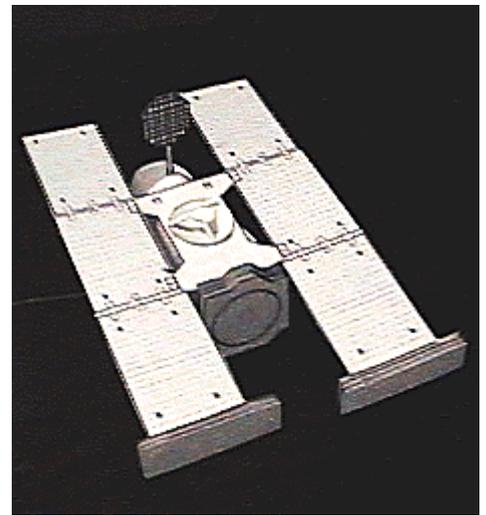


# A Detailed 1/26 Scale Model of the **Stardust Spacecraft**

## That You Can Download and Build

You've read all about Stardust on these web pages.

Now, here's a really good way to learn all about the spacecraft... **Build one!**



This free model is designed for anyone who wishes to learn more about the Stardust Spacecraft, although it is probably not appropriate for children less than about ten years of age to build unassisted. It has all of Stardust's major components, and shows both its scientific instruments. You'll see first hand how the spacecraft shields itself from fast-flying comet debris. That's an assembled one in the photograph on the right.

Stardust, like all interplanetary spacecraft, was designed for high structural strength, minimizing mass. That makes it possible to reproduce its mechanical design with remarkably good fidelity, using only paper! The image at right shows the paper model assembled from pages which you can download. Its scale is about 1/26.

You can go ahead and download the Stardust Scale Model right now. The parts are contained in a "Portable Document Format" (pdf) file, which you can read using the Adobe Acrobat Reader software.

### **Here's how it works:**

First browse the illustrated Assembly Instructions. Read through them to see if this project is going to be right for you. If you decide to continue, then...

Next, print the Parts file using your black & white printer, onto card stock. Cut out the parts, fold and glue according to the instructions, and you'll have an accurate scale model of the Stardust Spacecraft. Most of the parts can be cut out using scissors, but in some places for best results, a sharp art knife should be used. This, of course, requires close adult supervision if a child is working on it. Regular white glue is recommended.

The pages are designed to be printed on 8.5x11-inch sheets, or A4 size sheets.

This model not by any means a quick and easy assembly job; it's serious model building. It offers an opportunity to spend a good amount of quiet time learning all about Stardust. Probably four hours would be a minimum assembly time.

# Assembly Instructions

Version 1.5

This is a detailed scale model of the Stardust Spacecraft, which is flying its mission to sample and return matter from a comet. Assembly is a project which is probably not appropriate for people younger than about ten years of age, depending on skill and motivation. The image above shows a completed scale model.

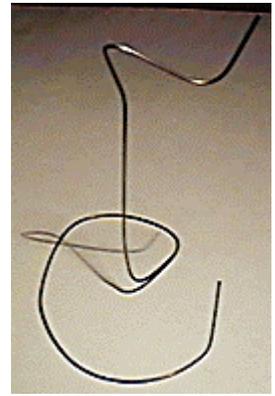
The Parts Sheets are available to download from the same web site offering these instructions:

<http://stardust.jpl.nasa.gov/classroom/model>.

## A. YOU'LL NEED THE FOLLOWING:

- White paper card stock (also called "cover" stock, about the thickness of a postcard) which your computer's printer can accept (or, if your printer can't accept card stock, maybe you can find a copy machine which will, so you can copy the parts sheets from plain paper to card stock).
- Scissors, to cut some parts from the parts sheets.
- A pair of miniature long nose pliers.
- An art knife, such as X-Acto #11, with a sharp new blade, and a proper pad on which to cut. This will be needed to cut some parts from the parts sheets, and to trim sections of soda straw. **Adult supervision is required** for children using sharp tools. **Caution:** one can injure oneself, as well as the furniture, with an art knife! You can avoid injury by being very careful, by cutting in a way that does not move the blade towards your skin, and by asking an experienced person for help.
- Wooden toothpicks for applying glue.
- Scotch Tape or equivalent.
- Glues. Use regular white glue (Elmer's Glue-All or equivalent). You might instead try a thick white glue, sold in art and fabric stores, called "TACKY GLUE" (Aleen's or equivalent).
- You will also need a glue stick (UHU or equivalent) which has a low moisture content (these instructions will show you when to use it).
- Space. Set up a well lighted, comfortable work area, with room to set glued parts to dry.
- Time. Plan to set aside several hours for unhurried assembly. It may take eight hours or more to assemble your Galileo Scale Model.
- Patience. There may be some trying times. If so, remember that extra time and care will pay off with a surprisingly accurate, and handsome representation of NASA's Stardust spacecraft.
- Optional: Some gold material would add realism to your model. Stardust was equipped with gold-colored blanketing for thermal control and micrometeoroid protection. If you want to add this detail, you'll be on your own: look at all the pictures of the Stardust Spacecraft on the web, and add the gold-colored blanketing your model as accurately as you can. Gold-colored foil/paper, such as gift wrap is one choice of material for this. Another may be aluminized yellow plastic film, such as you might find in a metallic colored helium balloon.
- Optional:

- You may wish to fashion a stand for your model. A simple stand can be made by bending a length of wire. Brass wire from a hobby store, or steel wire such as coat hanger wire, will work. About half a meter, or 18 inches, in length is plenty. Such a stand may also be convenient to support parts during assembly. If you choose to work with wire, be cautious to prevent eye injury. This image shows a stand made of soft iron wire obtained from a craft store.
- Optional: You might find it helpful to use an electric hair drier to set the glue in some places. If you do, be very careful not to blow the pieces apart.



## B. BEFORE BEGINNING ASSEMBLY:

- Go to the [Introduction Page](#) to download and print the Parts Sheets onto white card stock. You might also wish to print these instructions, if it isn't convenient to refer to your computer during assembly.
- Examine all the parts, and read their names.
- Read all of these instructions. Compare model parts with the illustrations.
- Have a look at some [information](#) about the Stardust Spacecraft and its mission.

## C. IN GENERAL:

- What to cut out? Each part is drawn against a shaded background. This shading appears grey when printed on a black & white printer. Each part should be completely cut away from its shaded background. Some parts have areas within them of shaded grey. These areas should be cut out of the part. Spacecraft details are printed on most of the parts. Don't confuse these with background shading. If there's any question, look at it on a color computer monitor: all the background shading appears blue: if it isn't blue, don't cut it away.
- When you finish cutting out a part, flatten it.
- Any folds will be made in the direction away from the printed side, leaving the printed side facing out.
- Score for folding, where directed.
- Scoring will help make a neat model, with straight, clean folds. To score a part, place a metal straight edge along the line on the part as instructed, then lightly scratch along the line with an art knife, guided by the straight edge. Be careful not to cut through the paper, but just break the surface. You almost don't have to press down at all with the sharp art knife. After scoring, the fold will be in the direction away from the scored side.

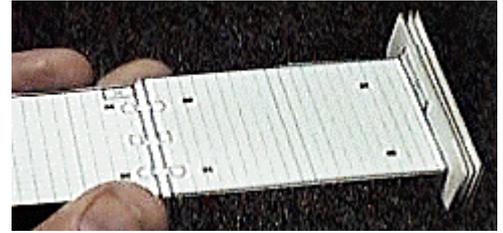


# 1. ASSEMBLE THE SOLAR PANELS.

See illustration of a completed Solar Panel at bottom of this page

Print the Parts Sheets onto white card stock.

Cut out a Solar Panel from Parts Sheet 1. Cut along the black outline, removing the part from the grey background.



Cut out a Panel Stiffener from Parts Sheet 1. Using a straightedge, score lightly along its center line. Fold lengthwise, making it L-shaped in cross section.

Apply glue using a glue stick outside along the length of one side of the Panel Stiffener. Use only a low-moisture glue to prevent warping. Press the glued Panel Stiffener along the center of the underside (the non-printed side) of the Solar Panel part. Adjust the panel so it is nice and flat.

(Note: the panel stiffener helps support the solar panel on your model in Earth's gravity. It does not appear on the actual spacecraft.)

Cut out the four rectangles of one Whipple Shield from Parts Sheet 1. As with all parts, flatten them after cutting out. Cut out one long thin rectangle labelled Shield Spacers from Parts Sheet 1.

Cut the Shield Spacer at each of its five black lines, to make six small rectangles. Bend each tiny rectangle in half to form an L-shape.

Glue two small L-shaped spacers to the L-shaped lines on a Whipple Shield rectangle. When dry, glue a second Whipple Shield rectangle down on top of the spacers, aligning it with the rectangle below it.

Repeat this step, stacking up all four Whipple Shield rectangles, separated by L-shaped spacers. The top shield rectangle has no L-shaped lines.

At the end of the Solar Panel, find the tabs labelled Y and Z. Cut between them, and fold one up 90 degrees, and one down. Apply glue to the outside of both tabs (the side facing away from the solar panel), and glue it to the completed Whipple Shield, centering it as shown in the image.

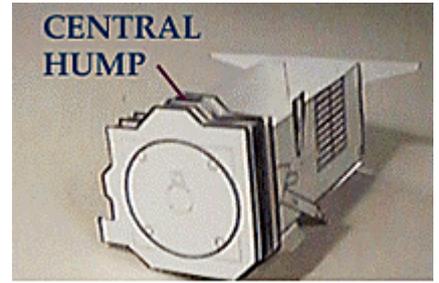
Repeat the above steps to complete the second Solar Panel.

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## 2. ASSEMBLE THE SPACECRAFT BUS.

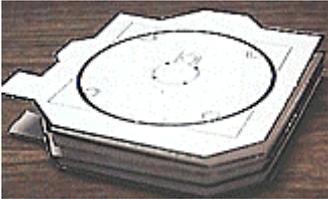
See illustration of the completed Spacecraft Bus at the bottom of this page

Cut out the part marked REAR from Parts Sheet 2. Cut out the three parts marked MID, and the FRONT Whipple Shield. These five pieces will stack to become the Main Whipple Shield.



Cut out one long thin rectangle labelled Shield Spacers from Parts Sheet 2.

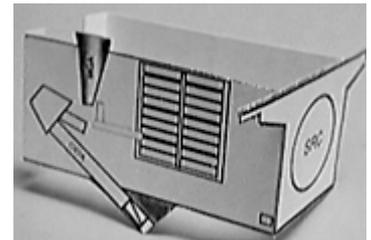
Cut the Shield Spacer at each of its seven black lines, to make eight small rectangles. Bend each tiny rectangle in half to form an L-shape.



Glue two small L-shaped spacers edgewise to the L-shaped lines on the Whipple shield marked REAR. (One way to do this is to pick up the spacer with long-nose pliers and dip its edge into glue.) When dry, glue a Whipple Shield marked MID down on top of the spacers, aligning its printed square with the printed square below it. Repeat this step, stacking up all five Whipple Shield panels, separated by L-shaped spacers. The top panel, the Front Whipple shield has no L-shaped lines.

Cut out the + Y PANEL from Parts Sheet 2. Score the line connecting the FLAP at each end, and fold the two FLAPS back 90 degrees. Cut out the - Y PANEL, then score and fold its flaps back.

Cut out the - X PANEL from Parts Sheet 2. Glue the REAR FLAPS of the Y PANELS to its non-printed side as shown in the black & white image below of the Spacecraft Bus Assembly in progress.



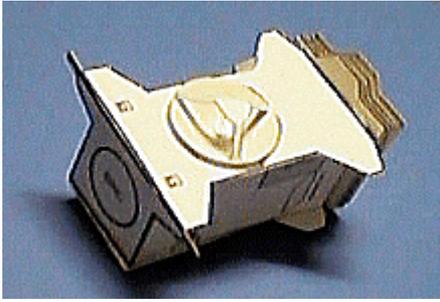
Cut out the -Z PANEL from Parts Sheet 2. Glue it to the bottom of the Bus Assembly. The BOTTOM will be the side BELOW the letters SRC on the - X PANEL in place. Printing faces outward (downward), and the narrow end, with printed louvers, faces rearward toward the - X PANEL. Tabs marked X fold down for gluing inside.

Apply glue to the two FRONT FLAPS on the Spacecraft Bus assembly, and set them against the non-printed side of the Main Whipple Shield. Center the bus within the shield, oriented with the shield's central hump pointing upward as in the illustration.

Cut out the + Z PANEL from Parts Sheet 2. Glue it to the top of the Spacecraft Bus Assembly. The printing faces outward (upward). The end with two square markings (Sun Sensors) face rearward, toward the - X PANEL in place. Tabs marked X fold down for gluing inside.

Hey, the Spacecraft Bus is done!

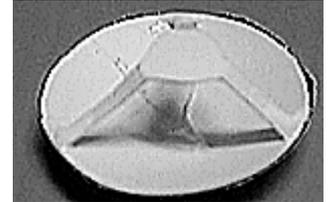
### 3. BUILD AND INSTALL THE HIGH-GAIN ANTENNA.



See illustration of the completed High Gain Antenna Installation at the bottom of this page

Cut out the HIGH GAIN ANTENNA DISH (HGA) from Parts Sheet 3. Be sure to cut out the wedge. Apply glue between the radial black line and the edge of the wedge, then overlap the other side of the wedge over, onto the glue. The circle becomes a cone. Press the seam together until the glue dries. Then crush the tip of the cone a bit by mashing it against a flat surface with your thumb.

Cut out the TRIPOD from Parts Sheet 3. Crease each of its three legs down where they join the central circle. Apply glue to the ends of the legs, and stand it inside the HGA, with the legs very near the edge of the dish. Let the glue dry.



Glue the completed HGA into the circular opening atop the Spacecraft Bus assembly, rotated so that one of its tripod legs points directly forward toward the main Whipple shield.

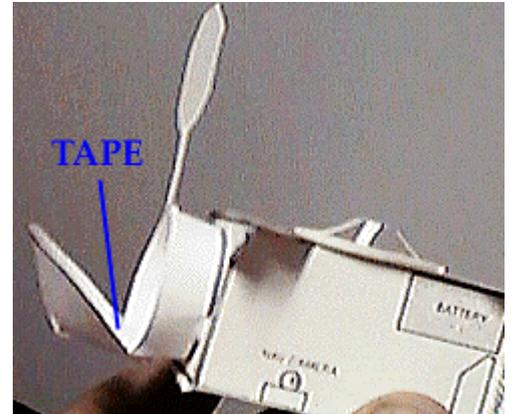
This completes the HGA installation!

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### 4. BUILD AND INSTALL THE SAMPLE RETURN CAPSULE.

See [illustration](#) of the completed Sample Return Capsule Installation at the bottom of this page

- Cut out the SRC BODY from Parts Sheet 3. Apply glue between the radial black line and the edge, where it says GLUE. Then overlap the other end of the piece over, onto the glue. It forms a section of a cone. Place edgewise on a flat surface to make sure the seam is straight before squeezing and holding till glue dries.
- Dip the smaller end of the SRC BODY in glue to wet the edge. Set it onto the circle marked SRC on the spacecraft bus (- X PANEL). Center it and let the glue dry.
- Cut out the SRC HEAT SHIELD from Parts Sheet 3. Be sure to cut out the wedge. Apply glue between the radial black line and the edge of the wedge, then overlap the other side of the wedge over, onto the glue. The circle becomes a cone. Press the seam together until the glue dries. Then crush the tip of the cone a bit by mashing it against a flat surface with your thumb.



### Now you have a choice of ways to complete your model...

If you wish to assemble your model with the SRC closed as if ready to return to Earth, then just glue the SRC Heat Shield onto the SRC BODY, with its cone pointing outward. You're finished with this page; click on to the LET'S FINISH link below.

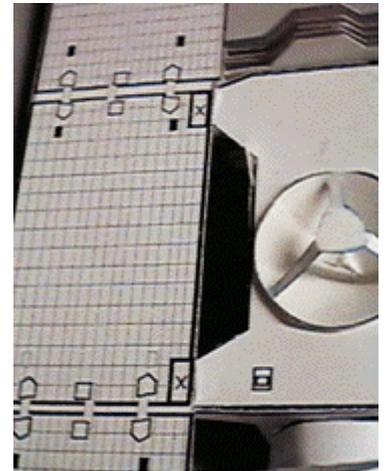
If you wish to assemble your model showing the Aerogel Collector Grid deployed and exposed to collect cometary or interstellar material, then complete the following steps...

- Cut out the AEROGEL COLLECTOR GRID from Parts Sheet 3. Apply glue to the X at the end of its support leg, and glue it to the - X PANEL, inside the SRC BODY, at a point just above the letter R in SRC which is printed there. Adjust the arm and grid to point up out of the SRC BODY as shown below. Let the glue dry.
- Bend the AEROGEL COLLECTOR GRID's support arm so it is vertical, and glue it where it touches the edge of the SRC BODY, just to hold it straight. See the image.
- Take a small piece of Scotch Tape or equivalent, and stick it inside the SRC BODY, extending down and out. Stick it to the inside of the SRC HEAT SHIELD to hold it in an open position as shown. Adjust so it's straight, and then apply some glue where the SRC HEAT SHIELD touches the SRC BODY to hold it in place.
- This completes the SRC installation!

## 5. INSTALL THE SOLAR PANELS.

View the whole [assembled model](#)

- Looking down on the Spacecraft Bus, you'll notice four "shoulders" in the + Z PANEL, outward from where the HGA is mounted. Apply some glue to the tips of those shoulders.
- Locate the two squares marked X on a solar panel. Turn the panel, with printing up, so its Whipple shield is pointing in the same direction as the Main Whipple shield on the bus. Press the solar panel down onto the bus's "shoulders" just below the X. See the image. Squeeze the X onto the shoulder tip with long nose pliers in two places. Make sure the Solar Panel is aligned parallel to the bus, and level with the + Z PANEL.
- Repeat with the other solar panel.



This completes the Solar panel installation!

## E. YOU'VE FINISHED YOUR STARDUST MODEL.

Now that you're familiar with the names of all of the spacecraft's major structures, and its instruments, be sure to thoroughly use the [Stardust](#) web site to learn more about the spacecraft and its mission.

Model design by Dave Doody

An afterhours project. No tax dollars were harmed in the making of this model :-)

8 August, 1999

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