

grammes which lie ahead. To say this is to state a fact. Thus earth satellites have discovered the magnetosphere, explored the solar wind and prepared the way for a surge of interest in those branches of astronomy which are not possible on the surface of the Earth because of the obscuration of the atmosphere. Although it will be useful to learn more of the Moon, it is probable that for several years to come, instruments in earth satellites or planetary rockets would be a better buy than rockets for carrying people about, which is not of course the same thing as to say that there is no case for spaceflight by people—that is a different argument. It is also fair to say that there are many branches of science in which activities on the surface of the Earth would yield strictly scientific benefits more cheaply even than simple earth satellites. It is often easier to obtain funding for an expensive satellite experiment than a small fraction of that amount for a related terrestrial experiment. It follows from this that, where strictly scientific considerations are concerned, the objective should be a sensible balance between the various kinds of activity, with if anything more emphasis on old-fashioned ways of investing money in research. And it also follows that strictly scientific considerations will not be much of a help in planning the strategy of the next few years. One of the merits of Dr Paine's arrival at NASA is that he has recognized that scientific benefit is neither necessary nor sufficient to the space programme.

Telecommunications

Much the same can be said of the potential technological benefits of what lies ahead. So far and for a long time to come, the chief product of space technology is likely to be telecommunications. Certainly the potential value of weather satellites and exploration satellites, however substantial they may be, cannot compare with the demonstrable value of communications satellites. And there is nothing in the prospectuses of the space stations and the Moon capsules to suggest that other equally valuable applications are just around the corner. This is why it is ironical that the communications between Europe and North America should have been hampered during the flight of Apollo 11 by the failure, some weeks earlier, of the main Intelsat III satellite above the Atlantic. If technological benefit were the objective, Dr DuBridge and his advisers would find themselves saying that the greatest benefits are to be had in telecommunications. And there, of course, the benefits are so clear that communications carriers will actually pay for them.

In circumstances like these, the best tactics are varied tactics. Within whatever budget it can win from the Administration and Congress, NASA should be encouraged to seek diversity. The objective should be the accumulation of experience, so that by the late seventies, when nuclear rockets are in service, there will be a chance to seize whatever opportunities then present themselves. In retrospect, it is perhaps a pity

that so many flights to the Moon are to be crammed into the next two years—an earlier beginning on the Saturn Workshop might have been a good exchange! To be sure, this would have been hard to decide a year ago, when there were good grounds for doubting the confidence of NASA in its technical prowess. Now, there should be plenty of encouragement to branch out. An acceleration of the nuclear rocket programme would be worth paying for at the expense of other parts of the budget.

Budget Size

But how big should the budget be? This is a perennial source of argument and confusion. In the days when NASA was inclined to hide behind the coat tails of science and technology, of course, the most measured answer was quite properly a declaration that it would be better to spend the money on other forms of science—ground-based astronomy, for example. In reality, the justification of the space programme does not need to be as narrowly based, and it is also a plain fact that what the United States spends on the exploration of space is less than one per cent of the GNP of the richest nation in the world. Given that none of the \$25,000 million spent on space research has actually left the surface of the Earth, there is evidently no reason why the United States should not go on spending a similar proportion of its wealth on activities like these. And although it often seems a mockery that NASA should go on spending money while the haunting social problems of the United States remain unsolved, that is an illusion. For one thing, the mockery that counts is that contrast between the \$128,000 million spent by the Department of Defense and the \$2,000 million allocated to the Poverty Programme. But it is also hard to see how the expenditure on space could be transferred to other fields. Not merely is the relief of social problems a less popular if because a less tangible cause than the exploration of space, it is also the plain truth that \$3,700 million would not go far towards the remedying of, say, urban problems even if enough were known of the possible solutions to suggest that the money could be spent with confidence.

Defining Objectives

But what then should be the magic future? From now on, NASA will stand out among the agencies of the Federal Government by being saddled with the responsibility not merely for attaining its objectives but for defining them. In the jungle of Washington, this is a vulnerable position. It is much easier if somebody else—the President or Congress—lays down the law and then finds itself obliged to pay the bill. In practice, however, it would obviously be a great waste of talent and initiative if the space programme were now to be abandoned or even severely curtailed. Most probably, Congress will itself more or less be asking that NASA should live within a budget corresponding to roughly the present figure adjusted for