UOSAT – Britain's hobbyist satellite

In the run-up to the UOSAT launch, Bill Mitchell* outlines the functions of the satellite and the measurements it is to make. As he points out, the keen amateur will be able to monitor the radio and video transmissions from UOSAT using inexpensive equipment

THE FIRST SATELLITE built specifically to promote a greater practical interest in space science among educational establishments, and with facilities for use by radio amateurs and hobbyists, is now undergoing final test prior to its launch in September of this year. Designed and constructed by the University of Surrey with material and financial support from British industry, UOSAT (University Of Surrey SATellite) will transmit coded and voice-synthesised speech data that can be picked up by most amateur VHF FM communications receivers. It will also incorporate a charge-coupled device (CCD) camera for the transmission of pictures that can be received by an ordinary domestic TV set by the use of a simple adaptor circuit.

Unlike previous radio amateur satellites launched either under the auspices of AMSAT (Radio Amateur Satellite Corporation) OSCAR series, or by the USSR (RS1 and 2), which have been intended primarily for increasing the VHF and UHF range of transmissions by radio amateurs, UOSAT's function is to stimulate a greater practical interest in space science among schools, colleges and universities; to provide radio amateurs and hobbyists with a tool for studying the ionosphere through which the transmissions travel; and to establish an active body in the UK with the resources to contribute further to the amateur satellite programme.

As such, with the wide range of measurements it is capable of performing and the large volume of data that it will be transmitting back to earth, UOSAT represents a unique British achievement in space science for the masses, and can possibly be best described as a universal multimeter in the sky.

Vision And Voice

Much of the analogue and digital data being transmitted back to earth will require something more than a standard FM communications receiver, although their reception will not be beyond the capabilities of the keen amateur. What makes UOSAT so unique is the provision of earth pictures from its solid-state camera, and its synthesised speech transmission.

Covering an area of 500 x 500 km (300 square miles) of the earth's surface, the image from the earth-pointing camera will be formed on a charge-coupled device (CCD) and stored in the satellite's on-board computer until transmission to ground, a process that takes three to four minutes. Unlike images from conventional weather satellites, the picture will be transmitted in such a way that it may be readily received and stored by a simple receiver and displayed on any domestic TV set. The pictures will have a resolution of about 2 km and will show 16 grey levels, with land features and land/sea boundaries being enhanced. Experimental data in graphical form will also be available by the same link.

Once the satellite is in orbit and functioning correctly, the University of Surrey plans to make available full details and circuitry for the necessary ground receiving and display equipment that will enable a domestic TV set to receive these pictures. At present, the intention is that the circuit will be supplied by an appointed contractor, and will take the form of an easy-to-assemble kit of parts costing around £150.

The speech transmissions will be made by means of an electronic voice synthesiser controlled by the on-board computer, and will include details of telemetry, experimental data and satellite operations using a vocabulary of about 150 words. Transmissions will be on 145.825 MHz, and any standard unmodified narrow-band FM amateur receiver should be able to receive them by means of a small, fixed pair of crossed dipole aerials.

Experiments For The Scientists

The satellite will also carry a number of experiments intended for scientific research. These include a series of beacons transmitting at different frequencies, two particle counters to provide information on solar activity and auroral events, and a magnetometer — identical to that used on the Voyager missions to Jupiter and Saturn — for measuring the earth's magnetic field. These experiments will make possible a detailed study of how phenomena such as solar activity affect the transmission of radio signals through the ionosphere.

On-board Micro Control

UOSAT will be controlled by a powerful on-board microcomputer, based around the RCA CDP 1802 microprocessor, which will have access to the satellite experiments, telemetry and command systems. It will enable telemetry surveillance, command and status management, experiment data storage and processing, dissemination of orbital data together with operating schedules and general news, and closed-loop attitude control using magnetorquers. It has direct high-speed data links with the magnetometer and radiation experiments to allow rapid data acquisition yielding fine time-resolution data, and also has access to the earth imaging experiment memory area for the purpose of image processing.

The computer software is resident in dynamic RAM loaded from the ground via the telecommand link, and can be modified or replaced during flight by a ground command station at the

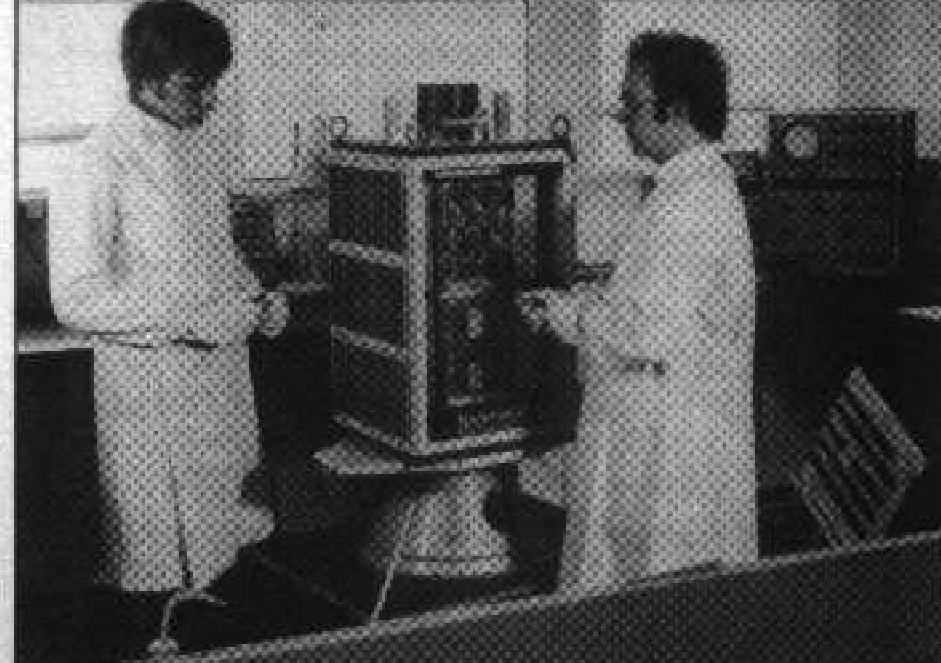

Figure 1. The clean room at the University of Surrey in which UOSAT is being assembled. On the left is Steve Greenland and on the right is Dr Martin Sweeting, Project Manager

first educational &

University of Surrey. This will enable the accommodation of changes in the mission profile and allow for the rectification of possible software or hardware failures.

Launch Date

UOSAT will be launched as a secondary payload by a NASA Delta 2310 rocket from the Western Test Range at Vandenberg, California, the main payload being the NASA Solar Mesosphere Explorer spacecraft. The launch is currently scheduled for September this year, but this may be advanced to July depending on the readiness of the NASA rocket and prevailing weather conditions. An announcement on this will be made as soon as possible. However, whatever the launch date, UOSAT will be placed into a polar orbit with a period of 95 minutes, at a height of 530 km (about 330 miles), and the expected life before re-entry is estimated at four to five years.

Data And Transmission Frequencies

For those who may be interested in establishing their own receiving station for UOSAT, the following lists the types of data being transmitted and the frequencies of transmission.

Telemetry

To cater for a wide range of user ground-station facilities, 60 analogue telemetry channels and 45 digital status points will be available via the VHF (145.825 MHz) and UHF (435.025 MHz) data beacons in the following formats: 1200, 600, 300, 110 and 75 baud ASCII; 45.5 baud RTTY (Baudot); 10 or 20 words per minutes Morse code; and synthesised voice.

Any pair of these formats will be available simultaneously via the VHF and UHF data beacons. The 1200 baud telemetry option also has a CHANNEL DWELL facility.

Data Beacons

Two VHF/UHF beacons will provide the primary engineering and experiment data links to the outside world, and these have been designed to provide a healthy satellite-to-ground transmission link to enable reliable and straightforward reception by the simplest of amateur ground stations using a fixed pair of crossed dipole aerials.

The data sources available to these beacons are: telemetry, ASCII, Baudot, Morse code, satellite computer, primary output port, secondary output port, speech synthesiser, earth imaging experiment (CCD camera), and image data.

Details of the two beacons are as follows:

General data beacon —	Frequency:	145.825 MHz
	Modulation:	CW
	Data format:	audio frequency shift keying
	Power output:	450 mW
Engineering data beacon —	Frequency:	435.025 MHz
	Modulation:	CW
	Data format:	audio frequency shift keying
	Power output:	400 mW

Propagation Studies

Phase-referenced beacons on 7.001, 14.001, 21.001 and 28.001 MHz will support a wide range of ionospheric experiments and observations, while two microwave beacons on 2.401 and 10.470 GHz will encourage the study of super high frequency (SHF) propagation.

Two particle radiation counters (one detecting electrons of energies greater than 40 keV, and the other detecting protons greater than 2 MeV) will provide real-time information on solar activity and auroral events. A three-axis, wide-ranging, fluxgate magnetometer will examine the fine structure of the earth's magnetic field, any disturbances to it and their relationship to radio wave propagation.

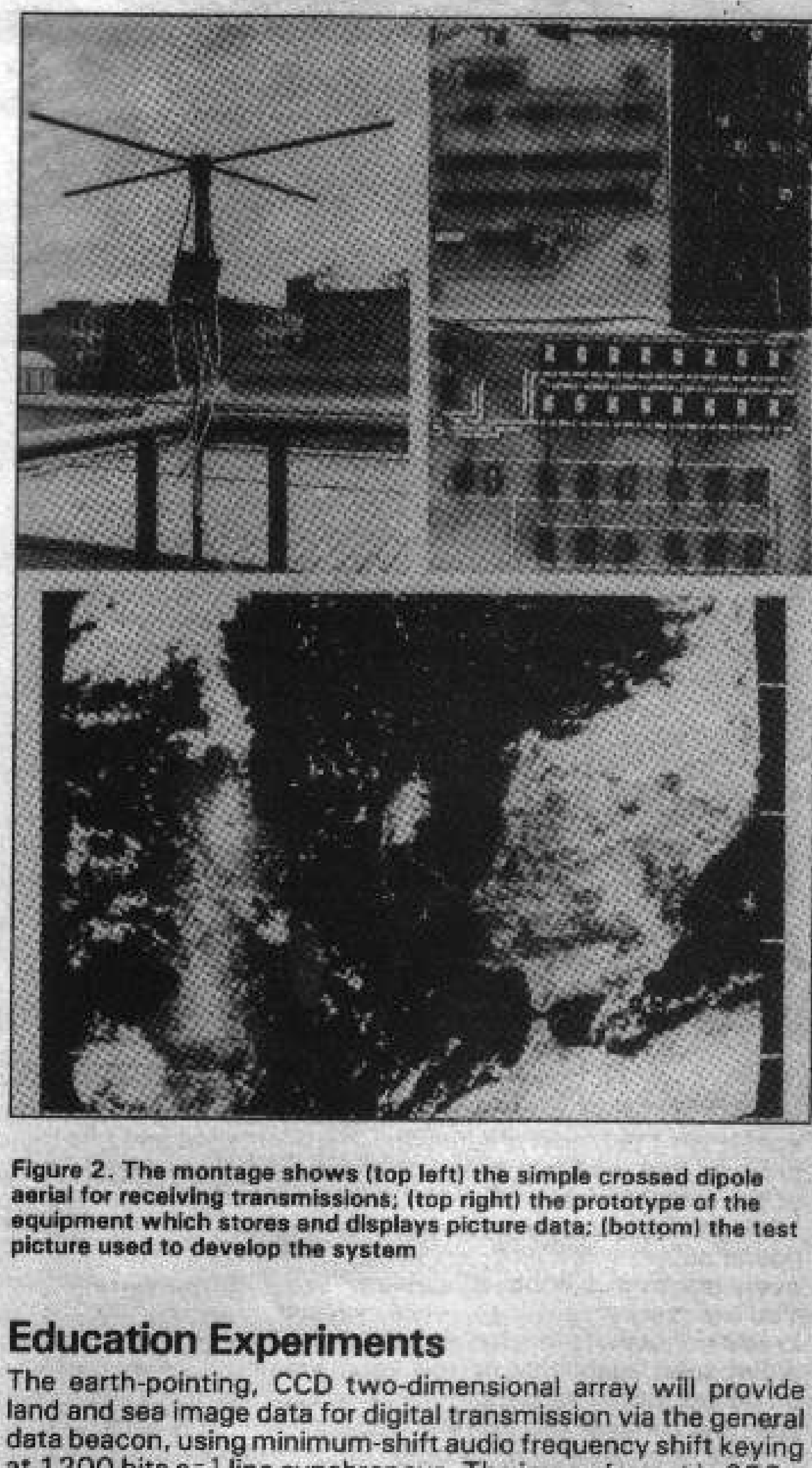

Figure 2. The montage shows (top left) the simple crossed dipole aerial for receiving transmissions; (top right) the prototype of the equipment which stores and displays picture data; (bottom) the test picture used to develop the system

Education Experiments

The earth-pointing, CCD two-dimensional array will provide land and sea image data for digital transmission via the general data beacon, using minimum-shift audio frequency shift keying at 1200 bits s^{-1} line synchronous. The image format is 256 x 256 pixels with 16 grey levels. The camera optics are organised to cover a 500 x 500 km area of the earth's surface yielding a resolution of around 2 km.

The digitally synthesised speech experiment module under the control of the satellite computer will 'speak' telemetry, experiment data and satellite 'news' with a limited vocabulary of around 150 words transmitted on either of the data beacons.

A Chance To Make Your Mark

If successful, these experiments should help to overcome the difficulties faced by most amateurs trying to enlarge their knowledge of space sciences. Any radio amateur will be able to use his or her equipment to gain interesting and useful knowledge about that area of space surrounding the earth which most affects the quality of radio transmissions.

The potential that exists for radio amateurs to make a contribution to space science will, through the use of UOSAT, be comparable with that of amateurs in fields such as astronomy and ornithology.

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