nations elsewhere which are likely to be affected profoundly—often as beneficiaries—by what happens in the United States. There are questions of what will happen next, what will happen after that and what will be the long term effect on human behaviour of the capacity to travel to the Moon and eventually beyond. None of them is trivial.

To begin with, it is important that the momentum of the Apollo programme will almost certainly determine the pattern of the next two years, at least for the United States. Three further Saturn rockets are being equipped for journeys to the Moon, the next in November this year. With the survival of the greater part of the budget of $3,600 million, NASA is also able to start work on the outfitting of a further six rockets, which will provide a total of ten landings on the Moon spread over two years. The programme which has been mapped out will bring joy to most selenologists. The landing sites are sprinkled generously over the surface of the Moon. The flight in November is aimed at another mare—one which shows up as blue, not red. The third landing is intended for rough ground, in the Fra Mauro formation, and then, if things go well, there is a long list of exotic places to be visited—the edge of the crater Censorinus, the dark and apparently volcanic formations of the Littrow area, the rim of Tycho, the Marius Hills (which an Orbiter photograph suggests may be volcanic domes), the formation known as Cobra's Head in Schroeter's Valley where reddish glows have occasionally been seen, the Hyginus Rille (which is distinguished by the volcanic craters which straddle it) and, finally, Copernicus, the most conspicuous crater of them all. At most of the sites, the astronauts will leave behind packages of instruments including most probably replicas of the sensitive seismograph left behind in the Sea of Tranquillity.

Orbital Satellites

Nobody will deny the interest of having within the next two years such a thorough survey of the interior of the Moon. Even though the value of the seismology will depend on the overlapping of the active lives of individual seismographs, the results could with luck yield a fairly accurate description of the internal structure of the Moon, irregularities and all. But later visits of Apollo spacecraft will also leave behind magnetic instruments, heat flow apparatus and various devices for the analysis of the solar wind, while the astronauts themselves will be able to carry out geological and geophysical investigations on the spot. As part of the same programme, NASA is anxious to develop a better suit for walking on the Moon, and hopes to extend the endurance of the Apollo spacesuit from under three hours to more than four. Obviously there is a busy time ahead.

Beyond Apollo, the most prophetic signs are the ways in which NASA has seemed in the past few months to have set its heart on schemes for launching habitable and reusable space stations into orbits about the Earth. There has already been a good deal of development of components for what is called the Saturn I Workshop—a device fashioned from the empty second stage of a Saturn 1B rocket (not the monster Saturn V needed for journeys to the Moon) by a crew of three sent up on a similar rocket. This system will be in service by the middle of 1972 if NASA has its way, and the hope is that it will prepare the ground for a much more vaguely specified but much more ambitious space station in the late seventies.

Interest in the Moon will not evaporate, however, although it is probably significant that there is now much less enthusiasm than there used to be for more or less permanent stations on the Moon. If it is necessary to make direct observations of the Moon, of course, visiting will be necessary, but for general observation of the solar system or even of the surface of the Earth, satellites are likely to be cheaper and safer for a long time to come. Whether satellites as large as some of the ambitious schemes which are talked of in the Soviet Union as well as the United States will quickly become realities depends on the speed with which it seems safe to put a great many eggs in one basket. The successes of the past few days should not hide the likelihood that there are still risks to be taken.

Nuclear Rockets

Among the technical imponderables of the seventies, nuclear powered rockets are also prominent. In the past few months, the development of the NERVA engine (which is managed by the US AEC) has been going well. Work has begun on the design and construction of rocket engines with a thrust of 75,000 pounds but capable of continuous operation for close on an hour. Although the first flights cannot take place until 1977 or thereabouts, there is no question that the arrival of nuclear power for rocket engines will change the perspective of those who plan space journeys for people. It is almost self-evident, for example, that devices like these are the only practical means by which journeys to the distant planets—taking several years with existing equipment—could be planned. On the strictly technical side, where the question is simply that of encouraging NASA to emphasize one field of activity rather than some other, it is clear that the President's advisers cannot leave nuclear rockets out of account.

Research Satellites

Some attempt to estimate the potential benefits of these several lines of development is unavoidable. One question to be asked, not dodged, is whether the potential interest of the various schemes to science, to technology or—what comes to the same thing—to both can provide any kind of guidance. For all the excitement of the past week, it is only fair to say that in the space exploration of the past decade, the attainments of unmanned satellites have been greater—and cheaper—than anything which is promised by the pro-