

## POSTSCRIPT

This postscript gives the sense of a meeting of members of the Advisory Panel held in November 1983 at the Aspen Institute's Wye Plantation. The document was prepared by E. B. Skolinoff, and carefully reviewed by the participants. Certain exceptions expressed by participants are noted within the text.

The preparation of such a document by an OTA Advisory Panel is an unusual act ion; Advisory Pane ls are selected to represent a wide cross cross-section of informed opinion, and serve only to give guidance and review to an OTA assessment. In this case, however, the people l i steal below chose to go beyond the traditional role, and express their own views directly. Panel members have also been given the opportunity to fully review and comment on the fulltext of the report itself.

# REPORT OF THE SECOND ADVISORY PANEL MEETING Held at Aspen-Wye Plantation in November 1983

by  
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## Participating Panel Members\*

Robert A. Charpie, Chairman  
Harvey Brooks  
Peter O. Crisp  
Freeman Dyson  
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Andrew J. Goodpaster  
Charles Hitch  
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George E. Mueller, Jr.  
Carl Sagan  
Eugene Skolnikoff  
James Spilker

The panel was asked to consider the proposal for a manned civilian space station in the light of the development of the Nation's space activities generally, and of possible future civilian activities and goals in space. The panel approached this task first as a broad enquiry into future objectives in space and how the proposed space station relates to those objectives. The results of that enquiry made it inappropriate for us to engage in a more detailed evaluation of the current space station proposal.

As background for our conclusions, we need to note that the panel believes U.S. civilian space activities are and should be of high value to the Nation domestically and internationally. The country has a variety of motivations behind its space commitments—political, psychological, scientific, technological, economic—all of which have validity and importance. In particular, in looking to the future, the panel believes it essential that the program should come to represent again the sense of exploration and adventure, the energizer of both technological and institutional innovation, the source of outward-looking na-

\*The participants are in general agreement with this summary of conclusions, although some members may not necessarily endorse all the details or the phrasing of certain statements.

tional pride that captured our imagination, and that of others, in its first two decades. Those characteristics can be achieved in different ways, not necessarily correlated to the magnitude of the space budget. We also believe there should be ways that the program can be used more effectively as an instrument for peace and cooperation in a world in which the environment of space is threatening to become one more arena for military competition.

Our conclusions are as follows.

## I. Current Space Station Proposal\*

The panel has major reservations about the current NASA concept for a permanent manned space station and recommends against commitment to such a project at this time. We are quite certain that a space station of some kind will eventually be needed. However, the objectives underlying the current concept seem diffuse and imprecise. Approval of the proposal now would tend to lock the Nation's civilian space efforts into a large, expensive program that would likely preempt alternative possibilities and programs.

The panel was most concerned about the absence of studies that evidence a larger vision of space objectives and opportunities, against which this, or any future space station proposal, could be evaluated (see 11). A space station should not be an end in itself, but rather a step toward other goals. Those other goals, which need to be carefully developed and publicly debated, should provide a necessary framework for evaluating the role and usefulness of any proposed design for a space station.

The panel recognizes that not all possible activities and payoffs can be anticipated, and that

\*George E. Mueller disagrees with this conclusion, which he regards as not constructive with respect to direction for NASA, and supportive of unnecessary study. He does agree with the need to make the space station a step to a long-range goal, and would support asking NASA to design a facility to support such a program.

unexpected opportunities emerge in the course of developing a new capability. And the panel accepts the validity of the desire to take advantage of the capabilities offered by the Shuttle. But some of the immediate functions envisioned for the proposed space station (exploring near-Earth applications, for example) can be evaluated without much, or any new infrastructure in space, in fact, by imaginative uses of the Shuttle; and a more fully thought-out station keyed to longer-range objectives would be more likely to stimulate innovation and imagination.

Moreover, the station as envisioned would appear to have little payoff either for development of new technology (see III), or for the political-psychological benefits at home and abroad we have already indicated should be given substantial weight (see also XI).

The development of a habitable space station to gain expertise of people in space is an important argument, but also one with little present basis for evaluation. We have seen no analysis of the differential costs of a manned v. an unmanned facility, nor an analysis of the opportunity costs of that differential. It is important that it be understood that the panel does not argue against man-in-space per se (the Shuttle may provide a good portion of that experience), but rather that a better rationale than has been provided us is required for a goal worthy of attainment.

## II. Analysis Capability

The lack of studies analyzing long-term space goals and opportunities was striking to the panel. There were not even studies available that laid out possible alternatives to the current proposal. Without these, the panel felt it was not possible to sensibly evaluate the scale, nature, cost or purpose of a manned civilian space station. An initial "goals" paper prepared by OTA staff represented a start toward the kind of studies that are needed.

The panel believes this situation is deeper in its significance than simply whether adequate studies had been conducted before the space station proposal was put forward. NASA has been positively discouraged by successive administrations from engaging in or sponsoring much for-

ward thinking, presumably to discourage the emergence of costly ideas or prevent the appearance of lobbying. One result is that apparently little capability exists within NASA, and essentially none outside, able to carry out on a continuing basis the kind of informed, analytical, critical studies that any major program area ought to have. The need is acute.

We have considered various options for creating such a locus for the professional study of public policy questions relating to the civilian space program and would make several observations. Clearly, NASA should have a larger internal capability for long-term analysis, but that alone would not be adequate for obtaining objective outside views or for establishing public credibility. The Administrator of NASA could, and we believe should, serve as a sponsor of such studies, perhaps working through a broadly based advisory committee to enhance objectivity and credibility. We recommend that early consideration be given to a long-term program of support of studies in the private sector (analytical organizations, commerce, industry and universities) that would build a community of knowledgeable analysts of the Nation's space activities, analogous to that which has been developed in other areas such as energy and the environment.

Such a program of studies also implies a more open planning process and the concomitant continuous rethinking of NASA objectives that go with that openness. This process can provide an opportunity for more extensive engagement of the private sector (see VI), an objective we believe should be high on NASA's agenda, and can engage the interest of constituencies not already deeply involved in the space area.

## III. R&D

A major factor in evaluating a proposal for the next step in the space program should be the contribution that objective will make to the development of new technology. The panel does not believe the civilian space station as proposed is likely to have as significant a technology-forcing effect as should be required from a program that would be the centerpiece of the space agency's activities for close to a decade.

In fact, the situation is more serious, for advanced technological development has been severely cut back in the space program since the early days of the Shuttle program. Key technologies that would be necessary for later missions, such as advanced space propulsion systems or machine intelligence and robotics, have not been adequately (or at all) supported because of funding limitations. Even technologies to fully exploit current space applications have been relatively neglected. The current proposal for a civilian space station would generate little such technology development and, more than likely, would prevent funds being available for such programs. Yet, those technologies represent what should be major payoffs of space activities and the central features of future space activities.

Accordingly, we recommend that NASA engage in the conscious development of seminal technologies that are likely to form the building blocks for future space goals. This should be carried out in close cooperation with industry, rather than wholly in-house, with the Government stimulating private-sector ventures and financing where possible. The model of the highly successful relations between the National Advisory Committee for Aeronautics (NACA) and industry for aeronautical technology could well be followed by NASA for space technology development.

#### IV. Immediate Alternatives to a Space Station

In recommending deferral of the proposed NASA civilian space station commitment, we do believe other steps should be taken. Two of high priority are given above: begin analyses of possible long-term space goals, and design a program of technology development. In addition, some of the stated purposes of the proposed space station could be explored with the existing Shuttles. In particular, the possibilities and viability of manufacturing in space, repair of low-Earth-orbit space satellites, and much scientific research can and should proceed with present capabilities and, if indicated, their modest improvements. Such programs can provide necessary information to judge more definitively what the real needs are to carry out those functions on a continuing basis. It makes little sense to make major commitments

to an expensive large-scale facility if already existing capabilities remain underexploited because of shortage of funds,

In any programs undertaken in the near term, however, it is important that they not be allowed to develop a life of their own that prevents more desirable alternatives, or interferences with other ongoing programs of great importance, such as those in space science.

#### V. Long-Term Mission Possibilities

The panel discussed some possible long-term activities that satisfied some of the criteria we believed to be important: likely to command widespread attention, inherent scientific interest, technology forcing relevance to global issues, substantial significance to human problems, suitability for international cooperation (see VII) and private-sector participation (see X). We have not examined these in detail, nor do we advocate any particular choice. They are suggestions of the kinds of space goals we believe should be analyzed and studied in detail.

One category of possible goals would involve programs (let us specify to contribute knowledge about present or future planetary and human issues. For example, programs designed to learn more about the global "greenhouse" effect that could result from accumulating carbon dioxide in the atmosphere through, among others, intensive examination of the atmosphere of Venus, which has experienced its own massive CO<sub>2</sub> "greenhouse." Another such goal would be the study of the effects of large-scale fire, volcanic action and dust storms through targeted studies of the Martian environment, which is rife with such events.

More directly Earth-oriented, a possible organizing focus of an important segment of space activities could be the detailed monitoring of the habitability of our planet on the surface and in the atmosphere. The substantial hazards and possible catastrophes lying ahead—CO<sub>2</sub> and other gas accumulation, ozone depletion, soil depletion, deforestation, desertification, agriculture disease vulnerability, among others—make a major dedicated program of global monitoring potentially of crucial importance for the future.

A different kind of goal in space would be to contribute directly to more general research objectives in the life, material, or other sciences. For example, some of the effects of zero gravity on the body appear to be similar to the effects of aging. Are there important contributions that can be made through space research programs on aging, an increasingly important social goal for an expanding global population? Many other such complementary research targets could undoubtedly be developed and evaluated.

And, of course, there is a long list of possible scientific goals in space that can be considered:

1. unmanned rendezvous missions to an asteroid or comet to provide early solar system history;
2. Mars exploration, with unmanned roving vehicles;
3. landing on the Saturn moon Titan, which has a nitrogen atmosphere, complex organic matter and strong evidence of a liquid ethane/methane ocean;
4. solar spacecraft able to penetrate some distance into the Sun while sending back information; and
5. Venus probes.

**Longer-term:**

6. landing on asteroids, planets or comets with return of sample material;
7. probes beyond solar system;
8. manned lunar station;
9. manned asteroid station; and
10. manned missions to Mars.

Note, incidentally, that the current space station proposal would not necessarily be the preferred next step for most of these goals.

## V1. Private-Sector Involvement

The panel is strongly of the belief that the private sector can be more effectively and extensively engaged in the Nation's space activities than it has been to date. For the most part, current involvement has been restricted to a select group of NASA contractors or subcontractors. There is need for involvement of a much broader industrial constituency to elicit new ideas for space applications and techniques. Not only is it desirable to engage the innovative and entrepreneurial character of American high-technol-

ogy industry, but also to attempt to bring down unit costs of space assets and activities over time, and to involve consumer-oriented industries in space applications that may be marketable.

To engage the private sector effectively to achieve these objectives poses several requirements. Consultation with industry should start with a broad dialogue on a wide range of possible space goals and mission opportunities, not with the detailed design of an already-determined space station.

A second requirement is to develop a clarity of commitment to activities that signals long-term interest. Such commitment is necessary to encourage industry to invest its resources of manpower and money in the development of technology potentially useful for those activities. Such a clarity of commitment should be the outcome of the joint studies and consultation referred to above,

A third, with regard to space applications, is to use either public corporations (perhaps of the Comsat type) or other institutional innovations to take over commercial development and exploitation of space technology. NASA is not well suited to the design and marketing of commercial/industrial systems or services—that is not its purpose—and simply attempting to hand over an existing developmental system, such as Landsat, to the private sector for operation is unlikely to be viable.

It is also possible that the present structure of NASA is not well suited to prompt a major increase in private-sector space activities because of the present large commitment to in-house laboratories (see IX) and present technology procurement practices. We cannot make a definitive judgment on that, but recommend an objective evaluation by NASA and by Congress.

## VII. International Cooperation

International cooperation has been a goal of the U.S. space program from the beginning, but the panel believes much more could be done. Cooperation is particularly attractive for future activities for several reasons: technical competence is more widely distributed throughout the world than in the past, resource limitations are

more of a constraint on all countries, and many space activities are relevant to all people, not just Americans.

It is possible that the costs of space activities could be reduced by genuine joint programs that enlisted not only the funds, but also the talents of other nations. Examples, such as Spacelab, already exist. But for more extensive cooperation, there must be a commitment for joint planning at a very early stage, and reasonable guarantees of program continuation once a commitment has been made. Past history of American project cancellations in midstream do not contribute to confidence in the United States as a reliable partner.

Near-Earth space applications are of obvious interest to other countries from a commercial perspective, but programs for monitoring the changes in habitability of our planet would provide other common motivations. And, planetary probes that would potentially provide information relevant to this planet's concerns—for example, those goals mentioned earlier of improving understanding of the CO<sub>2</sub> greenhouse effect by studies of Venus, or gaining knowledge of the effects of fire, volcanoes and dust from study of the Martian environment—would also provide common foci of interest with other countries.

In fact, the potential benefits for all from space activities should provide a high incentive target for cooperation even if the other possible benefits of resource and talent sharing are less clearly relevant. There are also, of course, difficulties inherent in international cooperation, difficulties that stem primarily from problems of meshing of disparate bureaucracies and political systems. There is also the problem that the structure and incentives in NASA, and more broadly in the budgetary and decision process in the U.S. Government, do not lead naturally to seeking international cooperation. This, too, is an **issue we** believe deserves separate attention by NASA and by Congress.

It should be noted that there seems to be considerable interest within Western industrial countries in cooperating on the proposed civilian space station; European countries, Canada, and **Japan are waiting** for the United States to decide what it intends to do. Cooperation, to be really meaningful, must involve joint planning and

study of alternatives before selection is made. We recommend a more open set of discussions that ask what we and other interested countries *should* be doing together.

Any military overtones to NASA projects (see VIII) will likely have a negative effect on possibilities for international cooperation. Though it may be possible in practice to separate the military from the civilian interests in specific missions, it is a problem that we cannot afford to ignore.

There are also potential political benefits to be gained over time through intimate and extensive cooperation with others. Cooperation with Eastern bloc countries, and especially the Soviet Union, will not remove the sources of conflict, but may be used as an instrument to ameliorate those conflicts and offer alternatives.

### VIII. Effect of Military Programs and Interests'

The panel is very concerned about the effects on the civilian space program of a major new and enlarged focus on military uses of space. Though there might be some budgetary competition, the primary problem would be the competition for scarce technical manpower and industrial resources. The most qualified personnel would likely be attracted to the rapidly expanding and technologically exciting defense sector, and NASA itself might see some of its best people leaving.

In addition, such a large-scale military commitment would likely serve to give a military image to our space activities abroad, where the distinction between civilian and military interests may **not be clear.**

International cooperation in the civilian program may also be harder to achieve because of increased concern in the United States over apparent loss of technology assumed to be critical for national security. Controls over information could well be sufficiently onerous as to rule out some forms of otherwise desirable cooperation.

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\*To avoid the appearance of possible conflict of interest, members of the panel with past and present involvement in military space activities did not participate in the formulation of this section of the report.

## ix. NASA Operations and Organization

The panel did not make any formal evaluation of NASA's structure and performance, but a few observations based on the experience of panel members and the issues at stake are in order, some already mentioned.

As has been noted, NASA is not well positioned for much more extensive cooperation with the private sector, or with other countries. The specific reasons are different in each case, but the underlying factors in NASA appear to be: the pride in past successes achieved by "going it alone"; the perception of private-sector activities as competitive with, not complementary to, its interests; the lack of desire among most scientists and engineers to devote themselves to the administrative orchestration of multicultural, multi-political projects; and the large fixed facilities of NASA that inhibit flexibility. All of these discourage assignment of major responsibilities outside the organization.

This structure also serves to maintain high fixed overhead costs in NASA, again discouraging exploration with industry of ways of bringing unit costs down. It is not clear what cost reductions would be possible, but it would be difficult to evaluate the possibilities given the present structure.

To some extent, the existing structure may also discourage the development of alternative goal concepts, and generally inhibit imagination, since changes in programs may have negative effects on the present organization.

These observations may be exaggerated, or should perhaps be balanced by other important attributes. We urge attention to the issue, however.

## x. International Economic Competition

International competition in provision of civilian space services has already emerged, primarily with European countries, and is likely to grow **in the future as Japan becomes more heavily engaged. To some extent, that competition has been encouraged by U.S. policies that have not provided adequate guarantees for the future,**

such as launch services, or have not been adequately consumer-oriented in systems design and development (for example Landsat). However, competition is inevitable, quite apart from U.S. policies, for advanced industrial nations with high-quality technological capabilities are likely to enter any market with economic potential.

Men and women in orbit, utilizing sophisticated and costly space assets, may be an important capability for U.S. commercial exploitation of the economic potential for near-Earth orbits, but we consider that case as not having been demonstrated as yet. In fact, commitment to such a capability could delay exploitation, by preempting funding and personnel that might better explore possibilities with industry through **use of the present Shuttle capability or its modest extensions.** It could, in fact, be a massive commitment to the wrong kind of station, even **for economic purposes.**

There is another aspect of the economic value of space activities—the spinoff of new technology to the commercial sector. In this respect, as we noted before, the proposed space station would likely hold relatively little interest as a means of developing new technology—especially in comparison with other feasible goals.

## XI. Geopolitical Competition

**The Soviet Union has been conducting a vigorous manned space station program which, notwithstanding some serious mishaps, is apparently on track. Beyond the continuing exhibition of space prowess, presumably of important political value to them, the uses to which their capabilities are intended to be put are not clear—perhaps this is similar to the American situation—though Soviet Union scientists have often indicated that the long-range goals for their space program include manned bases on the Moon or Mars. Regardless of later goals, they have certainly been gaining useful information about people in a space environment (which they share quite extensively with the United States).**

There is **a natural reaction in such circumstances that leads to programs undertaken to "match" the achievements of the Russians, or to be concerned about the information or experience they have obtained that is not immediately**

available to us. But, for the United States to undertake a large-scale program not necessary, or ill-suited, to our needs is more likely to handicap us in the future in geopolitical competition with the Soviet Union. Especially is this so in this case in which the civilian space station goal is not likely to command dramatic attention or to lead to important new technology.

Civilian space activities are, in fact, an important arena for international political competition. The panel's plea is for the United States to aim for a goal worthy of attainment from this perspective, as well as from others. The international political effects of visible, dramatic nonmilitary accomplishments are important in presenting an image of a dynamic Nation able to preserve its vitality in an open, democratic form of government. Many throughout the world find hope and encouragement in that demonstration; it is important to us as well as to them.

We note again that competition in civilian space accomplishments need not rule out the

possibility of some cooperation as well, even with our primary competitor. The more important the subject, the greater would be the political significance of cooperation.

We close with reiteration of the panel's conviction of the importance of the civilian space program to the country, and the significance of the next major steps in space that the Nation undertakes. Our ideas, our imagination, and our critical analytical abilities need to be engaged in laying out the alternatives before us just as our institutions, public and private, need to be appropriately engaged in implementing the decisions finally made. In the long run, a sustained and effective civilian space program will depend on building a lasting political consensus, a consensus based on informed public debate and understanding of the significant objectives that can be served by civilian space activities.