Planetary Exploration: How to Get by the Budget-Cutters?

For the National Aeronautics and Space Administration, 1967 was to have been the year the nation committed itself to an ambitious set of "post-Apollo" goals. As things have turned out, however, this year has been one of debacle for NASA's plans to mount, for the 1970's, a major program of unmanned planetary exploration. Now, although 1968 promises to be another bleak budget year for nondefense agencies, NASA is again scrambling to get a planetary program approved.

The outcome of its proposals, which differ in certain major respects from the recommendations of the agency's scientific advisers, remains highly uncertain pending a review by the White House and the Congress. Meanwhile, the recent landing of the Soviet spacecraft on Venus suggests that, unless the United States keeps pace with the Soviet Union, the chief scientific contribution of its missions to the planets may be to confirm basic discoveries made by the Russians.

To profitably examine NASA's chances of getting a planetary program off the launch pad next year, a review of the agency's treatment this year at the hands of the budget-cutters is necessary. Funds to start development of the $2.5-billion program of unmanned Voyager missions to Mars in 1973 and 1975 were denied by Congress, as were those for the 1971 Mariner mission, a precursor to Voyager. In fact, the only "new start" allowed in NASA's scientific program was that for the Apollo Telescope Mount (ATM), which will provide a stabilized orbital platform for a variety of solar and stellar observations. The ATM will be "flown" in 1970 in conjunction with the manned earth-orbital workshop.

The budget cuts meant that, beyond 1969, NASA had no approved planetary flights and few scientific flights of any kind. Further development of the 200,000-pound-thrust Nerva II nuclear rocket engine, possibly for use in manned planetary expeditions in the 1980's as well as in lunar and earth-orbital missions, also was frustrated for lack of essential funds.

What went wrong? Unquestionably the decisive factor in the congressional decisions to slash the NASA budget from the $5.1 billion requested to about $4.6 billion was the Vietnam war and its drain on the Treasury. Significant too, however, was the tragic Apollo spacecraft fire of 27 January, which put NASA in a bad light and led to congressional investigations that delayed action on the agency's budget.

The space appropriation bill did not come up for final decisions until the end of a long, hot summer of urban riots, a presidential proposal for a tax increase, and mounting congressional concern at the prospect of a huge wartime budgetary deficit. Indeed, when the House Appropriations Committee recommended a space budget more than a half-billion dollars under the administration's request, the President himself said such a reduction was acceptable in the light of existing circumstances.

Still other factors appear to have contributed to the heavy cut in NASA's budget and the gutting of the planetary program, however. Public support for NASA has declined since the days of heady excitement over the first space spectaculars. According to a Louis Harris opinion survey reported on 31 July, 54 percent of the sample polled felt the space program was not worth the money being spent on it, while only 34 percent felt it was worth it (12 percent were "unsure"). The poll showed "low-income" people opposed to the man-on-the-moon project by 3 to 1. This loss of popularity is reflected in congressional attitudes. Moreover, members of Congress appear less concerned than in the past about the possibility that the Russians will steal a march on the United States, although Soviet competition continues to generate substantial support for the space program.

Post-Apollo projects such as Voyager attracted the budget-cutters' attention because they could be deferred or eliminated without harming programs already under development. Ninety percent of the money requested by NASA this year was for Apollo and other "ongoing" programs. Voyager made an especially tempting target for those members of Congress who believed it would be the precursor of a manned mission to Mars costing untold billions.

"When I was testifying [before congressional committees] some people felt that Voyager represented a commitment far larger even than Apollo," one high NASA official told *Science*. "I tried to point out that manned planetary flight was not in the cards for the foreseeable future. But, having agreed to the manned lunar program by some sort of process, they were cautious about making another large commitment."

On 8 November, James E. Webb, NASA's administrator, revealed to the Senate space committee a new set of NASA proposals for planetary missions for which he was seeking White House and congressional approval. In disclosing these plans, Webb was, ostensibly, merely responding to a senator's question. In fact, the question was inevitable, and Webb must have felt that his proposals might gain momentum if they became known to space scientists, contractors, and other interested parties who could apply political pressure.

According to Webb, NASA is proposing (i) five new Mariner missions (the last Mariner now authorized is a 1969 mission to Mars), the series to start in 1971 and perhaps be completed by 1976; (ii) a Voyager mission to place two spacecraft in orbit around Mars in 1973 and probably release small probes into the Martian atmosphere; and (iii) a larger Voyager mission to Mars in 1975, with two spacecraft orbiting the planet, while two others—each carrying an automated laboratory—attempt a soft landing.

The 1971 Mariner mission to Mars, to be launched by an Atlas-Centaur rocket, would be, not the "flyby" proposed earlier and rejected by Congress, but an orbiter capable of making its photographic and other observations for a longer time, yet less expensive than the original mission because it would use equipment left over from the 1969 Mariner and exclude a costly atmospheric probe.

Other Mariner flights specifically mentioned by Webb were missions to Venus in 1972 and 1973, both to be launched by Titan IIIC rockets. The 1973 Mariner, on its encounter with Venus, would be deflected gravitationally all the way to Mercury—an elegant celestial cushion shot. The 1973 Voyager mission also would be launched by a Titan IIIC booster, rather than by the much larger and ten times more

costly Saturn V rocket to be used for the 1975 Voyager.

Webb noted that work on the Lunar Orbiter and Surveyor (soft-lander) programs, the 1967 Mariner-Venus project, and the preliminery design of Voyager (for which $37 million has been spent) ends this fiscal year. A total of $700 million and more than 20,000 man-years of experience has gone into the 16 lunar and planetary flights NASA has made. If the President decides not to provide for a planetary program in his next budget, Webb said, the R & D teams which have prepared past missions will be disbanded and the best people will be assigned to "supporting research and technology"—that is, theoretical studies and other work looking toward planetary programs which ultimately might be approved. Webb said such action will not be taken before he tries to persuade the President to budget funds for those flights previously described.

For NASA to seek to present the foregoing proposals to Congress this coming January, just a few months after the rejection of its earlier planetary mission plans, is nothing if not bold. In his discussion with the Senate committee, however, Webb said the immediate budgetary impact of his planetary exploration plan would not be great.

Expenditures would not become heavy until fiscal 1970 and 1971, he said. He explained that the only additional money NASA seeks to spend on planetary programs in fiscal 1968 is $18 million which could be "reprogrammed" from money appropriated for other purposes. The principal source of funds for reprogramming is the "Apollo Applications program" (AAP), an endeavor designed to make use of the Apollo technology for various manned earth-orbital and extended lunar missions. This program has been revised because Congress cut its budget by about a third.

(The number of AAP flights has been sharply reduced, and no AAP missions will be flown before 1970. "At that time," Webb told the Senate committee, "we will fly a precursor training mission for scientists-astronauts with certain earth-orbital experiments, and then proceed with dual launch missions with the orbital workshop and the Apollo Telescope Mount.")

Webb's new set of planetary proposals has going for it the fact that, with expenditures for Apollo declining, spending for other programs can grow over the next few years without necessarily increasing the overall NASA budget. There is reason to believe, however, that Webb's proposals already may have met with some resistance in the Bureau of the Budget. Just what kind of planetary program the bureau and the President, to whom NASA can appeal, will accept is a matter of conjecture.

But it is Congress that finally will fix the ceiling and horizons for NASA's operations. Should a program akin to NASA's current planetary proposals receive presidential approval, congressmen will know that ultimately its costs would run to several billion dollars. And, while Voyager and Mariner funds were cut out this year chiefly in the name of wartime economy and not because of opposition to planetary exploration, most congressmen clearly have only the most superficial interest in such missions. Moreover, a program of planetary exploration, lacking a simple, easily understood goal comparable to that of landing a man on the moon, is too diffuse and abstract to readily arouse the enthusiasm of the man on the street. Accordingly, budget items bearing a planetary label are likely to remain vulnerable unless the case for planetary exploration is presented to Congress and to the public more persuasively than it has been in the past.

By trying to involve outside scientists more deeply in its decisions, NASA is indicating its belief that strong support by the scientific community will be essential in selling its post-Apollo programs. The agency's scientific advisers are now playing a larger role, principally through the new Lunar and Planetary Missions Board. This 18-member board, established early this year under the chairmanship of John W. Findlay, assistant director of the National Radio Astronomy Observatory at Charlottesville, Virginia, is supposed to have close working relations with NASA's senior officials.

According to its charter, the board will (i) have access to NASA's internal documents, (ii) take part in major internal NASA reviews and coordination meetings relating to lunar and planetary exploration, and (iii) maintain relations with the scientific community and its institutions, including the National Academy of Sciences (five board members are also members of the Academy's Space Science Board).

Although, in general, NASA is said to have tried to live up to its assurances that the board will be a party to all major policy deliberations in its field, the package of planetary-mission plans which Webb presented to the Senate committee was adopted by the agency in such haste that there was no consultation with the full board. NASA officials did try to discuss the proposals with the board members by telephone, but this was by no means a substitute for a review by the board itself.

The space agency adopted the package of planetary proposals with the knowledge that in some major particulars the board's position differed from its own. As described to *Science* by one board member, these differences are as follows. (i) The board favors attempting a Venus-Mercury flyby at the earliest possible opportunity, in 1970, instead of waiting until 1973. (ii) It recommends including an atmospheric probe in the 1971 Mariner-Mars mission, though not the costly probe NASA formerly planned. (iii) It favors attempting a galactic probe and flyby of Jupiter in 1974, in preparation for the "Grand Tour" in 1977, 1978, and 1979—the opportunity to swing by Jupiter to Saturn, Uranus, and Neptune (a flight which could not be repeated before the year 2153). (iv) It does not recommend a Voyager "lander" mission in 1975 of the kind requiring a Saturn V launch. To plan this kind of Voyager mission for 1975 is regarded by the board as premature in the light of current technology and knowledge about Mars. A more evolutionary approach to the investigation of the planet is preferable, the board feels. At a meeting in Houston last week, it is understood, the board reaffirmed its position on the foregoing issues.

The space agency and the board are at least agreed, however, on the importance of having a major planetary program in the 1970's. Nor is it beyond possibility that when an approved national planetary program emerges, if one does, it will be one which both NASA and the board can enthusiastically endorse. In any case, NASA's effort to use the board as one of its principal links with the scientific community signals the agency's awareness of the political needs of the day. Indeed, Homer E. Newell, NASA's associate administrator, says, "The scientific community has to somehow make it plain that it wants a space science program, just as it made it plain that it wanted the [200 Bev] accelerator."

But, even while exhorting scientists to support its programs, NASA is with-

drawing some of the support it has been giving the universities. This year, for example, the agency planned to cut again its sustaining university program from which universities and graduate students received $46 million in fiscal 1966, reducing it to $20 million in fiscal 1968. (Congress, wielding an even sharper knife, cut it to $10 million.) In so doing, NASA expressed a vague hope that the National Science Foundation and The U.S. Office of Education would take over its support of new predoctoral candidates.

This cutback in support is disturbing to university-based scientists. In a recent speech at Cornell, Gordon J. F. MacDonald, UCLA geophysicist (now on leave at the Institute for Defense Analyses) and member of both the Space Science Board and the Lunar and Planetary Missions Board, expressed a concern which many of his scientific colleagues no doubt share. He observed that most significant discoveries in space science had been made by university scientists, then added: "In the face of a decreasing budget, there will be strong and perhaps overwhelming pressure to maintain the space establishment, particularly the large federal laboratories, at the expense of continued support of the universities. . . . Extraordinary courage [will be required of] the NASA administration to counter these pressures and to continue a strong university-based research effort. However, to do otherwise will insure a degradation in the quality of the research program and, in the long term, further erode the support for space activities."

To enlist greater support for the planetary program and to help identify possible alternatives to NASA proposals, Representative Joseph E. Karth (D–Minn.) says he will ask some non-NASA scientists to testify before the Space Science and Applications Subcommittee, of which he is chairman. He hopes such scientists are more willing to appear before him now than they have been in the past, when those approached often indicated a desire not to take issue with NASA publicly.

Usually the House and Senate committees handling the annual space authorization and appropriations bills hear only from NASA witnesses. Scientists might do well to try to abolish that tradition by asking to be heard. Conceivably, even this year such witnesses might possibly have been persuasive in pointing out lower-cost alternatives to NASA's 1971 Mariner

A newly published study of the Soviet space program indicates that, while political uncertainty buffets the American space efforts, "the Soviet program has unfolded in an orderly way, building rather conservatively step by step" and "has blossomed into a varied complex of mission goals as widespread as our own." The study,* produced for the House Science and Astronautics Committee by the Science Policy Research Division of the Library of Congress, deals gingerly with the question of which nation is ahead, and altogether avoids any prescriptions. But it leaves the clear implication that, at a time when the U.S. is uncertain about its postlunar landing intentions, and Congress is hacking at the space budget, the Soviet space program is now in its most flourishing state since Sputnik went aloft in 1957 (see Table 1). The issuance of such conclusions during a period of budgetary strain for NASA might normally justify suspicions as to motive and purpose. But, on the basis of past performance, the Science Policy Research Division has earned a right to respectful attention. The space study, headed by Charles S. Sheldon II, acting chief of the division and senior specialist in space and transportation technology, is typically dispassionate and has a ring of knowledgeability.

Putting aside the difficult question of the wisdom of given levels of investment in space activity, the study concludes that the Soviet space program "in terms of hardware and resources is roughly the same as ours." But in terms of percentage of gross national product (GNP), it goes on to point out, the Soviet space program probably represents 2 percent of the U.S.S.R.'s GNP, as compared with the approximately 1 percent that the U.S. invests in space activities.

The report notes that "for the first year since 1957, the Russians now lead in the number of successful launches. This is in addition to their probable continuous lead in total weight placed in orbit. Even with our large new vehicles beginning to fly, the Russian lead in tonnage of payload has continued to grow. We are not closing the tonnage gap. Stated in terms of nominal capacity to place a given weight in low Earth orbit (without reference to whether weight was sacrificed to higher velocity in order to fly higher), the Soviet Union to mid-1967 had placed a nominal order to fly higher), the Soviet Union to mid-1967 had placed a nominal 2 million pounds in orbit, and the United States a nominal 1.4 million pounds."

The report sharply dismisses reports that the Soviets have lost several space crews in orbital mishaps. "[When] these Soviet failures are said to occur," it notes, "all standard American sensors which catalog all the objects in space somehow do not detect these Soviet failures. But strangely," it continues, "a small and persistently lucky group of amateurs in Italy, Germany, and California intercept actual voice messages, heavy breathing, and groans over their radios that no official monitoring station ever catches."—D.S.G.

Table 1. Approximate comparison of United States and Soviet successful space launchings primarily civil oriented versus presumptively military oriented.

Year	Primarily or ostensibly civil				Presumptively specialized military	
	NASA	DoD	U.S. total	USSR	DoD	USSR
1957	0	0	0	2	0	0
1958	0	5	5	1	0	0
1959	5	0	5	3	5	0
1960	5	1	6	3	10	0
1961	10	0	10	6	19	0
1962	18	2	20	15	32	5
1963	10	3	13	10	25	7
1964	22	2	24	17	33	13
1965	24	8	32	24	31	24
1966	30	9	39	20	34	24
1967*	19	5	24	22	21	25
Total	143	35	178	123	210	98

*Through 4 October 1967.

*Review of the Soviet Space Program, Report of the Committee on Science and Astronautics, prepared by the Science Policy Research Division, Legislative Reference Service, Library of Congress, 138 pages; available from the Government Printing Office, Washington, D.C. 20402, 35 cents.

and 1973 Voyager projects. Representative Joe L. Evins (D–Tenn.), chairman of the Independent Offices Appropriations Subcommittee, which handles appropriations for NASA and nearly a score of other agencies, might be a particularly inviting target for missionary work. Certainly it is clear from the following incident that his information about the space program and its scientific overseers and cheerleaders is far from complete. During hearings last April, Evins noted that the NASA organization chart showed the Academy's Space Science Board, which is a few months older than NASA itself. "Is this new?" he inquired.

In promoting a change for the better in its fortunes on Capitol Hill, NASA should, Karth believes, show greater restraint in its enthusiasm for manned flight extravaganzas. Giving a speech last August, Karth expressed astonishment at having learned that only 2 weeks before, in the face of growing doubts among the citizenry about the space program's value, the Manned Spaceflight Center at Houston had asked 28 companies to submit proposals for a study of a manned Mars and Venus reconnaissance spacecraft under consideration for flights in 1975 and 1977. To Karth, these requests, since cancelled, were further evidence of the folly that can result from NASA's dichotomous management structure, in which the manned and unmanned programs are run by separate offices. Recent efforts by NASA to strengthen its management have neither eliminated the dichotomy nor silenced Karth and other critics.

However, the fate of a new round of proposals for planetary exploration may turn more on events in Vietnam than on anything the space agency and its friends in Congress and the scientific community can do to refurbish NASA's image and explain its goals. Yet such an effort may be needed if NASA is to make the best of a federal budgetary situation which holds little promise for agencies with large new plans.—LUTHER J. CARTER

Systems Analysis: No Panacea for Nation's Domestic Problems

The management technique known as "systems analysis" or the "systems approach" may have enabled Defense Secretary Robert S. McNamara to revolutionize administration of the Defense Department. But how would it fare if pitted against the domestic problems that confront federal, state, and local governments? Could systems analysis help end air and water pollution, educate the illiterate, heal the sick, eliminate crime, untangle transportation snarls, or boost recipients of public aid into self-sufficiency?

The answer, according to a report prepared for the U.S. Arms Control and Disarmament Agency by the Denver Research Institute (DRI), is a qualified "yes." Titled "Defense Systems Resources in the Civil Sector,"* the DRI report finds that systems analysis can become "a powerful tool" for dealing with *some* civil problems—but only if government agencies and private industry remove the numerous "obstacles" that currently inhibit use of the new techniques. And even then, the report makes clear, systems analysis is no panacea.

The report, based on interviews with 119 "knowledgeable people" in government and industry and on a review of the limited literature, was prepared by John S. Gilmore, John J. Ryan, and William S. Gould, industrial economists at DRI. The group sought primarily to analyze the systems capabilities of defense firms and evaluate the civil market for these resources in case there should be a cutback in defense spending. They concluded that civil systems work is "unlikely to absorb any great share of total defense resources." Instead, "its greatest promise is in improving the quality of government administration."

What are these promising new systems techniques, which have been called everything from "quantified common sense" to the "greatest advance in the art of government" in nearly a century? Definitions vary with the definer, but generally the "systems approach" involves identifying a problem, defining the objectives which must be achieved to solve it, considering alternative methods for meeting these objectives, and choosing the most attractive alternative "by rigid cost-effectiveness analysis, by intuition and judgment, or by something in between," the authors say. Systems techniques may also be applied to subsequent design and engineering work.

The defense systems approach evolved after World War II, largely in response to the technological revolution in weapons. Nuclear warheads, nuclear power sources, guided missiles, jet aircraft, electronic computers, and other developments created doctrinal problems, the DRI report says, "that would have seemed fantastic to earlier generations of men making national security policy and budgeting for its execution."

Much the same sort of complexity now seems to be building up in the civil sector too, the DRI study notes. Governments are finding it difficult to allocate limited resources among rapidly increasing demands, and swollen urban areas have brought a host of problems that demand solution with increasing urgency. These demands—coupled with an effort by defense firms to find civilian markets—have spurred efforts in the 1960's to develop a "civil systems" capability. The most widely publicized have been sponsored by the State of California, which contracted with four aerospace companies in 1965 for systems studies on information handling, crime, waste management, and transportation, and later followed these up with additional systems studies.

The DRI report gives the California effort mixed reviews. It found that knowledgeable professionals praised the initial studies for their "comprehensive scope" and "freshness of thinking," but criticized the studies for being "sometimes weak in their knowledge of the subject area," for making "political-

*Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; $1.