to remain in the front rank of modern nations) is to attack them vigorously and with the participation of all who will be involved in the change. And this is precisely what the French S&T planning apparatus is attempting to do. The apparatus must mutate to meet France's new needs. But a logical start has been made.

Summary

The imaginative French attempts to plan civil science and technology in a basically private-enterprise economy merit worldwide attention. The basic French S&T philosophy and structure are described here for the first time in any very complete form. The planning apparatus has made many important contributions to France's recent scientific and technological development. This article has attempted to document both these contributions and the major weaknesses in the current planning structure. And it has noted the major problems French S&T planning must face in the future. Undoubtedly the planning structure will continue to evolve to meet these challenges. But the real question is whether it can do so fast enough or completely enough to cope with the urgent demands of future international competition, increased industrial consolidation, more flexible educational and research organizations, and a more decentralized affluent society. Perhaps an even more proper question is whether France could hope to meet these demands *without* intelligent planning of its scientific and technical commitments.

References and Notes

1. A. M. Weinberg, "Criteria for scientific choice," *Minerva*, Winter, 1963.
2. P. Bauchet, *Economic Planning, the French Experience* (Praeger, New York, 1964), p. 77.
3. Derived in part from *La Recherche Scientifique en France* (Délégation Générale à la Recherche Scientifique et Technique, Paris, 1964). Important national laboratories such as the Institut National de la Recherche Agronomique, Institut National d'Hygiene, Centre National d'Études Telecommunications are included in the "laboratories" reporting to the ministries.
4. As of this writing, these include: Minister of Education (universities, CNRS, Natural History Museum, Collège de France, Paris Observatory, most of the "*grandes écoles*"); Minister of Agriculture (Institut National de la Recherche Agronomique); Minister of Industry (Bureau of Geological and Mining Research, Geological Map Service, National Institute of Applied Chemical Research, nationalized coal, gas, and electricity industries and their laboratories, "parafiscal" cooperative industrial research associations); Minister of Public Health (Institut National d'Hygiene); Minister of Posts and Telecommunications (Centre National d'Études de Telecommunications, CNET); Minister of the Armed Forces (Defense Research through the Delegation Ministerielle pour l'Armement); Secretary of State for Scientific Research (Atomic energy, space research).
5. Actually the decree of 29 November 1958 created only the post of General Delegate for Scientific and Technical Research. The General Delegation, of which he is head, was not created until 1959.
6. There are commissions on: Agriculture; Agriculture and Food Industries; Building and Public Works; Chemistry; Commerce; Cultural Investment; Energy; Fuels; Fats; Handicraft Trades; Housing; Iron and Steel; Manufacturing Industries; Mines and Non-Ferrous Metals; Overseas Development; Postal and Telecommunications; Broadcasting and Television; Health and Social Investment; School, University and Sport Investment; Sea Fisheries; Tourism; Transport; Urban Development (*2*), p. 35.
7. The typical work group would have three to ten people intimately involved, with a large number of people called upon temporarily for specific assistance.
8. J. Hackett and A. M. Hackett, *Economic Planning in France* (Allen and Unwin, London, 1963), p. 46.
9. Currently, these are the "members by right": Director of the Budget, Director of the Treasury, Chief of Service—Economic Studies and Finances (Ministry of Finance), Delegate General for Scientific and Technical Research, President of the Action Committee for National Defense, Chief of the Technical Bureau of the State—Major General of the Armies, Inspector of Armament Programs and Production, the Delegate Administrator General of the Government and the High Commissioner of Atomic Energy, Director of University Education to the Education Ministry, Director of the CNRS, Director of the National Institute for Agricultural Research, Director of the National Institute of Health, the Inspector General responsible for Technical Research for the Ministry of Industry. The President of the Center for Space Studies and the Director of Research and Testing of the Ministry of the Armed Services are more recent members.
10. Source: letter, 18 May 1965, Office of the Scientific Attaché, Embassy of France, Washington, D.C.
11. This article results from a one-year study of national science planning in Europe. I interviewed 177 high-level people in universities, businesses, government, and independent institutes. I thank the Ford Foundation and Alfred P. Sloan Foundation for their support and the Conseil National du Patronat Français for arranging interviews throughout France.

NEWS AND COMMENT

After the Moon Landing: Senate Hearings Open Way for Debate

"We are involved in a great many things that we decided long ago with very little discussion," said Senator Clinton P. Anderson (D–New Mexico) in reference to Project Apollo, the program for a manned round trip to the moon in this decade. The Senator, who chairs the Aeronautical and Space Sciences Committee, made it clear that he feels Apollo is "a fine goal," and he added, "I am glad that we have gone ahead with it." But future goals for the space program, he declared, should be preceded by ample public discussion. The Senator made his remarks in the course of three days of hearings held in August and published with supplementary material earlier this month, under the title "National Space Goals for the Post-Apollo Period."* The 383-page volume comprises the best available compendium of what the officialdom of space is thinking of post-Apollo, and, especially for those who share the Senator's views of the genesis of the moon program, it commands serious attention.

The object of the hearings was not to determine what any concerned citizen feels about post-Apollo, but rather, as a staff member of the committee explained to *Science*, "to get the views of the people who have a major input on the program. It was not intended as a public sounding board." This may strike some space skeptics as a closed-circuit discussion. But the relevant fact is that post-Apollo planning is now in the most preliminary stages of discussion, and the official views elicited by Anderson's committee provide informa-

* $1, U.S. Government Printing Office, Washington D.C. 20402. Also available, for 40 cents, is a related volume, part 3 of "Hearings Before the Aeronautical and Space Sciences Committee," containing various post-Apollo planning documents, including the Future Programs Task Group report.

tion and, for those so inclined, a departure point for dissent that were altogether unavailable when Apollo was suddenly sprung by President Kennedy in the wake of the Bay of Pigs fiasco. The congressional committees with space jurisdictions have, with an occasional exception, shown little interest in obtaining the views of persons who are not connected in one way or another with the space program. (As a staff man explained, "Open it up to the public and you get all kinds coming in who say the money should be spent on cancer when they don't know that the cancer people have money coming out of their ears.") But if there is significant dissatisfaction, in or out of the space establishment, with post-Apollo planning, there is now an unprecedented opportunity for differing views to be made known. Outsiders obviously don't stand much of a chance against the detailed studies and proposals produced with NASA financing, but post-Apollo planning is now in a highly inchoate stage, and it is probably now at its most vulnerable to well-reasoned argument. It is advantageous to present these from a congressional witness chair, but the mails, statements of professional groups, and personal contacts also serve well to let Congress know what people are thinking.

The first thing to be said about post-Apollo is that, whatever the details may be, it is going to happen. With the civilian space program closely related to military applications, 400,000 people employed in aerospace work, and some $21 billion spent so far in civilian space activities, NASA is not going to close down after one round trip to the moon. Nor, with the political-economic base that it has built, is it likely to experience a budgetary decline. (In opening the hearings, Anderson stated, "A long lead time is required to carry out new space missions, and it would be unfortunate if the conclusion of the Apollo program were to be followed by a costly letdown in our space efforts.")

But, specifically, what is to be done? The answers from persons associated with the space program generally focused on moving from manned lunar exploration to instrumented exploration of Mars and other celestial bodies, and then possibly to manned exploration of Mars, but when and at what pace are questions that almost consistently drew cautious and tentative replies.

With the space program financially hard pressed to meet its lunar timetable, and many uncertainties still ahead, NASA Director James E. Webb shied away from any commitments to costly new programs and made it clear that the moon landing is to receive precedence over any other possibilities in space. In fact, Webb indicated that even the current unmanned scientific programs may have to yield to the lunar landing's requirements. Sticking to the conclusions contained in the Future Programs Task Group Report that NASA prepared last year at the request of the White House, Webb said, "In my view, what is necessary now is not a firm decision to undertake specific large new projects, but continued support and funding of the already ongoing scientific and technological efforts. . . ." The equipment and techniques developed for Apollo, he said, will provide the space program with the means for achieving other goals, once the lunar goals have been achieved. Meanwhile, he said, unless the space budget is increased, NASA should not undertake any costly preparations for post-Apollo programs, nor should it seek to step up the pace of the Voyager program for unmanned exploration of Mars. "I would like to proceed with Voyager," Webb said, "but I probably have to be careful even in saying this, because we have the 1967 budget coming up and what the President submits to Congress in view of all his requirements may be somewhat different from what those of us in the space program feel is necessary.

"So we have not in any way made a commitment," Webb continued, "to do the Voyager mission to Mars which would include a fly-by in 1969 and a landing in 1971, much less a manned mission. Also, my view now is that unless we go up somewhat in expenditures from our current level, we may even have to postpone the possibility of a Voyager landing on Mars to, say, 1973."

Similar caution on new commitments was expressed by Donald F. Hornig, the President's science adviser, but Hornig also introduced considerations of space competing with other national needs. Referring to proposals to establish lunar bases, Hornig said, "Even if both feasible and scientifically useful, I cannot now say whether it would be more in the national interest to spend the large amounts required on lunar bases or on other important national undertakings." After a manned lunar landing, he said, we will be in a better position to decide what should be done next. As for speculation on a manned landing on Mars by 1985, Hornig offered "some very tentative, personal impressions," including, "Whether such a long mission is physiologically or psychologically feasible is almost impossible to judge before we have more experience with Apollo . . . and other manned systems." But again, he raised the issue of competition for resources, observing that "if we compare the probable scale and technical difficulties of a manned Mars expedition with Apollo, it is hard to conclude that its probable cost could be much less than perhaps five times that of Apollo—that is, of the order of $100 billion. If this estimate is anywhere in the right ballpark, I can only conclude that at this moment there are a number of other national objectives that seem more urgent. It seems to me that about 10 more years of space activity will be required before we know enough or have had enough experience to begin even to plan intelligently."

While Hornig, who works for the budget-paring Lyndon Johnson, felt that a $100 billion investment in Mars was at least open to question, some of his colleagues from the scientific community showed no uncertainty. Among them were members of the National Academy of Sciences' Space Science Board (SSB) which last year produced a report, "National Goals in Space 1971–1985." This called for "a measured pace so that toward the end of this epoch (1985) we shall be ready for manned planetary exploration." Said SSB Chairman, Harry H. Hess, who chairs the geology department at Princeton, "I don't like this figure ($100 billion). I don't think it need cost that much, even our program, but it might. On the other hand, if you multiply $5 billion by 20, it is $100 billion. So, if we continue the space program at about the present level, we come out with the same sort of figure." To this Senator Anderson agreed, noting that "some people become frightened if the program runs to $60 billion. A portion of a 20-year program is something else again."

The witness who came closest to expressing the discontent that some members of the scientific community feel toward the allocation of funds within the space program was Gordon J. F.

Accelerator Competition: Teams Visiting Sites

The great accelerator competition has now entered the site-examination stage, with four-man teams organized by the Atomic Energy Commission touring all 85 of the locales that remain in the running for the $348-million facility (*Science*, 13 August, page 730; and 24 September, page 1484).

By the end of December the teams are expected to forward their findings to the National Academy of Sciences committee which is advising the AEC on the site selection. Each team is headed by a representative of the AEC general manager's office and includes representatives from the AEC's division of construction, from the division of research, and from one of the AEC's several high-energy physics laboratories. The Academy committee asked the AEC to provide the inspection teams after the AEC concluded that 85 of the 126 proposals submitted met the basic site criteria. The committee, which is a part-time body, had originally been led to believe that the number of sites forwarded by the AEC would be considerably smaller. Because of the heavy workload, it turned to the AEC for assistance.

Prior to each site visit, the AEC informs the affected congressional delegation of the team's plans. This is a standard courtesy which provides the incumbent with the substance for a public announcement which may carry the suggestion that he had something to do with bringing the visitors to his constituency.

The latest enticement in the nationwide competition for the accelerator is an offer by New York State to provide economical power rates for the machine. In a letter to E. R. Piore, the IBM vice president who chairs the Academy committee, Governor Rockefeller stated that he had a commitment from the state's seven power companies to deliver power to all but one of the state's eight proposed sites at a cost of not more than half a cent a kilowatt hour. In New York, the lowest rate for large blocks of power delivered at non-peak hours is 1.1 cents, and the average rate is 2.8 cents. The Governor's offer was reported in the New York *Times*, which noted that "The availability of suitable power facilities at a competitive price is a chief requirement for the accelerator site. Others are educational and cultural facilities enabling the research center to attract and hold its staff of scientists and engineers."

Immediately beneath the *Times* story on the $348-million facility was a public service announcement which provides an illuminating commentary on the management of resources in the U.S. The announcement told drought-stricken New Yorkers: "Don't empty ashtrays into the toilet. Every flush uses 5 to 8 gallons."—D.S.G.

MacDonald, assistant director of the Institute of Geophysics and Planetary Physics at UCLA and a member of the Space Science Board. MacDonald, the youngest member of the President's Science Advisory Committee, did not take direct issue with Webb's disclosure that instrumented exploration of Mars may have to be delayed because of the budgetary requirements of Apollo. But in a carefully worded statement he recommended an expansion of planetary research, and he then went on to raise questions about the adequacy of NASA's scientific advice. Stating that "scientific considerations suggest a major program of planetary investigations in the 1970–85 time period," MacDonald said, "Among the planets, primary emphasis should probably be given to Mars with secondary emphasis to Venus and the major planets and significant attention to comets, asteroids, and Mercury. If such a program of lunar and planetary investigation is to be instituted," he continued, "then progress should be made toward the Apollo extension system (the adaptation of Apollo equipment for further missions), the Voyager program should be expanded and accelerated, and programs should be developed for exploration of the outer planets and Venus.

"If the emphasis on the space program shifts over the next few years," MacDonald stated, "from a manned lunar mission to a broadly based program of lunar and planetary research . . . the change of emphasis will require a different balance of facilities with a very much stronger emphasis on the development of scientific mission capabilities. At present, the existing manpower and facilities assigned to development of scientific lunar and planetary programs are clearly inadequate for the broadly based program discussed above."

MacDonald added that "Both the national interest and the interest of the scientific disciplines involved demand that the maximum scientific competence be brought to bear upon both the formulation and realization of long-term goals of NASA. Neither the present discipline-oriented NASA subcommittees nor occasional summer conferences by large groups are adequate for this purpose and it is essential that steps be taken to rectify this weakness in the decision-making process."

Later, in response to a question from Senator Stephen M. Young (D–Ohio) MacDonald said that he thought NASA's scientific advice should come from a "working group in the same way that the President's Science Advisory Committee is a working group, meeting every month or carrying out longer studies if need be; that it be composed of representatives from a broad range of scientific disciplines and include representatives from the engineering technological interests. Nothing of this sort exists at present."

"Well, then," asked Senator Young, "should scientific competence alone be responsible for NASA's long-range planning?"

"Certainly not," replied MacDonald. "I think that the development of the scientific and technological programs will require this kind of advice. The long-term national commitments must be made in a much broader arena of discussion and include many . . . representatives of many aspects of our society."

If those representatives have any thoughts about post-Apollo, now is the time to come forward.

—D. S. GREENBERG