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THE SURVIVAL CRISIS OF THE U.S. SOLAR SYSTEM EXPLORATION PROGRAM[1]

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[1]This paper is a revision of an account originally prepared for the NASA History Office in 1989, but never before published. I want to thank James Beggs, Hans Mark, Bruce Murray, Louis Freidman and Sylvia Fries for their comments on the original version of the paper

After almost two decades of spectacular successes in the United States program of solar system exploration, 1981 was a year in which the program's survival was literally very much in question. Initial Reagan administration budget cuts, the cancellation of a previously approved planetary mission, and the unsuccessful attempt to gain White House support for a U.S. mission to Halley's Comet eventually threatened the program with almost total termination. The National Aeronautics and Space Administration (NASA), under severe White House pressure to reduce its budget, identified the planetary exploration program as its lowest priority scientific activity, and said that it would drop the program entirely if forced to accept the budget reductions being proposed by the Reagan administration. Only in December 1981, and only on the basis of intervention having more to do with institutional and political interests than with the scientific or societal merits of planetary exploration, was the program saved from termination. Although no new missions were approved at that time, this reprieve provided an opportunity for the solar system exploration community to rethink its program strategy and to gain support for the program's continuance, albeit with reduced expectations and at reduced budget levels. Those adjustments provided the foundation for the solar system exploration program on the 1990s; however, it also meant a long pause in the program. The United States launched no missions beyond Earth orbit between 1977 and 1989; the first mission reflecting the revised exploration strategy was Magellan, launched in May 1989. (It should be noted that almost three years of this "mission gap" were the result of the grounding of the Space Shuttle after the 1986 *Challenger* accident.) This paper traces the events surrounding this survival crisis of the U.S. planetary exploration program. In doing so, it is intended to cast light on the general issue of the politics of program termination, retrenchment, and continuity, and on the process of setting priorities among different areas of big science.

Background to the 1981 Crisis

According to one authoritative account, in the period immediately following World War II, "only a handful of astronomers in the world were giving much attention to the local problems of the Solar System."[2] For most, the interesting scientific questions lay far beyond the solar system: in the stars, interstellar matter, other galaxies, and the large-scale structure of the universe.

That situation changed a decade later, when the progress of space technology and its links to high priority political, military, and scientific goals in the United States and the Soviet Union made possible a large and ambitious program of space exploration. The initial impetus was provided by the Soviet launch of Sputnik 1 in October 1957 and the U.S. reaction to that launch. During 1958 and 1959, NASA planners were designing an American space program for the next decade that included

[2] Fred Whipple, "Discovering the Nature of Comets, Mercury, January-February 1986, p. 5.

exploration of the solar system by spacecraft travelling to the Earth's Moon and to at least the more accessible of the other planets, Venus and Mars.[3]

But those early mission planners discovered a void in contemporary knowledge of the solar system due to the half-century or more hiatus in ground-based study of the planets. This void made the design of a scientifically valid program of space-based lunar and planetary research very difficult. Faced with this situation, in the early 1960s the new National Aeronautics and Space Administration "responded with a multifaceted program that transformed the field. [Ground-based] Observatories were constructed, instruments acquired, astronomers trained, research programs funded, and other activities supported."[4] In essence, NASA created anew the field of planetary astronomy by supporting a vigorous ground-based research effort; by luring other scientists, particularly geologists, into the field with generous research grants; by supporting the training of new planetary astronomers, and most fundamentally by offering scientists the opportunity to place their instruments on space missions to the planets.

Accompanying the creation of a scientific community interested in solar system research was the involvement with NASA of a premier engineering organization to plan and carry out planetary missions. As part of the government reorganization that created a civilian space agency, in 1958 the Jet Propulsion Laboratory (JPL), an institution associated with the California Institute of Technology that had been founded by Theodore von Karman and his associates in 1936, was transferred to NASA as a Federally Funded Research and Development Center. The laboratory had emerged during and immediately after World War II as a center of U.S. competence in rocketry.[5] The Jet Propulsion Laboratory is formally a part of the elite California Institute of Technology (Caltech), and its employees are Caltech employees. The U.S. Army was JPL's sponsor in its formative years; in late 1957 and early 1958, JPL engineers teamed with Wernher von Braun's rocket team at the Army's Redstone Arsenal and with university scientists to develop and launch America's first satellite, Explorer I. After President Eisenhower transferred sponsorship of JPL from the Army to NASA later in 1958, the laboratory quickly identified lunar and planetary exploration as that portion of the emerging civilian space effort most likely to provide the engineering and operational challenges it sought.

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[3] For accounts of early planning for lunar and planetary missions, see Edward Clinton Ezell and Linda Neumann Ezell, On Mars: Exploration of the Red Planet 1958-1978, NASA SP-4212 (Washington: Government Printing Office, 1984).

[4] Joseph N. Tatarewicz, "'A Strange Plea' -- The Campaign for Planetary Astronomy in Support of Solar System Exploration, 1959-1962," in National Air and Space Museum, Research Report. 1985, p. 92.

[5] For a discussion of the history of the Jet Propulsion Laboratory through the mid-1970s, see Clayton Koppes, JPL and the American Space Program (New Haven: Yale University Press, 1982). For JPL history from the time that Bruce Murray became its Director in 1976, see Peter J. Westwick, *Into the Black: JPL and the American Space Program, 1976-2004* (New Haven: Yale University Press, 2006)

Although other NASA research centers occasionally became involved in solar system missions in the 1960s and 1970s, JPL and the associated scientific community it helped to nurture remained at the center of the U.S. planetary effort for the next twenty years. The accomplishments of the U.S. program of automated solar system exploration became a hallmark of the U.S. effort in space, second in public visibility only to the manned Apollo lunar landing program. From the initial Mariner spacecraft flyby of Venus in 1962, through missions that studied the Moon, Venus, and Mars, to the Viking landings on Mars in 1976 and the Pioneer[6] and Voyager flybys of Jupiter and Saturn in the late 1970s and the 1980s, there was a constant flow of new data and spectacular images.

Underneath this surface appearance of great success, however, was constant uncertainty about the future of the solar system exploration program. As early as 1967, Congress had canceled a very ambitious and expensive mission to launch aboard a giant Saturn V booster two automated spacecraft to land on Mars; in response, NASA Administrator James Webb ordered a complete rethinking of NASA's planetary exploration program. Out of that planning effort came many of the successful missions launched during the 1970s.[7]

Key to the long-term vitality of any area of space science is the flow of new data required to address outstanding scientific questions.[8] These new data come from a continuing series of missions which ideally are carried out on a schedule and in a sequence keyed to the priorities of the relevant scientific community and its supporting engineering teams. "New starts," i.e., approval to begin development of a new mission, are thus the lifeblood of a vigorous area of space science. Approval for new starts for solar system missions proved difficult to obtain during the 1970s, as the civilian space program's national priority and budget were reduced, as other areas of space science developed ambitious plans, and as a major new development program, the Space Shuttle, took an increasingly large share of NASA's available resources. Noel Hinners, head of the space science office in NASA's Washington headquarters, told Congress in February 1976 that the planetary program was on a "going out of business trend."[9] Indeed, between 1975 the peak of funding for the Viking project to land two spacecraft on Mars (a much less ambitious mission than the one canceled in 1967), and 1977, funding for the planetary program fell by a factor of four.

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[6] The Pioneer mission was managed by NASA's Ames Research Laboratory, not JPL.

[7] For an account of this rethinking, see Amy Paige Snyder, "NASA and Planetary Exploration" in John M. Logsdon, ed., with Amy Paige Snyder, Roger D. Launius, Stephen J. Garber, and Regan Ann Newport, *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program*, Vol. V: Exploring the Cosmos, NASA SP-2001-4407 (Washington: Government Printing Office, 2001), pp. 280-285.

[8] See the 1986 report of the NASA Advisory Council, The Crisis in Earth and Space Sciences, for a discussion of this issue.

[9] U. S. Congress, Senate Committee on Aeronautical and Space Sciences, *NASA Authorization for Fiscal Year 1977,* Hearings, Part 2, p. 1138.

The planetary community did get one major new start early in 1977, when the outgoing Ford administration approved two ambitious space science missions, an Earth-orbiting large space telescope that eventually became known as the Hubble Space Telescope, and a complex spacecraft to orbit Jupiter and its satellites and to send a probe into the Jovian atmosphere. This latter mission, later named Galileo, would have a troubled history, largely due to its links with the Space Shuttle and other launch systems; four years later, in 1981, its proposed cancellation became the issue on which the fate of the planetary exploration program hinged.

There were no planetary new starts in the President's budget proposals in 1978, 1979, or 1980; by then, the journal *Science* reported "planetary science [is] on the brink again" and pointed out that planetary scientists faced "a difficult uphill battle in the next decade of selling less glamorous but scientifically vital missions with ever-increasing price tags." The Viking mission had cost over $1 billion, Galileo was estimated to cost at least $500 million, and the next mission waiting for approval, a spacecraft to orbit Venus to carry out a mapping mission using a powerful radar had a cost estimate of over $500 million. *Science* estimated that there were only "six hundred or so" planetary scientists in the United States; this was a dramatic increase from the few scientists of twenty years earlier, but still a relatively small group in the overall context of U.S. science, and even of U.S. space science.[10]

Adding to the uncertainty regarding the future of the planetary program at this point was an emerging conflict within the interested community over the appropriate strategy for gaining approval for future missions. On one side was the leadership of the overall space science community as well as of the planetary science community. The Committee on Planetary and Lunar Exploration (COMPLEX) of the National Academy of Sciences Space Science Board had developed a strategy for planetary and lunar exploration based almost solely on scientific merit.[11] Most planetary scientists believed that this science-based strategy should be their primary guide in assigning priority to and advocating particular missions and should be followed by NASA in determining which missions to propose for funding.

On the other side were individuals like Bruce Murray, Director of JPL beginning in 1976, and Carl Sagan, increasingly a public figure as well as a working scientist. Murray had argued from the time he took over JPL that to gain public and political support for future, expensive missions, they must combine both scientific and technical merit and "pizzazz" -- i.e., public interest. Top priority, argued Murray, should be given to missions that combined elements of exploration -- the discovery of new places -- with their scientific objectives. In the 1977-1981

[10] Richard Kerr, "Planetary Science on the Brink Again," Science, 14 December 1979, pp. 1288-1289.

[11] The COMPLEX strategy was spelled out in three separate reports: Committee on Planetary and Lunar Exploration, Space Science Board, *Strategy for the Exploration on the Inner Planets. 1977-1987*(Washington: National Academy of Sciences, 1978); *Strategy for Exploration of the Outer Planets. 1978-1988*, (Washington: National Academy of Sciences,1979); and *Strategy for the Exploration of Primitive Solar System Bodies -- Asteroids. Comets. and Meteorites. 1980-1990* (Washington: National Academy of Sciences, 1980).

period Murray became an unceasing advocate for a U.S. mission to Halley's Comet during its 1985-1986 apparition, on the grounds that such a mission would capture public imagination as well as yield important scientific results.[12]

Many in the scientific community were skeptical of the realism of Murray's strategy, arguing that pointing out that NASA's string of glamorous firsts in the solar system could not go on indefinitely, but that a tremendous amount of good but less spectacular science remained to be done. These scientists preferred a course of action that counted on NASA, the White House, and Congress to provide the funds required to carry out that science, and providing the scientific community the authority to assign mission priorities primarily on the basis of scientific merit.

In the fall of 1980, there were signs that the approach of the scientific community might bear fruit. While Murray had been unsuccessful during the year in convincing NASA to insert a hastily-conceived Halley flyby mission in its plans, NASA had put forth as its top scientific priority a "new start" on the Venus Orbiting Imaging Radar (VOIR) mission. This was the mission that had been on the top of the planetary scientists' wish list for the past three years; it was based on the use of a large and powerful "synthetic aperture" radar instrument to penetrate the clouds constantly shrouding the Venusian surface, so that the planet could be mapped with resolution of better than 100 meters. The Carter administration announced a few days before the Presidential election (in an apparent attempt to win a few votes in California) that it intended to include VOIR in its Fiscal Year 1982 budget, which would go to the Congress in January 1981. Even after Carter's defeat, the mission stayed in the final Carter budget proposal to Congress, and for a few months at least most of the planetary community thought its future less uncertain.

New Administration—New Priorities

A budget submitted by a defeated administration has only limited significance until its contents and underlying philosophy are validated by the new President and his associates. In 1981, very much the opposite was the case. Ronald Reagan had won in a landslide by promising, among other things, to reduce federal spending and to redirect government priorities. To help implement that goal, one of President-elect Reagan's early decisions was to designate as director of the Office of Management and Budget Representative David Stockman, an aggressive and extremely competent 34-year old Congressman from Michigan.

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[12] For a personal account of the planetary program's rise and fall, see Bruce Murray, Journey into Space: The First - Three Decades of Space Exploration (New York: W.W. Norton,1989). For an account of attempts to gain approval for a mission to Comet Halley, see John M. Logsdon, "Missing Halley's Comet: The Politics of Big Science," *ISIS*, 1989:90 (June 1989)

Stockman was a fiscal conservative, and with vigor began identifying areas of the federal budget for reduction. Rumors of a Stockman "black book" that contained a draconian list of proposed budget cuts quickly began circulating in Washington, and when the Reagan revision of the FY 1982 budget was sent to Congress on 17 February, those rumors were confirmed. Overall, $41.4 billion in budget cuts were proposed, with areas such as social and urban programs bearing the brunt of the reductions.[13]

In this context, the NASA budget fared fairly well. The proposed Carter FY 1982 $6.7 billion budget for NASA was reduced by $604 million, but this amount still represented an 11 per cent increase over the FY 1981 budget. (Most of the additional NASA funds went to the troubled Space Shuttle program.) But the Office of Management and Budget required NASA to cancel one of its three approved space science missions, the Hubble Space Telescope, the Galileo mission to Jupiter, or the U.S. spacecraft that was part of International Solar Polar Mission, a joint U.S. / European project to send two spacecraft over the poles of the sun. NASA chose to cancel its part of the Solar Polar project, greatly angering its European partners.[14] This meant that the planetary program had avoided the immediate prospect of Galileo, its only approved mission, being canceled. But the new start for VOIR was rescinded, and there was no commitment from the White House to any vision of the future of the country's efforts in space.

Much worse was to come as the year progressed. It was some time before key Administration positions relevant to the nation's space program were filled: the Reagan administration did not announce its choices for NASA Administrator and Deputy Administrator until April 23, and a Presidential Science Adviser was not named until May 19. These were among the last major administration appointments to be announced. While the planetary science establishment and its allies within NASA were trying to develop a strategy for convincing the new administration to provide adequate support for the future missions they favored, Bruce Murray continued his personal campaign to gain White House approval for a flyby mission to Halley's Comet.[15] To make his argument, Murray went outside NASA channels to lobby Congress, the White House, and the media, in the process alienating both NASA management and those who believed that the integrity of the space science program, as certified by the leaders of the scientific community, was its primary political asset. At a time when the planetary science community needed to be unified in order to withstand threats to its continued support, Murray's activities as the head of the NASA facility charged with managing the planetary program, and the associated campaign for the Halley mission mounted by The Planetary Society (the public membership group founded by Murray and Carl Sagan), were causing significant divisions among those interested in solar system exploration.

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[13] *The New York Times*, February 18, 1981, p. Al.

[14] See Joan Johnson-Freese, "Canceling the U.S. Solar-Polar Spacecraft," *Space Policy*, February 1987, for a discussion of this decision.

[15] For Murray's account of his attempts to gain support for a mission to Halley's Comet, see Bruce Murray, Journey Into Space, Part Five.

The threats to the program were more real than anyone except the top management circles of NASA and those handling space budgets within the Office of Management and Budget recognized. The new NASA Administrator was James Beggs, who had been a senior manager at NASA in the late 1960s, then an executive in the aerospace industry, and who had extensive Washington experience. Beggs and especially his wife Mary were also well-connected politically to the upper levels of the Reagan administration. The new NASA head was disturbed by the FY 1983 OMB budget target for NASA of $6.5 billion that had been given the agency in March, and on August 17 he wrote Presidential Counselor Edwin Meese's deputy, retired Admiral Robert Garrick, that "I have come to the conclusion that some fundamental policy decisions need to be made before we can formulate the FY 1983 budget." Beggs pointed out that NASA was committed to doing three things: (1) completing the Shuttle program; (2) maintaining a space science and exploration program; (3) maintaining an aeronautical research program. In his view, "given the current budget numbers,... we cannot continue to do all these things simultaneously." Beggs indicated his preference was "to cut out one of these activities and for this we need policy guidance."[16]

Beggs was to repeat this request frequently in the next several months, but the only vehicle through which policy guidance was provided was the budget process. Ignoring the early OMB target of $6.5 billion, on September 15 NASA submitted to OMB a FY 1983 budget request of $7.572 billion in new budget authority and $7.186 billion in budget outlays. Beggs identified the cuts that could bring the new budget authority down to $7.1 billion, but argued that a reduction below that level would require major cuts in the Shuttle program (which he knew were not acceptable to the White House) or "dropping out of one or more major program areas, such as planetary exploration [emphasis added]." Beggs took an aggressive position, refusing to give OMB a budget at a level less than $7.1 billion without first getting the policy guidance he had requested.[17]

The NASA budget request fell on unsympathetic ears. In fact, President Reagan told a nationwide television audience on September 24 that unless additional budget cutting measures were taken immediately, the Federal deficit would increase to unacceptable levels. As one step, the President announced an additional twelve per cent across the board cut in the FY 1982 budgets for non-defense government programs; the fiscal year was due to start in less than a week. This was not a propitious environment in

[16] Letter from James Beggs to Rear Admiral Robert M. Garrick, August 17, 1981. Copies of this and other documents cited in this paper are on file in the NASA Historical Reference Collection at the NASA History Office, NASA Headquaters, Washington, D.C. Such documents are identified in these references by the acronym NHRC.

[17] Letter from James Beggs to David Stockman transmitting NASA's FY 1983 budget recommendations, 15 September 1981 (NHRC).

which to argue for substantial budget increases for an agency such as NASA; NASA funding was in the domestic discretionary part of the Federal budget. In addition, it had become clear over the summer that additional funds would be required to keep the Shuttle on its planned schedule to achieve operational capability as soon as possible.

That same day, David Stockman provided NASA its official budget target for FY 1983. Rather than the preliminary $6.5 billion target that NASA had already ignored, the ceiling was to be $6.041 billion in FY 1983 outlays, with an additional cut to $5.687 billion in outlays to come in FY 1984.[18]

NASA Sets Its Priorities

Beggs' reaction to these low budget targets was quick and sharp. He told Stockman on September 29 that meeting the OMB guidelines while maintaining "viable programs in some areas" would mean closing down "other major programs that NASA has operated since its inception."[19] The planetary exploration program was at the top of the list of the efforts that NASA was "willing" to give up, if forced to accept major budget cuts. Beggs offered the following rationale:

> *The planetary exploration program is one of the most successful and viable NASA programs. However, it is our judgment that in terms of scientific priority it ranks below space astronomy and astrophysics. Planetary exploration is much more highly dependent on launch vehicles, and it is our opinion that the most important missions that can reasonably be done within the current launch vehicle capability have, more or less, been done. The next step in planetary exploration is to do such things as landing missions and sample return missions, and these require full development of the Shuttle and the ability to assemble elements in earth orbit before sending the assembled spacecraft on its way.*
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> *In our judgment, it is ultimately better for future planetary exploration to concentrate on developing the Shuttle capabilities rather than to attempt to run a "subcritical" planetary program given the current financial restrictions we face. Of course, elimination of the planetary exploration program will make the Jet Propulsion Laboratory in California surplus to our needs.*[20]

This statement embodied the worst fears of the planetary community. The scientific payoffs from their work were assigned secondary priority, and their program's fate was tied to the Space Shuttle, rather than to the expendable boosters that had launched all planetary missions

[18] Letter from David Stockman to James Beggs, September 24, 1981 (NHRC).

[19] Letter from James Beggs to David Stockman, 29 September 1981 (NHRC).

[20] Ibid.

to date. If NASA's ties to JPL were severed, the engineering and operations teams required to carry out the complex missions of the future would be broken up or assigned to other, non-NASA work.

Influences on NASA Priorities

A variety of factors led NASA's leaders to single out the planetary program for potential termination. One was the fact that the planetary science community was relatively small compared to scientists working in space physics or space astronomy, and had not developed a position of influence within the space community. Reinforcing the higher status of the space astronomy and astrophysics community was the completion of the National Academy of Science's survey report *Astronomy and Astrophyics for the 1980's,* generally known as the Field Report after its primary author, Harvard astronomer George Field. This report gave highest priority within the overall area of astronomy to a series of Shuttle-launched, Earth-orbiting facilities known as the "Great Observatories," among which were the already approved Hubble Space Telescope and Gamma Ray Observatory. Another factor was that most future planetary missions then being proposed would indeed be very costly and likely to return less dramatic data and images than their predecessors. The divisions within the planetary community itself on future priorities and on scientific and political strategies limited its ability to maintain its funding priority within the NASA space science program.

Another important influence was NASA's strong commitment to the Space Shuttle as its only means for launching future space science missions. Projects in areas of space science such as astronomy and astrophysics seemed well-matched to the Shuttle's capability to put heavy payloads into low Earth orbit, and such mission could be launched at almost any time. By contrast, planetary missions required a Shuttle-launched upper stage to propel them from the Shuttle's orbit to a deep space trajectory, and they had to be launched at widely-spaced times called "launch windows" determined by the alignment of the planets. The mismatch between the requirements of planetary exploration and the capabilities of the Space Shuttle certainly contributed to a NASA preference for missions in other areas of space science.

The two top NASA officials, Administrator James Beggs and Deputy Administrator . Hans Mark seem to have been following different approaches to priority setting at this time. At his confirmation hearings in June, Beggs had said that "the potential for stopping our planetary exploration program or putting large gaps in it is very disturbing to me. I think planetary exploration is a hallmark of the agency. It would be a disaster if we gave it up."[21] B_y threatening to terminate whole areas of activities if NASA were forced to take large budget cuts and by putting the planetary program on the top of the termination list, Beggs was playing budgetary hardball. The Shuttle program was sacrosanct due both to its association with the public appeal of humans in space and to its links to national security. The planetary program was NASA's only

[21] *Aviation Week and Space Technology*,_ June 24, 1981, p. 56.

other widely-known activity. In addition, it had its roots in Southern California, the home base of the President and many of his top advisers. Beggs' calculation was that shutting down the planetary program would not be an acceptable option to the White House, and thus that NASA would get a budget allocation adequate to keep going both the planetary program and other activities to which NASA had assigned higher priority.[22]

By contrast, the situation in September 1981, and his position in NASA's front office, gave Hans Mark the opportunity to put into practice some long-held views. Mark, who has his doctorate in nuclear physics, is an individual with wide-ranging interests beyond the technical arena and a relish for being provocative in ideas and actions. Mark and Beggs were not previously close associates and temperamentally were very different individuals. Mark had come to NASA from his position as Under Secretary and then Secretary of the Air Force and Director of the National Reconnaissance Office during the Carter administration. In that role, he had been the chief defender of the Space Shuttle program within the Department of Defense at a time when Carter was considering canceling the effort. From 1969 to 1977, Mark had been Director of NASA's Ames Research Center, and so was quite familiar with the agency's programs.[23] Mark had for some years been skeptical of the value of the NASA space science program. In 1975 he had written:

> *In the last decade, the United States has spent on the average a half a billion dollars on space science. This budget is roughly equal to that of the National Science Foundation and I, personally, find it difficult to believe that we have a cultural or intellectual justification for continuing our space science effort at the same level for the indefinite future...*
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> *My concern stems from the fact that unfortunately the results of space science to date have not been of major significance. While there have been a number of valuable findings, it is fair to say that no fundamental or unexpected discovery has been uncovered in the course of our exploration of the planets and the regions surrounding the Earth...*

Mark did find one field of science that might meet his criteria for scientific excellence and to which observations from spacecraft might make important

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[22] Interview with James Beggs, 2 February 1989. Other interviews carried out in connection with this research include: Hans Mark, 10 December 1988; George A. Keyworth II, 4 April 1989; Bruce Murray, 17 May 1988; Geoffrey Briggs, 4 August 1988; John Naugle, 24 June 1988; Eugene Levy, 3 June 1988; Angelo Guastaferro, 16 May 1988; and Louis Friedman, Executive Director of The Planetary Society, 17 May 1988.

[23] For Mark's own account of his career, see Hans Mark, Space Station: A Personal Journey (Durham: Duke University Press, 1987).

contributions. This was astrophysics, the study of stars and galaxies beyond the solar system. [24]

In addition to his views on space science, Hans Mark had long held a strong opinion on the appropriate future of the Jet Propulsion Laboratory. As Caltech had begun a search for a new JPL Director in 1974, Mark had been asked if he wanted to be considered for the job. His reply was negative; he noted that "the basic problem faced by the laboratory is that its purely NASA business [i.e., planetary exploration] will probably decline... It is absolutely essential for the health of the laboratory to seek new business opportunities in the most aggressive manner possible... The major opportunities for new business lie in the Department of Defense."[25] Mark doubted that such a redirection would be acceptable to Caltech and thus judged that he should not be a candidate for the JPL job.

These two themes -- that space science was not of the highest priority and that JPL ought to apply its skills to defense-related work -- were interwoven in Mark's activities as NASA struggled with the need to cut its budget. In August 1981, Mark and his engineering assistant Milton Silveira produced a document titled "Notes on Long Range Planning." In it they argued that making the Space Shuttle operational should "have the highest programmatic priority in NASA for the coming years to realize a return for this large investment" and that a space station "should become the major new goal of NASA." With regard to space science, "in the coming decade, scientific investigations conducted in Earth orbit will be the most important because they will take advantage of the unique properties of the Shuttle." Finally, they concluded that "planetary exploration will be de-emphasized somewhat until we have a Space Station that can serve as a base for the launching of a new generation of planetary exploration spacecraft." [26]

As Director of JPL, Bruce Murray, particularly in light of his lack of success in gaining approval for the Halley mission that he thought was essential to the future viability of JPL and the solar system exploration program, had also come to the conclusion that JPL had to seek other sources of support if it were to maintain its vitality as a premier technological organization. He found in Mark a very receptive accomplice. On August 16, Mark wrote Murray that he wished "to encourage and support in every way possible your present efforts to expand JPL activity in Department of Defense (DOD) space program activities, with the objective of sustaining JPL's unique capabilities by taking on work that is related to the strengths of the

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[24] Hans Mark, "New Enterprises in Space," Bulletin of the American Academy of Arts and Sciences, Vol. XXVIII, No. 4, January 1975, p. 19.

[25] Letter from Hans Mark to Robert Sharp, 9 April 1974 (NHRC).

[26] The memorandum is reprinted as Appendix 4 to Mark, The Space Station. The quoted passages are on p. 239.

institution."[27] Two months later, in a handwritten note to Murray, Mark made his combined themes very clear:

> *Where you and I have differed over the years is in our judgment of whether the popular support enjoyed by the planetary exploration program can be translated into the necessary long-term political support to assure a stable level of funding large enough to carry out what the planetary community thinks of as an adequate program. I have never believed that this could be achieved and I still do not believe that it can be done. It is for this reason that I have urged -- and that I continue to urge -- that the leadership at JPL must take immediate and aggressive steps to get a strong and stable defense-related program going at JPL. After having watched "big science" closely in the United States for almost three decades, there is no doubt in my mind at all that national defense is the only truly stable source of large research and development funds.*[28]

Though for different reasons, Beggs and Mark clearly put the NASA planetary program in jeopardy by assigning it the lowest priority of all of NASA's major activities. In the ensuing several months, OMB was quite happy to accept NASA's ranking and to propose the planetary program's cancellation as a way of controlling NASA's budget, not only in FY 1983 but in subsequent years.

Disagreements in the Budget Process

Throughout October and November, James Beggs continued, unsuccessfully, to push for a meeting with OMB Director Stockman, Presidential Counselor Meese, and White House Chief of Staff James Baker (who collectively had been designated in July as the top-level Budget Review Committee), and NASA resisted submitting a formal budget FY 1983 request until mid-October. Finally, it was agreed to use the September 15 NASA budget submission as the basis for OMB review. As mentioned earlier, that submission had requested $7.572 billion in FY 1983 budget authority. Included in the request was a proposed $276 million budget for planetary exploration; this amount provided $87 million for Galileo and $20 million for restoring the new start for VOIR.

NASA received its tentative budget allowance from OMB late in November. The overall budget had been reduced by $1.313 billion from the NASA request, to $6.259

[27] Letter from Hans Mark to Bruce Murray, August 16, 1981 (NHRC).

[28] Note from Hans Mark to Bruce Murray, October 14, 1981. (NHRC)

billion. The planetary budget had been reduced to $118 million, and included no funds for either Galileo or VOIR. [29]

Beggs appealed the OMB allocations to Stockman on November 30, 1981. He told the Budget Director that "as someone who has devoted his entire professional career to working for American pre-eminence in space and aeronautics, I cannot accept the proposition that national economic imperatives compel the draconian funding reductions you have proposed on programs which have had such an extraordinary history of success." Beggs pointed out that he had "repeatedly asked for meetings with senior policy level officials in the Administration to resolve these policy questions." In his appeal, Beggs asked for restoration of full funding for the planetary program.[30]

Beggs' appeal set the stage for the final decisions on the fate of the planetary exploration program. The focal point for those decisions was the Budget Review Board, which scheduled a meeting on the NASA appeal on December 9.

In preparation for that meeting, NASA and interested Executive Branch offices summarized their conflicting views in brief position papers. NASA argued that the scientific return of the planetary exploration program had been "extraordinary, and the implications for the future are boundless. Americans have taken enormous pride in the nation's planetary exploration endeavors which have been a true reflection of the greatness and vigor of the United States." The NASA appeal also pointed out that "the precipitous reduction of activity at the Jet Propulsion Laboratory risks loss of a major national asset. It is our understanding that DOD is planning to increase their reliance on the Jet Propulsion Laboratory for assistance in development of advanced sensor systems for national security applications. An unstructured phase-down of JPL would result in the loss of the most talented members of JPL staff to the detriment of planned DOD activities."[31]

The OMB staff justification for the proposed budget cuts noted that "given the urgent need for fiscal restraint and noting particularly the high out-year cost implications, OMB staff believe that lower priority programs such as planetary exploration must be curtailed -- even if they have been successful in the past." The OMB paper also noted "that the context in which NASA [in Beggs' 29 September letter] earlier provided an unsolicited statement that planetary exploration is of relatively lower priority than astrophysics and space-based astronomy has

[29] These figures are drawn from the material prepared by NASA to appeal the OMB allocations and transmitted to the White House by a letter from NASA Comptroller C. Thomas Newman to Craig Fuller, Director of Cabinet Administration, December 5, 1981 (NHRC).

[30] Letter from James Beggs to David Stockman, November 30, 1981 (NHRC).

[31] FY 1983 Budget Appeal, National Aeronautics and Space Administration, Planetary Exploration, December 5, 1981 (NHRC).

not changed." Canceling Galileo and not starting VOIR, estimated OMB, "could save about $1.2 billion."[32]

The advocates of canceling or deferring indefinitely the U.S. planetary exploration program had gained an ally during the fall as Presidential Science Adviser George A. "Jay" Keyworth was put in charge of an overall review of U.S. space policy and programs. Keyworth was a physicist who had been a mid-level manager at Los Alamos National Laboratory before coming to Washington. He was not well known to members of the academic science community other than those who had worked on nuclear weapons or laser programs. Although both Keyworth and Hans Mark had close ties to Edward Teller, and although their positions on planetary exploration came to resemble one another, they were not personal friends, nor did they consult with each other on their approach to space policy.

Keyworth initially had seemed sympathetic to arguments supporting both the scientific and political payoffs from planetary exploration,[33] and had taken an active and somewhat supportive role in the final stages of attempts to mount a U.S. mission to Halley's Comet. But the Washington *Post* reported on December 2 that Keyworth "has recommended halting all new planetary space missions for at least the next decade -- an idea he said the White House seems to be buying."[34] Keyworth's position, while resembling that of Hans Mark with its emphasis on using the Space Shuttle to support Earth orbiting astronomical and astrophysical facilities such as the Hubble Space Telescope and other "Great Observatories," also apparently recognized the possibility of a redefined, less ambitious and thus less expensive planetary exploration program. He told *Aviation Week* that "for years, some scientists who have been visionary enough to have seen this [budget limits] coming have been asking what type of planetary exploration could be done that is somewhat less expensive. What I wish to do is very much encourage the scientific community to start evaluating what can be done, so we can have a program that is balanced across planetary, astronomy and astrophysics, and solar and terrestrial." He added:

> *There is something special about planetary. It's more than science: it's exploration... It's a symbol of U.S. leadership in science and technology. From that sense, I think keeping a healthy planetary program alive is important beyond just the bounds of science.*[35]

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[32] Office of Management and Budget, "Summary of OMB/NASA Positions: Space Science and Related Programs (Including Planetary Exploration),"undated (NHRC).

[33] Interview with Eugene Levy, who had met with Keyworth at the latter's home in Santa Fe in June, before Keyworth officially assumed his position in Washington.

[34] Philip J. Hilts, "Science Board to Advise President Proposal," Washington *Post,* December 9,1981.

[35] Alton K. Marsh, "Adviser Urges Shuttle Emphasis," *Aviation Week and Space Technology*, December 14, 1981, pp. 16-17.

Apparently, what Keyworth most objected to was the high cost of the planetary missions that NASA was proposing, compared to their likely scientific returns. He noted that the United States had already done initial exploratory missions to most planets, and that a project like VOIR was just a "higher resolution experiment."[36]

Whatever his public stance, in his arguments to the Budget Review Board, Keyworth indicated that "I totally concur" with OMB's decision to cancel Galileo and VOIR, because those missions would "revisit the planets at much higher cost without commensurate additional scientific payoffs." He suggested that "the shuttle offers us a new capability to expand our horizons through . . . new astrophysical initiatives," and that "NASA is not in principle opposed to this philosophy. Their basic concern is over continued stability at the Jet Propulsion Laboratory." In summary, Keyworth indicated that "the cut in planetary exploration represents an example of good management.[emphasis in orginal] If 'business as usual' were to continue in planetary exploration, an unjustifiable increase in the overall space program would result."[37]

As the Budget Review Board meeting approached (it apparently was postponed to 15 December), it appeared that NASA had few allies in the inner circles of the White House who could block the proposed budget cuts, and with them the end of a significant U.S. program of planetary exploration. If help was to arrive, it would have to come from outside, or from the President himself.

Trying to Save the Program

Potential sources of support for the planetary program included the planetary science community, those in the public with a particular interest in solar system exploration, those in potentially influential positions in and out of government who had become Bruce Murray's allies as he tried to gain approval for a U.S. mission to Halley's Comet, and similarly influential individuals whose primary interest was in the health of the California Institute of Technology. The planetary program had become identified with Caltech's Jet Propulsion Laboratory, and had brought worldwide attention and prestige to the university. In addition, the annual fee paid by NASA to Caltech for managing JPL had become an important component of the Caltech budget.

It did not take long for news of NASA's September 29 response to the OMB budget guidelines to reach the various elements of the planetary community. The

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[36] M. Mitchell Waldrop, "Planetary Science in *extremis*," *Science*, December 18, 1981, p. 1322. Interview with George Keyworth.

[37] Paper prepared for Budget Review Board, "Selected White House Views. Department: NASA. Issue: Planetary Exploration," 8 December 1981 (NHRC).

Washington *Post* on October 6 reported that "NASA Weighs Abandoning Voyager, "[38] by now on its way to a 1986 flyby of Uranus after its August 1981 encounter with Saturn, and *Aviation Week* in its October 12 issue reported that "termination of U.S. planetary spaceflight and closure of the Jet Propulsion Laboratory would be considered. This would include cancellation of the Galileo Jupiter-orbiter/probe . . .. Shutdown of the NASA deep space tracking network, thus preventing data acquisition from Voyager on its 1986 Uranus and 1989 Neptune flybys, has been suggested."[39]

Coincidentally, the Division of Planetary Sciences of the American Astronomical Society was meeting during the week of October 12. This meant that the scientists who would be most affected by the termination of the planetary program were gathered in one place. Not surprisingly, their response was outrage. Eugene Levy, chairman of COMPLEX, the top scientific advisory body for solar system exploration, was particularly vocal. "At this moment," he commented, "not one of us knows whether, a year from now, the U.S. will have a program of solar system exploration." Levy continued

> *We are not faced with an invigorating, open-minded appraisal of where we are in our scientific investigations of the solar system. We are not seeing an administration eager to assess national scientific programs, and committed to moving forward vigorously with those that have particular intellectual, cultural and national importance. Instead, highly placed government officials assert that most of the important things in planetary exploration have already been done! They announce that "the era of planetary investigations is over!" Decisions are being made without serious study of the issues, without significant consultation with individuals and institutions that grasp the scientific questions, and with reliance instead on personal preconceptions. We may see important policy-level decisions, affecting major scientific activities of the United States, formulated at the whim of a few randomly placed people in the administration -- people who are neither informed on these issues, nor sensitive to the importance of science and technology for our society in the large. [emphasis in original]*[40]

At the meeting there was significant controversy over how to respond to the threat of program termination. While some thought it appropriate to be active advocates in favor their area of science, others believed that the integrity of the scientific community would be compromised by such open advocacy[41]. All agreed that a letter

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[38] Thomas O'Toole, "NASA Weighs Abandoning Voyager," Washington *Post*, October 6, 1981.

[39] Craig Couvalt, "NASA Assesses Impact of Budget Cut Proposal," *Aviation Week and Space Technology,* October 12, 1981.

[40] *Science News*, October 24, 1981, p. 260.

[41] One result of the debate over how to respond to threats to continued government funding of space science activities, including planetary exploration, was the creation of a Space Sciences Working Group under the auspices of the American Association of Universities, the Washington-based

reflecting the community's concerns should be sent to the most senior White House official identified as having policy responsibility for space, Presidential Counselor Edwin Meese. Accordingly, David Morrison, outgoing chairman of the Division of Planetary Science, and Carl Sagan, in his role as President of The Planetary Society, on October 14 wrote Meese "to ask your support to ensure the survival of planetary exploration in the United States." They argued that "a thousand years from now our age will be remembered because this is the moment we first set sail for the planets," and told Meese that "we and millions of Americans will appreciate any help you give to the enterprise of the planets."[42]

Meese's response was speedy and seemingly positive. On October 22, he wrote Morrison and Sagan, saying: "Your points are extremely well taken and will be definitely taken into consideration within budgetary limitations. Please know that this Administration is dedicated to the exploration of space, as [sic] have been the history of our nation. I have shared your concern with the President."[43]

Six weeks later, when the news that OMB had indeed recommended terminating the planetary program and that Science Adviser Keyworth was supporting the OMB position reached the science community, there was an attempt to organize a letter and telephone campaign to members of Congress, but no concerted approach to the Executive Branch by the planetary community. Pioneer space scientist James van Allen attempted to have the Space Science Board of the National Academy of Sciences take the lead in protesting the proposed cuts[44], but this would have meant that the Board would be supporting a particular area of space science, something it had always been hesitant to do. Indeed, National Academy President Frank Press privately rebuked COMPLEX Chairman Eugene Levy for appearing to speak for the Academy in calling Science Adviser Keyworth "intellectually naive" regarding the scientific arguments underpinning the planetary program.[45]

Similarly, there was no organized campaign of public protest over the potential termination of the planetary program mounted in the October-December 1981 period. The vehicle for mobilizing public protest would have been The Planetary Society. The dramatic images from the Voyager flybys of Jupiter and Saturn, the high public profile of Sagan and his public television series "Cosmos," and an effective direct mail

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organization representing the interests of major U.S. research universities. This group began its operations in early 1982, and attempted to influence Congress on those portions of the NASA space science budget of most interest to academic researchers.

[42] Letter from David Morrison and Carl Sagan to Edwin Meese, October 14, 1981 (NHRC).

[43] Letter from Edwin Meese to Carl Sagan, October 22, 1981. An identical letter was sent to Morrison (NHRC).

[44] *Aviation Week and Space Technology*, December 7, 1981, p. 17.

[45] Interview with Eugene Levy.

membership campaign led to the Society's membership mushrooming from 25,000 to 70,000 within a little more than a year. The Planetary Society membership had been mobilized in August 1981 for a letter writing campaign in support of a U.S. mission to Comet Halley. The White House received some 10,000 letters from society members; they were routed to NASA unopened, and never answered. The idea of another mobilization of The Planetary Society membership was considered in early December; one proposal was to send a mailgram calling for immediate protests to the White House to one-quarter of the Society's members and a letter with the same message to all members. But the combination of the lack of payoff from the earlier campaign and the difficulty and costs of gathering enough support to influence Executive Branch decisions in the short-run led to abandoning the idea for such a campaign. The Planetary Society did remain active in the behind-the-scenes efforts to rescue the program.[46]

Finding Powerful Allies

The final recognition that there would be no U.S. mission to Halley's Comet had left Bruce Murray deeply concerned about the future of the Jet Propulsion Laboratory. He pursued two major lines of action with respect to ameliorating JPL's prospects. One was to gain Caltech faculty approval for a significant increase in Department of Defense support, including classified projects, for JPL. Murray, with Hans Mark's support, had been marketing JPL's capabilities to the Air Force Space Division and to the Central Intelligence Agency, with particular attention to satellite surveillance activities[47]. One obstacle to this campaign was the press reports that NASA was considering cutting its ties to JPL. Murray wrote Beggs in mid-October, telling him that "we have encountered people in DOD who are very concerned about continuing discussion of new DOD tasks with us because they surmise we are going to be declared surplus by NASA. They don't want to be involved in any action which somehow might lead them to become institutionally responsible for JPL." Murray asked Beggs for a public statement of NASA's intent to retain its ties with JPL, whatever budget cuts were made.[48] Murray received Caltech faculty approval, with little controversy, for increasing the DOD share of JPL's workload up to 25-33 percent at a October 20 meeting of the faculty.

Recognizing the uncertain future of JPL, the Trustees of Caltech in January 1981 had created a "Trustees Committee on JPL." That committee had a number of members of national

[46] Interview with Louis Friedman. For a history of the early years of The Planetary Society, see *The Planetary Report*, January / February 1986, pp. 3-11.

[47] Memorandum from E.D. Hinkley and C.B. Farmer to Bruce Murray, “Technical Meeting at CIA Headquarters,” October 20, 1981 (NHRC).

[48] Letter from Bruce Murray to James Beggs, October 16, 1981(NHRC) .

reputation and influence; it was chaired by Mary Scranton, wife of former Pennsylvania Governor and Republican Presidential aspirant William Scranton, and herself an individual with high-level political connections. The Caltech Trustees Committee on JPL met for the first time on October 23, and approved Murray's plan to make JPL into an institution that maintained its primary affiliation with NASA while taking on significant DOD work. Key to that plan, of course, and thus to JPL's stability as an institution, was maintaining a significant planetary mission workload; if that objective were not achieved, noted Murray, "JPL could become an unintended casualty in the rearrangement of federal priorities."[49]

Concern over JPL's future had already been brought to White House attention by Arnold Beckman, Chairman of Beckman Instruments and a Caltech Trustee. Beckman had written Edwin Meese on October 5, saying that the NASA response to Administration FY 1982 and FY 1983 budget cuts "threatens to create total chaos and a rapid disintegration of a 5,000 person, $400 million Southern California enterprise . . .. There are obvious implications to the support of the President and to his Party should the Administration permit such a catastrophe to take place."[50]

As reports of OMB's budget recommendations surfaced in early December, Beckman (at Bruce Murray's urging) once again wrote Meese, saying that he could not "emphasize strongly enough the gravity of such a decision [to cancel Galileo] and its negative effect on JPL and the California Institute of Technology." Beckman urged Meese "not to allow the emasculation of the technical and scientific capabilities of the Jet Propulsion Laboratory. "[51]

Similar letters of support for JPL and the planetary program were sent to Meese by conservative California Representative John Rousselot (The letter had been drafted by JPL.) and by Thomas Pownall, President of Martin Marietta. Pownall argued that his company's work on solar system missions had convinced him "that we and our planetary program associates and competitors have enhanced significantly our ability to satisfy the critical needs of our primary Aerospace customer, the Department of Defense, because of the extraordinary challenges we have met and managed and the disciplines we have developed in the process."[52]

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[49] Letter and enclosures from Bruce Murray to Mrs. William Scranton, October 16, 1981; memorandum from Bruce Murray to JPL Senior Staff, "JPL Directions for the Future," October 30, 1981; letter from Bruce Murray to Hans Mark, November 3, 1981 (NHRC).

[50] Letter from A.O. Beckman to Edwin Meese, October 5, 1981 (NHRC).

[51] Draft of letter from A.O. Beckman to Edwin Meese, December 10, 1981. Draft was prepared by JPL and transmitted to Beckman by a December 10 letter from Bruce Murray.

[52] Letter from John Rousselot to Edwin Meese, December 10, 1981 and letter from Thomas Pownall to Edwin Meese, December 10, 1981 (NHRC).

Most active of JPL's politically connected supporters at this point was Mary Scranton. She reported to Bruce Murray that Keyworth's early December public statements on canceling the planetary program had provided "a rallying point around which to arouse interest and sympathy." In response, Scranton contacted Senators Charles Percy, Charles Mathias, and Mark Hatfield and Vice President George H. W. Bush. She also spoke with Fred Bernthal, top assistant to Senate Majority Leader Howard Baker. Scranton reported that the Vice President had already been briefed on the JPL situation by prominent California Republican Robert Finch, and that she had only asked Bush to "look at the political problem that cancellation of such program might bring to the Republican party in the future."[53]

Caltech President Marvin (Murph) Goldberger made an early December trip to Washington in support of JPL. He met, among others, with a group of Senators interested in the planetary program and other Caltech activities. In particular, Golberger urged Howard Baker to express his support for a continued program of planetary exploration.[54] Goldberger was a Democrat, and although he had good connections with the liberal Republicans in the Senate, he had limited ability to influence the conservative Californians in the Reagan inner circle.

The various approaches to Senate Majority Leader Baker bore fruit. On December 9, he wrote President Ronald Reagan in support of Galileo, saying "I urgently request that $270 million be restored to the NASA budget for FY 1983 to continue the Galileo mission as originally planned."[55]

Although Baker may have had his budget figures wrong (The proposed FY 1983 budget for Galileo was actually $87 million.), the political impact of his intervention was decisive. Baker originally intended to hand his letter directly to the President on December 9, but did not do so. So he called the White House on both December 9 and December 10 to make sure that President Reagan had indeed seen the letter and to "underscore his interest." Baker stressed that the letter was not "a pro forma request nor a matter of parochial Tennessee interest." Rather, Baker indicated that "he personally feels strongly about this issue." The Baker letter was routed to David Stockman for action; it is not clear whether in fact it ever reached the President.[56]

The Budget Review Committee met on 15 December. Science Adviser Keyworth took the lead in suggesting a compromise in which $80-$90 million would be added to

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[53] Letter from Mrs. William W. Scranton to Marvin Goldburger, December 6, 1981 (NHRC).

[54] Letter from Bruce Murray to Arnold Beckman, December 10, 1981 (NHRC).

[55] Letter from Howard Baker to the President, December 9,1981 (NHRC).

[56] Memorandum from Powell Moore to the President, December 10, 1981 (NHRC). Interviews with George Keyworth and James Beggs.

NASA's planetary exploration budget in order to avoid the cancellation of the Galileo mission. This alternative, noted Keyworth "would permit the stability and excellence of the Jet Propulsion Laboratory to be continued." The Budget Review Board asked NASA "to consider this alternative and report back immediately." It also hoped that OMB and NASA could settle the issue and that "an appeal to the President... be avoided."[57]

As a result of Baker's intervention, the immediate possibility of the demise of the U.S. program of solar system exploration had passed. But the program had hung on by its fingertips; for the fifth year in a row, no new planetary mission was approved, for no funds for VOIR were restored to the NASA budget. What was gained was a year's breathing space, and the opportunity for NASA and the planetary community to come forward with a program that could gain the support of the Reagan administration.

Redesigning the Planetary Exploration Program

The planetary exploration community, both within and outside of NASA, was prepared to take advantage of its reprieve from summary termination. In late 1980, then-NASA Administrator Robert Frosch had approved the creation of a Solar System Exploration Committee (SSEC) as an ad hoc subcommittee of the NASA Advisory Council. The SSEC was to have a two-year lifetime (1 November 1980 - 31 October 1982), was to include as members representatives from all space science and technical disciplines interested in planetary exploration, and was to develop a strategy to encompass solar system missions proposed for initiation in the 1985-2000 time period.[58] It was within the SSEC framework that the planetary program was restructured to become politically and financially acceptable to the Reagan administration.

The idea for a committee to rethink the planetary program came from John Naugle, who had been in charge of the NASA space science effort from 1967-1974. Naugle had retired from NASA in 1974, only to be called back to service by Administrator Frosch as the agency's chief scientist in 1977. Naugle was no stranger to the need for planetary program planning. As mentioned earlier, in 1967 NASA Administrator James Webb had canceled all of NASA's future planetary activities in a pique after Congress had rejected plans for landing two automated spacecraft on Mars using a Saturn V booster. Naugle's first assignment in 1967 as space science chief was to propose a new planetary program; to do that, Naugle worked with a

[57] Budget Review Board Decisions, National Aeronautics and Space Administration, December 11, 1981. The date on this document places the timing of the Budget Review Board meeting in question. Originally scheduled for December 9, most evidence suggests it was postponed until December 15. This means either that the date on this document is incorrect or that, after Baker's intervention with the President, the Budget Review Board met on the NASA appeal on December 11.

[58] "Purpose of Solar System Exploration Committee," 10 November 1980 (NHRC).

Lunar and Planetary Mission Board composed of concerned non-NASA scientists and chaired by astronomer John Findlay of the National Radio Astronomy Observatory.

The results of the Lunar and Planetary Mission Board's activities from 1967-1971 formed the basis for the extremely successful planetary program of the 1970s, including the Pioneer missions to Jupiter and Saturn, the Mariner 9 mission to orbit Mars, the Viking Mars landers, and the Voyager spacecraft to flyby Jupiter, Saturn, and eventually Uranus and Neptune. As Naugle assessed NASA's situation in 1979 and 1980, he recognized that the plans developed by the Mission Board had been carried out and that, because there was no accepted NASA long-range approach to planetary exploration in the 1980s and beyond, each planetary new start proposal was being assessed on an *ad hoc* basis, and was vulnerable because it was not seen as part of an integrated strategy.[59]

Naugle convinced Tim Mutch, NASA Associate Administrator for Space Science, and Angelo (Gus) Guastaferro, head of the planetary program in NASA's headquarters, of the value of a planning process similar to that carried out a decade earlier. Mutch asked Naugle to chair the SSEC, which met for the first time on 10-11 November 1980. The committee was originally comprised of thirteen members (other members were added during 1981 and 1982); Guastaferro served as its Executive Secretary.

A starting assumption for the SSEC was that the scientific strategy for solar system exploration just completed by COMPLEX, the Committee on Planetary and Lunar Exploration of the National Academy of Sciences' Space Science Board, would serve as the starting point for SSEC deliberations. This strategy assigned priorities to unanswered scientific questions regarding the solar system; its goal was making major steps in understanding the process by which the planets formed from the solar nebula and how they have evolved with time and how the appearance of life in the solar system is related to the chemical history of the system. The COMPLEX strategy did not translate top-priority scientific objectives into a particular set of planetary missions and then develop a strategy for their implementation; this was to be the purpose of the SSEC.

After an initial meeting in late 1980, the SSEC began its work in earnest during 1981; it was clear that it was operating in a very different environment than had the Lunar and Planetary Mission Board a decade earlier. The differences were emphasized in a June 1981 presentation to the SSEC by Don Hearth, who had been Director of the NASA Headquarters Planetary Office at the time of the Mission Board activity. Hearth noted that, while both in 1967 and now in 1981 the planetary program was in a "going-out-of-business" situation and there was a lack of consensus on program content, compared to the situation a decade earlier:

- there was much greater competition for resources within NASA;

[59] Interview with John Naugle.

- the planetary program was no longer the dominant activity within the Office of Space Sciences;
- in 1967 very little of the solar system had been explored, whereas in 1981 there was a substantial record of achievement;
- in the late 1960s, there had been widespread recognition that the nation must have a planetary program;
- in the late 1960s, the position of the Soviet Union in planetary exploration had been much more challenging; and
- in the late 1960s, five NASA centers were participating in planetary activities -- now only JPL was active.

Hearth noted that all of these factors, in addition to the hostile attitude of the Reagan administration, would make it difficult to gain approval for anything but a low-cost planetary effort.[60]

The overall approach of the SSEC to its assignment emerged relatively quickly. The committee met frequently (November 1980, January, February, April, and June 1981) leading to a week-long "summer study" in August 1981. The work of the SSEC was supported by intensive studies carried out by NASA centers and contractors, particularly the Jet Propulsion Laboratory at Caltech and NASA's Ames Research Center. The committee also "took testimony" from a variety of interested individuals such as physicist and visionary Gerard O'Neill, astronomer Carl Sagan, and *New York Times* science writer Walter Sullivan.

Two major conceptual issues were central to the SSEC discussion. One was whether to recommend a broadly conceived, “balanced” (a code word for giving roughly equivalent attention as objects of study to the inner planets, to the outer planets, and to comets and asteroids) approach to solar system exploration along the lines recommended by COMPLEX, or to pursue an approach that focused on a particular scientific issue or a specific solar system body. The other was whether it was in fact possible to develop a scientifically valid strategy for solar system exploration that could be carried out at significantly lower cost than had been the case during the 1970s.

The question of a broad versus a focused approach arose at the first SSEC meeting; there was strong support for both approaches voiced by different members of the SSEC. In subsequent meetings, the committee considered various candidates for a focus, including:

- providing a basis for better understanding the Earth through the comparative study of the planets
- providing a scientific basis for the future exploitation of near-Earth resources; and

[60] Summary Minutes of the Solar System Exploration Committee, June 1-2, 1981, pp. 4-5 (NHRC).

- providing precursor information required to undertake subsequent manned exploration of Mars .[61]

At the January 1981 SSEC meeting, committee member Charles Barth of the University of Colorado raised the possibility that there existed productive planetary missions, each with limited objectives, that might cost approximately $100 million each; the SSEC asked Barth to develop his idea in more detail.[62] At its February meeting, the SSEC heard James Pollack of Ames argue for embedding such small missions in an "Explorer-type line" in the planetary exploration budget. In the Explorer program of lower-cost Earth-orbiting missions, each project was not treated as a "new start" requiring separate budget approval, but rather was funded out of an annual budget provided to the Explorer program overall.[63] Many SSEC members expressed "skepticism that any planetary mission of value can be undertaken for less than" $250-$300 million and questioned "the receptiveness of the OMB and Congress to new level-of-effort line items such as Explorer." The committee did recognize, however, "the importance of thinking through the potentiality of relatively low cost specialized planetary missions."[64]

At its June meeting, the SSEC heard a presentation by JPL's Don Rea, a committee member, on the lab's study of what were called "Mariner Mark II" missions. These had originally been identified as "targeted missions" but the name had been changed to associate the effort with the earlier Mariner program, since, "with its distinguished lineage," this name would provide "the connotation of modest cost with excellent return."[65] The goal of the study was to develop a capability for outer planet missions "characterized by reduced mission costs, cost-effective advanced technologies, high inheritance over 4-5 missions, and a requirement for chemical propulsion only."[66] The concept of a basic spacecraft for use in a variety of outer planet missions fit well into the overall SSEC approach, and was quickly adopted by the committee.

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[61] Solar System Exploration Committee, NASA Advisory Council, Planetary Exploration Through Year 2000 (Washington: Government Printing Office, 1983), p. 65.

[62] Summary Minutes of the Solar System Exploration Committee, January 26-28,1981 (NHRC).

[63] Explorer-class missions are low-cost science and technology missions involving sub-orbital or Earth-orbiting spacecraft. Explorer missions usually study the Earth and its immediate environment.

[6464] Summary Minutes of the Solar System Exploration Committee, 23-24 February 1981, p. 3 (NHRC).

[65] Memorandum from D.G. Rea to Bruce Murray, "Title of 'Targeted Missions Study,'" 19 May 1981.

[66] Minutes of SSEC Meeting of 1-2 June 1981, p. 8.

By its June meeting, the committee was able to reach consensus on a statement of a basic rationale for and approach to solar system exploration. The elements of that consensus were:

1. The fundamental motivation for the planetary program remains the broadly based exploration of our solar system that has produced a multitude of major discoveries during the last two decades. Beyond intrinsic exploratory rewards, this program continues to produce a rich harvest of scientific information. . . .The exciting exploratory phase is far from complete.

2. We advocate a mix of missions varying in complexity and cost to pursue this program of exploration. Some of the objectives can be met by means of smaller focused or dedicated spacecraft. Others will require larger systems capable of returning samples to Earth. Within each of these categories, we are seeking . . . major cost savings by maximizing inheritance and minimizing the development of new systems for a given mission.

3. The SSEC should identify the relationship between solar system exploration and NASA's human activities in space. This orientation includes an interest in assessing the potential of mineral and volatile resources in the near-Earth environment.[67]

Gus Guastaferro left NASA Headquarters in April 1981; his position as Executive Secretary of the SSEC was assumed by Geoffrey Briggs, deputy director of the NASA Headquarters Planetary Office. At the June SSEC meeting, Briggs suggested to the committee an approach to dividing the missions required to achieve the goals of the planetary program for the rest of the century into three categories based on mission complexity and cost. These classes he described as Pioneer-class (least expensive); Mariner-class (of moderate expense); and Viking-class (expensive). Viking-class missions, suggested Briggs, should only be proposed if they could be tied to a "key date, such as the 500th anniversary of Columbus' discovery of the New World." The committee's reaction to Briggs' plan was "guarded."[68]

By the time of the SSEC summer study, which took place in La Jolla, California from Augus10-14, Noel Hinners had replaced John Naugle as SSEC Chairman. Naugle was leaving NASA to work in industry and believed that he had been successful in getting the SSEC study started in a productive fashion; in addition Naugle had become ill over the summer and could not attend the La Jolla meeting. Hinners, like Naugle, was a former head of NASA's Office of Space

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[67] Attachment 5 to Minutes of SSEC Meeting of June 1-2 ,1981.

[68] *Ibid,* pp 6-7.

Science and in 1981 was the Director of the Smithsonian Institution's National Air and Space Museum.

The summer study resulted in an interim SSEC report. Developing that report meant assigning tentative mission priorities and adopting an overall programmatic approach. Two approaches were considered. One would identify a minimally viable core planetary program plus options that could be added to the core if resources were available; the other was the three-tier approach that had been suggested by Geoffrey Briggs, with more details provided by John Niehoff of SAIC, a NASA support contractor.

During its summer study the SSEC adopted the three-tier approach to classifying future missions and developed a core plan that included only Pioneer- and Mariner-class missions. Pioneer-class missions were estimated to cost between $100-$150 million each; Mariner-class missions, from $300-$500 million. The cost of most Viking-class missions was estimated at a billion dollars or more, and the SSEC recognized that there was no chance of gaining political acceptance for such missions, however scientifically attractive they might be, in the budget climate of the early 1980s. As candidates as the initial Pioneer-class missions, the SSEC identified a Mars orbiter to locate water on the planet, a Mars geochemical orbiter, and a lunar geochemical orbiter; as the initial Mariner Mark II missions, a rendezvous with comet Tempel II, with an asteroid flyby en route, and a Saturn orbiter were proposed.

Even though Viking-class missions were considered too expensive to include in the core plan, given the perceived budget realities, SSEC members were unwilling to accept the idea that no such ambitious missions would be approved in the future. They wanted potential large, expensive missions to be identified and studied in enough detail to understand their scientific and exploratory payoffs, their technological requirements, and the likely costs.[69]

The results of the SSEC summer study were presented to the NASA Administrator, to the NASA Advisory Council, and to the Division of Planetary Science of the American Astronomical Society. In addition, a brief summary of SSEC activities was published in *Science*.[70] In effect, then, the interim conclusions of the committee were widely known within the concerned community as the policy and budgetary conflicts over the future of the planetary program heated up in the October-December 1981 period.

Following its summer study, and now that the main outlines of its findings were in place, the SSEC planned to spend the year remaining in its charter refining its conclusions and involving a broader segment of the scientific community in its activities. To those ends, both JPL and Ames embarked on more detailed studies of

[69] Summary Minutes of the Solar System Exploration Committee, October 26-27, 1981, p. 3 (NHRC).

[70] M. Mitchell Waldrop, "To the Planets, Cheaply," *Science*, September 18, 1981, p. 1350.

missions that had been identified by the SSEC (Ames studied only Pioneer-class missions; JPL both Pioneer- and Mariner Mark II-class missions), and four science working groups were established, on Outer Planets, Terrestrial Planets (Solid Body), Terrestrial Planets (Atmospheres), and Small Bodies.

The 1981 work of the Solar System Exploration Committee thus created a basis for a new approach to planning and advocating planetary missions. The December White House decision not to cancel Galileo presented an opportunity to put that approach into practice.

A Future for Planetary Exploration

By the time of the early February 1982 meeting of the Solar System Exploration Committee, Acting NASA Administrator for Space Science and Applications Andrew Stofan could report that "policy makers now all seem to agree that NASA would stay in the planetary exploration business, where before they had favored taking NASA out of the business." Negotiations between OMB and NASA had resulted in a FY 1983 planetary budget of $154.6 million, an increase of only $36.6 million over the original OMB allocation. The Galileo budget was $92.6 million; no funds directly related to VOIR were included. To keep the overall planetary budget as low as possible while still funding the Galileo mission, funds for mission operations and data analysis (for ongoing missions) and for research and analysis (using data from completed missions) were significantly reduced.

Thus, while one approved mission remained in NASA's future plans, The White House provided only minimal support for the planetary science community overall. The SSEC members were therefore not comforted by Stofan's message, arguing that what was being requested was still a "get out of the business" budget except for Galileo.[71]

Nevertheless, a corner had been turned. Science Adviser Keyworth as early as mid-December (in his interview with *Aviation Week*) had indicated that his real goal was to bring the costs of future planetary missions into line with other elements of the NASA space science program. On 13 May, in a speech to a group of planetary scientists, Hans Mark modified his position, saying:

> *You all know that I have raised questions about the relative priority and the value of planetary exploration when compared to other scientific missions in space. I still believe that such questioning is important and that we should, periodically, go through the exercise of looking critically at the relative, as well as the absolute scientific value of the work we do. You should also know, however, that as a public official*

[71] Summary Minutes of the Solar System Exploration Committee, February 8-9, 1982 (NHRC).

> *responsible for assisting in the formulation of our space exploration program, I am thoroughly committed to continuing planetary exploration, not only for scientific reasons but also because of the fact that, in the long run, we are learning things that will eventually allow us to exploit the resources of the solar system. I believe that it is possible to structure a program of planetary exploration based on these justifications, and you have my personal commitment that I will work very hard in that direction.*[72]

Given the willingness of the White House to continue the planetary program, it remained fro NASA to decide which mission to propose for a new start in the next budget year, FY 1984. The SSEC was asked at its February 1982 meeting to recommend that mission, with the following guidelines: cost between $150 and $300 million; industry involvement in the project; and international cooperation if feasible. Candidates for a new start, thought NASA management, might be a Venus Mapping Mission, less expensive than VOIR, a lunar polar orbiter, or a Mars mission of some character.[73]

Immediately following this discussion, the SSEC had its initial exposure to JPL's thoughts on a less expensive Venus Mapping Mission. John Gerpheide of JPL described a mission using spare hardware and a less costly approach to mission development and operations that could accomplish most of the mapping objectives that had been established by COMPLEX.[74]

This approach was very attractive to the SSEC, because it provided a way of achieving what had been for four years now the top priority scientific objective of the solar system program, mapping the surface of Venus at high resolution, but doing so at the relatively lower cost that the SSEC was arguing was possible. The committee asked that the Venus Mapping mission be studied in more detail.[75] When those studies confirmed that the mission, now called Venus Radar Mapper (VRM), could indeed be carried out for less than $300 million, the SSEC at its June meeting endorsed the mission as the first new start in the restructured NASA program of planetary exploration.[76] NASA had already decided to put forward the mission as its top candidate for a FY 1984 new start in space science.

There was little controversy over the inclusion of VRM as the NASA budget underwent OMB review in October and November 1982. When President Reagan sent his FY 1984 budget

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[72] Speech for the "Saturn" Meeting, University of Arizona, May 13,1982, p. 5 (NHRC).

[73] Minutes of the SSEC Meeting of February 8-9, 1982.

[74] *Ibid.*

[75] *Ibid.*

[76] *Summary* Minutes of the Solar System Exploration Committee, June 3-4, 1982.

to Congress in January 1983, the mission was NASA's only new start in space science.[77] *The New York Times* headlined its story "Plans to Explore Planet Revived," noting that "after years of steady decline, the nation's planetary exploration program appears to have been rescued by the Reagan Administration." *The Times* added that "the tactic of winning approval for new missions by designing lower-cost vehicles . . .may soon become a basic strategy," although "space agency officials emphasized that the Administration has made no commitment" to missions beyond VRM. However, "only a program based on low-cost missions, they said, stood much chance for the foreseeable future."[78]

Conclusion

There has been much discussion over the years about the need to set priorities among areas of science and among various proposed "big science" projects. Common to these discussions is the search for some framework or process within which to make the difficult choices among competing uses for scarce resources on some sort of objective basis.

The events described in this section suggest that a different approach to priority-setting, one much more political in character than is preferred by leaders of the scientific community, actually operates. Government-funded activities create vested interests in their continuation, including both individuals and institutions. In an environment of resource scarcity, these activities also give rise to alternative claimants who argue for a revision of the status quo and a redistribution of benefits. All interests attempt to persuade those with the power to allocate resources to favor their point of view. This is nothing more than a description of the American political process in operation.

What happened during the "survival crisis" of 1981 was a political struggle over the future of the U.S. space science program and of the institutions through which it was carried out.The element of the overall program which had been in ascendancy in the 1960-1975 period, the solar system exploration effort, put on a last ditch struggle to maintain that position. The planetary community had seen its share of the space science budget shrink during the second half of the 1970s, as scientifically attractive mission proposals were put forth by the astronomy, astrophysics, and solar-terrestrial physics elements of the NASA science program. An attempt, spearheaded by JPL Director Bruce Murray and scientist-author Carl Sagan, to gain support for the planetary program on the basis of its exploratory character failed when no U.S. mission to Halley's Comet

[77] The Venus Radar Mapping mission was renamed Magellan and was finally launched to Venus on May 4, 1989. At the time of the SSEC discussions in 1982, the launch target for the mission had been 1988.

[78] John Noble Wilford, "Plans to Explore Planets Revived," *The New York Times*, February 20, 1983, p. A33.

was approved. A different approach, putting forth a scientific strategy to underpin particular planetary mission proposals, also was unsuccessful in arguing that the scientific payoffs-were worth the high costs of achieving them.

When two individuals, Hans Mark and George Keyworth, whose views on space science priorities meshed (although they were seldom in agreement on other issues) ended up in key positions in the Reagan administration, the battle over space science priorities was joined in earnest. The desire to reduce the NASA budget and the continuing high budget demands of the Space Shuttle program provided the background for arguments that other areas of space science should be given priority for the time being. The American political process -even the inner workings of the White House and the Executive office -- is open to scrutiny and engagement by those strongly concerned with particular policy, institutional, and budget decisions. Thus the stakes in the December 1981 budget appeal process were known to all parties, and those who stood to lose from the likely outcome mobilized to protect their interests. In doing so, they attempted to forge useful alliances with all possible sources of influence on the decision process.

In 1981 the key intervention was made by a powerful Congressional leader. What his involvement demonstrated was the limit of political acceptability of an action potentially justified on other grounds. The White House became convinced that eliminating or indefinitely postponing the planetary exploration program, even if it made sense in scientific or programmatic terms, was not going to be accepted by key actors in Congress; in addition, other concerned actors in industry, academia, and other relevant communities made known their unhappiness.

The decision process then turned to finding an approach that was politically acceptable and still achieved the key objectives of adjusting priorities and controlling budget growth. It was the good fortune of the planetary community that it could quickly bring forward a responsive alternative, in the form of the interim conclusions of the Solar System Exploration Committee. The SSEC not only developed a lower-cost approach to planetary exploration, but also had done so through the involvement of key leaders of the concerned community. Thus the SSEC approach had both substantive and political utility.

None of this was neat, and it resulted from particular individuals occupying particular positions at particular times. But the end product clearly was a shifting of priorities among areas of space science away from solar system exploration towards astronomy and astrophysics.

A Postscript on the SSEC Recommendations

During 1982, NASA decided to extend the life of the SSEC for another year so the group could pay particular attention to various proposals for very ambitious future missions. The SSEC published its initial report, *Planetary Exploration Through the*

Year 2000: A Core Program, in 1983. That report identified, in order of priority, the following initial missions in the Core Program:

1. Venus Radar Mapper
2. Mars Geoscience/Climatology Orbiter
3. Comet Rendezvous/Asteroid Flyby
4. Titan Probe/Radar Mapper

Key to the SSEC recommendations was the argument that solar system exploration should be treated as a coherent program, not as a series of separate missions. Such a program, estimated the SSEC, could be sustained at a total budget level of about $300 million/year.[79] This recommendation was never put into practice, and the planetary program continued to struggle for resources in the subsequent decades. The four missions that the SSEC recommended in 1983 had different fates. The Venus Radar Mapper, which became Magellan, was a total success. The Mars Geoscience/Climatology Orbiter, which became known as Mars Observer, failed as it arrived at Mars in 1993. The Comet Rendezvous/Asteroid Flyby Mission was first combined with the Titan Probe/Radar Mapper mission in attempt to argue that the two missions could be flown for the 150 per cent of the cost of a single mission. This argument was not successful, and the Comet Rendezvous/Asteroid Flyby Mission, known as CRAF, which was to be the first of the Mariner Mark II missions, was canceled. This allowed additional resources to be allocated to the Titan Probe/Radar Mapper, which became the Cassini-Huygens mission to explore the total Saturnian system, not just Titan. That mission was finally launched in October 1997 and continues to send back data about Saturn and its moons.

[79] Solar System Exploration Committee, NASA Advisory Council, *Planetary Exploration Through the Year 2000: A Core Program* (Washington: Government Printing Office, 1983), pp. 15-16.