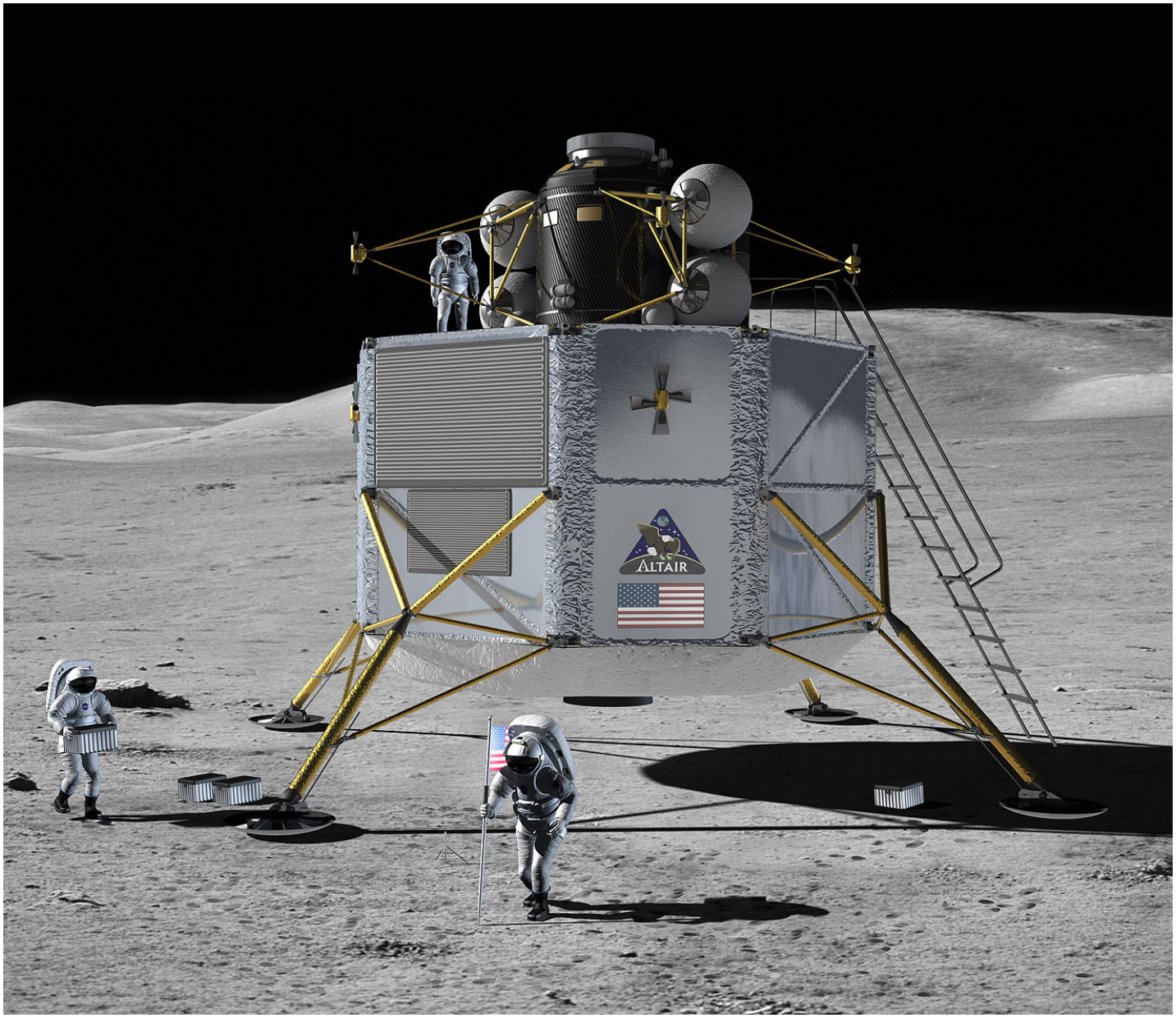
Instruction Manual: Space Launch System

Altair Lunar Lander (2008 version)

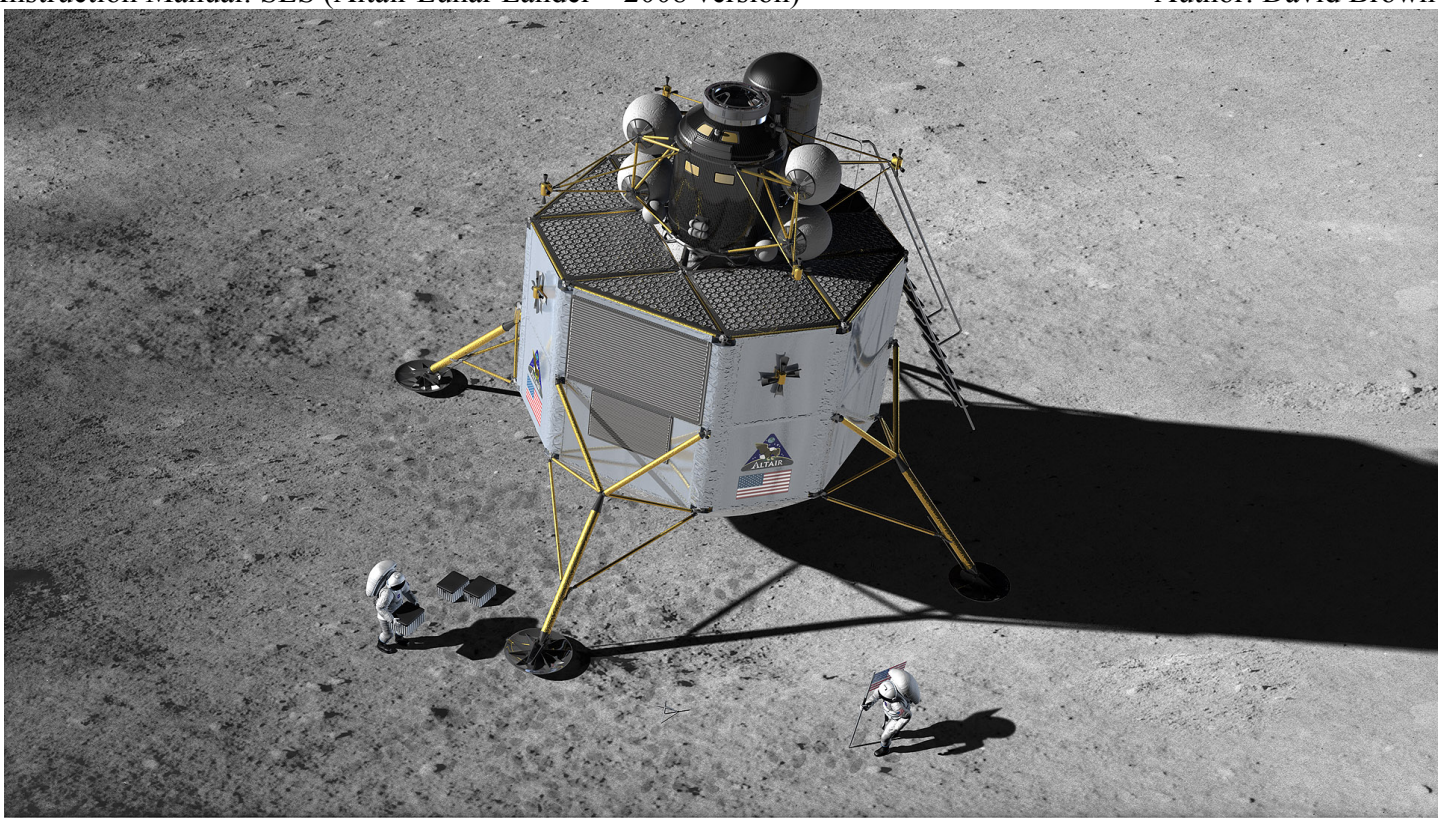
Designer's comments: This model has been designed without the benefit of engineering blueprints. Only publically available conceptual diagrams and illustrations have been used. As a consequence of this, a certain degree of 'artistic licence' has been used to create a model that exhibits at least a modicum of realism.

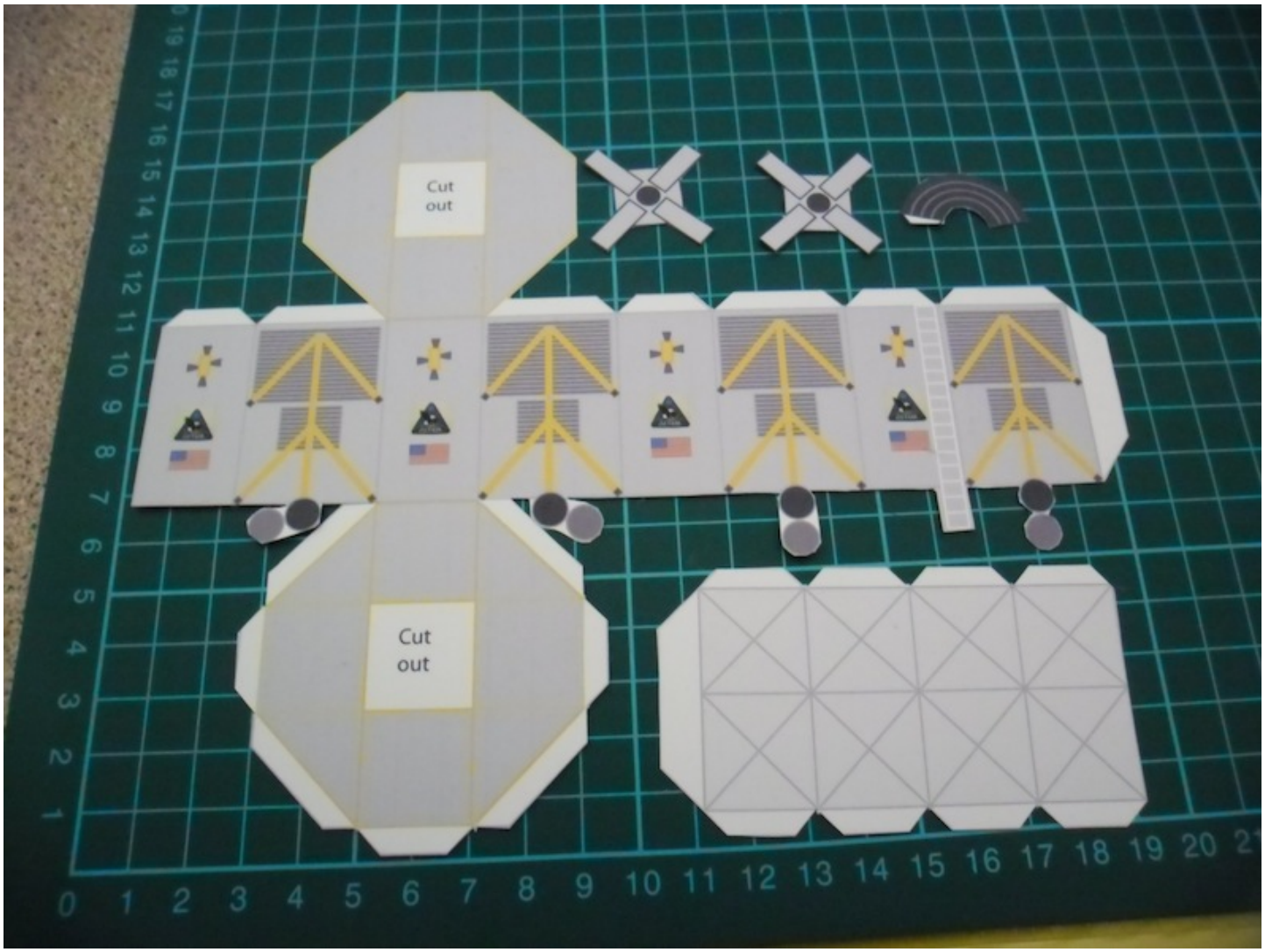
The assembly of a model should follow a procedure that vaguely resembles the method for cooking a meal; i.e.

- Prepare a place where you can work, without distractions.
- Get all of your equipment (utensils) out and ready.
- Get all of your parts for the model (ingredients) printed, cut out and ready to start.
- Lastly, try to have a location for your model prepared in advance, so that when it is finished, you will know where to place it.

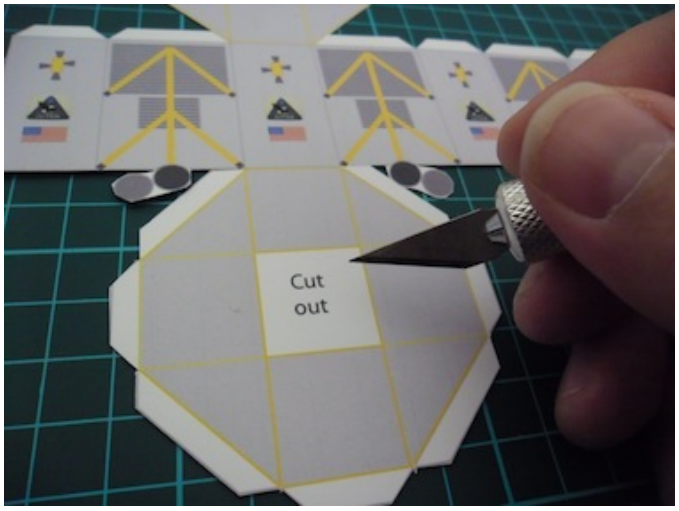


This model is based on the 2008 design concept for the Altair Lunar Lander. (Image credit: NASA).

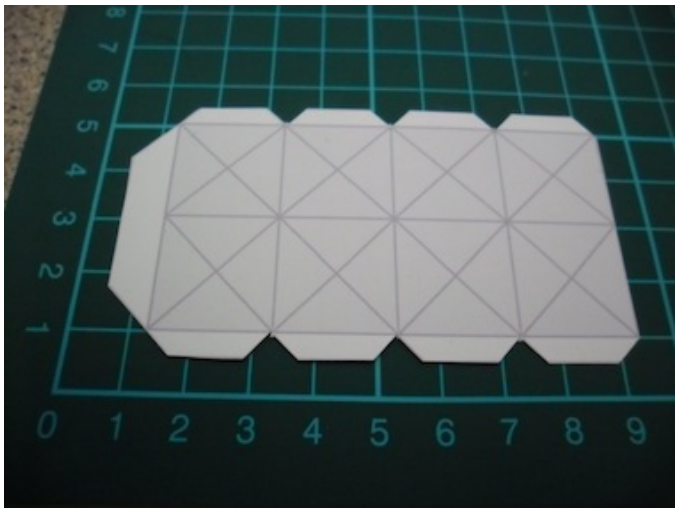




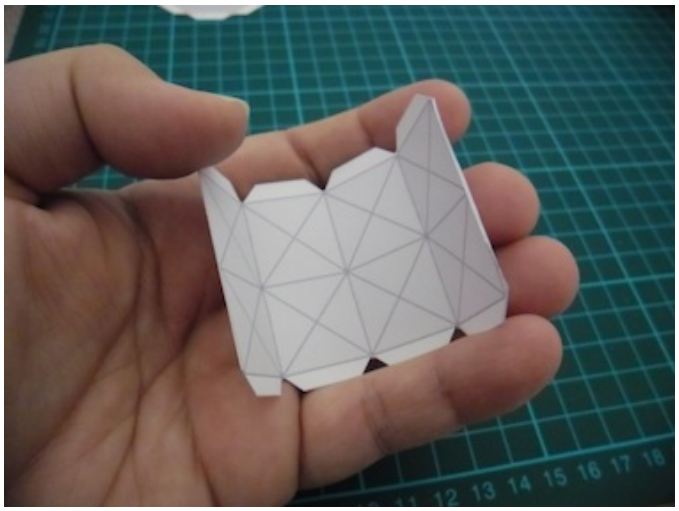
1. These are the parts necessary to construct the Altair descent stage (SLS launch version).



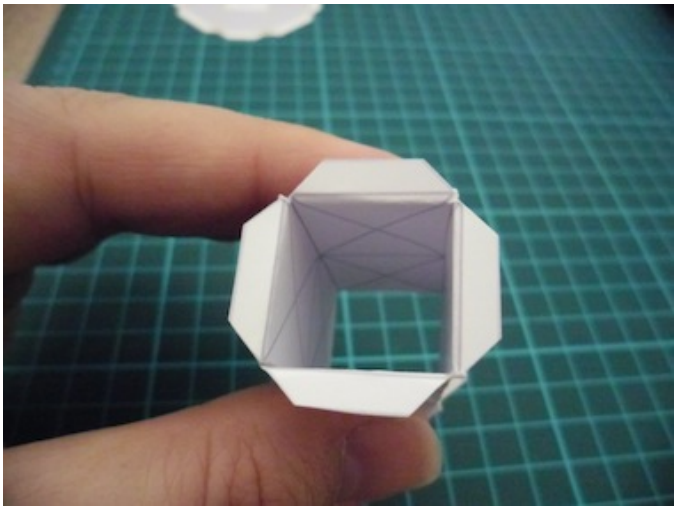
2. Cut out the white squares in the centre of each octagon section.



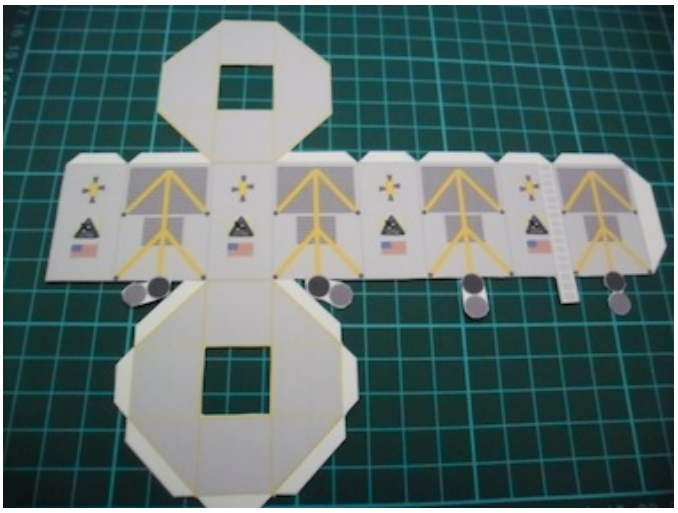
3. This part forms a rectangular "tube" which is to be placed in the centre of the decent stage.



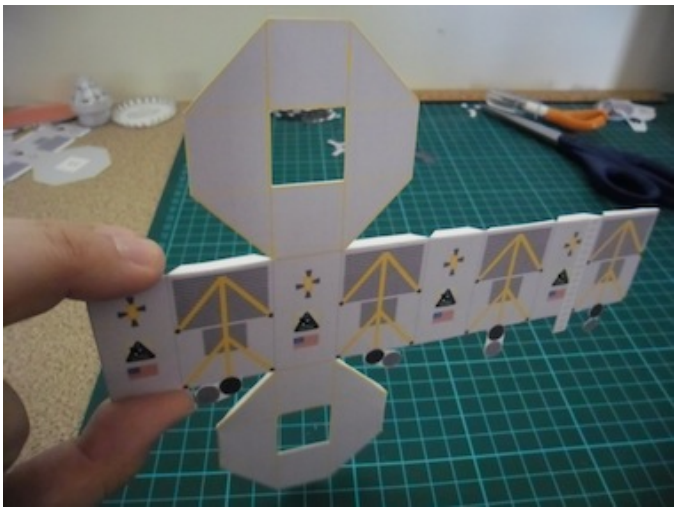
4. Fold the part into four rectangular lengths.



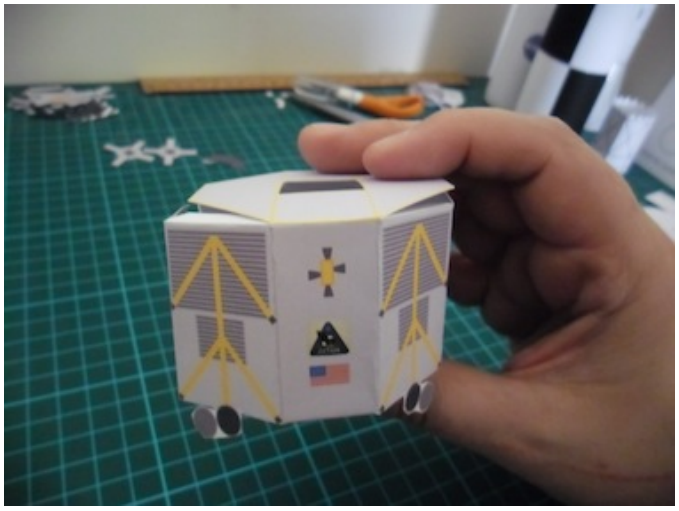
5. This is what the part looks like when glued into a single "tube."



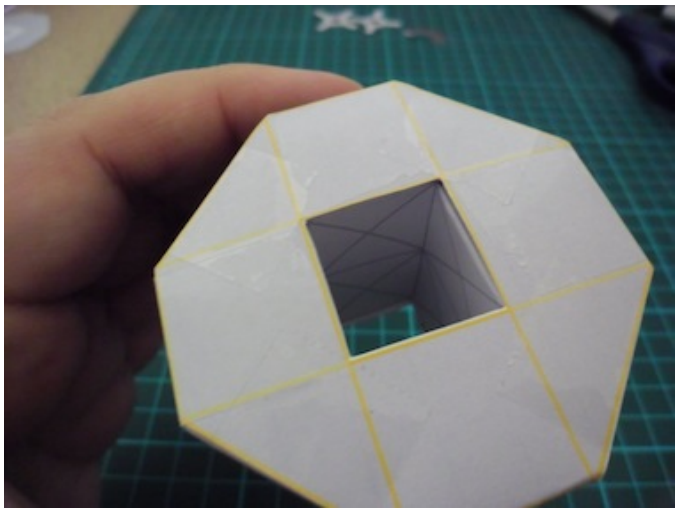
6. This is the exterior of the descent stage, ready to be folded and glued into the final form.



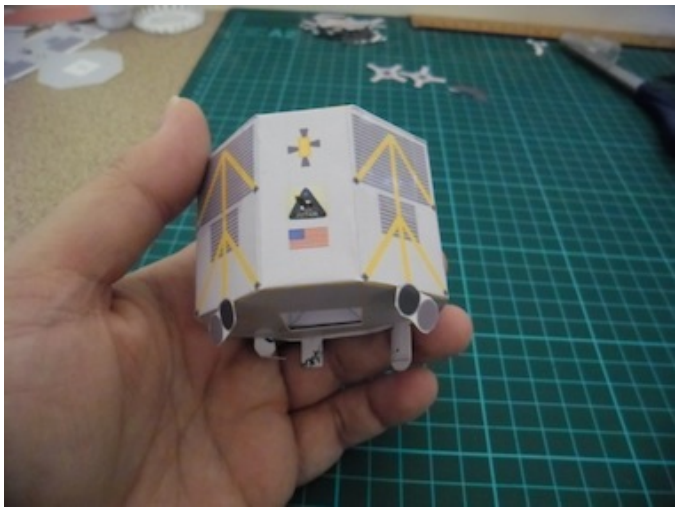
7. The white glue tabs need to be folded at a 90˚ angle to the sides of the descent stage.



8. When the sides are folded, the overall final form is a simple mathematical shape: an octahedron.

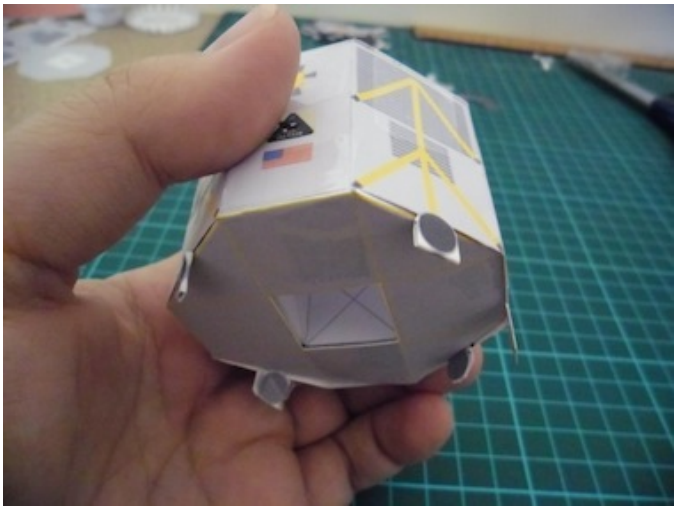


9. The centre “tube” is also glued into position, creating a “tunnel” from the top to the bottom.

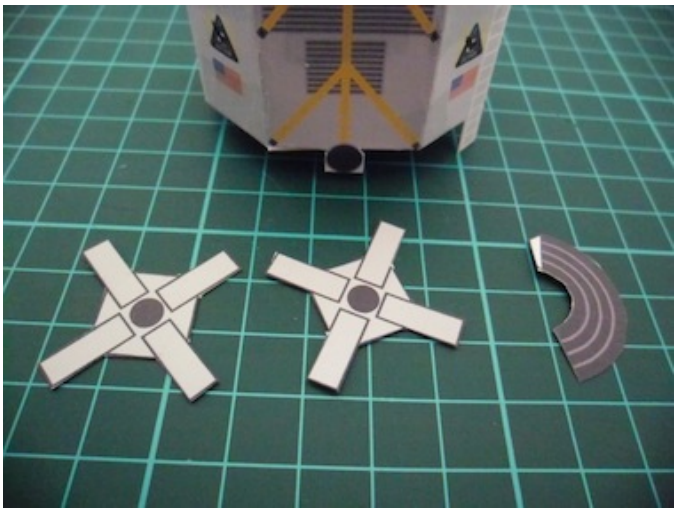


10. When glued together, the only remaining parts to finish will be the “feet” on end of the landing legs.

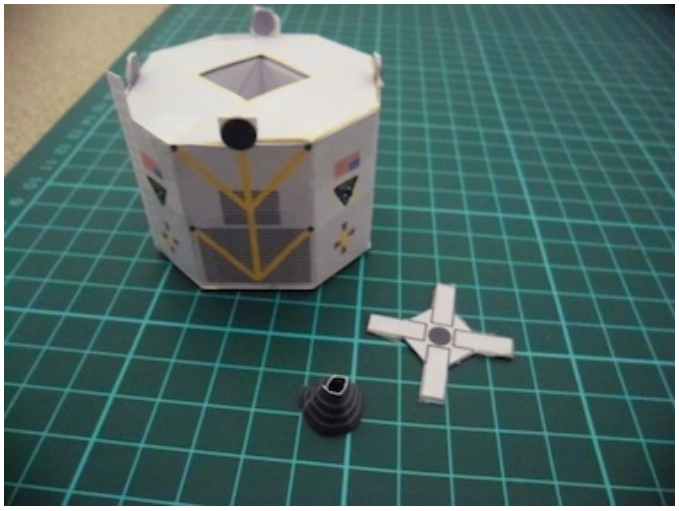
11. On one side of the descent stage, there is a simple ladder. The end of this ladder should not be touched or folded.



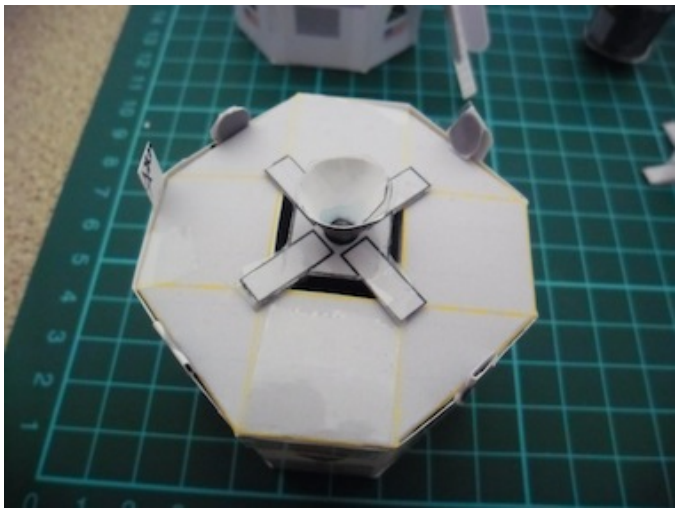
12. This is the underside of the descent stage, with the “feet” folded and glued together.



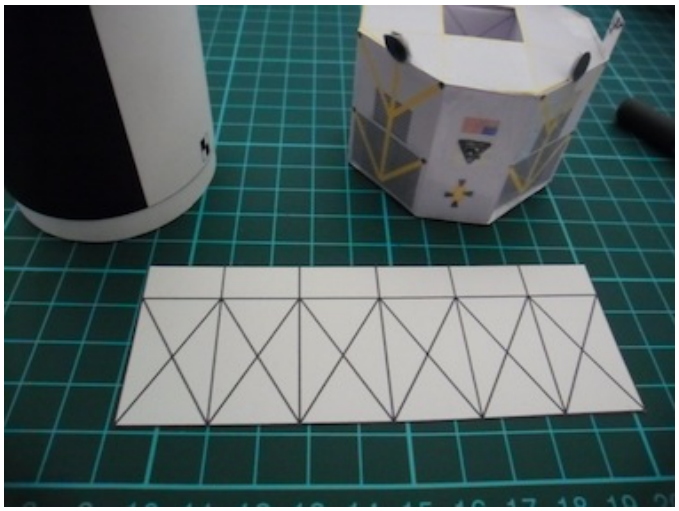
13. These parts form the descent stage engine. Glue the two cruciform parts together to form a brace.



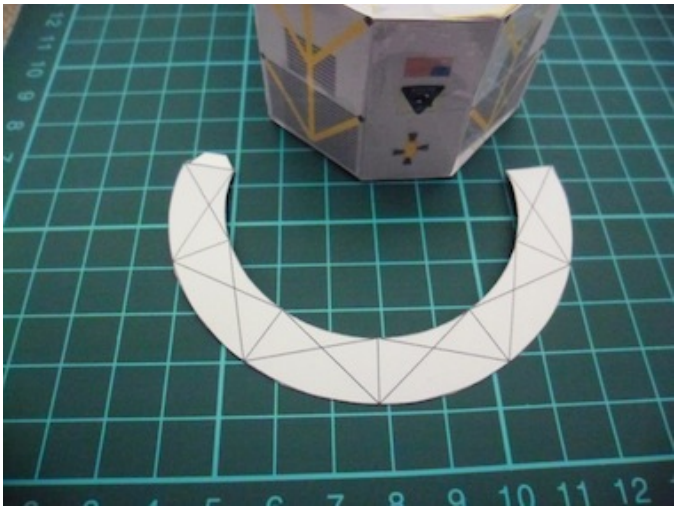
14. The engine is curved into the shape of an "engine bell" and is then ready for gluing.



15. This is what the engine of the descent stage should look like. Notice the gaps around the engine.



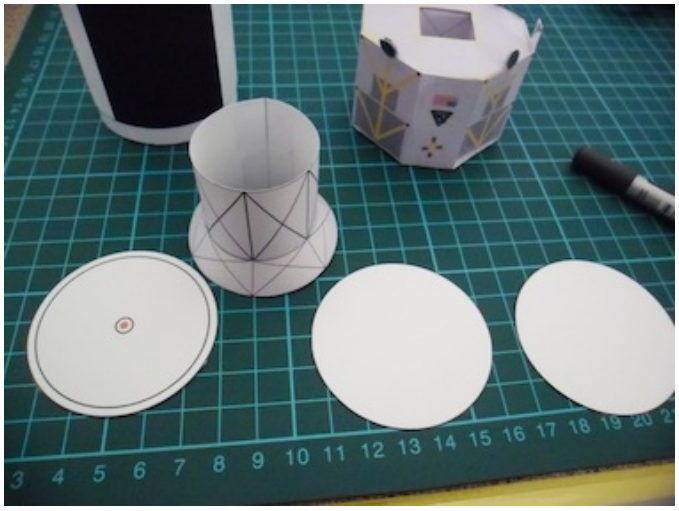
16. The necessity of having a "test stand" for continued assembly means that you will need to construct the payload support scaffolding for the third stage booster.



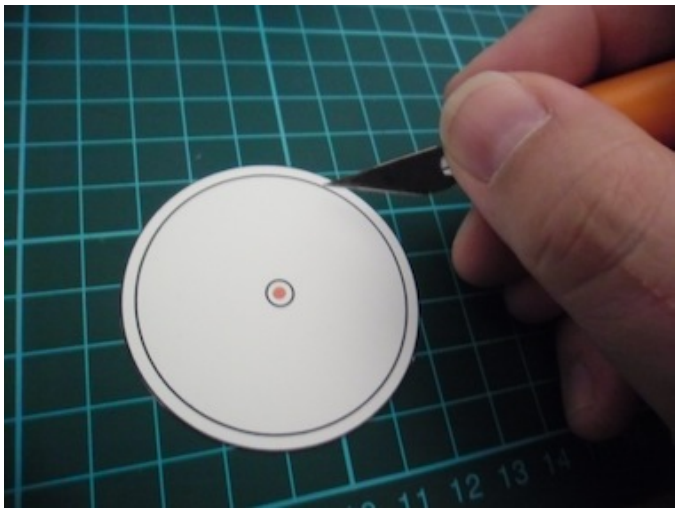
17. This part forms a cone around the payload scaffolding.

18. These two parts are the minimum that are necessary to construct a "test stand" for the Altair.

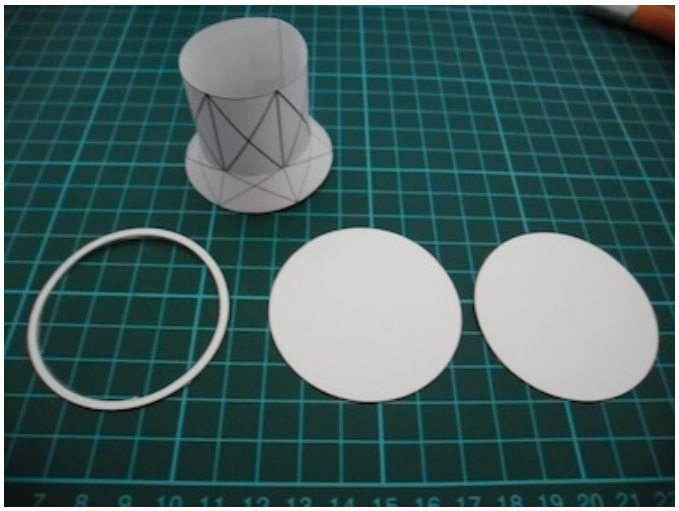
19. This is the finished "test stand" – however, further parts will be required to complete the third-stage payload scaffolding.



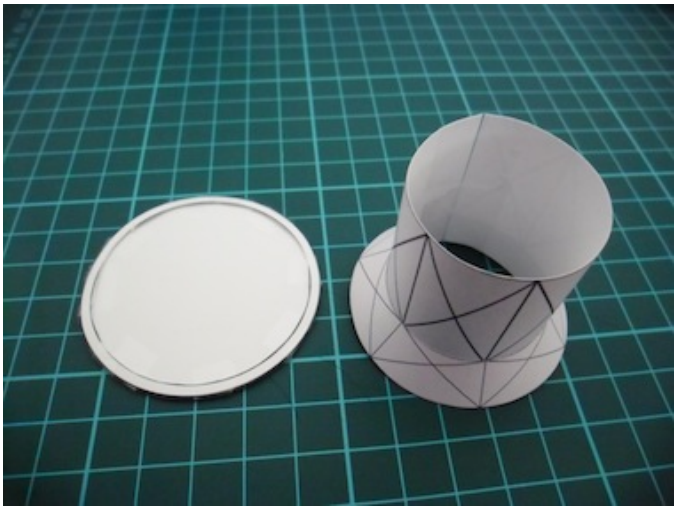
20. The above parts are needed to complete the payload scaffolding.



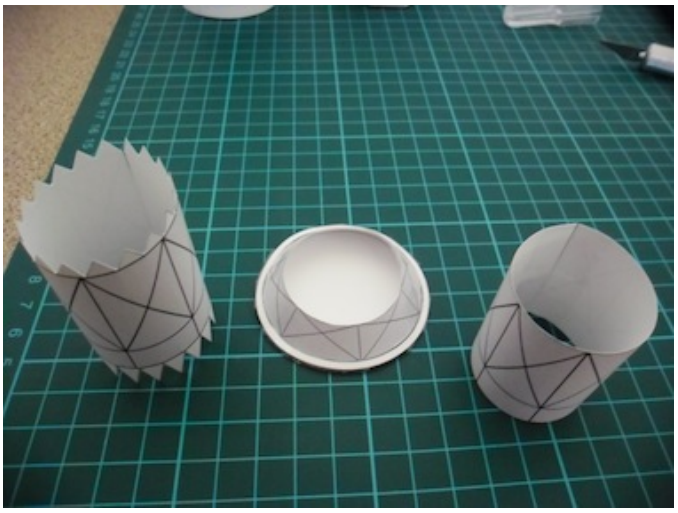
21. Cut out the centre of this circle, leaving a thin ring.



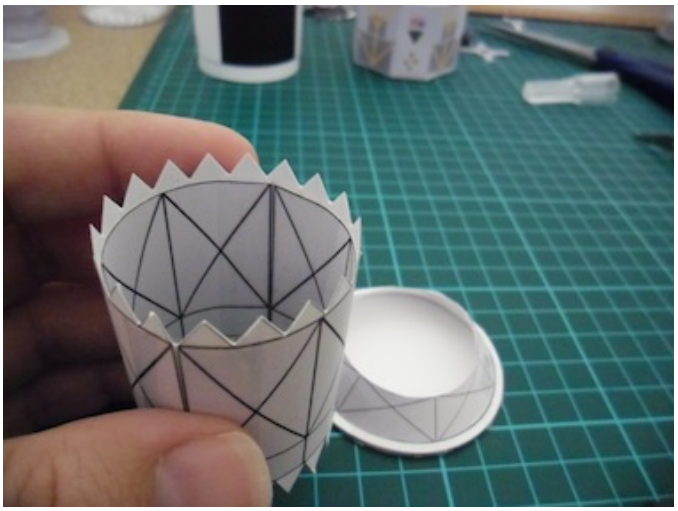
22. The ring and the two support circles need to be glued together, with the ring on the top.



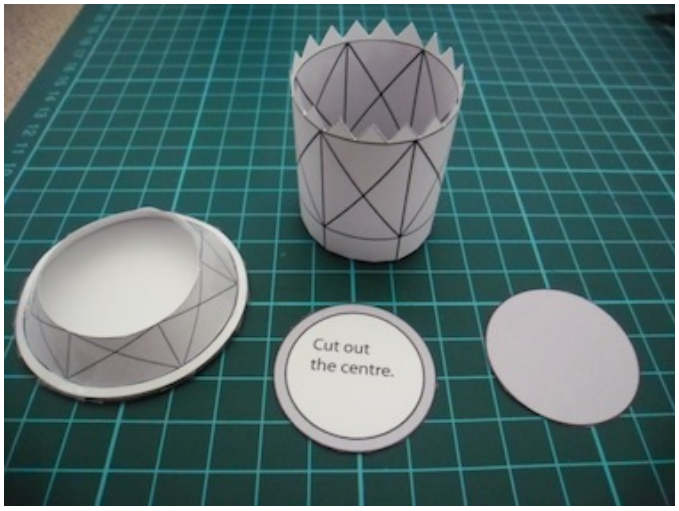
23. The base can now be glued to the payload scaffolding.



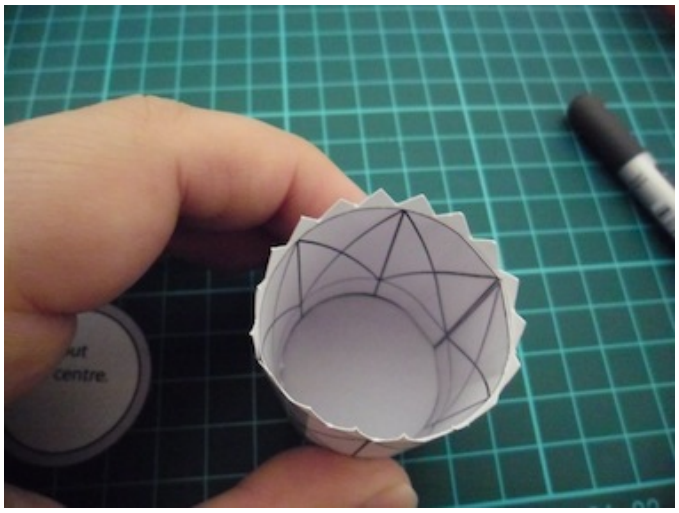
24. For additional detail, glue the interior to the exterior portion of the payload scaffolding.



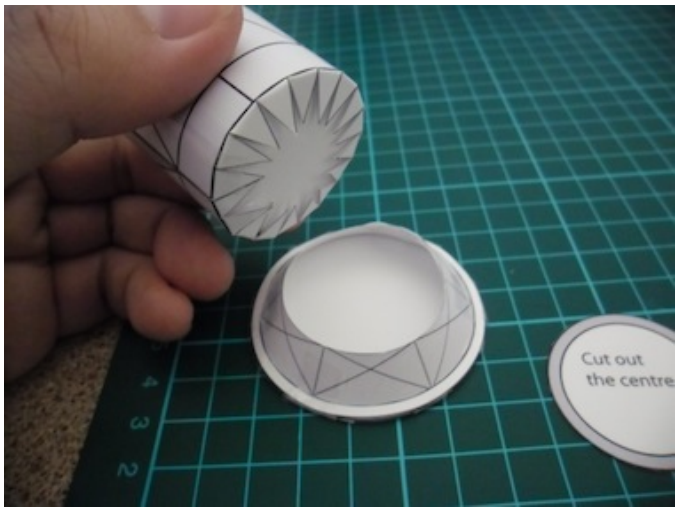
25. If you want the model to have greater detail, you may choose to glue the interior to the exterior prior to Assembly Step #18 (see previous page).



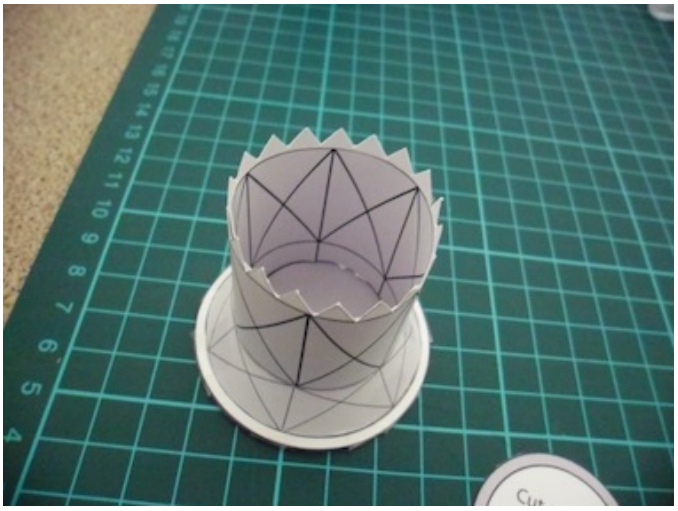
26. These are the parts needed for the final assembly of the payload scaffolding.



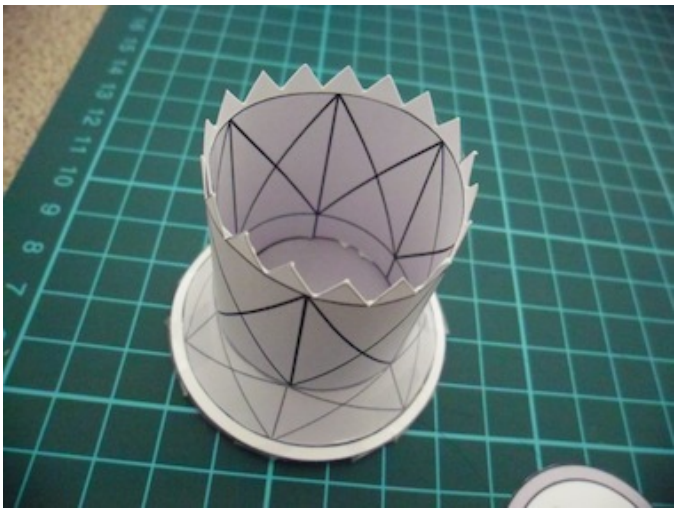
27. The grey circle is glued inside the payload scaffolding, creating a base for the scaffolding.



28. the base of the payload scaffolding is now [gently] placed in the centre of the cone.

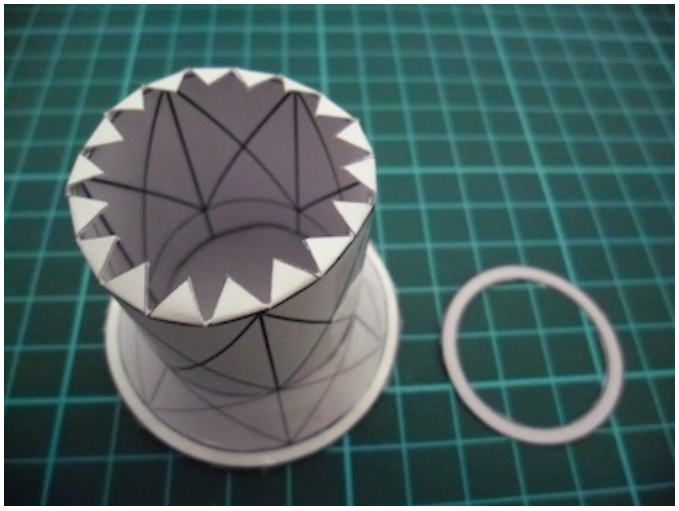


29. It will be a tight fit but the scaffolding should fit into place (if you have cut the parts correctly).

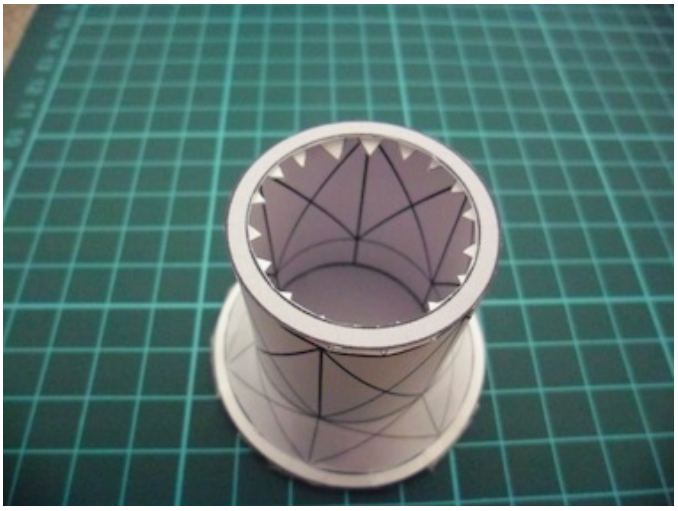


30. The triangular glue tabs will need to be folded inward to allow for the attachment of another part.

31. Cut out the white centre of the circle, leaving a small ring.



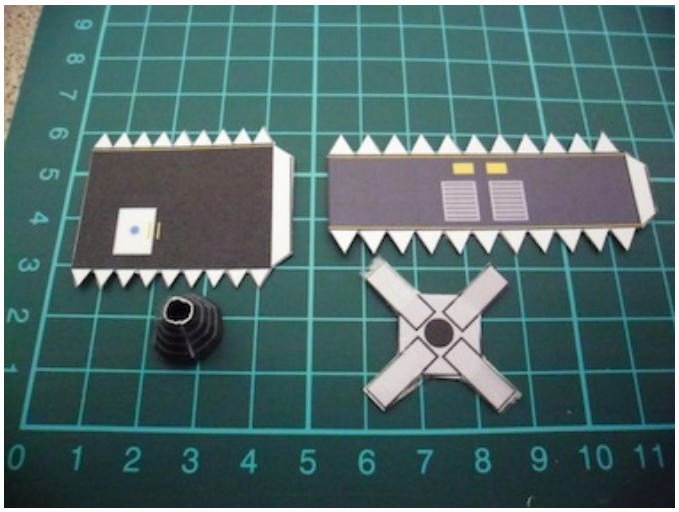
32. You may want to trim the small triangles prior to gluing…



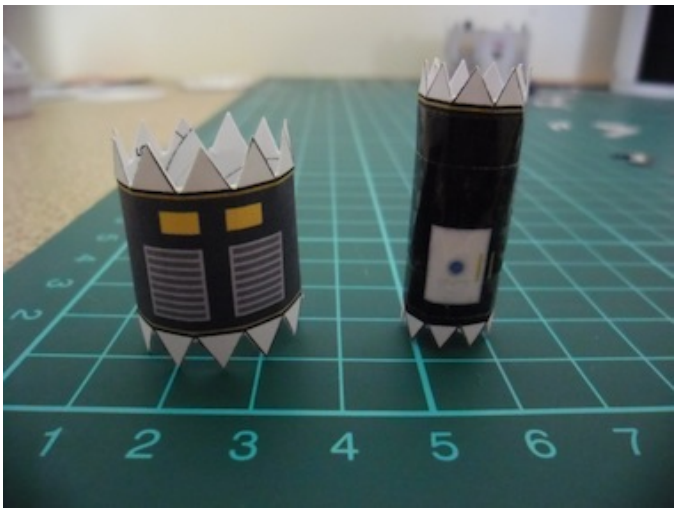
33. … otherwise your model will have several small "teeth" protruding into the circular cavity.

34. This is what the finished Altair descent stage should look like when placed on top of the payload scaffolding… and placed on top of the third stage. The 10-metre payload shroud is being held next to it to provide a comparison of the relative size of each model / part – and to show how much additional volume within the payload shroud will be available to accommodate any other models on top of the descent stage.

35. These are the parts for the Altair Lunar Lander (ascent stage). These parts are extremely small and will require the use of tweezers to manipulate them.

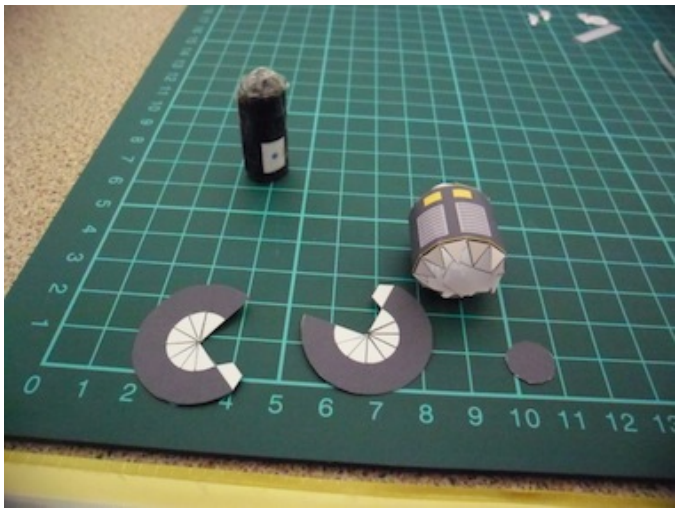


36. The ascent stage engine and cruciform brace are identical to those used on the descent stage. The other parts form the cylinders of the ascent stage.

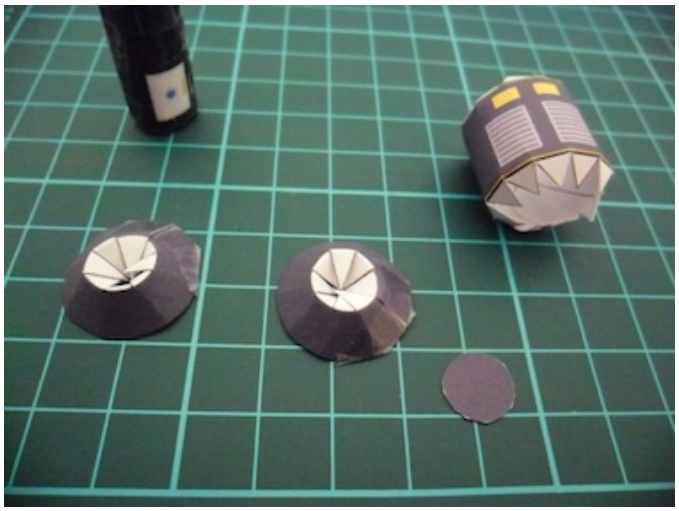


37. The two cylinders are the habitat (left object) and the airlock (right object).

38. The cone part and the circle necessary to form the conical top section of the airlock.



39. These three parts (the two cone parts and the circle) form the two conical end-caps on the habitat.



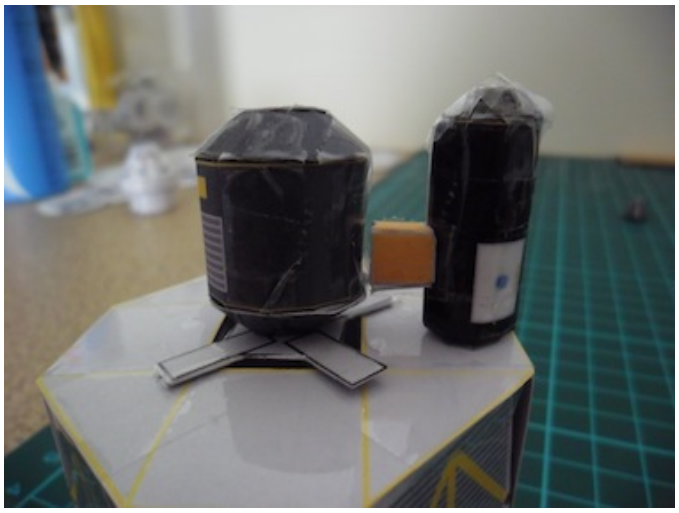
40. The two cone parts now formed and ready to be glued to the cylinder.

41. One cone (right) has the circle glued onto it, while the other is used as a base for the habitat.

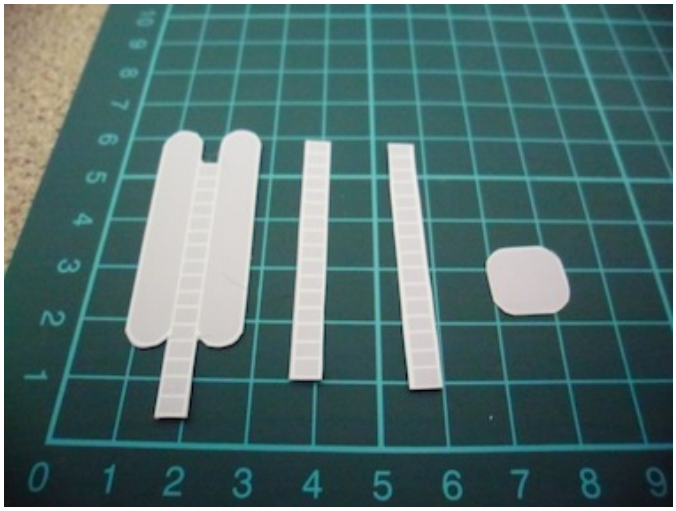
42. The orange-coloured part is the connecting tunnel between the airlock and the habitat.

43. This is the completed tunnel section, ready for gluing to the airlock. Do not glue to the habitat!

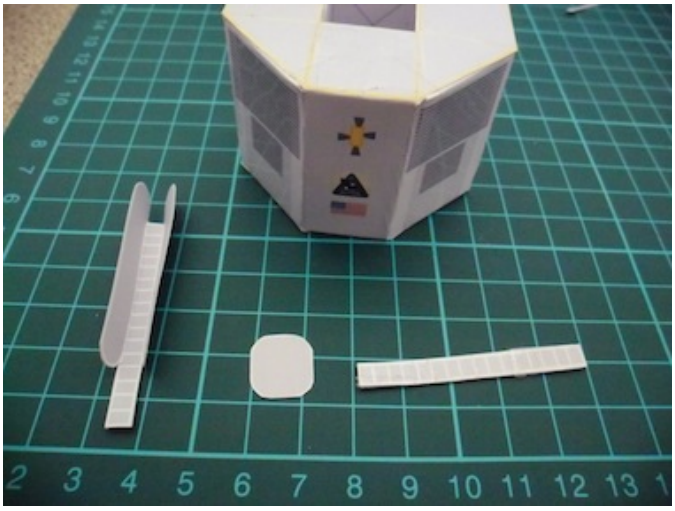
44. This is the habitat, glued onto the ascent stage engine.



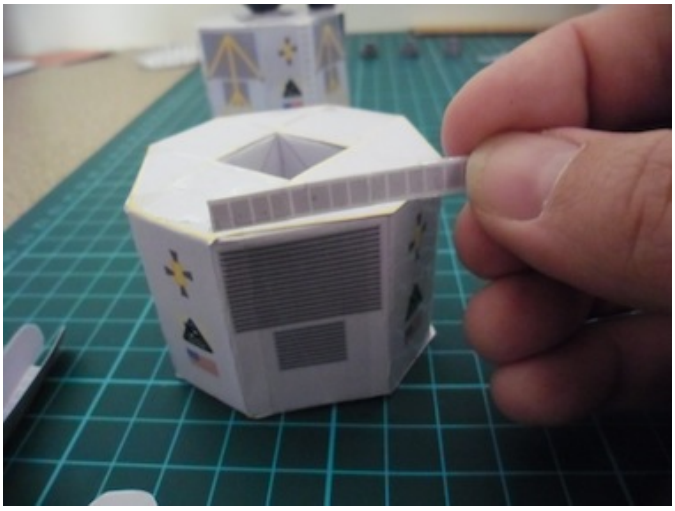
45. The habitat should be able to "launch" off of the descent stage; i.e. the habitat is not glued to the tunnel and the engine/cruciform is not glued to the descent stage.



46. These parts can be used to create hand-rails and an extended ladder.



47. Fold the sides of the ladder to create a pair of hand-rails. The small rectangle (right) is another hand-rail – to be attached to the descent stage.

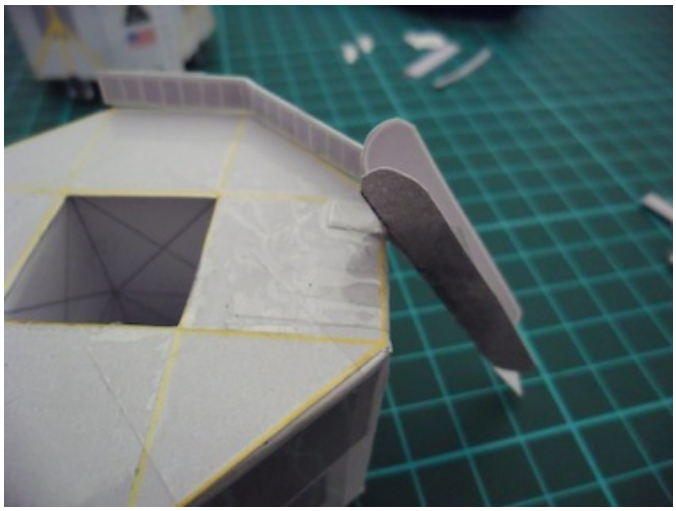


48. This hand-rail need to be placed at the side of the descent stage to determine where to fold it.

49. The hand-rail, folded and ready for gluing.

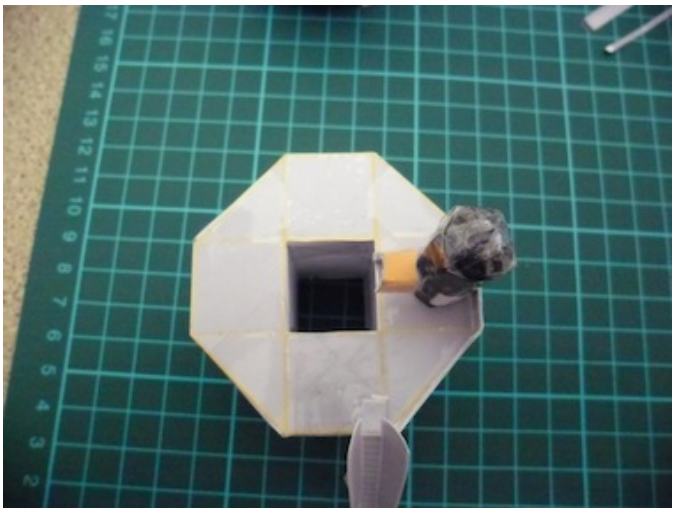
50. Although no glue tabs have been provided, the bent edge of the hand-rails can be easily attached.

51. The ladder with its hand-rails folded up. The small square part is folded into a joiner.



52. The ladder, glued via the joiner, is connected next to the Altair's hand-rail.

53. The glue-tab, if connected correctly, will act to "pull" the ladder into an "open" position.



54. The Airlock (the small cylinder) is glued down onto the descent stage next to the hand-rail.

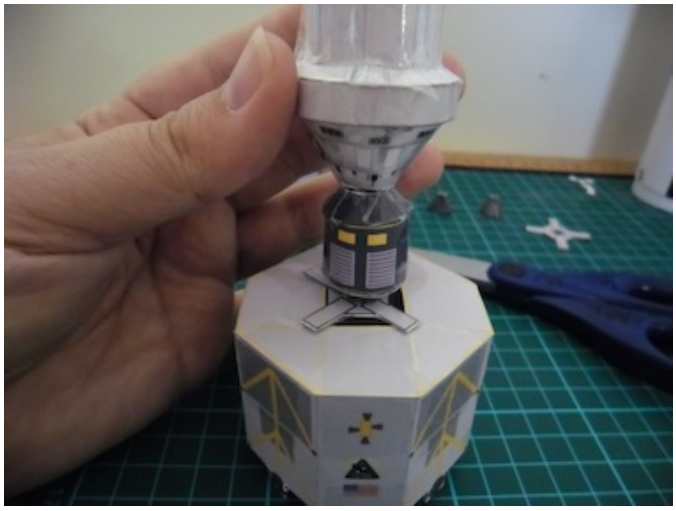
The important thing to consider (at this point) is that the airlock is fragile – but then, every single part and component that you have to glue down (from now on) is going to be equally as fragile.

You must glue down the parts in the correct order, otherwise the model will be crushed / damaged by its own weight (like a bag of grapes).

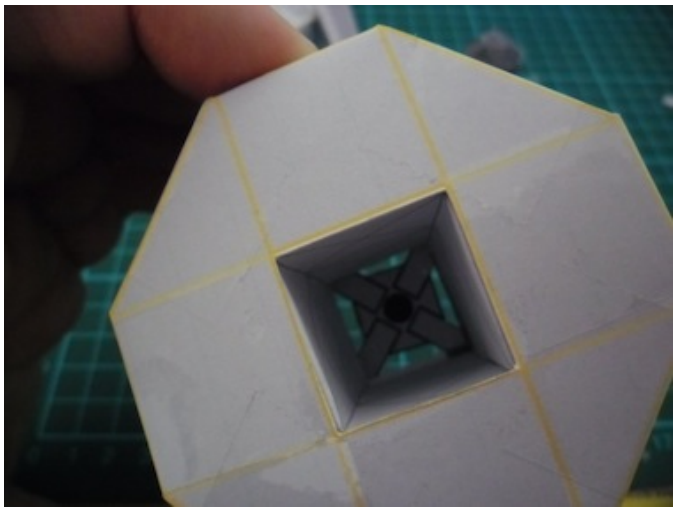
Build the Altair (manned lunar surface version) in the following order:

1. Descent Stage (octahedron and main engine).
2. Airlock Module with tunnel (orange part).
3. Habitat Module with ascent engine.
4. Descent Stage Hand-Rail and Ladder.
5. Descent Stage Landing Legs.
6. Ascent Stage Reaction Control Thrusters.

55. These parts create a docking port on the top of the habitat. Due to the difficulty of the task, these parts are considered to be optional.

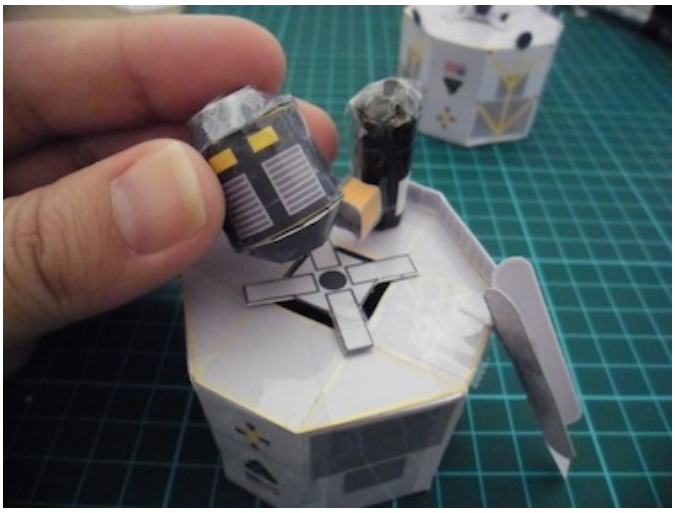


56. A small model of the CEV spacecraft is shown. You could glue a CEV to the descent stage (if you so wish), to create a model of the Altair prior to the final descent to the lunar surface.



57. This is the view through the descent stage.

58. This is the ascent stage engine and its cruciform structural brace.

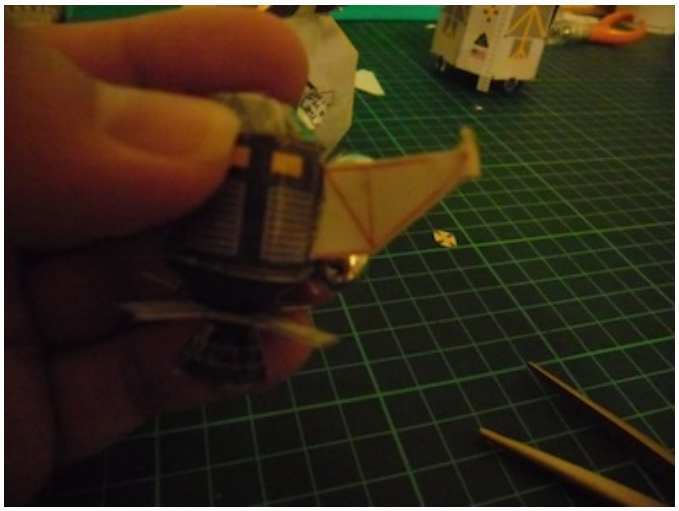


59. The habitat is then glued to the centre of the cruciform (the black dot). Remember, do not glue the habitat to the orange connecting tunnel.

60. Four small 10-millimetre metallic beads can be used for the external propellant tanks.

61. The part for the Reaction Control Thruster (RCS) is cut and [slightly] bent to form a "pylon."

62. This the opposite side of the RCS thruster pylon.



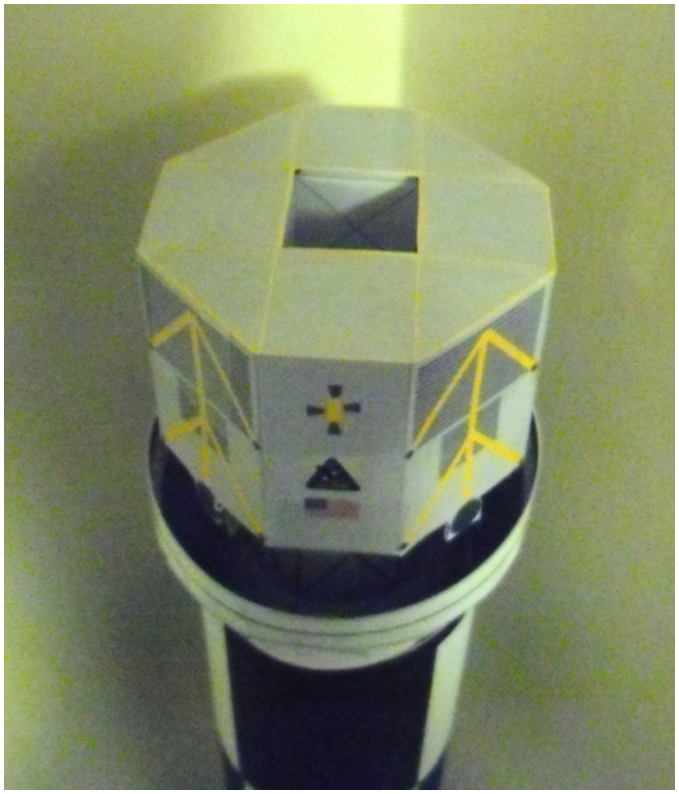
63. Once glued into position, the RCS should "stick out" at an angle from the habitat.

64. The RCS pylon can be glued onto the propellant tanks (silver beads).

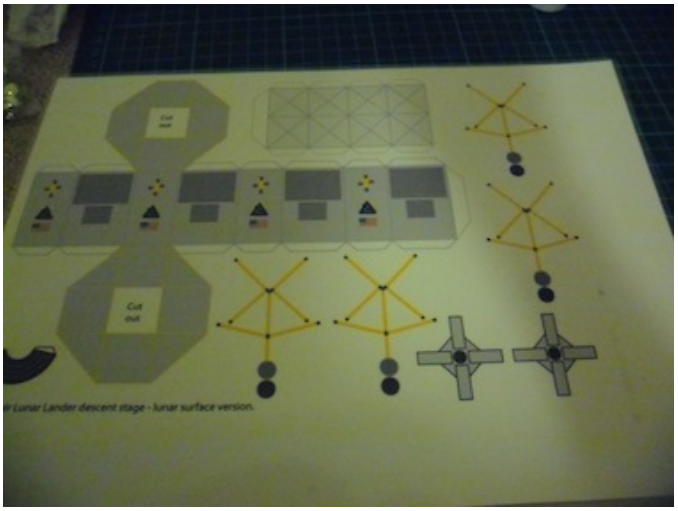
65. Here is the descent / ascent stages with one RCS pylon and one landing leg attached.

66. During an earlier test built attempt, I laminated the paper [parts] for the landing legs for added strength during the construction phase.

67. The above illustration shows how the Altair Lunar Lander, attached to the Orion Manned Spacecraft, will accelerate out of low Earth orbit and travel towards the Moon. (Image credit: NASA.)

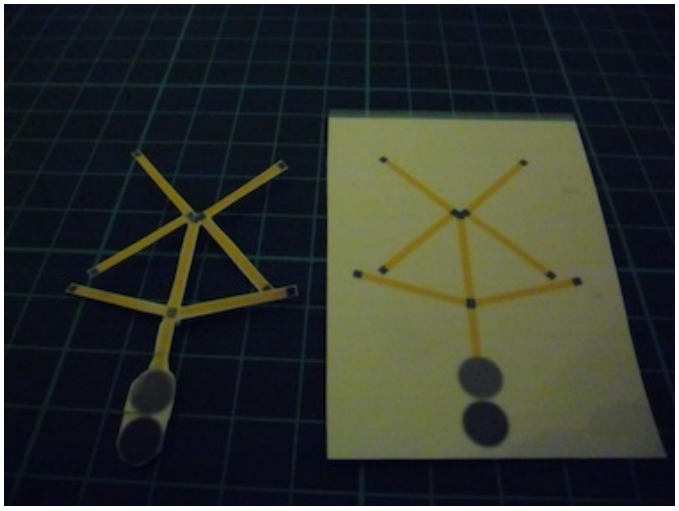


68. This is the descent stage, placed on top of the third stage booster… just like in the above illustration produced by NASA.

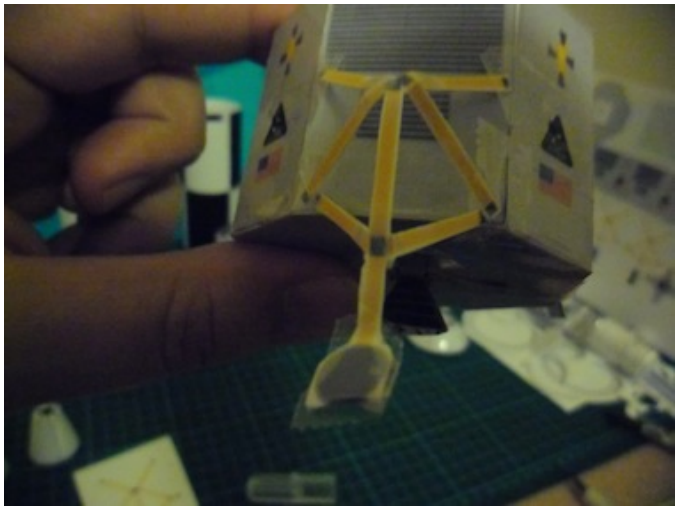


69. The above image shows the parts necessary to construct the lunar surface version of the Altair descent stage.

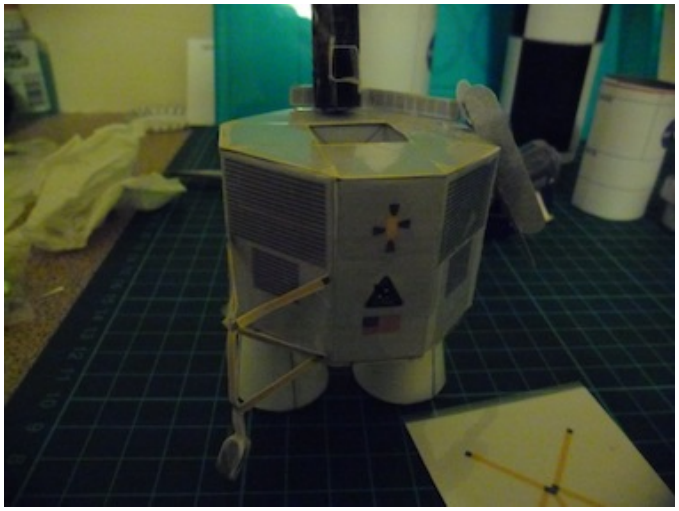
The main difference between the SLS-launch version (visible in the image to the left) and this lunar surface version is the fact the this design has the landing legs as separate parts, allowing it to be built as it would appear when the astronauts are exploring the surface of the Moon (as shown in the first two NASA images at the beginning of this document).



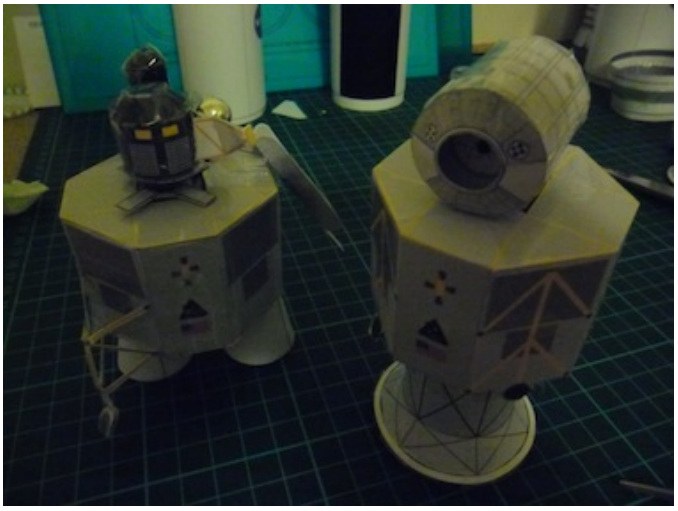
70. You will be faced with two agonising choices, to leave some of the paper around the landing legs (to strengthen them) or cut precisely on the edges.



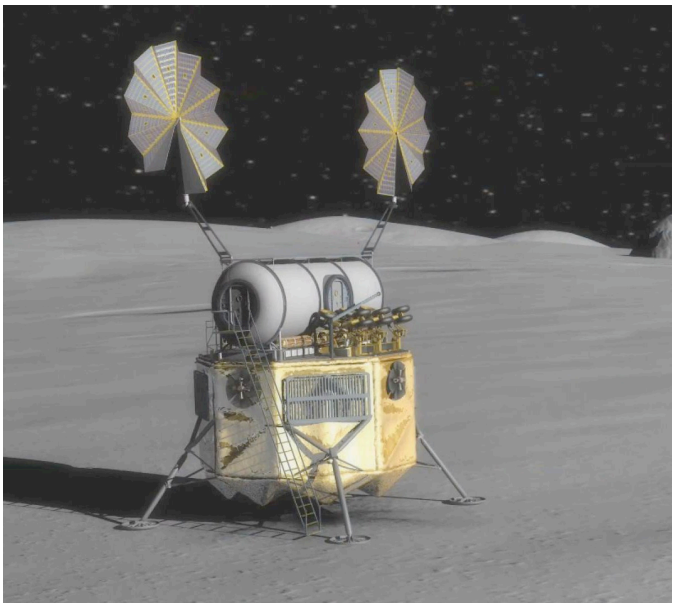
71. The legs need to be glued at the corners of the "radiators" and at the base descent stage, at the corners of the wide sections (see image above).



72. It might be necessary to balance the model on top of other objects so that you can glue the legs.



73. These are the two different Altair descent stages – the left has a half-built Ascent Stage and the right has an International Space Station module as a simple lunar habitat.



74. Some of the Altair design concepts (in 2008) showed the descent stage being used as a "space truck" to carry payloads to the lunar surface.

The above image (credit: NASA) shows a small habitat module with two solar panels. This initial lunar outpost would serve to enable astronauts to survive on the Moon for several weeks at a time. Obviously, a model of this "lunar base" would be considerably easier to build that the ascent stage.

For teachers who wish to use the Altair model in their classroom lessons, it would be prudent to have your students only attempt the launch configuration of the Altair Lander (the octahedron) with a simple cylindrical habitat module… as shown in the image at the top-right of this page.