

vey would be possible. A radio-relay satellite would be put into a more distant orbit to provide an almost continuous radio contact between the instrumented polar orbiter and the Earth. Such a mission, in which the scientific aspects have already been developed (see figure and box), is under consideration by NASA for a 1982 launch (see following story).

The Terrestrial Bodies Orbiter-Lunar mission is part of a new phase of

planetary exploration, by means of remote-sensing orbiting spacecraft. A somewhat similar approach, but with a spinning spacecraft, is now under way in the United States for exploration of Venus, and a Jupiter orbiter is in the planning stages. These latter two missions will also involve atmospheric probes, which are unnecessary for planets and bodies without a substantial atmosphere. Modified versions of the TBOL spacecraft could extend

further the exploration of such bodies in future.

More active European participation at this crucial stage in the exploration of the solar system would be timely and would enable European scientists, who contributed so much to the analysis of lunar samples, to revive the old scientific tradition of which we have been reminded in recent years by the anniversaries of Copernicus, Kepler and Galileo. □

USA

Ford's parting gifts

Colin Norman in Washington reports on the proposals for research and development in Mr Ford's third and final budget

WITH just three days of his brief and troubled Presidency left to run, Mr Ford this week presented Congress with a complex and detailed set of budget proposals for the 1978 Fiscal Year, which begins on October 1, 1977, more than eight months after he leaves office. Though they are likely to be substantially revised, both by the incoming Carter Administration and by the Democratic-controlled Congress, Mr Ford's parting economic proposals could result in substantial increases in support for science and technology, particularly for basic research.

The proposals represent the lame-duck Administration's detailed prescriptions for limiting growth in Federal spending, reforming the sprawling government bureaucracy and setting priorities among Federal programmes. During the next few weeks, President Carter and his economic advisers will sift through Mr Ford's budget and offer a raft of amendments to bring it into line with the new administration's economic and political philosophies. Carter will concentrate on the more political proposals, however, and it is likely that many of the less controversial programmes, which include most concerned with science and technology, will survive the change of administration more or less intact.

Mr Ford's budget includes a total of about \$26,300 million for research and development, an increase of about 8% over estimated expenditures this year. As in the past few years, defence and energy research and development account for the bulk of the increases, but basic research is also singled out for favourable treatment, rising by about 9%, to reach some \$3,000 million. Inflation is expected to hover around 6%, so the Ford budget proposals should result in a modest, but real,

growth in Federal research support.

According to a discussion paper published by the Office of Management and Budget, funding for basic research in the United States has declined by about 27% over the past decade, chiefly because funding increases have not kept pace with inflation. Although the document suggests that basic science in the United States is competitive with that of other countries, the decline in support "has raised concerns about whether the United States might not be underinvesting in basic research to the detriment of the nation's future".

The chief beneficiary of the proposed increases is the National Science Foundation (NSF), scheduled for an increase in funds for some 12%. According to Richard Atkinson, the acting director of NSF, a major use of the proposed increase will be to upgrade scientific instruments and equipment in universities and colleges. NSF's total budget is set to climb to \$885 million under Mr Ford's proposals.

The budget is the first to be produced since the establishment of the White House Office of Science and Technology Policy (OSTP), and some credit for the proposed increases is being claimed for the new arrangement. H. Guyford Stever, the head of OSTP and Mr Ford's science adviser (who will also leave the Federal Government this week) notes with some satisfaction that "although it is a constrained budget, it is not as constrained as in previous years". Asked whether he expects the Carter Administration to go along with the proposals, Stever pointed out that few of the research and development proposals have political implications, and he suggested that "if the incoming administration asks for advice on the research and development budget it would get much the same advice" as Mr Ford received. Since Mr Carter had not chosen a replacement for Dr Stever at the beginning of this week, he does not seem to feel an urgent need for such advice.

Included in the budget proposals are a number of new programmes which have been waiting in the wings for some time, and which are likely to meet with approval from the Carter Administration. Prominent among them is a major effort in earthquake research. A three-year project divided between the National Science Foundation and the Department of the Interior, it is expected to receive about \$150 million, with the first instalment of \$23 million coming this year. The goals are "development of a reliable prediction capability within 10 years through increased research on fundamental causes of earthquakes and precursor phenomena", establishment of building codes for structures in earthquake prone areas, publication of regional hazard assessment maps, and studies of the social, legal and economic implications of reliable earthquake prediction capability. Such a programme was recommended last year by a White House Advisory Committee, and a similar effort was incorporated in a bill passed last year by the Senate. The Carter Administration is unlikely to reject the proposal.

Another area to receive some long-overdue support in Mr Ford's budget is agricultural research. Some \$28 million has been proposed for a new programme of basic research on photosynthesis, nitrogen fixation, crop productivity, and genetic engineering of crop plants, funded through a system of competitive grants similar to those operated by the National Science Foundation and the National Institutes of Health. At present, virtually all the research supported by the Department of Agriculture is funded through block grants to institutions, and initiation of a competing grants programme has long been recommended, particularly by committees of the National Academy of Sciences, as a way to increase the quality of agricultural research. The proposed programme is virtually certain to receive a warm reception in Congress since the House last year approved a bill designed to initiate just such a programme.

Table 5 Conduct of basic research by major departments and agencies (in millions of dollars)

Department or agency	Obligations			Outlays		
	1976 actual	1977 estimate	1978 estimate	1976 actual	1977 estimate	1978 estimate
Health, Education and Welfare (National Institutes of Health)	660 (590)	744 (659)	796 (710)	694 (627)	644 (568)	745 (662)
National Science Foundation	541	612	688	534	574	650
Energy Research and Development Administration	346	389	427	330	370	413
National Aeronautics and Space Administration	298	352	365	297	321	360
Defence—Military functions	248	274	314	225	279	314
Agriculture	171	193	215	168	200	210
Interior	121	127	143	125	125	137
Smithsonian	26	31	32	28	31	31
Commerce	22	25	24	21	24	25
Environmental Protection Agency	14	21	18	13	21	14
All other	16	17	19	16	15	20
Total	2,463	2,785	3,041	2,451	2,604	2,919

Space science is also singled out for a modest increase in Mr Ford's proposed budget. A new start has been proposed on the construction of the Large Space Telescope (LST), a 2.4-metre optical telescope which is expected to be launched by the space shuttle in 1983. Estimated to cost a total of between 435 and 470 million dollars, the LST has consistently been ranked as a top priority space science project by the National Academy of Sciences, but restrictions on federal expenditures in the past two years have twice caused the programme to be deferred. Funds have also been proposed for another high-priority mission, construction of a spacecraft to orbit Jupiter and send probes into the planet's atmosphere. And finally, Mr Ford's budget includes funds to begin construction of three more shuttle orbiters, in addition to the two which have already been approved. There are, however, some casualties in NASA's budget, most prominent of which is a proposal to place a spacecraft in a polar orbit around the moon (see page 197). A start on that mission was anticipated in the 1978 Fiscal Year, but it has been deferred, at least until 1979. So far, Mr Carter has made few public comments about the space programme; thus the fate of Mr Ford's proposals for NASA are uncertain. The projected total costs of the LST may, however, make it a plum target and there is some speculation that Carter will ask NASA to seek foreign financial participation in the project.

One area of Mr Ford's research and development budget which is likely to be substantially modified by the Carter Administration is the proposed funding for energy research and development. Though Mr. Ford has recommended a hefty increase in total support for energy programmes, with some \$3,000 million included in the budget for research and development, much of the additional money would be swallowed up by nuclear energy research efforts. The Liquid Metal Fast Breeder Reactor

(LMFBR) programme alone is scheduled to increase from 686 to 855 million dollars. During the election campaign, Carter promised to reduce the priority of the LMFBR project and to seek international participation in it. He also consistently promised to try to reduce United States' reliance on nuclear power.

A particular focus of conflict between Ford's energy proposals and Carter's election promises is likely to involve programmes designed to increase energy conservation and to spur commercial introduction of solar heating devices. Mr Ford's budget would involve virtually no increase in funds for research and development on energy conservation, chiefly because the Ford Administration believes such efforts should be the responsibility of private industry rather than the federal government. Similarly, the proposed Ford budget would reduce federal support for a programme designed to provide subsidies for the production and installation of solar heating devices. Again, the argument is that the technology is relatively well developed and private industry should bear the chief responsibility for its commercialisation. Throughout the election campaign, Mr Carter frequently promised to make energy conservation and the development of alternative sources of energy his top priorities. Moreover, James Schlesinger, the former head of the Atomic Energy Commission, whom Carter has named as his chief energy adviser, has also argued strongly for increased efforts to stimulate energy conservation. The thorny question of government involvement in private industry, and Federal subsidies to spur commercial development of those technologies, will clearly have to be addressed very soon by the new president and his energy team. As for fusion energy, Mr Ford's budget provides funds for construction of a large Tokamak device at Princeton University—a project which was reported to be in jeopardy at one stage in the budget

deliberations—and it also contains funds to increase the already sizeable fusion project at Lawrence Livermore Laboratory.

Another area which is likely to be a source of controversy is support for biomedical research. The Ford budget provides very little increase in support for biomedical research funded by the National Institutes of Health (NIH), and in particular it seeks to hold the budgets of the National Cancer Institute and the National Heart and Lung Institute approximately constant, after several years of rapid growth. There is also a proposal to transfer responsibility for NIH's intramural research to the Assistant Secretary for Health, a suggestion which is likely to raise considerable protest from biomedical researchers since it smacks of increased political control over health research.

Ford tried to hold down spending by NIH in his two previous budgets but Congress has refused to go along with the reductions and instead it has voted hefty increases for biomedical research. The same pattern is likely to be repeated this year, but the Carter Administration will soon be forced to take a close look at priorities in biomedical research. In that regard, a study produced last year by a presidential commission recommended that there should be some changes in the privileged political position of the National Cancer Institute, but the recommendations have so far been neglected.

Finally, it is worth noting that when President Ford entered the White House in August 1974, he inherited, among other troubles, a scientific community which had been complaining bitterly about declining research support and the lack of a central science policy office. In his brief term of office, Ford has taken several steps to attend to the concerns of the scientific community, and when he leaves the White House this week, he will bequeath his successor a much more healthy scientific legacy. □