Planetary Science *in extremis*

The White House wants NASA to cease its deep space missions; planetary scientists, meanwhile, are forging a new plan

The Office of Management and Budget (OMB) wants the National Aeronautics and Space Administration to virtually cease its planetary exploration activities as of fiscal year 1983. The order was given to the space agency privately on 24 November.

Although NASA will undoubtedly appeal the decision and try to negotiate a compromise, it has little time. The FY1983 budget must be ready for submission to Congress in January.

The OMB proposal, as it stands, includes the cancellation of the Galileo orbiter/probe mission to Jupiter, which is already nearly built, and the Venus orbiting imaging radar (VOIR), which had been penciled into budget projections as a new start for 1984. The only mission that will *not* be affected is Voyager 2, now on its way toward encounters with Uranus and Neptune.

The OMB action is consistent with the recommendations of NASA associate administrator Hans Mark. In an internal memorandum dated 8 October he called for a "de-emphasis" of planetary science until NASA could complete its next major goal after the space shuttle: construction of a manned space station. (On the other hand, NASA administrator James M. Beggs has generally been supportive of planetary science, and has championed its cause at OMB. The mixed signals from the front office have generated considerable confusion in the agency's own ranks.)

The OMB action is also consistent with the views of presidential science adviser George A. Keyworth, who is conducting a full-scale review of space policy for the White House. He argues that orbiting scientific laboratories like the Space Telescope and the Gamma Ray Observatory, which can be maintained and upgraded by the space shuttle, promise to return a great deal more science than another generation of planetary missions. "I just think that the scientific potential of trying to exploit astronomy and astrophysics is much greater than would be achieved by continuing to put primary emphasis on the planetary program," Keyworth told *Science*. In 12 years of planetary exploration we have learned a great deal, he says, and new missions such as VOIR are just "higher resolution experiments."

Keyworth has worked closely with OMB in formulating NASA's pared-down FY1983 budget. He argues, however, that a shift in emphasis away from planetary programs toward shuttle-launched experiments should occur "even if we didn't have these budgetary constraints."

The National Academy of Sciences' Space Science Board, meanwhile, is preparing a rebuttal to Keyworth. "The position does not stand up to rational scrutiny," says Eugene Levy of the University of Arizona, chairman of the Academy's subcommittee on Lunar and Planetary Exploration. "There *have* been great discoveries during the last 12 years. But there are fundamentally important objects, the comets and asteroids, that we haven't even approached yet. They hold primitive, undisturbed material. Not only would they enhance our understanding of the origin of the solar system, but of stars in general. It's very complementary to the work that will be carried out by the space telescope; to separate one kind of research from the other is intellectually "naïve."

Ironically, all this is happening just as planetary scientists are attempting to forge a coherent and relatively inexpensive plan for continuing the program (*Science*, 18 September, p. 1350).

The effort is centered in the space agency's Solar System Exploration Committee (SSEC), an ad hoc group now 1 year into its planned 2-year lifetime. Its basic strategy is already clear: fly a greater number of missions, but keep them simple and focused on very specific scientific questions; use standardized spacecraft as much as possible; and time the missions to make ground operations most efficient and to keep the overall budget at a roughly constant level. The committee will spend its second year in refining its mission timetable and in figuring out how it will be possible to allow for occasional large-scale efforts analogous to the Viking Mars landers.

"If something *does* happen to Galileo and VOIR," says SSEC chairman Noel Hinners, "our work will become even more important—and a lot sooner than we thought."

Hinners, who is a director of the National Air and Space Museum and a former head of NASA's Office of Space Science, points out that the scientific rationale for further solar system exploration was laid out in detail by the Space Science Board of the National Academy of Sciences in a series of reports during the 1970's; the SSEC is simply trying to turn that strategy into a realistic set of missions for the 1985 to 2000 era.

"It's important to ask ourselves why we are where we are, so we don't just perpetuate the old problems," he says. "Part of it is our own doing. We've worked ourselves into the mind-set of the 'Big Mission.' If you tell scientists and engineers they're only going to get one mission for the next few years, there's a tendency to hang on all the bells and whistles. So the price is driven up, until you get a year of tight budgets or whatever, and you're in a hell of a bind. If we can show we're trying to reduce our vulnerability to that, it will enhance our credibility."

Levy agrees that the program lost flexibility in the 1970's. But he emphasizes that there was nothing wrong with the space craft that *were* flown. He also echoes the universal opinion among planetary scientists that the real problem has been the space shuttle and what NASA's efforts to bring it to completion with inadequate funding from Congress have done to the agency's other programs.

Between 1974, when expenditures peaked for the Viking mission to Mars, and 1977, when the two Voyagers were launched and Galileo was approved, the planetary budget, adjusted for inflation, fell by a factor of 4. It has remained ever since at a level of $200 million to $300 million per year (1982 dollars). Out of that NASA has had to pay for Voyager operations, the Pioneer Venus mission, Galileo development, the Deep Space Network, which communicates with the spacecraft, and all its other planetary activities. There has been nothing left over to start any new missions. Mean-

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while, the agency decided in 1977 to terminate its large expendable launch vehicle program. There seemed little need for it, since the only mission that would have required one of the big Titan III-C's was Galileo, which was not scheduled for launch until 1982. It was assumed that the shuttle would be operational by 1979, as planned. But as it happens, the shuttle fell far behind schedule. Galileo's launch date has since been slipped from 1982 to 1985 and the delay has driven its cost from about $450 million to $700 million.

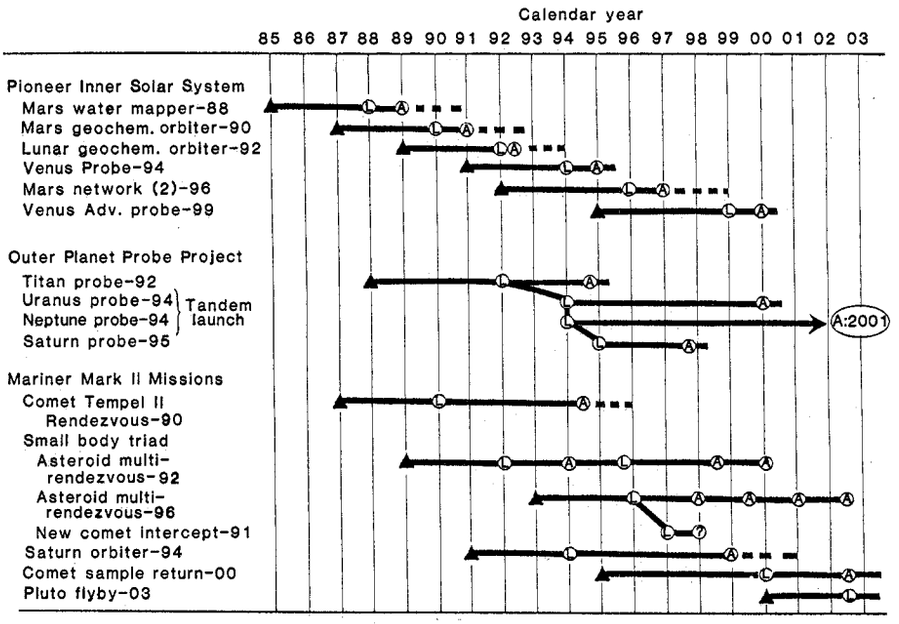
It was in this context last year that the SSEC was born. NASA's chief scientist, John Naugle, had seen it all before. In the late 1960's the Apollo program had been squeezing out unmanned planetary exploration in much the same way. The situation had been turned around then by the Lunar and Planetary Mission Board, which spent 3 years planning a suite of missions that evolved into the Pioneer, Mariner, Viking, and Voyager series of the 1970's. Naugle's hope was that the SSEC could accomplish a similar feat. The committee began its deliberation in November 1980. (Naugle himself retired in 1981.)

In its first year the SSEC has drawn up several alternative sets of missions, along with launch timetables that would keep the solar system exploration budget roughly constant at $300 million to $400 million per year (1982 dollars). The budget estimates assume a 1985 launch for Galileo and a 1988 launch for VOIR.

The committee has identified potential savings in spacecraft hardware, ground operations, and program management. For example, each mission will be based on one of three types of standardized spacecraft. Those in the "Pioneer" series, now under study at NASA's Ames Research Center in Mountain View, California, and the Jet Propulsion Laboratory in Pasadena, California, will be relatively simple vehicles designed for the moon and the inner planets (Mars, Venus, and Mercury). Derived for existing terrestrial orbiters, they will carry only a few instruments focused on specific scientific problems, and will radio their information to the earth at low or modest data rates.

Probes, also under study at Ames, will sample the atmospheres of Venus and the gaseous outer planets Jupiter, Saturn, Uranus, and Neptune. They will be derived from the advanced probe for Galileo, and will ride to their destination aboard a carrier spacecraft or "bus" that will itself carry a few instruments.

Finally, the "Mariner Mark II" series, under study at the Jet Propulsion Laboratory will explore the outer planets and the small, primitive bodies of the solar system, the comets and asteroids. In general they will resemble Voyager, although they will incorporate some of the advanced cameras and instrumentation from Galileo. Their pointing will not be as accurate as Voyager's, nor will their data rate be as high. But more efficient techniques of data encoding may allow them to return nearly as much information. A modular design will also make it easy to upgrade the instrumentation for later missions.



An SSEC mission timetable

This tentative plan, one of several under study, gives dates for new starts (solid triangles), launch (L), and arrival (A).

Ground operations for the two Voyagers currently cost some $15 million per year, even when they are simply cruising between planets. This is largely because the Voyager engineers have to be in constant contact with the spacecraft. Hinners says that one way to save money might be to have a "hibernation mode" for the cruise phase.

More potential savings could also come from planning the missions in groups, which would allow similar spacecraft to be built either simultaneously or in quick succession. For example, the Outer Planet Probe Project would send probes to Uranus, Neptune, Saturn, and Saturn's moon Titan, with launches clustered between 1992 and 1995. Between 1995 and 1997 the Small Body Triad mission would send two Mariner Mark II spacecraft to rendezvous with a series of asteroids, and a third to intercept a new comet.

"We've given a lot of thought to structuring missions," says John Niehoff of Science Applications, Inc. "We try to maximize the use of a spacecraft design once it's developed. For example, use the same spacecraft as both a lunar and a Mars geochemical orbiter. But that cost saving is only realized if you start the next mission very soon after the first. Otherwise the restart costs add about 25 percent."

Probably the most important single goal in planning the mission timetables has been to level out the peaks in funding. "We can't give the NASA administrator a program where he sees these tremendous peaks busting the budget every few years," says one SSEC member. "It's okay to give him a challenge, but don't give him that kind of problem."

The SSEC is also considering going a step further and recommending that at least some parts of the solar system exploration program be funded at a fixed level. Congress, instead of approving each new mission individually, would simply fund the program as a whole (with appropriate review) and let NASA work out the timetable. This approach has worked very well in the space agency's Explorer program, which includes many of its small science satellites.

"We've got to get into a mode where the whole thing is not torqued every 4 years," says Hinners. "Planetary science is peculiar in needing stability because of the 10- to 15-year lead time for the missions and the large number of people involved."

For its second year, the SSEC has set up working groups to advise engineers at Ames and JPL on refinements in the

mission sequences and on the kind of spacecraft they will need. Not incidentally, these groups include several dozen planetary scientists who are not in the SSEC itself; the idea is to broaden the base of support for the committee's final recommendations next year.

The SSEC's strategy is not without its pitfalls. Some are scientific: "You have to recognize that you can't do everything with small-scale missions," says Levy. "For example, we have already learned things about Mars that call into question the stability of the climates of terrestrial planets [including the earth's]. We know that Mars' climate was vastly different in the past, and we suspect that the shift was triggered by very subtle changes in its orbit, or in the amount of solar radiation it received. But we don't even know when it happened. There is no way you can pin it down without a substantial program that will eventually include a surface rover and a sample return. "There is a perception in Washington that when you've visited an object once, you've learned all you need to know. It's hard to convince the politicians that the problems of interpreting Mars are more pressing than before."

Hinners agrees on the need for large-scale missions: "We have to allow for the possibility that X years from now, the political climate may shift and the opportunity may arise for, say, a Mars sample return. We have to have the planning ready to respond, just as NASA had the Apollo idea ready when Kennedy needed it."

"Even with just the small missions there is a danger in appearances," says Hinners. "Congress and the Office of Management and Budget tend to measure the vitality of the program by the number of new missions," he says, not by total science being done or even the overall funding level. "It's common sense to break up some of the big missions into smaller chunks. But that gives you a lot of new starts. So people on the Hill may just say 'you had a new start last year. It's not your turn this year.' " Previous attempts to promote smaller scale missions and fixed level funding have foundered on this very problem. "We're going to be talking with OMB and the congressional staffs to see if we can get away from this numbers game," says Hinners.

What is really needed, however, and what has not yet been forthcoming, is a renewed political commitment to the idea that planetary science is worth doing. Hinners, for one, is cautiously optimistic about the future, saying that he finds no overt vendetta against planetary science anywhere; the problem is basically one of tight budgets. In that sense it may help that the SSEC plan calls for no new starts before 1985—"an administration away," as one member puts it.

But for now, planetary science seems to have few friends in the upper levels of Washington. And the outlook for any new initiatives, however modest, looks bleak indeed.—M. MITCHELL WALDROP

Pared Down PSAC Proposed

Ever since President Nixon axed the President's Science Advisory Committee (PSAC) in 1973 because it insisted on offering advice—sometimes in public—that ran counter to his policies, elders of the scientific community have lamented the lack of a science advisory committee in the White House. Their years in the cold may soon be over, however, for George A. Keyworth, President Reagan's science adviser, has proposed the establishment of a 15-member board that he can call upon for outside advice.

In an interview with *Science*, Keyworth made clear, however, that the proposed board would have neither the status nor the independence that PSAC enjoyed. Rather, it would function as an appendage of the Office of Science and Technology Policy (OSTP), which Keyworth heads. It would work on issues that he selects and offer advice to him rather than to the President, as PSAC did. "The main thing is that I want a body that feels and is a part of the office," Keyworth said.

What Keyworth has in mind is a committee that would meet at least once a month, which he could turn to for quick studies of specific problems. The panel would thus function much like an addition to OSTP's staff, which Keyworth says is "pretty overwhelmed with work right now." A final decision on whether the committee should be established rests nominally with the President, but in practice it will be Edwin Meese III, Reagan's chief counsel, who will decide. So far, says Keyworth, the idea has "been received with some considerable enthusiasm."

Frank Press, President Carter's science adviser, says that he wanted to establish a formal science advisory committee but was prevented from doing so because of problems with the federal advisory committee act. The act requires meetings of government advisory committees to be advertised in the *Federal Register* and, except for discussion of budgets or classified material, to be held in public. Such a requirement, Press argues, could expose to public scrutiny delicate matters of presidential advice and the Carter White House was not keen for that to happen. Keyworth does not seem so concerned, however. He says he has planned the committee on the assumption that it would come under the advisory committee act, and he has not sought an exemption.

Keyworth is clearly anxious to avoid the committee becoming the voice of the scientific community within the White House. PSAC's demise was at least partly due to the fact that it was generally seen as representing the interests of scientists and that its members were drawn largely from the liberal end of the political spectrum. The final straw came when the committee opposed Administration policy on the deployment of antiballistic missiles and on the construction of a fleet of supersonic aircraft, a sin that was compounded when some committee members went public with their opposition in congressional testimony.

Indeed, Keyworth says that the reason it has taken him 6 months to propose the establishment of a science advisory board for OSTP is that he has been seeking the right kind of people to serve. "It has taken me a long time and a lot of thought to pick people on the basis of judgment as well as on the basis of their demonstrated qualifications as scientists and engineers," he says. He is looking "for the kind of judgment that addresses the country's needs rather than the parochial interests of the communities themselves."

Keyworth says he now has a slate of people in mind and is ready to set up the committee as soon as he gets the go-ahead from the powers that be.

—COLIN NORMAN

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