

Build your own space probe

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1 Background

This is a simple practical activity to build a model of a rover like those sent to Mars in recent years. There has been much interest in the red planet over the last few years and several probes have been sent to look for signs of life, both past and present, on the surface. Some examples of rovers are: Sojourner, and the NASA twin rovers Spirit and Opportunity. The European Space Agency (ESA) are planning another rover mission for 2009 called ExoMars which will search for signs of life on the red planet using several techniques including drilling in rocks and analysing soil samples.

The idea of this activity is to build a model of a rover out of household items. The handout gives some ideas for things that might be useful on a rover such as those sent to Mars and can be used as the basis for a discussion. It is intended to give some ideas, but there are plenty of other possibilities.

2 Some recent rovers

Sojourner was a NASA rover which landed in Ares Valles on Mars in 1997. As with most rovers, it landed safely with the aid of a heatshield, parachutes and airbags. A number of the mission objectives were technology-related: testing the use of communications systems, navigation sensors and testing the rover's performance on the unknown Martian terrain.

Science experiments included cameras, atmospheric sensors (temperature, pressure, wind speed) and the Alpha Proton X-Ray Spectrometer (APXS), a circular device mounted on the front of the rover. It was designed to examine rocks to determine their composition. It did this by bombarding samples with alpha particles of a known energy from a radioactive source carried onboard the rover. The resulting spectra contained information on the chemical make-up of the rocks on the surface allowing the scientists to look for signs of minerals associated with water.

More information on the Sojourner rover can be found at the Mars Pathfinder website at

<http://marsprogram.jpl.nasa.gov/MPF/>

Spirit and Opportunity are NASA rovers exploring the surface of Mars at the time of writing (September 2005). They were sent to two different places on the Martian surface to investigate the history of water on the planet. Spirit landed in Gusev crater, a possible remnant of a lake in a much larger impact

feature, while its twin, Opportunity, landed on Meridiani Planum where the mineral composition of the surface suggests periods of water flow in the past.

The rovers are identical and carry an impressive array of scientific instruments. Firstly, each rover has a camera assembly mounted on a mast to raise it above the body of the rover. There are two CCDs in each camera to provide stereoscopic images which allow distances to be determined. Each camera also has a filter wheel with a selection of filters to provide spectral information so that the composition of the rocks can be investigated. Also on board are three spectrometers: the Mini-TES (an infra-red spectrometer), a Mössbauer spectrometer (designed to study minerals containing iron by pressing the sensor directly to the sample being analysed) and an updated version of the APXS. These spectrometers are located on an extendable arm which can be moved to the rock to be sampled. Also on the arm is the Rock Abrasion Tool (RAT), a drill which can cut a wide, shallow hole in a rock to sample beneath the surface.

As well as the science instruments, each rover has a set of operational instruments. Each has an array of solar panels to provide power for the motors and instruments, Hazcams to watch for potential navigational problems (such as rocks or ditches), and some antennas for transmission of telemetry and data back to Earth, and receiving commands from the operators at NASA.

More information on the science instruments aboard the Spirit and Opportunity rovers can be found at

http://marsrovers.jpl.nasa.gov/mission/spacecraft_surface_instru.html

3 Materials

Basically you can use whatever is available. Some suggestions for materials for different parts of a rover are given below. In addition you will need glue, selotape and blue tack to stick all the bits together, and some paints to finish the whole thing off. An example image is on the activity sheet (based on the Sojourner rover) and more rover images can be found on the websites given above or on ESA's Mars website at

<http://www.esa.int/SPECIALS/Aurora/index.html>

Rover body: Useful items for constructing the rover body are cardboard boxes such as cereal packets or printer paper boxes, depending on how large you want your rover to be. Solar panels can be painted on the top or made out of sheets of cardboard.

Wheels: Toilet roll tubes make good wheels if chopped up into shorter sections. Wooden skewers can be used to make axles. One issue with real rovers is how they cope with uneven terrain. This is hard to do with a model, but could be used as a discussion topic.

Science instruments: Almost any objects can be made to look like a scientific instrument with a bit of imagination. For example, 35mm film cans can be used to make sensors, sections of plastic bottles can be used for weather experiments (rain gauges, wind speed sensors), lollypop sticks can be used as booms to support instruments and sections of eggboxes can be used as antennas.