SPACE RESEARCH

Better Geophysical Satellites

A CAREFUL study of the potential uses of geophysical satellites, carried out by a working group under the joint chairmanship of Dr G. L. Pucillo of the NASA Electronics Research Center and Dr Stephen Madden of the MIT Measurement Systems Laboratory has now been published (NASA CR-1579, Clearing House for Federal Scientific and Technical Information, $3). The document is an exceedingly thorough examination of the benefits to be obtained from satellites orbiting the Earth at a comparatively modest height—250 kilometres is the ideal. The essence of the case is that sufficiently accurate orbits would make it possible to throw light on a number of problems in geophysics and even oceanography. The difficulty is that it is bound to be some time before sufficiently sensitive instruments will be available to do everything that the working party hopes for.

In the immediate future, the working party does, however, consider that it would be feasible to design radar altimeters with an accuracy of ± 1 metre which would be mounted in Earth satellites to provide direct measurements of the distance to the surface of the Earth at intervals of 10 seconds for periods of a year at a time. Such a satellite, the panel says, could provide important information about the gravitational field of the Earth as well as tidal variations and storm surges. The panel also asks for the setting up of tracking facilities between satellites close to the Earth and other instruments at a greater distance. The ideal would be that the distant satellite should be in a geosynchronous orbit and that the nearer instrument should carry the radar altimeter. In any case, the panel considers, it should be possible by setting up tracking facilities between two satellites to determine the velocity of the nearer one to within 1 millimetre per second which would enormously improve the accuracy of the geodetic information obtained. One byproduct of this would be improved marine navigation —it should be possible, the panel estimates, for ships' velocities to be determined to within 5 centimetres a second and for positions to be determined to within 100 metres. With the same technology, it would be possible to follow ocean currents by means of floating reflectors launched into the sea, while continuing laser ranging of the Moon, to within 15 centimetres, of the kind now made possible by the Apollo 11 reflector, should make it possible to keep a watch on the movement of the tectonic plates of which the crust of the Earth is made by siting observing stations at suitable places—the Canadian Shield, Hawaii and Australia are suggested. Because of the errors in the present tracking system, estimated at 15 centimetres and greater than the annual relative movement of the crustal plates, this is evidently a long term programme. The panel does, however, suggest that the same techniques, coupled with long baseline interferometry in the radio spectrum, should be used not merely for following the movements of continents, but for the accumulation of seismic strain in areas such as the Pacific coast of North America—to this end the panel argues that immediate attention should be given to the establishment of a geodetic network running from California to Alaska by means of which the accumulation of seismic strain could be determined by satellite geodesy. One of the panel's technical recommendations is for the development of satellites equipped with small ion engines, capable of compensating for atmosphere drag at altitudes of 250 kilometres or thereabouts—according to the panel, this would be one of the most effective ways of providing close orbit satellites which could yield geodetic information more rapidly.

Further away, the panel argues for radar altimeters accurate to 10 centimetres, partly because instruments of such a kind could play an important part in defining the general circulation of the oceans. One of the practical problems here is that the theory of the determination of the geopotential from satellite tracking data is not fully understood—eventually it may be necessary to mount instruments which measure directly the gravitational field in satellites designed for geodetic purposes. Eventually, the panel says, it should also be possible to use the satellite-to-satellite tracking technique as a means of pinning down positions to within 10 centimetres and velocities to within 0·5 millimetres per second. Whether laser ranging will yield the ± 2 centimetre accuracy which the panel talks about is less clear, but the committee is in no doubt that this goal is worth aiming at.

The unknown quantity in this study is the extent to which the cost of what is plainly an ambitious programme of instrument development and procurement could be accommodated within the budget of NASA as at present balanced. The panel estimates that the work for which there is an immediate need would cost about $10 million a year, that the full use of the systems then developed would cost $50 million a year in the late seventies and that there is no reason why NASA should not spend even twice as much on such research. In part, of course, much of the development work foreseen in the document would have been carried out at the NASA Electronics Research Center, now handed over to the Department of Transportation. The prospect that there will be money for the good works now identified is also remote, given NASA's devotion to the space station and the shuttle.

Shuttle Engine Started

THREE American companies, the Aerojet Liquid Rocket Company, the Rocketdyne Division of the North American Rockwell Corporation and Pratt and Whitney, have been chosen for the second stage of the development of the main engine for NASA's space shuttle. In an announcement last week, NASA said that it would negotiate a fixed price contract with the three companies for the further definition of the shuttle engines and for the development of a prototype engine design. Each contract will be worth about $6 million and it is hoped that the results will be available a year from now so that the engines could be tested on the ground and in flight during 1975. Each will produce for 400,000 pounds of thrust and will burn liquid hydrogen. A cluster of engines would be used in the booster as well as the orbiting part of the space shuttle. The new engine will differ from those now in service not merely in its greater thrust but in the relatively high pressure maintained in the thrust chamber and by the use of extendable nozzles for providing thrust outside the atmosphere.

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