On NASA's Office of Space Science Draft Strategic Plan: Letter Report

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On August 27, 1997, Space Studies Board Chair Claude R. Canizares sent the following letter to Dr. Wesley T. Huntress, associate administrator for NASA's Office of Space Science.

As you requested in your letter of April 27, 1997, the Space Studies Board (the Board) has reviewed the draft Office of Space Science (OSS) strategic plan received on July 3. In carrying out the requested "broad and comprehensive review," the Board has focused on the main questions provided in your letter:

- Is the plan responsive to principal scientific issues and opportunities identified by recent National Research Council strategic research guidance? Are key areas fully addressed?
- Does the draft plan address interdisciplinary issues adequately? Is the overall program balanced?

The review was based in part on inputs received from the Board's space science discipline committees. The Committee on Planetary and Lunar Exploration was briefed on the maturing plan by Dr. Carl Pilcher on June 2; the Committee on Solar and Space Physics was briefed by Dr. Pilcher on June 4; and the Committee on Astronomy and Astrophysics met with Dr. Pilcher on the draft plan on June 25. Using teleconferences and electronic mail, each of the committees subsequently developed and forwarded independent inputs on the plan to the Board for consideration at its meeting on July 16. At that meeting, the Board reviewed and discussed the draft plan and these inputs and assembled this consensus assessment and summary of suggestions.

In general, the Board was impressed by the scientific breadth and inclusiveness of the plan. At the same time, the Board would like to offer some comments and suggestions for strengthening the plan; these can be divided into several general areas: (1) science content; (2) technology issues; (3) education and public outreach; (4) process, principles and partnerships; (5) interdisciplinary science; and (6) general comments on scope and content. The first two areas, science content and technology, correspond with the first elements in your letter of request (responsiveness and comprehensiveness). The remaining areas below relate to

the other topics in your request letter (interdisciplinary issues and balance) and provide some additional general suggestions.

Please note that "Appendix 4—Metrics" was not provided with the version of the draft plan supplied to the Board and was therefore not included in the present review.

Science Content

The Board and its committees found the OSS draft plan very responsive overall to previous National Research Council science recommendations. The Plan includes most of the high priority objectives recommended by the Board in astronomy and astrophysics, 1 in planetary exploration, 2 and in solar and space physics. 3 The goals and objectives developed in the workshop report *The Search for Origins: Findings of a Space Science Workshop* 4 are also broadly represented. The following suggestions are offered to help strengthen the plan's science content in related areas.

The role of Discovery and Explorer missions in addressing "Goals" and "Objectives" (Part I Tables 2 and 3, and Part II section B.1 in the draft plan) was not clear. The plan should indicate how these important principal investigator-initiated and peer-reviewed missions are viewed in the context of the plan and how they support its stated goals and objectives.

The critical importance of Research and Analysis (R&A) programs and their role in the overall science program are not stated clearly. In particular, the Board felt that the R&A program should be displayed on an equal footing with "Enabling Technologies" and "Education and Public Outreach" (sections B.3 and B.4 of the draft plan). Several key contributions of R&A could be described in the plan, including R&A's central role in theory and instrument development (including suborbital programs), preparation for future mission data analysis, fostering of university and industry participation in technology development, and graduate student training.

The Board did not discern in the draft plan the significance of inclusion of specific missions in the section on post-2005 missions (section B.2). That is, all the missions in the plan for this time period are in the OSS roadmaps, but not all of the roadmap missions are present in the plan, and the selection criteria and rationale for inclusion of particular missions in the plan were not evident. Also, the Board did not understand from the plan the relationship between current technology investments and how missions will be selected from the post-2005 list. Is it intended that the NASA field centers engaged in technology development will dictate the post-2005 list by their selection of technology research, or that the mission list provided in section B.2 will dictate the technology investments nearer-term? What is the process for this decision-making?

Finally, several important items recommended in the Board strategies cited

seemed to be absent from the list of Objectives in Table 3: discovery of extrasolar planets; Mars research other than the search for life, such as study of its interior and emplacement of a network of surface stations; study of the generation and evolution of magnetic fields within the solar system; study of the structure and processes of the Sun; and expansion of "interactions of planets with the solar wind" to include other solar system objects. Specific measurements and missions that the Board would like to bring to your attention are ultraviolet spectroscopy after the end of Hubble Space Telescope operations, a Jupiter multiprobe mission, and the continuation of solar-terrestrial probes after 2005.

Technology Issues

The Board perceived several weaknesses in the technology discussion in the draft strategic plan. As presented, the technology portion of the draft is less a plan than it is a list of attributes. This is especially significant since technology readiness will drive mission schedules, which in turn will drive the pace of scientific research in individual areas. Technology progress should be directed to support science goals, and technology development and science objectives should be coordinated so that technology investments can be made at the right time in mission planning. The approach to technology selection is not described in the plan and would appear to be a closed process within the NASA field centers.

The Board offers the following suggestions for strengthening the technology component of the plan. A strawman science mission time line could be provided, with technology development planning correlated with this time line. A large amount of this information already exists in the form of the four theme area science and technology roadmaps referred to in the "planning" box in the draft plan (section B), and so the challenge is not to develop this information but rather to represent the substance of the technology matrices, schedules, and mission "flow downs" at a level of detail appropriate for the strategic plan. This presentation of technology planning should be related to the technology program organization already laid out in the draft. Extra attention to this area is warranted because of the crucial influence of new technology development and availability on the future timing of science flight opportunities.

Description of a process for communicating science requirements for technology development to universities and industry and for engaging their participation would be helpful. In this connection, a process needs to be defined for open and peer-reviewed selection and assessment of existing, proposed, and developing technologies. This principle is enlarged upon in the 1995 Board report *Managing the Space Sciences*. 5 The strategic plan should present planning for partnerships between universities and industry to involve young scientists and engineers in technology development; this would include opportunities for young scientists and engineers to become involved in suborbital, balloon, aircraft, and small satellite projects to afford them experience with flight operations and instrument performance in a flight environment. Provision for investment in training scientists skilled in instrument development is also important.

The draft plan identifies a number of important areas where enhanced technical capabilities are required, and describes NASA's organization of the development effort into four major programs. In noting the applicability of new technology to multiple enterprises and their shared dependence on it, however, the plan does not discuss in either its "Enabling Technologies" or "Partnerships: Within NASA" sections how the needed inter-enterprise coordination and cooperation will be managed. In Managing the Space Sciences, the Board suggested a leadership role for the NASA Chief Scientist in carrying out this function. 6 The strategic plan might elucidate how this coordination and cooperation will be overseen, whether by the Chief Scientist or by an alternative arrangement.

The Board suggests that the plan include provisions for post-completion review of technology development work in terms of achievement of objectives, schedule, and cost. Related to this, a universal process for collecting and reporting cost data for technology development should be explored, and a framework for risk management for new technology could be proposed.

Education and Public Outreach

NASA will spend less on K-12 education than the NSF, which will in turn spend less than the Department of Education; beyond this, the entire federal effort is dwarfed by state and local government expenditures on education. Therefore, as recognized in the March 1995 OSS education strategy, NASA will contribute most effectively by focusing on developing and implementing activities that capitalize on the unique knowledge and capabilities of the agency. 7 The education part of the strategic plan should explicitly address these special NASA contributions to the nation's K-12 education enterprise and how they will fit into this larger system.

Process, Principles, and Partnerships

While the draft plan is broadly responsive to Board science strategies, it would be strengthened by a clear presentation of key decision-making processes. These processes that determine which missions and technologies are developed should be an important part of the strategic plan. For example, the role of peer review could be more clearly described: in Part II ("B. Strategy" of the draft plan), it is stated that Discovery and Explorer missions are "designed totally by members of the community and selected competitively by NASA … "—yet the role of peer review in this process is not articulated. Beyond this, the plan could more generally assert the principle of using peer evaluation to support competitive selections for basic research and innovative technology development, as well as for science flight missions. 8 The decision rules presented by OSS to the Breckenridge planning workshop in May 1997 are germane and could also be included in the plan.

The important role of NASA's internal advisory committees is not explained in the draft plan. Other factors to be considered for inclusion in the plan are the mix of large and small missions; programmatic balance; cost-effectiveness; interactions with universities and industry; and the role of the field centers.

Related to process issues is the draft plan's partnering discussion. The Board felt that the plan's section on partnering, which focused on NASA's internal relationships and its relationships with other government agencies and with international collaborators, was a strong component of the plan. The section could be further strengthened by adding similar subsections on partnering with universities and with industry.

Interdisciplinary Science

Interdisciplinary science issues are another area that could be strengthened by an expanded presentation on processes. The plan did not appear to provide for integrating important interdisciplinary research (such as the role of planetary magnetic fields, particle acceleration and reconnection, the relationship between stellar and solar variability, laboratory and theoretical studies of atomic and molecular physics, and generation of magnetic fields on all scales) into the overall program. Also, the solicitation, review, and management of interdisciplinary projects can suffer from lack of management "ownership," and OSS's approach to mitigating this tendency was not described. Related suggestions include increasing overlaps in membership between internal advisory committees and possibly establishing a performance metric for the development and quality of interdisciplinary programs.

General Comments on Scope and Content

In summary, the draft plan presents a comprehensive overview of science goals. Overall, the document's utility as a strategic plan could be augmented by broadly strengthening its presentation of key strategic processes as indicated in sections above. Inclusion of a discussion of budget and schedules for accomplishing the science goals would help demonstrate their realism, balance, and feasibility.

The plan could also be improved by creating a "network" for each mission identified in Appendix 3. This network would include analysis of what technologies are required for each mission and when; what R&A projects are required and when; what the value of the mission would be to society; what education and outreach would be involved; and what the estimated cost of the mission would be. The missions in this network could be grouped by themes. The network would form a basis for the strategic plan itself, which could then discuss the anticipated level of resources and analyze what can be done with the resources. Time lines for technology development and mission planning, which would be updated on a regular basis, would become integral components of the plan.

The Board hopes that these suggestions will be of help in revising the draft plan and looks forward to working with you to further strengthen space science.

1 Space Studies Board, National Research Council, *A New Science Strategy for Space Astronomy and Astrophysics*, 1997 (National Academy Press, Washington,

D.C.).

2 Space Studies Board, National Research Council, *An Integrated Strategy for the Planetary Sciences: 1995-2010*, 1994 (National Academy Press, Washington, D.C.).

3 Space Studies Board, National Research Council, *A Science Strategy for Space Physics,* 1995 (National Academy Press, Washington, D.C.).

4 The text of this workshop report is reprinted in the Space Studies Board Annual Report—1996, Space Studies Board, National Research Council, in press (National Academy Press, Washington, D.C.).

5 Space Studies Board, National Research Council, *Managing the Space Sciences*, 1995 (National Academy Press, Washington, D.C.), page 68.

6 See pages 38 and 65, note 5 above.

7 These are discussed in the Office of Space Science education plan, Partners in Education: A Strategy for Integrating Education and Public Outreach into NASA's Space Science Programs, NASA, March 1995, pages 4-6.

8 These issues are discussed in *Managing the Space Sciences,* pages 56-60 and 68, note 5 above.