article attacking him in *Fortune*. In 1953, on the basis of a denunciation, President Eisenhower ordered that Oppenheimer's security clearance be terminated. The ensuing, long-protracted security investigation became a *cause célèbre*. Many of his scientist friends came out in his defense, a few came out against him. The Proceedings, published by the AEC, give a vivid story of the discussions within the U.S. Government on defense policy between 1947 and 1953. They have been avidly read by friend and foe abroad.

Both the Security Hearing Board, by a vote of 2 to 1, and the AEC, by a vote of 4 to 1, decided to withhold security clearance from Oppenheimer. In the final majority opinion by the Commission the only real argument against granting him clearance was the grotesque story of Haakon Chevalier in 1942. Intrinsically this "espionage attempt" was of no importance whatever (the counterintelligence corps did not even bother to investigate the lead), but apparently Oppenheimer, under stress and overwork at Los Alamos, had invented a rather foolish cock-and-bull story to shield his friend, and had then denied it.

It was not until April 1962 that the government made amends. Then President Kennedy invited him to a White House dinner for Nobel prize winners. And in 1963, just after taking office, President Johnson gave Oppenheimer the highest honor given by the AEC, the $50,000 Fermi award. In his acceptance remarks Oppenheimer said, "I think it is just possible, Mr. President, that it has taken some charity and some courage for you to make this award today."

V. A Changed Person

Oppenheimer took the outcome of the security hearing very quietly, but he was a changed person; much of his previous spirit and liveliness had left him. Excluded from government work, he apparently did not have the strength to return to active work in physics. He was as interested and well-informed on physics as ever before, still a leading figure at international conferences. But his main activity was now along more general lines.

He was deeply concerned, both before and after 1954, with the public understanding of science. His Reith lectures over the BBC, given in 1953 and published under the title *Science and the Common Understanding,* are among the most lucid and, at the same time, most profound popular expositions of atomic and quantum theory. Here, again, he never took the easy way of explaining just the facts, and he carefully avoided any facile analogies between the uncertainty principle and biological processes.

He was much aware of, and troubled by, the inability of the modern scientist to communicate his exhilarating experience of discovery, and also the contents of his discoveries, to the educated layman, in contrast to the close communication between science and society two centuries earlier [see, for example, "Some Reflections on Science and Culture" (1960)]. In still other lectures ["The Open Mind" (1955)] he discusses the relation of scientists to society, and many facets of the atomic policy of the United States. He always gives the impression of having long wrestled with the problem; he always raises a great many penetrating questions; and he gives few concrete answers.

If this left his audience only partly satisfied, they were compensated by the beauty of his style. I have seldom heard a speaker, scientist or otherwise, who had such a command of the English language, and who could so well fit words to the depth of the thought. There was wit also, and a store of good anecdotes, but, most of all, the signs of a deeply concerned human being.

Oppenheimer will leave a lasting memory in all the scientists who have worked with him, and in the many who have passed through his school and whose taste in physics was formed by him. His was a truly brilliant mind, best described by his long-time associate Charles Lauritsen: "This man was unbelievable. He always gave you the answer before you had time to formulate the question."

Post-Apollo: NASA's Plans Get Boost from LBJ and PSAC

Some answers are now available to the long-standing question of what will be the major goals of the U.S. space program following completion of the initial Apollo moon voyages. The program's longer-range goals must remain a matter of speculation because, if for no other reason, man's fitness for long-duration space flight is still to be determined. Nevertheless, the National Aeronautics and Space Administration has charted a course of sorts for the post-Apollo era and is pursuing it with the encouragement of President Johnson and his scientific advisers. Manned planetary expeditions and orbital space stations are among the space agency's ultimate goals.

In his budget message to Congress in January the President, alluding to NASA's post-Apollo plans, observed that the country would now have to look beyond Apollo "unless we wish to abandon the manned space capability we have created. . . . This budget," Johnson said, "provides for the initiation of an effective follow-on to the manned lunar landing. We will explore the moon. We will learn to live in space for months at a time. Our astronauts will conduct scientific and engineering experiments in space to enhance man's mastery of that environment."

The new NASA budget reflects a decision for NASA to pursue what the agency has called a "balanced program," involving the use of much of the Apollo technology. The meaning of this bland and ingratiating label is that, after Apollo, the space program will not again focus on a single overriding objective, such as a manned flight to Mars. The era of the balanced program should begin late in this decade, provided the timetable for the first lunar landings is not upset by mishaps such as the recent Apollo spacecraft fire.

NASA hopes to lay the foundation for the new program over the next few years by undertaking a variety of manned and unmanned space activities. Some would test man's ability to survive and perform effectively during prolonged space flight. Others would be

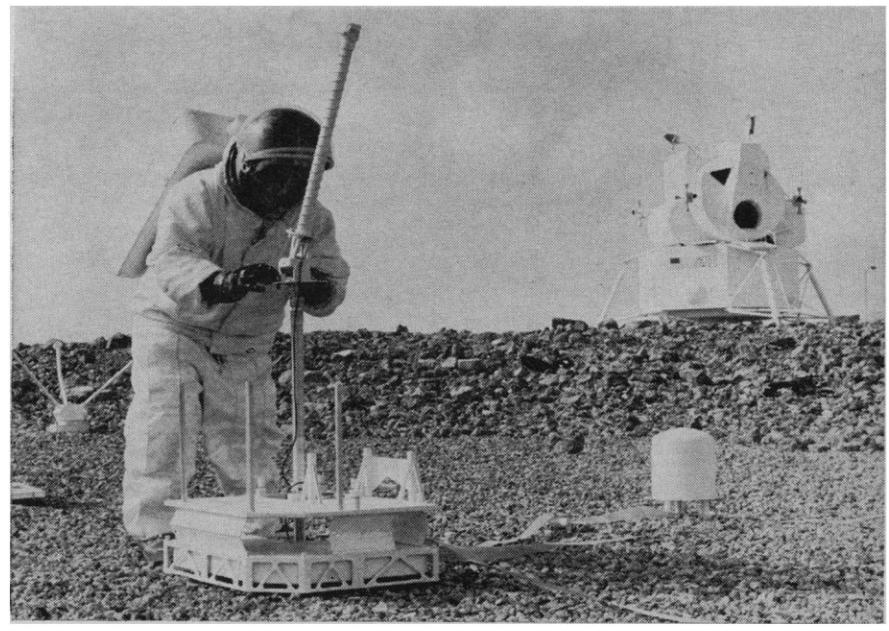
preparation for extensive lunar exploration and for investigations to be conducted from earth orbit. The orbital investigations would be concerned with solar and stellar observations and possibly with gathering data on the earth's resources and atmospheric phenomena.

Provided Congress supplies the wherewithal, NASA will conduct about eight major launch missions each year in the post-Apollo period, which, roughly, begins after the first three lunar landings and extends well into the 1970's. The first of the "Apollo applications" will not necessarily await the first lunar landings, however. According to NASA plans, an orbital workshop, to be fashioned inside a spent Saturn IVB stage by a three-man crew, will be established in 1968 or 1969 as the first of such applications. The first astronaut crew to use the workshop will remain aloft only 1 month, but plans call for increasing the flight time for later crews until flights lasting as long as a year have been achieved.

An Apollo Telescope Mount (ATM), regarded as the forerunner of long-lived orbital astronomical facilities of great scientific potential, will be placed in orbit and attached to the workshop, if NASA's plans are realized. Four separate launches and several orbital rendezvous will be required to establish the workshop and join ATM to it. The ATM, which can be operated by one crew member, is expected to be in service during a peak of solar activity.

Other instrument packages may be launched for use with the orbital workshop. For example, instruments are being developed for possible use in testing the feasibility of obtaining useful data about earth resources by means of active and passive sensors and developing techniques for extrapolation and correlation of data obtained simultaneously from several sensors. Such a package could include multiband, metric, and panoramic cameras; tracking telescope; radar imager; laser altimeter; passive microwave imager and radiometer; absorption spectroscope; and other devices. An effort also is being made to develop a package of meteorological instruments capable of measurements more sophisticated than those made by existing satellites such as Nimbus and Tiros.

In an effort to permit more extensive exploration of the moon, NASA plans to modify the Apollo hardware and to develop mobile lunar vehicles. The goal is to make 2-week-long manned investigations of the lunar surface. In order to carry out short orbital ferry and resupply missions the Apollo command module will be modified to carry as many as six men, three more than it carries now. The life-support equipment of the Apollo system will be altered to permit flights of longer duration for both lunar and orbital operations.



Apollo lunar-surface-experiments package is deployed by a technician at the Manned Spacecraft Center's Lunar Topographical Simulation Area. The package, to be carried to the moon aboard a lunar module, is designed to gather lunar data in such areas as geology, geophysics, geochemistry, and particles and fields. [NASA photo]

The loftiness of NASA's ambitions is further indicated by the fact that the agency is hoping the President will permit it and the Atomic Energy Commission to proceeed soon with development of the Nerva II advanced nuclear rocket engine. A nuclear rocket would be useful for lunar and planetary voyages and for placing payloads in high earth orbit.

Unmanned as well as manned investigations figure importantly in plans for the post-Apollo era. For instance, the new budget provides funds for a Mariner mission, with an atmospheric probe, to Mars in 1971. This is in addition to the Voyager mission to be launched by a Saturn V in 1973, which will include a soft landing on Mars. (The current budget provides money for a Mariner flyby of Venus in 1967 and for two flybys of Mars in 1969.) Another new scientific mission is Sunblazer, in which a satellite will make close-in observations of the sun.

Though the foregoing is by no means a complete catalog of NASA's plans and aspirations, it suggests the directions in which the agency's activities are moving. The NASA program seems largely in harmony with the recent recommendations of the President's Science Advisory Committee's combined space science and space technology panels, headed by Franklin A. Long of Cornell (chairman) and Lewis M. Branscomb of the Joint Institute for Laboratory Astrophysics, Boulder, Colorado (co-chairman). Although the panels' report* was not made public until 9 February, it was available to the President's science adviser and the Bureau of the Budget while the new NASA budget was still under review.

Officials of NASA regard the report as useful and as a boost for their program. John E. Naugle, deputy associate administrator for science, observes, for example, that NASA, the National Academy of Science's Space Science Board, and the PSAC panels all are now on record as recommending a broadly balanced program of space science and applications. As another NASA official put it, "This PSAC report is a roadmap indicating pretty much the same trip the agency wants to take."

The White House, in releasing the report, noted that the PSAC panels had "rejected the adoption of a single new dominating goal" and had recommended

**The Space Program in the Post-Apollo Period.* The report may be obtained for 50 cents from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

a well-integrated program of manned and unmanned space efforts directed toward five major objectives: "(i) A limited but important extension of Apollo in order to exploit our anticipated ability to explore the moon; (ii) a strongly upgraded program of early unmanned exploration of the nearby planets, on a scale of time and effort that will enable the results of this program to contribute significantly toward the planning of future manned expeditions; (iii) a program of technology development and of qualification of man for long duration space flight in anticipation of manned planetary exploration; (iv) the extension and vigorous exploitation of space applications for the social and economic well-being of the nation and for national security; and (v) the exploitation of our capability to carry out complex technical operations in near earth orbit for the advance of science, particularly astronomy." (The report said orbital astronomy could well serve as "a major scientific focus of the U.S. space program in the 1970's.")

The space agency no doubt was eager to be thus encouraged in its ambitions by panels working under the auspices of PSAC, a body concerned with the government's total scientific program. It is true, of course, that among the 24 members of PSAC's combined space panels there are a number of enthusiastic "space scientists." Moreover, better than a third of the members have served (or are still serving) on the Space Science Board, which, in effect, has come to be NASA's scientific advisory body. Nevertheless, a certain parochialism seems inevitable in any group of scientific advisers qualified to recommend priorities in a specific field. In any event, the PSAC panels' report is likely to be accepted by many people in Congress and by the interested public as an expert and reasonably impartial body's mark of approval for NASA's slowly emerging post-Apollo program.

The panels' explicit encouragement of a major role for man in space was particularly pleasing to NASA. ". . . The panels believe that an attractive long-term objective for space exploration is a program directed ultimately at the exploration of the planets by man," the report said. "In spite of the great difficulty and considerable hazard of this enterprise, we support a program directed toward its accomplishment because we believe the question of extraterrestrial life to be of great significance to scientist and layman alike, and believe it likely that man's presence may ultimately be required to provide full and satisfactory answers."

Addressing themselves to a question which has generated controversy among scientists, the panels offered a bit of philosophy on how large the space program should be. "The optimum level of effort," they said, "lies between that which is so low as to remove the discipline of rapid progress or so high as to remove the necessity for ingenuity and for pressing the technological state of the art."

For fiscal 1968 a NASA budget of $5.11 billion has been submitted to Congress, with the funds for Apollo ($2.6 billion) showing a decline of $310 million from fiscal 1967, but with the funds for space science and applications ($694 million) showing a $87.5 million increase. The PSAC panels, in order to indicate possible implications of their program recommendations, sketched out three alternative space budgets for fiscal 1972, a time still early in the post-Apollo period.

For Program A, which would imply a decision to postpone manned planetary exploration indefinitely, the budget would be $3.5 billion. Included as major program elements under this budget would be a modest program of manned and unmanned lunar exploration; a program of unmanned planetary exploration directed at Mars and Venus; and a program of earth-orbital operations (conducted at a "constrained pace") for scientific purposes such as adjusting and repairing telescopes and for applications offering economic benefits.

For Program B, which would imply a commitment to prepare for manned planetary exploration at an unspecified date, the budget would be $5.8 billion. It would provide for lunar exploration; a modest program of unmanned planetary exploration serving to prepare for eventual manned exploration; a large program of earth-orbital operations, designed in part to develop capabilities for planetary flight; and a large program of launch-vehicle production and development.

For Program C, which would be similar to B except that it would be accelerated in order to launch a manned planetary flight by a fixed date (say 1985), the budget would total $7 billion.

Whether manned planetary exploration will in fact take place depends, of course, on a variety of political and financial considerations and, perhaps decisively, on man's ability to endure the biological and psychological stresses of prolonged space travel. On this point, the PSAC panels seemed more restrained in their optimism than NASA itself has been.

At NASA's recent Gemini summary conference at Houston, Charles A. Berry, chief of the Manned Spacecraft Center's medical program, delivered a report which was quite sanguine in tone. "In some respects the medical community becomes its own worst enemy in the attempt to protect man against the hazards of new and unknown environments," Berry said. "Frequently the physician dwells upon the possible individual system decrements, and forgets the tremendous capability of the body to maintain a state of homeostasis in many environments." According to Berry, the effects of the space environment on man seem much less than had been originally anticipated. "Although much remains to be learned," he said, "it appears that if man is properly supported, his limitations will not be a barrier to the exploration of the universe."

The PSAC panels pointed out, as Berry has himself, that Mercury, Gemini, and Apollo flights are too short to permit reliable extrapolations on which to predict the effects on man of long-duration flight. Moreover, inadequacies in bioinstrumentation have impeded the collection of data, the panels noted. They called special attention to the problems encountered by Gemini astronauts in working outside the spacecraft. "Although the evidence suggests that brief, heavy workloads can be met adequately, the findings are equally suggestive of impaired capability in prolonged effort, both during and after flight," the panels said.

Their report endorsed NASA's plans to have astronauts build the orbital workshop inside the spent rocket stage, but it cautioned that "some doubts arise about man's ability to carry out extensive construction efforts in space." The panels did seem confident that astronauts would be highly useful in occasionally adjusting, repairing, or altering the large, costly telescopes which, the panels hope, eventually will be placed in orbit for use by ground-based astronomers.

Though generally warm in their comments on NASA's programs and plans, the PSAC panels were not satisfied on every score. For example, they complained of a lack of integrated planning in the areas of manned and unmanned space flight. "The panels have been presented with two distinct and apparently independent plans for plane-

tary exploration," they said. "On the one hand, there is the Voyager program, centered around unmanned Saturn V launched missions to Mars in 1973 and 1975. . . . On the other hand, the panels were presented with a detailed plan for a manned mission to fly to the immediate vicinity of Mars and return (Mars flyby), possibly as early as 1975. . . . It was suggested that a single Mars flyby mission of this type might return a greater amount of useful information than is likely to be returned by the entire proposed program of Voyager missions to Mars in the 1970's. . . . There was, however, little indication of joint studies to develop agreed comparisons of the two types of missions or to develop a possible mixed strategy. . . ."

While the panels proposed nothing unsettling, such as a merger of the Office of Manned Space Flight with the Office of Space Science and Applications, they did offer a general guideline. "We recommend that NASA study the advantages of adopting a planning and decision-making structure which emphasizes program objectives rather than the means used to obtain them," they said.

The panels also recommended that, with respect to the emerging earth-resources-survey program, NASA undertake detailed cost-benefit studies of the manned and unmanned flights proposed for the survey tasks. It was suggested that, for some survey work, satellites, whether manned or unmanned, may not be the most economic means at hand. The panels noted that there have been proposals to use satellites to survey geological, agricultural, and forest resources, and to examine such things as the use patterns of metropolitan areas. "On the whole, the studies undertaken have not yet presented a convincing case that such survey programs can best be carried out by satellites," the panels said.

However, the expression of these doubts and reservations does not detract much from the essential fact that NASA has the support of the President's scientific advisers. Moreover, the President himself, by submitting to Congress a NASA budget which seems to point toward eventual planetary flight, has given the space agency a vital boost. Those who have long been inquiring about the space program's ultimate destination have not received a final answer, but they have been given more than an inkling.

—LUTHER J. CARTER

NEWS IN BRIEF

● **U.S. AND INTERNATIONAL SCIENCE**: A catalog of major international science programs in which the federal government participates is contained in a report issued by the Science Policy Research and Foreign Affairs Division of the Legislative Reference Service. The report was drawn up at the request of the Science, Research, and Development Subcommittee of the House Committee on Science and Astronautics. In its 167 pages, the report describes the international science activities of government departments and agencies, the National Academy of Sciences—National Research Council, and intergovernmental agencies. Where possible costs of the programs are given but an accounting of the entire amount that the United States spends on international cooperative programs "is not known, nor is it likely that it can be known," the report says. The study was not intended as an evaluation of the programs but a section of the summary states: "None of the activities appears to be without justification, but there is reason to question, as always, whether or not coordination is adequate or if it exists at all." The report, *The Participation of Federal Agencies in International Scientific Programs*, may be obtained from the Committee on Science and Astronautics, 2318 Rayburn House Office Building, Washington, D.C. 20515.

● **FDA FINALLY APPROVES FISH PROTEIN**: After 6 years of asking, urging, and studying on the part of others, the Food and Drug Administration has set aside its aesthetic squeamishness and scientific doubts and approved the use of fish protein concentrate (FPC) as a food additive for human consumption. The Bureau of Commerical Fisheries of the Department of the Interior is now surveying possible sites for the construction of a demonstration plant to manufacture the product. This construction was authorized in a bill passed in the last session of Congress and signed by President Johnson on 2 November, contingent on the approval of fish protein by the FDA. The bill also authorizes the Interior Department to lease another plant to demonstrate the feasibility of production of FPC by the commerical fishing industry. Approval of FPC was requested in separate petitions to the FDA last year by the Department of the Interior and the VioBin Corp. of Monticello, Illinois. The Bureau of Commercial Fisheries has been working on a method of manufacturing fish protein concentrate for the last 3 years at a model unit in Beltsville, Maryland. The FPC food additive regulations of the FDA appear in the 2 February Federal Register.

● **AEC AWARDS**: Three members of the Atomic Energy Commission's headquarters staff have received the AEC Distinguished Service Award—highest honor it bestows upon employees—for their contributions to U.S. nuclear energy programs. The award—a medal, certificate, and citation—went to: Edward J. Bloch, Deputy General Manager, for outstanding service in directing and administering major AEC programs; Brig. Gen. Delmar L. Crowson, USAF, Director, Division of Military Application, for his contributions to the national defense; and George F. Quinn, Assistant General Manager for Plans and Production, for outstanding contributions to Commission programs.

● **SOCIAL, BEHAVIORAL SCIENCES STUDY**: Increased interest in the social and behavioral sciences on the part of government agencies, Congress, and others concerned with national support of the sciences has prompted a survey of the two disciplines under the joint auspices of the Social Science Research Council and the National Academy of Sciences–National Research Council. The purpose of the survey is to provide a basis for an informed and effective national policy for strengthening and developing the fields. A committee, headed by Ernest R. Hilgard, professor of psychology, Stanford University, is being set up to organize and execute the survey. The study will give major emphasis to anthropology, economics, history, political science, psychology, and sociology, with a more compact treatment of geography, linguistics, and psychiatry. The resulting report, expected to be published by autumn of 1969, will include information on manpower in research and training, financing of research and teaching, levels of research activity, and equipment, facilities and space, both actually used and forecasts of needs.