both the level of detail and the painstaking attention to structure and precise construction in the 35 paper models

Noteboom has designed and shared online with the world. One of the greatest compliments he’s received, he says, is from a model builder that praised the way everything about his models “fit together.”

The allure lies in constructing something three-dimensional out of a flat piece of paper, Noteboom said. “It’s intriguing to make something very sturdy out of something that isn’t. I treat the piece of paper as a piece of metal, though metal is easier because you can shape it into intricate forms. With paper you can’t.”

In addition to designing paper models, Noteboom is a licensed radio amateur hobbyist specializing in television transmissions. He lives in the small village of Rozenburg, near Rotterdam, with three cats, and handles facility operations at a local school.

More of Ton’s models can be found at <http://jleslie48.com>

About Hubble Space Telescope

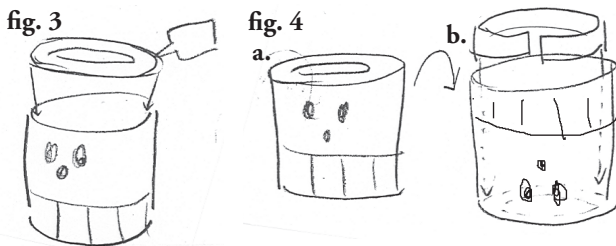
This highly-detailed model of the Hubble Space Telescope (HST) is intended for experienced model-builders. You may build only the exterior part of the model which shows all of the HST’s surface features, or you have the option of also making the removable internal structure which includes the mirrors and instruments. All of the files you need can be downloaded from www.hubblesite.org/go/model

The details of this model are based on the telescope’s configuration after Servicing Mission 3B in 2002.

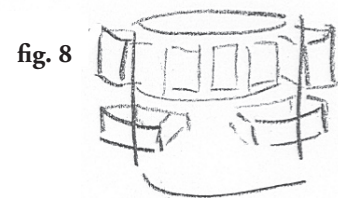
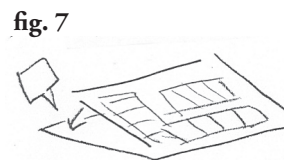
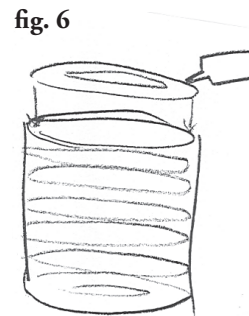
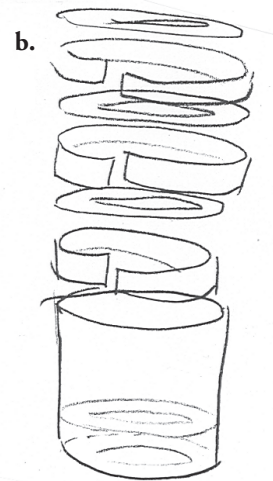
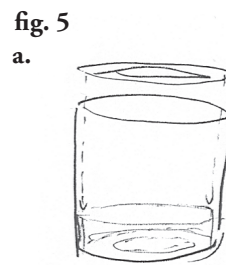
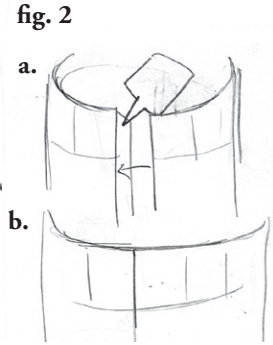
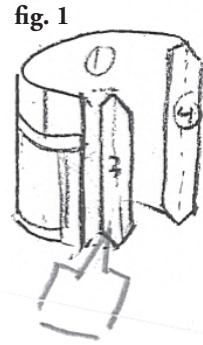
Assembly instructions

Aft shroud

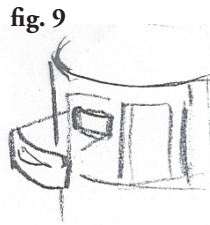
1. Glue tabs 3 and 4 to the back of piece 1 along the opposing shorter sides (fig. 1).
2. Then glue the free ends of the tabs behind piece 2 so that it forms a short tube, making sure that the row of bays on pieces 1 and 2 line up together, forming a ring around the top of the tube. Be sure the edges of the pieces 1 and 2 meet very tightly (fig. 2). This is the aft shroud: the three black circles are on the front side and the row of bays goes around the top.
3. Aft shroud supports: First, turn the aft shroud upside-down and test-fit ring 5 into the bottom. It should fit snugly just inside the edge of the tube. Apply a small amount of glue all the way around the outside edge of the ring. Carefully insert the ring just inside the bottom edge of the tube and make sure the paper edges are securely glued all the way around. Let it dry (fig. 3).



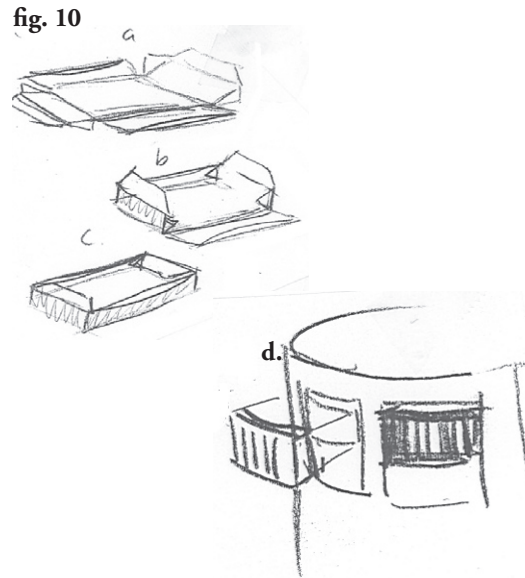
4. Roll strip 6 into a loop and insert it inside the aft shroud so it is up against the glued ring (fig. 4). Use very little glue to glue down the ends if necessary.
5. Insert ring 7 into the tube so that it snug against the edge of the spacer strips. Alternate spacers and rings until you get to ring 15 (fig. 5).
6. Glue ring 15 just inside the top edge of the aft shroud, just as you did with the first ring, by applying a little glue around the outside edge (fig. 6).
7. Bay doors: The sheet with the instrument covers (16-19) and the bay doors (20-29) should be folded in half and glued together for extra thickness before you cut out the pieces. TIP: a glue stick works very well for this (fig. 7).
8. Cut them out and apply the covers and doors where indicated on the aft shroud (fig. 8). If you gently bend them into a curved shape to match the aft shroud cylinder before gluing, they will be much easier to apply.



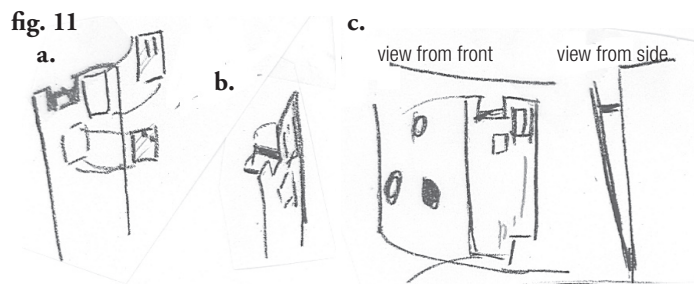
- Gently bend piece 30 into a curved shape and glue into place on piece 28 (bay 10) (fig. 9).



- Carefully fold pieces 31 and 32 and glue them into shape as shallow boxes (fig. 10a-c). When dry, glue the boxes into position on pieces 21 and 22 (bays 2 and 3) (fig. 10d).

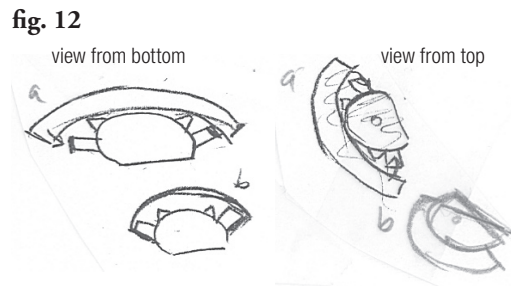


- NICMOS cryocooler: Glue pieces 34 and 35 where indicated onto piece 33, the NICMOS cryocooler (fig. 11a). Score the tab on the cryocooler deeply and bend inward at a 90° angle (fig. 11b). Using this tab at the top end, and the back of the cryocooler at the bottom, glue onto the aft shroud cylinder (fig. 11c).

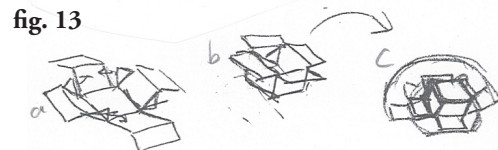


where indicated. It will stick out at a slight angle from the aft shroud (fig. 11c)

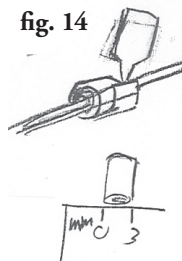
- Aft scuff plates: Assemble pieces 36 and 37 as shown to make the scuff plates, gluing the tabs underneath the thin curved strip. Make sure that the ends of the thin strip line up with the edges of the outer glue tabs (fig. 12).



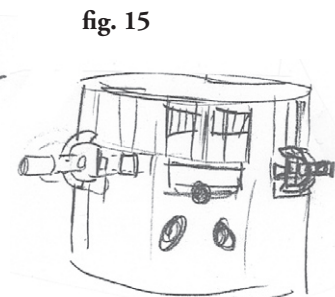
- Fold pieces 36a and 37a into small boxes as shown, with the top flaps opened out. [NOTE: With small boxes like these, it is extra important to score carefully before cutting the pieces out. Use tweezers to bend the flaps, and to help flatten them down when gluing.] Glue the finished boxes open-side-down to the underside of the scuff plates (fig. 13).



- Roll the strips 38 and 39 as tightly as possible and glue the ends down so you have a very small cylinder; it may be easier to roll them around a piece of thick wire or a tapestry needle if you have such items (fig. 14).



- Glue these small cylinders on top of the scuff plates at the cross mark. Glue the assembled scuff plates where indicated on the aft shroud body, so that the flat side of the plate faces the “front” of the aft shroud, where the three circles are (fig. 15).



16. **OPTIONAL:** Add the yellow handrails (piece 40) wherever you see them on the model. Cut the strips out very carefully, and run a little glue along the cut sides to keep the yellow decal attached to the cardboard. Hold the strips up to the model to see how long each rail should be and trim them one at a time. As you go along, glue them into place with very little glue, or with a dab of superglue at the ends (fig. 16). Use the white rail strip for the handrails on the NICMOS cryocooler. Set any extra handrails aside for use on other pieces of the model.

Base

17. Glue pieces 42 and 43 where marked onto the telescope base, piece 41 (fig. 17). **OPTIONAL:** Add yellow handrails as you did on the aft shroud.
18. Glue one of the pieces labeled 44 underneath one of the pieces labeled 45, to make a small vent (fig. 18a-b). Repeat so that you have four completed vents. Glue each of the vents onto the telescope base where marked (fig. 18c).

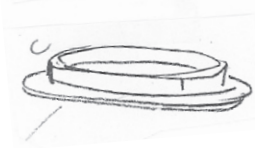
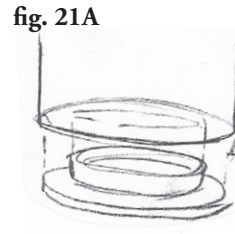
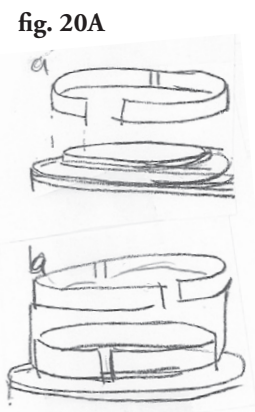
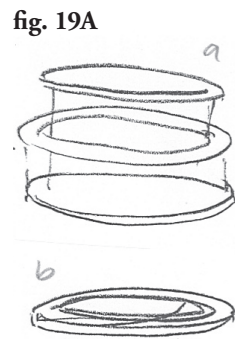
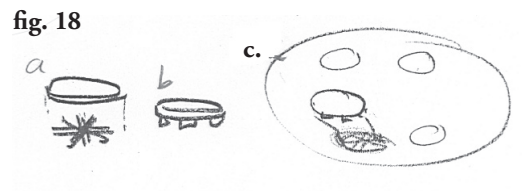
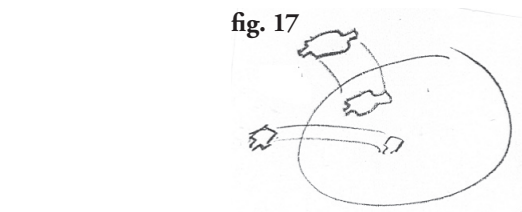
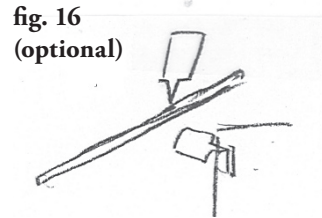
NOTE: This model can be made with the optional “Internal” section, which nests inside of it. If you are going to make the Internal parts, you will need to make the base removable. Otherwise, you can permanently glue the base shut.

If you need to keep the telescope base removable:

- 19A. Glue pieces 46 and 47 to the back of the telescope base (fig. 19A).
- 20A. Glue pieces 48 and 49 around the edge of piece 47 so they make a ring. Glue pieces 50 and 51 to the outside of the ring to reinforce it (fig. 20A).
- 21A. Test-fit the base into the bottom of the aft shroud: it should fit easily, like a lid (fig. 21A).

If you don’t need to keep the telescope base removable:

- 19B. Glue the telescope base onto the bottom of the aft shroud so that the two yellow “L” shaped pieces face the front of the telescope, where the three black circles are on the aft shroud (fig. 19B).



Forward shroud

22. Glue one half of glue tab 53 to the back of piece 52 along one of the shorter ends. Then glue the other end of piece 49 to the free end of the tab, making sure to line up the edges closely (fig. 22). You may find this easier if you first roll piece 52 around a smaller tube or cylinder so that it is already curled into shape before gluing. This cylinder is the forward shroud: the NASA/ESA logos are on the front side near the top.
23. Glue piece 54 around the top of the forward shroud where marked. Start at the point marked “S” to be sure the guides on this piece match up with the guides underneath it (fig. 23).
24. Just like the aft shroud, the forward shroud has a series of reinforcing rings and spacers (55-69). After cutting out the rings, color the backs and inside edges with black paint or a black marker.
25. Apply glue lightly around the edges of ring 55 and carefully insert it just inside the top edge of the forward shroud, holding in place until the glue is dry (fig. 25).
26. Turn the tube over and insert one of the rolled spacers into it so it is up against the ring and the black side is showing (fig. 26). It may be easier if you curl the spacers first, as above with the forward shroud. Without gluing, alternate spacers and

fig. 22

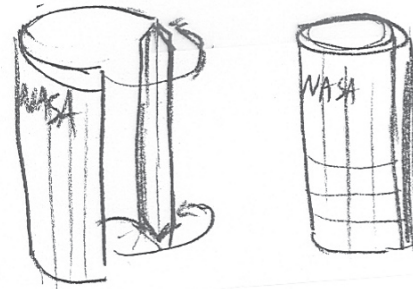


fig. 23

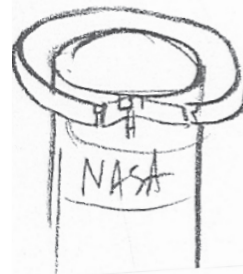


fig. 25



fig. 26



rings until you get to the last ring. You will have filled the forward shroud a little more than halfway.

fig. 27

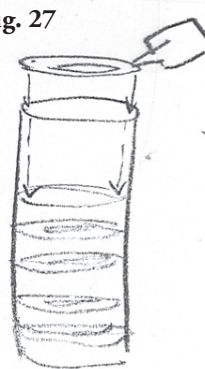
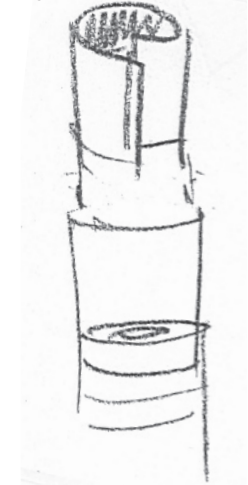
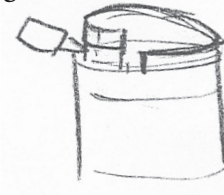


fig. 28



27. Glue the last ring in place with a little glue around the edges, as you did with the first ring, so that it is snug against the last spacer in the tube (fig. 27).
28. Curl and insert piece 70 snug against the last ring, as you did with the other spacers, using a little glue to secure it (fig. 28).
29. Glue piece 71, the aft shroud connector, around the inside of the bottom edge of the forward shroud, using the printed center line as a guide (fig. 29).

fig. 29



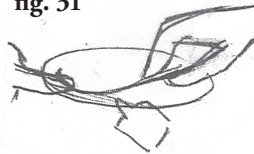
30. Glue pieces 72 and 73 together, back-to-back (fig. 30).

fig. 30



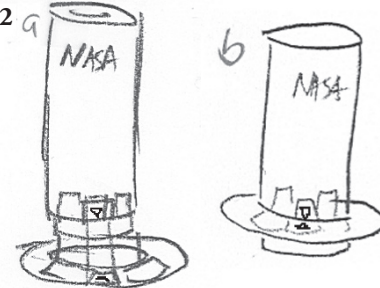
31. OPTIONAL: if you are using the yellow handrails on other parts of the model, carefully cut and seal rails 74 as you did with the previous set in step 16. With a drop of glue here and there, carefully bend the rails to glue them into the curved shapes printed on piece 73 (fig. 30). There will be a few extra pieces for the tops of the OTA bays later which will need to be applied the same way.

fig. 31



32. Slide piece 73 over the aft shroud connector like a collar, with the bay placement guides facing up. Glue into place at the base of the forward shroud, being careful to align the red arrows/bay placement guides on both pieces (fig. 32).

fig. 32



33. Assemble the OTA bays, pieces 75-83 (fig. 33).

fig. 33

piece 75



other OTA bays

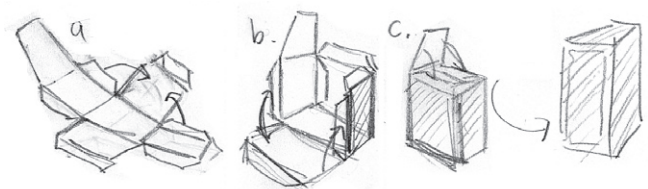
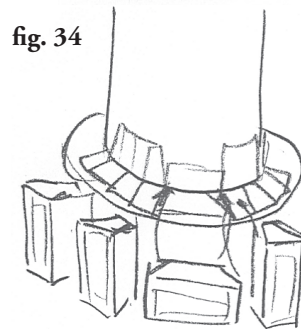
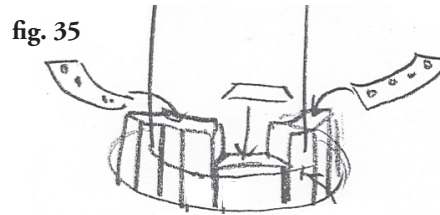


fig. 34



34. Glue the bays where marked onto the forward shroud and to each other (fig. 34).

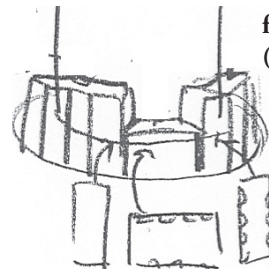
fig. 35



35. Glue pieces 84-86 where marked on top of the bays (fig. 35). OPTIONAL: Add the yellow handrails to these three pieces, as described in step 31.

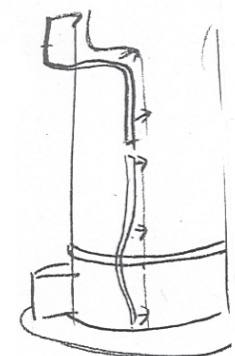
fig. 36

(optional)



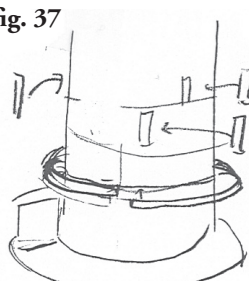
36. OPTIONAL: If you want to add the bay doors for extra dimension, as with the larger bay doors on the aft shroud, glue pieces 75x-83x onto the faces of the OTA bays. Be careful to line up the hinge markings around the edges (fig. 39).

fig. 38



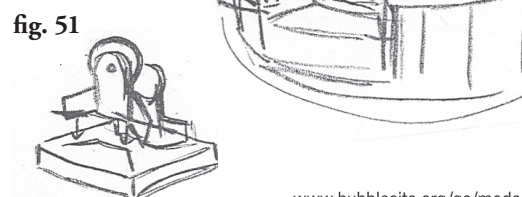
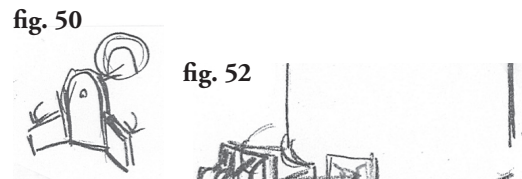
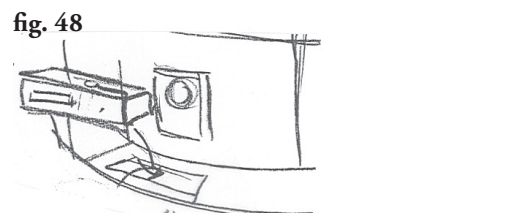
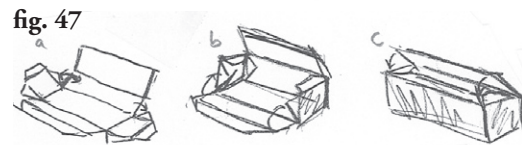
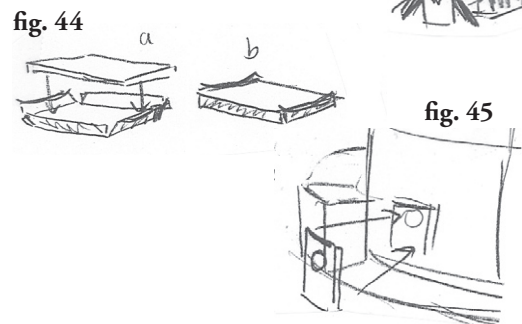
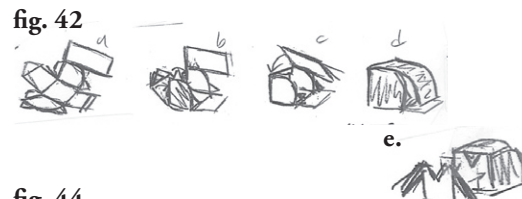
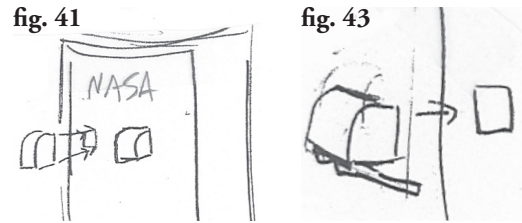
37. Glue pieces 87-95 where marked on the forward shroud. It may be easier if you gently bend piece 95 into the proper shape before gluing (fig. 37).

fig. 37



38. Glue piece 96 into place on the forward shroud, bending slightly before gluing. Glue piece 97 to continue 96; it will arch slightly when going over the top of piece 95 (fig. 38).

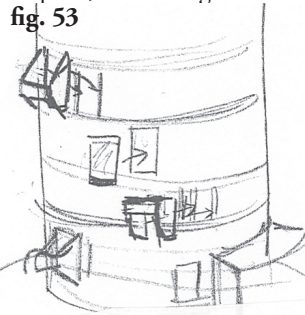
39. OPTIONAL: if you are using the yellow handrails, apply them now to the forward shroud as you did on the aft shroud in step 16.
40. Assemble pieces 99-101, the high-gain antenna clamps (HGA clamps) (fig. 40). [NOTE: With small boxes like these, it is extra important to score carefully before cutting the piece out. Use tweezers to bend the flaps, and to help flatten the flaps down when gluing.]
41. Glue the assembled HGA clamps where marked on the forward shroud, so that the curved side is facing the top of the tube (fig. 41).
42. Assemble the solar array clamp 102, which is very similar to the HGA clamps above. Glue piece 103 to it where indicated (fig. 42). Assemble pieces 104-105 the same way.
43. Glue completed solar array clamps to the forward shroud where marked, so that the curved side is facing the top of the tube and the yellow brackets face the bottom (fig. 43).
44. To make the base for the solar panel connector, fold piece 106 into a shallow box and glue piece 107 inside for support. Apply a little glue around the edges of piece 107 so the flaps on the box will stick (fig. 44).
45. Glue the solar panel base onto the forward shroud where marked, so that the circle is closer to the top of the model (fig. 45).
46. Repeat the last two steps with pieces 108-109 to make the connector on the other side. This is where the solar arrays will attach.
47. Assemble pieces 110 and 111 (fig. 47).
48. Glue where marked next to the OTA bays (fig. 48).
49. To make the bases for the HGA hinge, first fold pieces 113 and 115 in half along the dotted line and glue them together to make them double-thick. Assemble pieces 112-115 the same way you made the solar array connector base in step 44.
50. Deeply score piece 116 on the reverse side and bend forward at approximately a 45° angle. Glue piece 117 behind piece 116 (fig. 50). Repeat with pieces 118-123 to make four identical brackets.
51. When all parts are dry, glue two of the brackets onto each base where the guidelines are (fig. 51). If white glue doesn't hold securely, use superglue.
52. Glue the completed HGA hinge assemblies on either side of the forward shroud where marked, making sure the brackets are facing in the direction shown (fig. 52). These will hold the high-gain antenna later.



53. There are four identical magnetic torquers, each using one set of the identical pieces

provided. To make one, first glue piece 124 where marked on the forward shroud, making sure the darker end is toward the bottom of the tube and the lighter end toward the top. Score deeply and fold the two brackets, 125 and 126, and hold them up to the model to test-fit them against the guidelines.

Bracket 125 is closer to the top, and 126 is closer to the bottom (fig. 53). When you're sure where they go, glue them into place with a dab of superglue or tacky white glue along the edge, and hold in place until they set.



54. Glue piece 127 diagonally across the two brackets, centered across the cross mark as shown (fig. 54).

55. Repeat the last three steps to make the other three torquers. We have provided extras of piece 127, in case you need them.

56. Grapple fixture: Score piece 128 deeply. Test fit this bracket on to the forward shroud above the left side of the OTA bays, using the marked guides for placement as shown. Secure with a few drops of glue (fig. 56).

57. Glue piece 129 on the side of the bracket to brace it (fig. 57).

58. Repeat the last two steps with pieces 130-131 above the right side of the OTA bays, making a mirror-image of the first bracket (fig. 58).

59. Glue pieces 132 and 133 on top of the brackets, positioned so the small white cross is toward the top of the forward shroud (fig. 59).

60. Forward scuff plates: Glue pieces 134 (x4) and 135 (x4) to the forward shroud where marked, to make two sets of bracket bases (fig. 60).

61. Deeply score and fold piece 136 and test-fit on the forward shroud to the left of the NASA/ESA logos, so the feet of the bracket are centered on top of the bases you applied in the previous step. The wider side of the center platform should face the logos. Glue into place (fig. 61).

62. Test-fit and glue piece 137 across the top of the bracket, and 139 across the bottom, as shown (fig. 62).

63. Repeat the last two steps with pieces 139-141, on the right side of the logos. This should be a mirror of the first bracket, also with the wide side of the platform facing the logos (fig. 63).

fig. 54

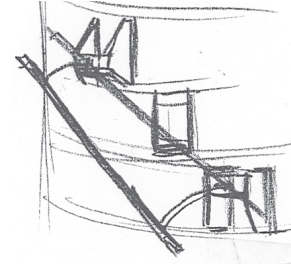


fig. 56

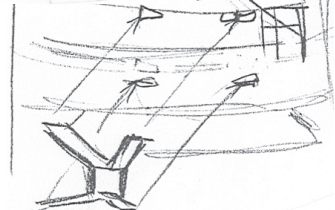


fig. 57

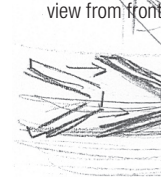


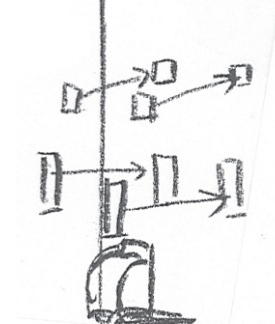
fig. 58



fig. 59



fig. 60



view from front

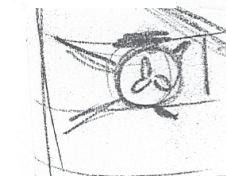


fig. 61

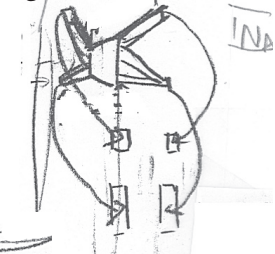
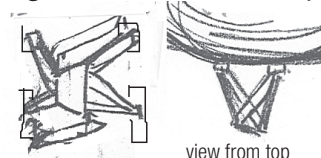


fig. 62



view from top

fig. 63



view from top

64. Assemble scuff plates 142 and 143 the same as the aft scuff plates in step 11, being sure that the edges of the curved strip line up with the glue tabs (fig. 12).

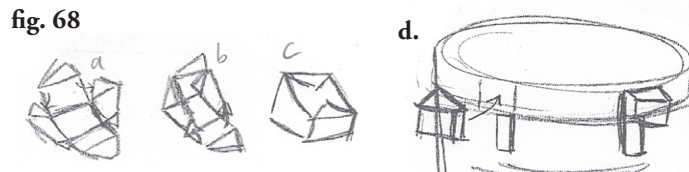
65. Attach each to the top of one bracket, so that the flat edge of the plate faces toward the logos (fig. 65.)

Aperture door

66. Glue piece 144 on top of piece 145 to make the door lock and glue into place on the front of the forward shroud (fig. 66).

67. Glue pieces 146 and 147 to the back of the forward shroud where marked (fig. 67).

68. Assemble door hinges 148 and 149. Glue them to the forward shroud where marked, so that the shorter sides face each other (fig. 68). The inside edges of the boxes should line up with the pieces you just glued to the tube.

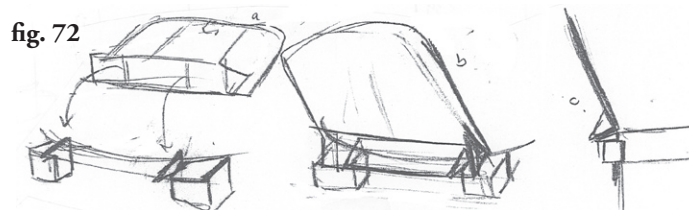


69. Glue pieces 150 and 151 to the inner sides of the hinges, being sure that the wedge shape sticks up over the box as shown (fig. 69).

70. Glue piece 152b to the back of the aperture door piece 152 before cutting it out. Glue details 153-155 to the front of 152 where indicated (fig. 70).

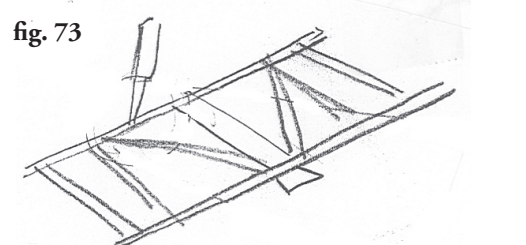
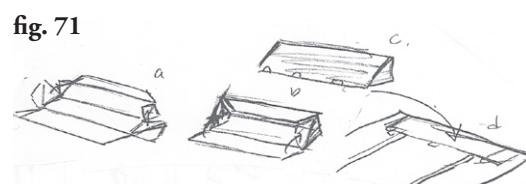
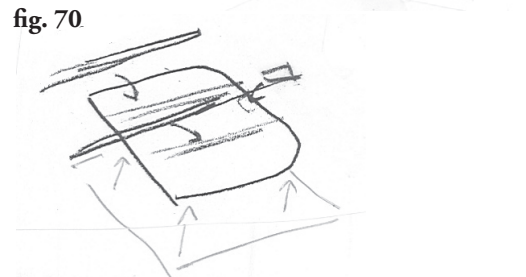
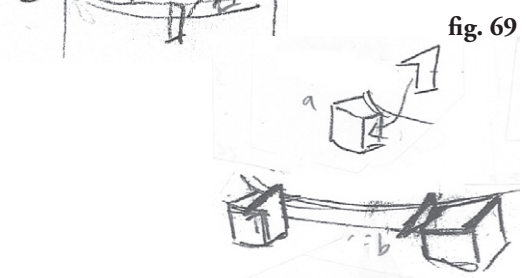
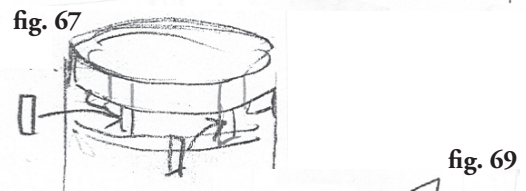
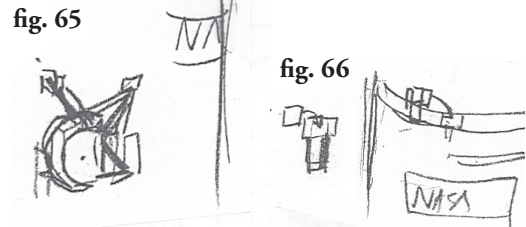
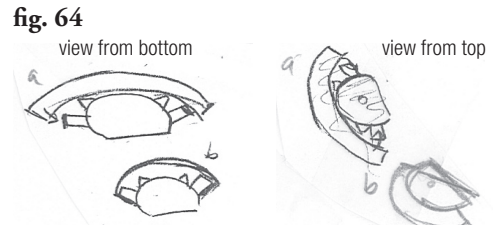
71. Assemble piece 156 (fig. 71). Glue where marked onto the aperture door (piece 152), being sure to line up the small yellow boxes.

72. When all parts are dry, attach the aperture door to the hinges by gluing the small wedges to the guide marks on piece 156 (fig. 72). The door will be propped open at a 16° angle.



Solar panels

73. Cut out pieces 157 and 158, including all the interior pieces. Reinforce these scaffolds with superglue: Carefully apply a few drops of superglue along the back and/or cut edges of the scaffolds, using the glue applicator tip or a toothpick to spread it quickly and evenly (fig. 73). Be very careful not to



touch the glued surfaces for several minutes, set them aside in a safe, well-ventilated place to dry.

- 74. There are four copies of piece 159 and four copies of piece 160; the two variations have a slightly different pattern on the yellow side. Fold them all in half and glue shut so that the patterns are on the outside. Keep the pieces separate (fig. 74).
- 75. When the scaffolds are completely dry, glue pieces 161 and 162 to their reverse sides. Be sure to match up the ends properly with the other side (fig. 75).
- 76. Using the marked guidelines on the yellow panels, glue the panel sections to the scaffolds as shown (fig. 76). The yellow side should face and peek through the scaffold, the black side face out, and the triangular tabs point toward the center beam of the scaffold, with a very small gap in between the left and right panels.

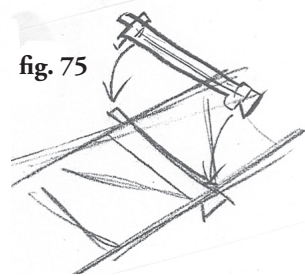


fig. 76

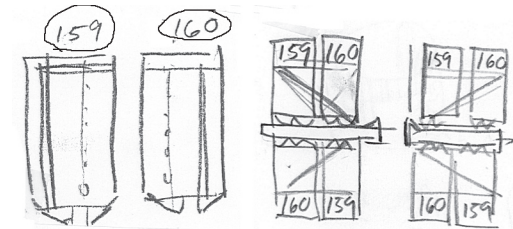
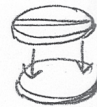


fig. 77



- 77. Glue pieces 162 and 163 together back-to-back to make the solar panel connector. Do the same with pieces 164 and 165 (fig. 77).
- 78. Roll piece 166 into a thin cylinder, rolling it tight enough to glue down the free end at the marked line, making a narrow tube with an outer diameter of about 4mm. You only need to apply glue to the last free inch or so of the paper (fig. 78). Repeat with 167. TIPS: Pieces 166-170 may be easier to make if printed/photocopied onto a piece of thinner paper, like standard typing paper, instead of the heavier paper used in the rest of the model. Try rolling pieces 166 and 167 up around a small dowel, with a diameter or no more than 2mm, removing the dowel after the cylinder is glued.

fig. 78



fig. 79

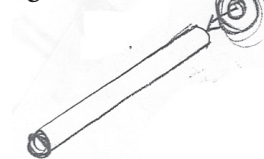


fig. 80

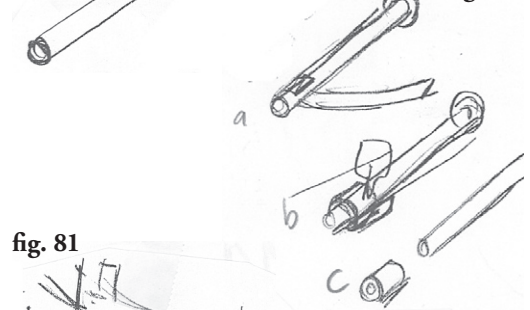


fig. 81

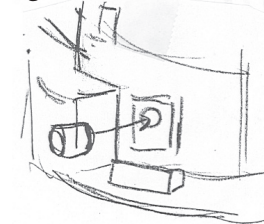
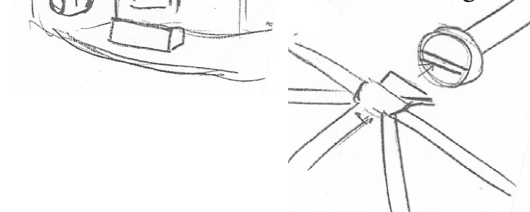


fig. 82



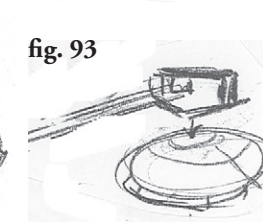
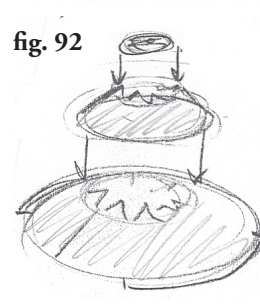
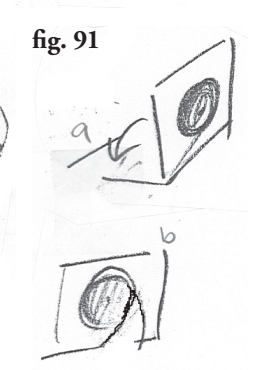
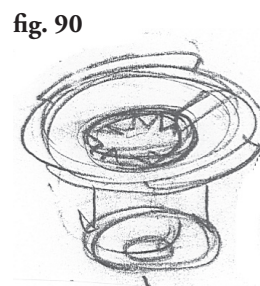
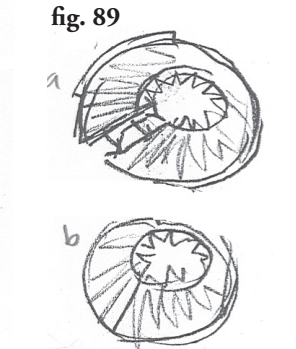
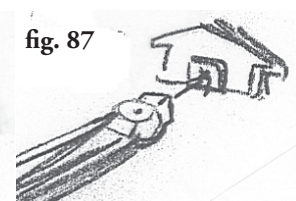
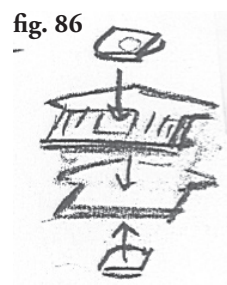
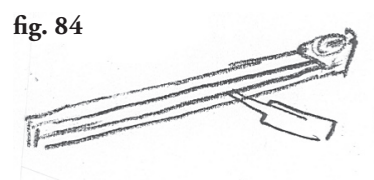
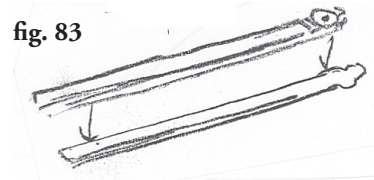
- 79. Glue the solar panel connector disk to one end of your cylinder to make the solar panel arm, leaving the other end free. If one end of the cylinder is smoother than the other, glue the disk to the less-smooth end (fig. 79).
- 80. Roll piece 168 very tightly around the free end of the cylinder into another short tube, so the grey side faces out. It's important that it's a snug fit. Glue down the free end of the strip, being careful not to accidentally glue it to the longer cylinder. When it's secure, slide it off the larger cylinder (fig. 80). You now have a short tube that fits exactly over the end of the solar panel arm. Repeat with piece 169 and the other cylinder.
- 81. One at a time, glue one end of the small cylinder to the circle marked on the solar array connector (pieces 106 and 108) on the forward shroud and let dry thoroughly (fig. 81).
- 82. Complete the solar panel array by gluing the scaffold to the arm via the connector disk. The flat end of the center beam of the scaffold is glued where marked on the disk (fig. 82).

When your model is complete, the free end of the solar panel arm should fit exactly into the “socket” on the forward shroud (fig. 97).

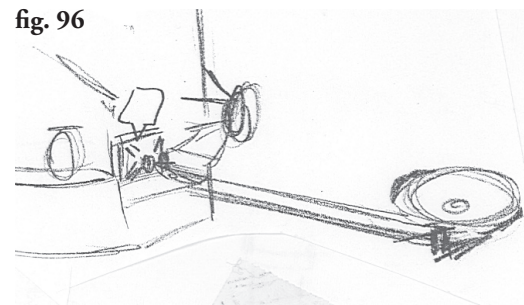
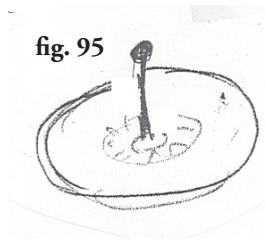
The model’s solar panels can rotate into position just like those on the real Hubble Space Telescope. In orbit, the solar panels are aimed towards the sun, while the open end of the telescope is usually points away from the sun.

High-gain antennas (HGA)

- 83. Glue the beams pieces 170 and 171 together back-to-back (fig. 83).
- 84. Reinforce the beams along the cut edge with superglue, as you did with the solar array scaffold, being very careful not to touch the glue or the glued surface until dry (fig. 84).
- 85. Repeat the last two steps with pieces 172 and 173, and set both aside to dry.
- 86. Glue pieces 174 and 175 back-to-back. Glue piece 176 to one side and 177 to the other (fig. 86). Repeat with pieces 178-181.
- 87. When all parts are completely dry, glue the round end of one beam to the star on the smaller assembly (fig. 87). Repeat with the other two pieces and let dry thoroughly.
- 88. Color the back side of pieces 182-183 and 185-186 with a black marker. Cut out the outer dish 182 without scoring any of the glue tabs. If you have a thick marker, especially one with a pointed cap, wrap the piece around it lightly to curl the paper into shape (fig. 88).
- 89. Carefully glue the long tab underneath the free end of piece 182 so it forms a shallow “cone” with a hole in the middle (fig. 89).
- 90. Do the same with piece 183. Use the glue tabs on the larger dish to glue the two sections together into a small bowl-like shape (fig. 90)
- 91. Fold piece 184 in half and glue shut before cutting out the circle, for extra reinforcement (fig. 91).
- 92. Use the glue tabs on the dish to attach the circle in the center (fig. 92).
- 93. Glue the completed dish onto beam assembly as shown (fig. 93). Set it aside and let it dry thoroughly.
- 94. Repeat steps 81-85 with pieces 185-187.



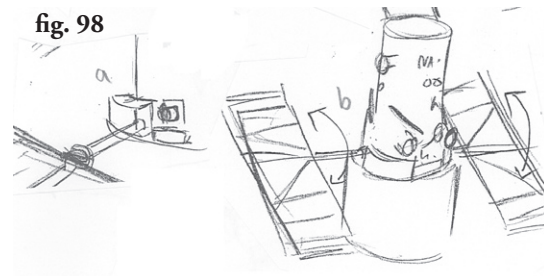
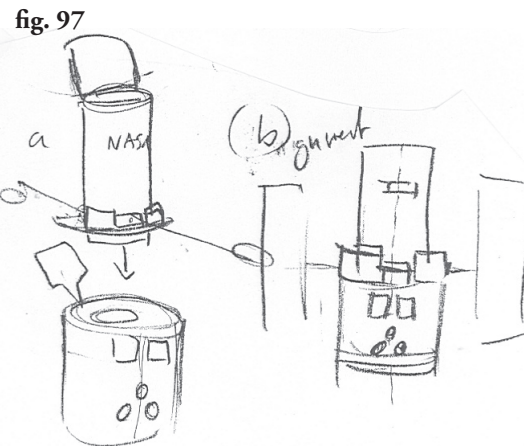
95. OPTIONAL: if you can find round-headed sewing pins, you may want to add them to the radio dishes as an extra detail. If the pins are longer than 1" carefully use sharp scissors or wire cutters to trim them down. Color the pin black (or at least the head of the pin) and glue the point of the pin into the center of the dish (fig. 95).



96. Test-fit and then glue the antenna into place on the forward shroud one at a time: Insert the free end of the antenna beam in between the brackets of the HGA hinge on the forward shroud (pieces 112 and 114). For a good hold, apply glue to the end of the beam and to the inside of the brackets, and pinch the brackets together until everything dries. Make sure one of the dishes is pointing up and the other is pointing down (fig. 96).

On the real Hubble, the dishes are usually pointing in different directions, in order to better stay in contact with different communications satellites.

97. Connect the forward shroud to the aft shroud, using the aft shroud connector as a guide. Glue the two halves together so that the NASA/ESA logo is in a straight line with the three black circles on the aft shroud (fig. 97).
98. Insert the solar panels into their sockets and rotate into a position you like (fig. 98). TIP: The black surface of the panels has the solar receptors, and is usually facing away from the open end of the telescope.
99. When all glue is completely dry, you can add a protective varnish to protect your model from fingerprints. In a well-ventilated area and following all instructions on the can, spray the model all over with a clear matte aerosol varnish and let it dry thoroughly.



The exterior of the model is now complete!

If you want to make the internal parts of the telescope, continue on to the next section. Otherwise, your model is now ready for display.

We want to hear from YOU!

If you've finished a model, why not share it with the world? Take a picture and send it in; we may post it on HubbleSite. Please visit the model gallery for details and to see what other people have made

www.hubblesite.org/go/model