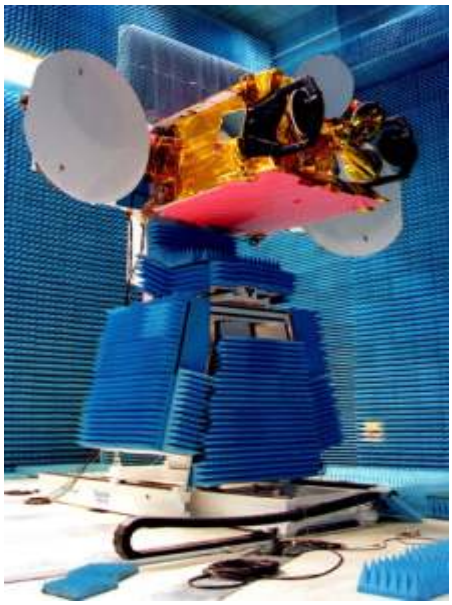
Aerospace Engineering in Portsmouth 2006

In his day, Isambard Kingdom Brunel was at the forefront of engineering. He had a finger in almost every engineering pie. Ships, railways, bridges and tunnels to name a few. In each of these areas he was a pioneer, creating the longest tunnels, the biggest ships, using new materials and new ideas.

However, aerospace was one field of engineering Brunel never became involved in - simply because it didn't exist at the time. The first powered aircraft didn't fly until 50 years after his death and the first satellite was launched nearly a hundred years after his death.

Inmarsat 4 - A state of the art communications satellite built in Portsmouth.
Image courtesy of EADS Astrium and Inmarsat

If Brunel had been around in the second half of the twentieth century what would he have been doing? As someone attracted to the cutting edge of engineering it's more than likely he would have been involved in aerospace in some way, probably building the biggest rockets and launching the biggest satellites.



A satellite undergoing radio frequency testing at the EADS Astrium Portsmouth site.
Image courtesy of EADS Astrium

Two hundred years after Brunel's birth, Portsmouth is a centre for a thriving aerospace industry and home to a number of flagship aerospace companies such as EADS Astrium.

EADS Astrium is a world leader in the design and manufacture of satellite systems. The site at Portsmouth specialises in building payloads for telecommunications, Earth observation, science and navigation satellites.

In 2005 the Portsmouth site completed work on the payloads of three Inmarsat 4 satellites. These are some of the largest and most sophisticated communications satellites ever built. The buses (the bodies of the satellites) were built at the Astrium plant in Stevenage and the two halves were assembled in Toulouse, France. The first Inmarsat 4 was launched from Cape Canaveral but the second was launched from a floating launch pad located 154° west along the equator.

This launch pad is a converted self-propelled oil rig. It is positioned on the equator so that rockets using it can get a boost into orbit from the Earth's own rotational speed.

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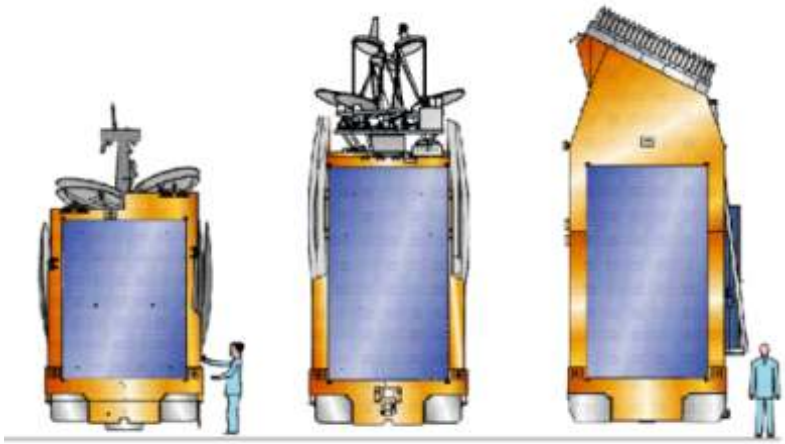
At present, two Inmarsat 4 satellites are in geostationary orbit above the Earth while a third is currently awaiting launch or will be retained as a ground 'spare' until required.

A geostationary orbit is particularly useful for communications satellites because it means that they orbit 36 000 km above the equator. At this altitude it takes them 24 hours to complete one orbit. This is the same time it takes the Earth to rotate once on its axis and so the satellite effectively 'hovers' over the same spot on the ground, giving the best 'footprint' coverage of the Earth for transmissions from the satellite.

A sea launch from the equator
Image courtesy of EADS Astrium and Sea Launch

In their geostationary orbits the two Inmarsat 4 satellites provide global communications coverage (except for the North and South poles).

The Inmarsat 4s are around 100 times more powerful than the previous generation of communications satellites and provide a ten-fold increase in communications capacity. The satellites also support the new Broadband Global Area Network (B-GAN) for internet links, video on demand, video-conferencing, fax, e-mail and telephone.



EutelSat W3A Amazonas | IntelSat 10-02 Hotbird 8 | Inmarsat 4 F1-3

The size of modern communications satellites
Image courtesy of EADS Astrium

The EADS Astrium site in Portsmouth has been at the pioneering edge of satellite payload design and manufacture for the last forty years and is considered a centre of excellence for satellite engineering.

We may have moved on since the days of Brunel, but Portsmouth is still home to world class engineering in many different areas and, without a doubt, Brunel would have been proud of that.

Build Your Own Communications Satellite

Building a communications satellite is a time consuming and expensive business. Every part has to be checked and rechecked because there's no fixing them once they're in orbit.

These instructions will help you build your own communications satellite. The satellite is designated IKB - 1a and is designed to orbit at an altitude of about 1.5 metres (if you hang it from your bedroom ceiling). It should cost considerably less than some of the satellites built by EADS Astrium and you will probably need to budget approximately £3.00 to cover the necessary hi-tech, space age materials.

This is what you will need:

Material

Four 1 litre plastic drinks bottles
A cardboard box with a slip on lid - an old A4 photocopier paper box is ideal
Eight squares of corrugated cardboard measuring 25 cm by 25 cm each
Four wire coat hangers
Two sheets of plastic mirror material - 30 cm by 30 cm sheets are ideal but the exact size doesn't matter. You can use tinfoil instead if these are hard to find.
A selection of small cardboard boxes
A roll of tinfoil
A yoghurt pot
As much corrugated cardboard as you can find

Tools etc

A hot glue gun
A selection of oil based paints - especially gold, silver black and white
Black poster paint/blackboard paint, white poster paint
Scissors
A craft knife
Pencil
Ruler
PVA glue
Side cutting pliers

Adult supervision may be required when using a craft knife and hot glue gun.

Now take a look at the satellite diagram on the next page - it will give you an idea of what you're about to build.

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The diagram opposite shows the main parts of a communications satellite.

The design of satellites like this is kept as 'modular' as possible to allow the different modules to be built at the same time and the communications payload to be tailored to suit each customers needs.

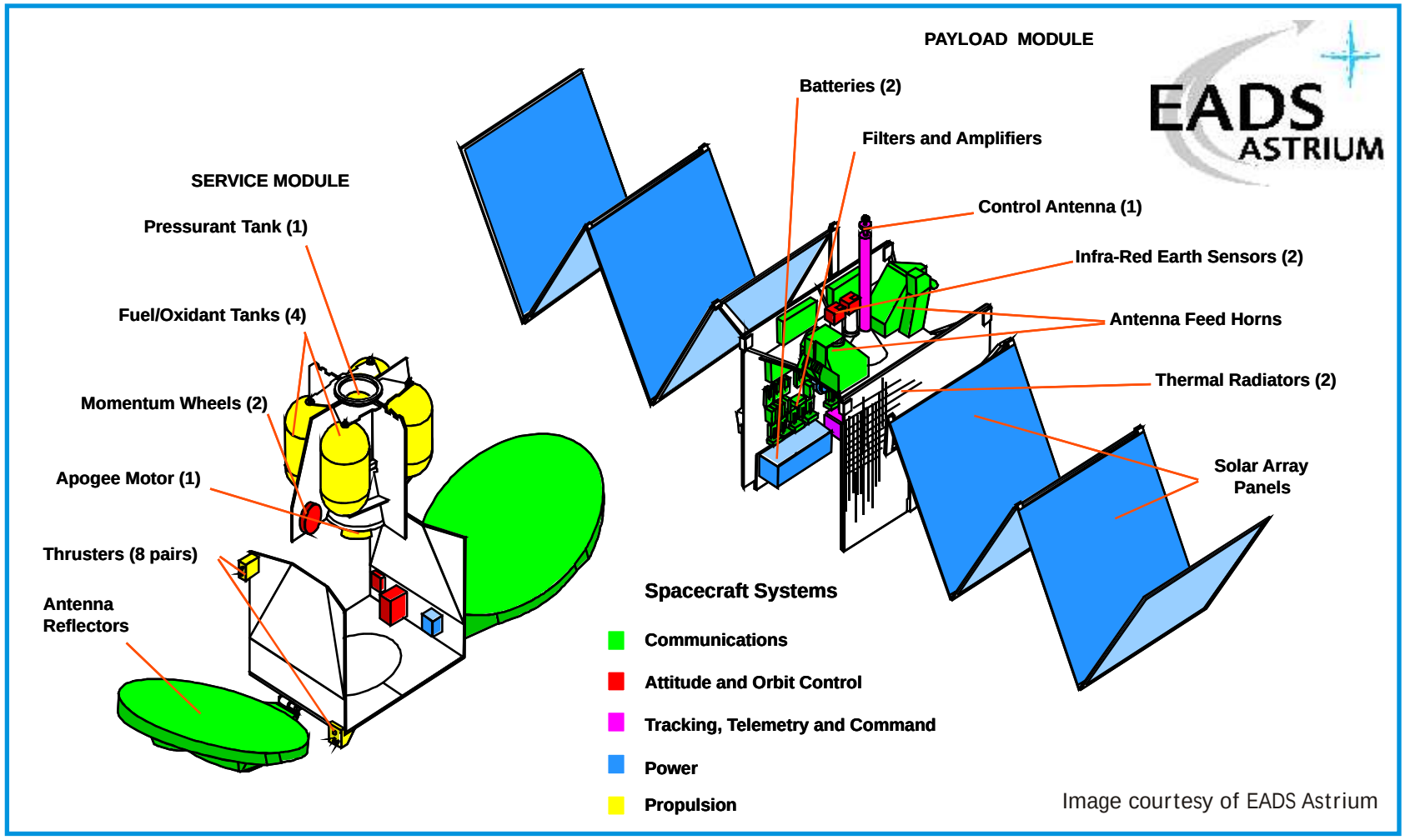


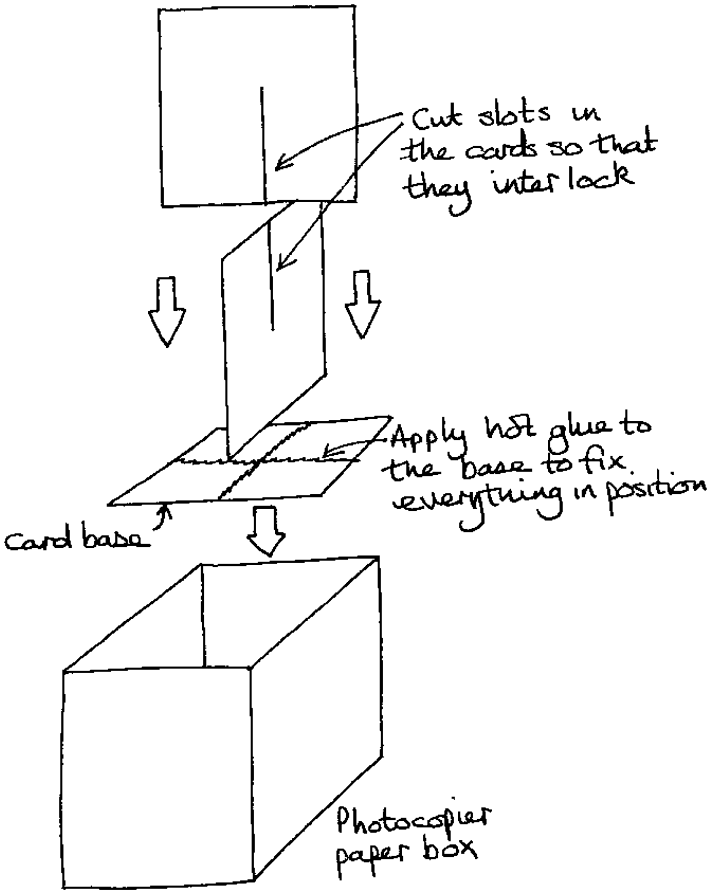
Image courtesy of EADS Astrium

Build Your Own Communications Satellite

Now this is what you need to do.

Central Structure & Apogee Motor Assembly

The apogee motor mounted in the base of the central structure is used to raise the altitude of the satellite's orbit.



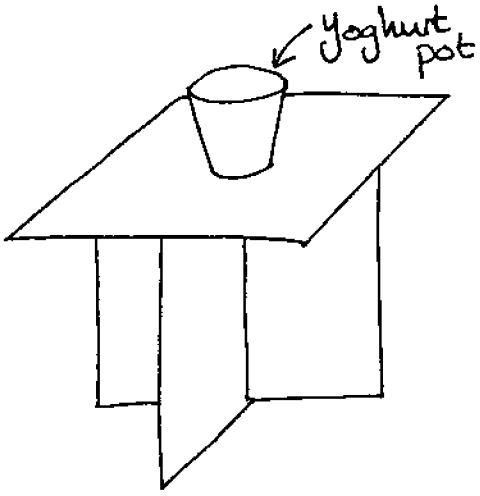
Step 1

Cut out two pieces of corrugated card and interlock them as shown in the diagram. Use the hot glue gun to fix them to a corrugated card base.

This assembly will need to be the right size to fit snuggly into your cardboard box so make sure you measure it before you cut it all out.

Once you are sure it all fits together correctly slide it back out of the box.

At this point you might want to paint the inside of your box white. Use water based paints if possible as these will dry quickly.



Step 2

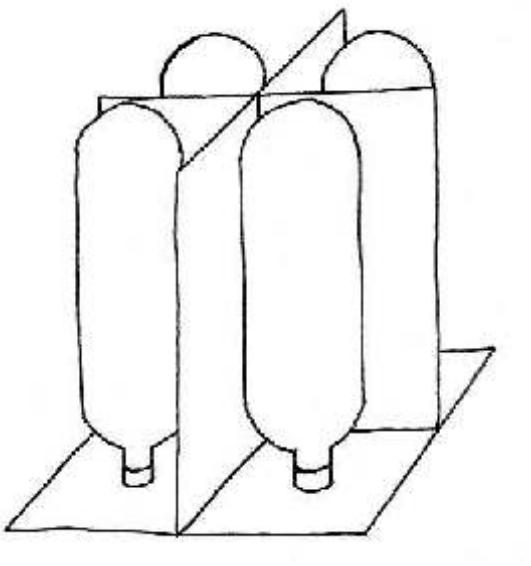
Turn the assembly you made in Step 1 upside down and use the hot glue gun to fix on your yoghurt pot as in the diagram.

Once the glue has dried paint this entire assembly black and the yoghurt pot silver. You will need to use oil paints to paint the yoghurt pot. You may also need to use oil paints to paint your assembly if the card has a glossy finish.

Continued on next page

Build Your Own Communications Satellite

Step 3
Take your four 1 litre bottles and paint them silver. You will need to do this with an oil based paint. When they are dry (it is best to leave them over night to dry thoroughly) use the hot glue gun to fix them to the card assembly.



Push the bottles so that they fit tightly into the corners. This is your apogee motor assembly.

Step 4
Cut a hole in the base of your box so that when you slide the apogee motor assembly in, your yoghurt pot (apogee motor exhaust nozzle) sticks out the base of the box. Once you are sure it all fits together remove the apogee motor. Do not glue the assembly in position just yet.

Antenna Reflector Assembly

The antenna reflectors are used to receive signals from the ground and bounce them back to a ground station a long way away - possibly on the other side of the Earth.

Step 5
Cut your two sheets of plastic mirror into the biggest circles you can. You may be able to do this with a big pair of scissors or you may have to use a craft knife. If using a craft knife place the mirror on a cutting mat or other suitable surface and mark out the circle you intend to cut with a marker pen. Use the craft knife very carefully and always cut away from you so that if the knife slips it will not hurt you. Adult help is strongly recommended for this.

Plastic mirror can sometimes be a bit difficult to find so in its place you can cut out two circles of corrugated card (about 30 to 40 cm diameter). Then use PVA glue to stick a layer of tinfoil (shiny side up) onto one side of your cardboard circles. Smooth out the tinfoil and then leave the glue to dry.

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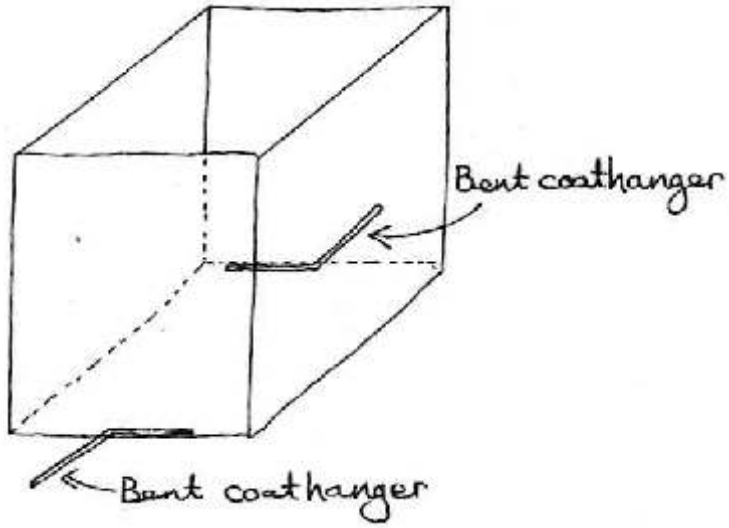
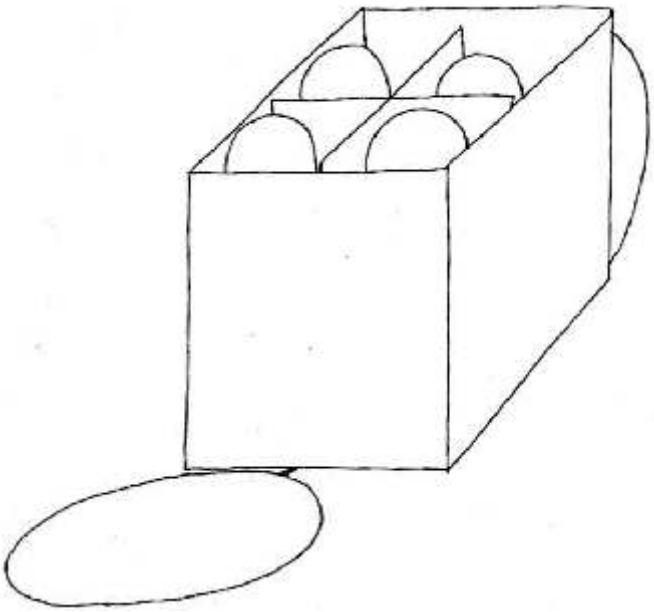
Build Your Own Communications Satellite

Step 6
If you are using plastic mirrors for your antenna reflectors cut out circles of corrugated card to form a backing for them. Fix them on with a few dots of hot glue. Paint the backs of the antenna reflectors gold.



Step 7
Use some side cutting pliers to cut two 25 cm lengths of stiff wire from your coat hangers. Bend the lengths of wire at right angles about half way along.

Then poke them through opposite bottom edges of your box, about halfway along as in the diagram. Glue them in position with the hot glue gun. These will support your antenna reflectors.



Step 8
Paint the insides of the two sides of your box which do not have the coat hangers poking through them black. Glue tinfoil, shiny side out, on the outside to represent the mirrored radiators. Paint the rest of the inside walls white and the outsides gold. Make sure you paint the box lid as well.

Now slide your apogee motor assembly into position and glue it in place.

Fix your antenna reflectors in position by poking the free end of the coat hanger wire into one of the channels in the corrugated cardboard mirror backing. Fix it in position with some hot glue.

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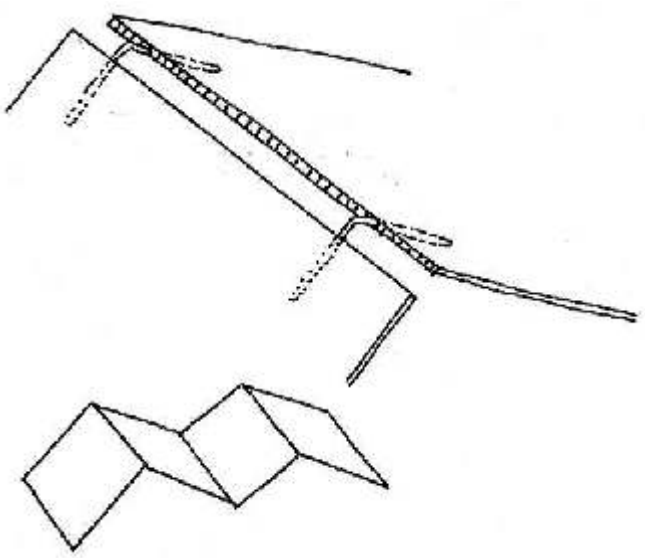
Build Your Own Communications Satellite

Assembling the Solar Panels

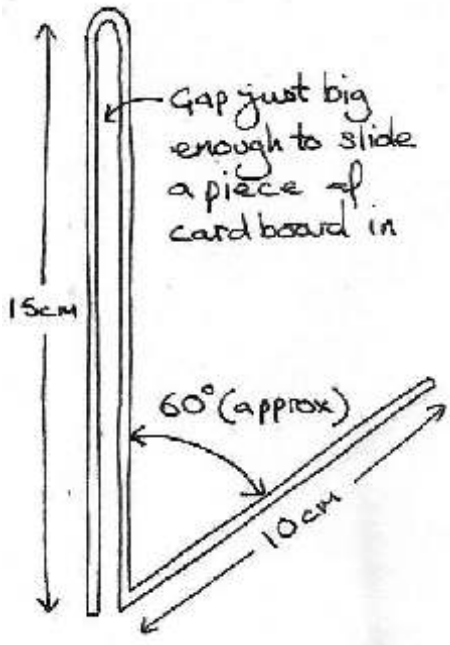
Solar panels generate electricity directly from sunlight. They are ideal for satellites and space craft where having to change the batteries every now and then would prove a little inconvenient, if not impossible!



Step 9
Paint your eight square panels of corrugated cardboard black.

Now cut 12 pieces of coat hanger wire with your side cutting pliers. Each one needs to be about 10 cm long. Bend each one to an angle of about 120°. Use these to join the elements of your solar panel together by poking the ends down the channels in the corrugated cardboard. Fix them in position with some hot glue. You need to finish up with two assemblies of four panels each

Step 10
Cut four 40 cm lengths of coat hanger wire and bend them into the shapes shown in the diagram.



Slide two of these pieces of wire over the sides of your satellite body and attach the solar panels as shown in the diagram on the next page (only one panel is shown for clarity).

The wire will need to be secured with hot glue and possibly some sticky tape on the inside of the satellite body.

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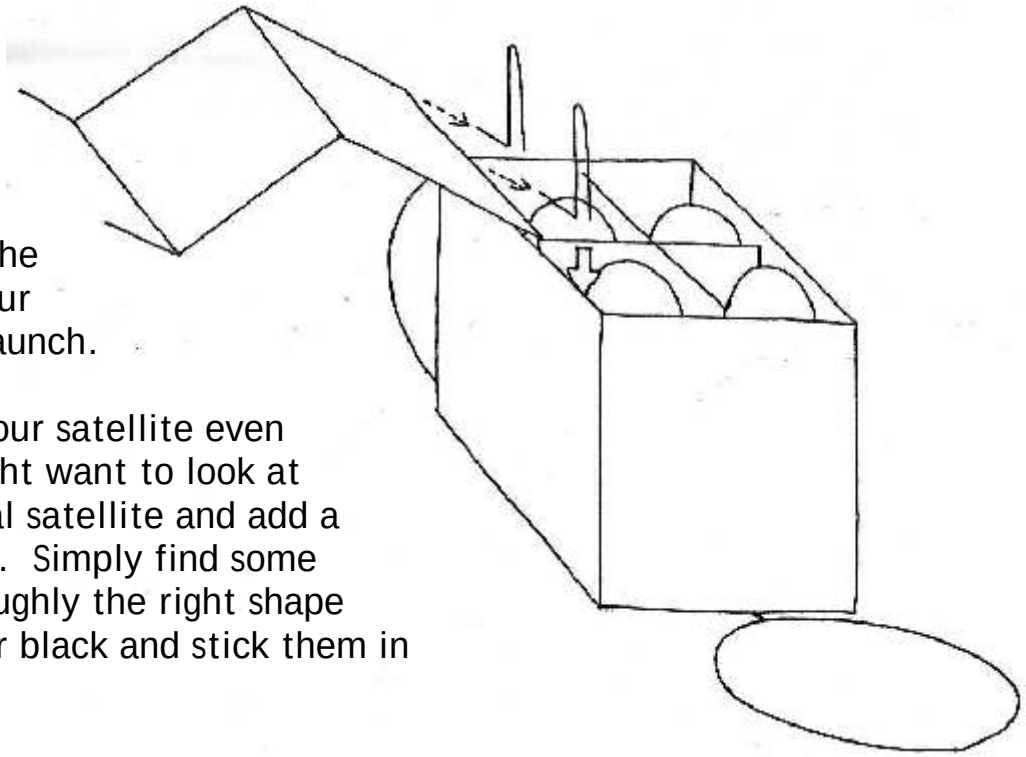
Build Your Own Communications Satellite



Finishing Off

Once both of your solar panel assemblies are fitted simply put the lid on your box and your satellite is ready for launch.

If you want to make your satellite even more realistic you might want to look at the diagram of the real satellite and add a few more components. Simply find some cardboard boxes of roughly the right shape and paint them gold or black and stick them in position.

You might also want to add labels to the parts of your satellite.

Using Your Satellite

The great thing about this satellite is that you can actually use it for communicating!

Simply hang your satellite from the ceiling so that the antenna reflectors (mirrors) are pointing downwards. You can then shine a torch at them and send morse code signals to someone on the opposite side of the room.