

work of this kind. The several programmes of environmental research (including agriculture) which many agencies at present support form a coherent package of their own, while there are also programmes of applied research, in space and in oceanography, for example, which deserve separate consideration.

The National Science Foundation has built up, in the past decade, an enviable reputation for probity. Like the Science Research Council in Britain, and like a great many organizations elsewhere in the world, it owes its success to the selfless way in which professional scientists, not distinguished for their lack of prejudice, are able to behave judicially once they find themselves in Washington sharing out public money. It is hard to believe that any other mechanism for dealing with the financing of university research could ever be devised, from which it follows that the National Science Foundation must grow larger whatever decisions are eventually made about the setting up of a Department of Science.

The dividing line should be determined by giving the National Science Foundation responsibility for the direct support of research in American universities, which implies that it should also take over responsibility for common facilities such as the accelerators and even for those parts of the programmes of the mission-oriented agencies such as NASA which are said to exist for the sake of the academics—the programmes in basic astronomy, for example. Naturally, such an enlarged science foundation would often find itself commissioning agencies such as NASA to carry out desirable pieces of research, but at least there would then be some assurance that the projects concerned had been weighed in the balance against other kinds of academic work. By such means, the National Science Foundation could easily grow to twice its present size. (In the coming fiscal year, the Federal Government as a whole is likely to spend more than \$1,500 million on university research.) It would be fair, however, if responsibility for supporting postgraduate students by training fellowships were transferred from the National Science Foundation and the NIH to some other part of the octopodal Department of Health, Education and Welfare—this, after all, is a part of the Federal Government's relationship with universities as a whole. Whether curriculum development should stay with the National Science Foundation is another question.

If the National Science Foundation should grow to such a scale, what need would there be of a Department of Science? This is an obvious question to ask. The first thing to be said, of course, is that there are a great many technical questions which are outside the limits of the brief of even an enlarged science foundation. What, for example, should be done about oceanography—a field in which it is inevitable that several powerful agencies should simultaneously have strong views? Metrication is another case in which a Department of Science would find itself having to reconcile conflicting interests. But these are all matters where the interests of the scientific community will best be served if important disputes can always be carried to arbitration at the White House. All this implies that

the immediate objective should not be an independent agency for science, compelled to win a place for itself in the jungle on the Capitol, but rather a strengthened Office of Science and Technology. It would help enormously if the office were more able than it has been to take forward planning seriously. There is also a powerful case for asking that the character of the President's Science Advisory Committee should be changed so as to make it much more directly a forum in which professional opinions, often in conflict with each other, could be brought to bear on policy making. If this were done well enough, it is entirely possible that the interests of the scientific community could be safeguarded without the presence of a ritual champion in the Cabinet. Development along these lines would be at once more immediately beneficial and less prone to major error than the setting up of an entirely new department. This, then, is the goal at which Dr DuBridge should now be aiming.

OIL POLLUTION

Crying over Spilt Oil

THE Union Oil Company of California seems doomed to be involved in major oil pollution disasters. It had the lease of the Torrey Canyon, and now one of its wells, 5.5 miles off the coast of California, has been leaking oil at a rate estimated to be at least 21,000 gallons a day. The well off Santa Barbara developed the leak and opened up five fissures in the sea bed around the drilling platform on January 29. Since then, the company has been drilling a second hole into the oil reservoir to relieve pressure and block the leak while, at the same time, tons of drilling mud have been pumped down the well in an attempt to staunch the flow of oil. At the surface, two allegedly biodegradable dispersants are being used but, learning from the Torrey Canyon, detergents have not been tried, and so far there has been no attempt to fire the oil. Fortunately, it seemed clear at the beginning of this week that efforts to staunch the flow were achieving some success.

For the first few days after the leak began, easterly winds kept the growing oil slick off the coast, but westerlies have since forced some oil onto what must be the world's most expensive coast. The result seems to have been an alliance of people concerned about ocean frontages, which cost anything up to \$2,000 a foot, and simple conservationists. Union Oil's plea that it has always rigidly enforced existing safety standards cut no ice with Californians, who quickly retorted by saying that all that proved was the inadequacy of the standards. The State of California has announced it will sue Union Oil when the extent of the losses of wild life has been assessed.

The attempts to deal with the oil have also been criticized by a group of academics at the University of California at Santa Barbara, who seem to be particularly incensed because no one has sought their help or advice even though the leaking well is almost in sight of the campus. They maintain that the disaster should be used as an opportunity to try new techniques for clearing or containing oil, and they claim that better results would be achieved if the dispersants were pumped directly into the fissures instead of onto the sea.

For the new Secretary of the Interior, Mr Hickel, the disaster could not have come at a worse time. He looks like being the first of the new cabinet officers to have to run the gauntlet of public criticism. He was, of course, accused of being a tool of the oil industry lobby when his nomination was challenged, and his decision to ask for a voluntary cessation of drilling from the other companies working in the Santa Barbara channel, and then, a day later, to allow drilling to restart, was particularly maladroit. But Mr Hickel has now initiated a review of the fifteen year old drilling regulations which were primarily designed to deal with the conditions encountered in the gulf coasts of Texas and Louisiana. President Nixon seems to have anticipated the outcome of the inquiry by saying at a press conference that "We've got to get to the source of the problem" and "that means very stringent regulations in off-shore drilling". Congress may be more inclined to pass proposals—which it balked at last year—for strengthening Federal control of pollution from drillings and tankers. Future drilling regulations will probably include some of the practices which companies still working in the Santa Barbara Channel have voluntarily but belatedly adopted. These include more frequent testing of safety devices to prevent blowouts, increased use of drilling mud to seal nascent fissures and installation of stronger well casings.

But how does a well blowing wild cause the sea bed to crack? It is too soon yet to know exactly what happened at Santa Barbara, but the pattern of events suggests that, to begin with, something went wrong at the base of the well. Once this happens, the pressure builds up and oil begins to escape either up the casing of the well or outside it, or into the strata above the reservoir. In either event it can cut fissures into the sea bed as it emerges. Once this has happened, the only cure is to drill a new hole into the reservoir starting perhaps half a mile from the well but with a sloping bore so that it ends up close to the well. Once the second boring penetrates the reservoir, any material heavier than the oil from the well can be pumped into the reservoir. This in effect strangulates the well by counteracting the pressure forcing the oil out of the oil-bearing rock. Union Oil has apparently adopted this procedure, and, now it has sealed it, it has the option of repairing the well or filling it up with concrete and giving it up as a bad job. The betting is that it will do the latter.

EARTH SATELLITES

Prospecting from Above

from our Astronomy Correspondent

NON-STICK frying pans used to be the spin-off which made space research worthwhile. The latest claimants are called earth resources satellites which, the arguments go, will lead to massive benefits in cartography, agriculture, oceanography, geology and hydrology simply by using space platforms as vantage points for looking at the Earth. The latest document to back earth resources satellites is a report prepared for a subcommittee of the House Committee on Science and Astronautics. In his introduction, Rep. Joseph E. Karth, chairman of the Subcommittee on Space Science and Applications, says that an earth resources

satellite system represents the largest potential return on investment of any space project so far. He goes on to recall how last year the subcommittee unsuccessfully tried to double NASA's modest budget for an earth resources satellite. Since then the subcommittee has kept more than a watchful eye on the project, and much of the report is a criticism of what has happened.

The report makes few concessions to the scepticism which many scientists share about earth resources satellites, however. Yet there is widespread doubt whether instrumentation has reached a stage advanced enough for a valuable earth resources programme. Prospecting for minerals, for example, put forward as a job which satellites ought to be doing, requires measurements which are hard enough to carry out from an aircraft flying at 1,000 feet, let alone from a satellite at 100 miles. And the proponents of simple geological mapping from space photographs cannot so far point to any new geological features revealed from satellite photographs. Naturally enough, much of the value of viewing the Earth from space depends on the detail which can be seen, and it is here that much of the controversy lies. The claim that Gemini photographs frequently contain greater detail than conventional aerial photographs is hard to believe, but high resolution photo-reconnaissance systems from military satellites could make geographical mapping from space a possibility. But will it be economically worthwhile? And will it ever be possible, let alone economic, to conduct land-use survey by satellite? Then the application of satellites to oceanography and hydrology, mentioned in the report, requires sensors in ranges other than the visible in many cases. The use of radar to detect the roughness of the sea, and infrared sensors to detect ocean currents where there may be schools of fish, are just two examples. Here it is more than likely that the development of the necessary instrumentation is at too early a stage to warrant the support for earth resources satellites for which the report asks. And in spite of the dispute which is reported to have blown up last year over the release of several hundreds of Apollo 7 photographs—only thirteen pictures were cleared for publication in the first week after the flight—there is no hard evidence that the photographers on Apollo 7 were able to bring back information about the surface of the Earth not otherwise available. To be sure, if it had not been for Columbus, the astronauts would have discovered the New World, but that is not what the present excitement is about.

Much of the congressional report is a history of what amounts to a tug-of-war between NASA and several other agencies, chiefly the Departments of the Interior and Agriculture. According to the subcommittee, while NASA has consistently lacked enthusiasm for earth resources satellites, the Interior and Agriculture Departments have been prodding for more action. Much of the discussion has centred around whether the sort of spacecraft envisaged by the Interior Department is or is not beyond the state of the art. "Just at or just beyond the current state of the art", according to NASA, but "currently within the state of the art" according to a committee set up at the direction of the Secretary of the Interior. For years—since 1964—NASA has considered earth resources projects as part of the manned space flight programme, to the dismay of critics who want to see much cheaper unmanned systems. But even since 1967, when the