On Life and Microgravity Sciences and the Space Station Program: Letter Report

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On February 25, 1994, Space Studies Board Chair Louis Lanzerotti, Committee on Space Biology and Medicine Chair Fred Turek, and Committee on Microgravity Research Chair William Sirignano sent the following letter to NASA Administrator Daniel Goldin.

Following their joint meeting last November 4 with you, Bryan O'Connor, and Harry C. Holloway concerning planning for the space station, the Space Studies Board's Committee on Space Biology and Medicine (CSBM) and Committee on Microgravity Research (CMGR) wrote a summary of their reactions to the discussion and plans along with associated recommendations. 1 Important decisions concerning selection and management of space station science are currently being made and will continue to be made over the next several months. It is the objective of the Board and its committees to contribute positively to these ongoing discussions and decisions as they are occurring rather than after the fact in order to help assure the scientific underpinnings of the station during this formative stage. In brief, the Board and the CSBM and CMGR have concluded the following:

1. Research in space biology and medicine and in microgravity conducted under the space station program should be selected and managed using proven techniques employed by the Office of Space Science and Applications (OSSA) in the past, for example, with the Spacelab program, which should serve as a model for space station research planning. The responsibility for these activities should reside with the Office of Life and Microgravity Sciences and Applications (OLMSA), not with the Space Station Program Office. Placing responsibility for selecting and managing space station science outside of the OLMSA could have a number of detrimental effects (see pages 2-3 below).
2. Termination or restructuring of the long-planned Spacelab program could result in the loss of much high-quality science and essential data that should be used in planning the design of the space station for research utilization (see page 4 below).

Rapid political and economic developments around the world are combining with severe budgetary pressures to create turbulence in the U.S. civil space program, including the space station program. Clearly, issues related to building and operating the space station will continue to be discussed and debated within NASA, with the Congress, and with our international partners before final resolution is obtained. The research community that will use the space station has a responsibility to the American public to provide advice on how to ensure optimal scientific return from the orbital laboratory. The Board and its committees recognize that only a snapshot of space station planning is currently available and that the information provided on November 4 does not reflect final decisions. The intent is to offer constructive suggestions about critical research management issues and the precursor research programs.

As you know, based on its charter and expertise, the Board has provided continuing advice on basic science and research aspects of the human spaceflight program. Several times since 1983, the Board has provided advice on the space station. 2-4 Although the Board's 1991 and 1992 statements acknowledged that the space station would serve national goals other than science, such as education and stimulating the U.S. technology base, both statements emphasized the need to appropriately design and equip the station for effective research by the life and microgravity sciences, the two principal disciplines the space station is intended to serve. The presidential directive to redesign the space station and plans to integrate the station with the Russian space station program prompted the Board to ask its CMGR and CSBM for a new review of the space station program that would focus on research management and the station's technical capability to support a research program. At the November 4 meeting, the CMGR and CSBM looked at planning for research management for the space station program and at precursor research during the period leading up to the station's availability. The two committees expect to consider the station's capabilities for enabling scientific research at a later date when its design is better defined. The role of OLMSA in managing the space station research program, and some recommendations regarding pre-station use of the space shuttle for preparatory research and cooperative research opportunities on Russian facilities, are discussed below.

Planning and Management to Enable Scientific Research

Planning and operating a space station as an international research facility will clearly present special challenges. Among the complex issues are how research opportunities will be advertised, how experiments will be reviewed for selection, how data will be archived and made available, how research time will be allotted, and how research management responsibilities will be allocated among international partners. It is imperative that a rigorous process of open solicitation, peer review, and continued input from the scientific community be developed and followed by NASA for the space station program. 5

Getting the best research results from the space station will require maximizing the quality of each individual phase of the research process, as well as integrating the

phases smoothly into a coherent whole, beginning with early planning stages and continuing through hardware design and development to flight operations and data analysis. An optimal program must also include vitally important contributions from underlying theoretical and supporting ground-based research programs. All of these components must be fitted together in a balanced and cost-effective way that includes flight opportunities as only one element, albeit a central one, of an integrated orbital research program.

The Board and its committees are concerned about whether a scenario in which the Space Station Program Office manages this complex process would give the best results. The Advisory Committee on the Redesign of the Space Station (the Vest Committee) recommended that the space station management organization include a Research Manager line position, with corresponding influence on development of the space station system and operations. 6 It is the committees' understanding that the purpose of this recommendation was to encourage a management structure in which the science utilization function plays more than an advisory staff role. During the November meeting, the committees' impression was that the space station program managers interpreted the Research Manager's role in broader terms, to include essentially all aspects of the orbital research program-definition of the science program, selection of investigations and experimenters, and development and operation of the flight hardware.

Specific concerns of the committees about possible detrimental effects on an integrated research program from structuring science management along flight hardware development lines include the potential for the following:

- Lack of attention to the supporting ground-based and theoretical research programs and poor integration of these programs into the flight program;
- Lack of familiarity with the science community and the process of scientific investigation versus the engineering and system development process;
- Weakened recognition that the research community does not divide cleanly, if at all, along flight experiment facility lines (e.g., there are not separate science communities for a centrifuge, cell culture system, human physiology equipment, and so on);
- Inadequate resources devoted to, or distraction of management attention from, use of the space station for scientific research. Research utilization must function in the context of the very real demands of developing a uniquely complex, human-rated, highly visible, and international space station system under tight budget pressure;
- Lack of focus on the needed evolution of instrumentation over the lifetime of the space station system; and
- Lack of emphasis on data analysis, storage, accessibility, and dissemination.

The Integrated Product Team concept described to the committees, wherein

individual flight-facility-oriented development teams are managed in turn by OLMSA, the Space Station Program Office, and then again by OLMSA, would not appear to vitiate these concerns.

NASA's OLMSA has two divisions devoted entirely to developing and operating major scientific programs conforming to the best recognized standards of science management, used effectively in the past by the former OSSA. Founded on the principles of open solicitation and intimate involvement of the most able researchers in their areas, these standards have demonstrated success in generating scientific advances from federal investment. The Board and the CSBM and CMGR recommend that NASA utilize these standards and its existing science offices structure to effectively manage use of the space station for scientific research.

The CMGR's and CSBM's specific recommendations are the following:

1. The space station system Research Manager should be directly responsible to the science offices responsible for flying space station payloads. NASA should adopt for the space station program the approach used successfully in planning and managing the research for the Spacelab program, which provides for both a flight director and a mission manager. The space station mission (research) manager should be responsible for the payloads and associated risks, including analysis and integration, establishment of milestones, and crew training. That person should be responsible to the science offices, whereas the flight director, who is responsible for the spacecraft, launch and landing, mission operations, and so on, should be responsible to the Office of Space Flight.
2. OLMSA should be responsible for defining the life and microgravity sciences research to be performed aboard the space station. To ensure a broad and balanced research program, including theoretical and ground-based components, OLMSA should actively involve the microgravity and life sciences research communities.
3. Once it has defined the science program, OLMSA should manage and conduct open solicitation and peer-reviewed selection of all experiments to be flown, including those for both operational and fundamental science studies, in concert with its international collaborators.
4. OLMSA should provide mechanisms by which the international scientific community can have direct and continued input into the design, development, and operation of the space station and its scientific hardware.

Spacelab Utilization and Cooperative Research Opportunities on Mir

In order to make the most effective use of the space station, it is essential to have a complete and current body of scientific data and experience relevant to the design of experiments that will fly. The Board, the CMGR, and the CSBM are

concerned about the possible termination of the long-planned Spacelab program as NASA proceeds with the emerging Shuttle-Mir program. Spacelab accounts for virtually all of the life and microgravity science experiments published in the shuttle era. Spacelab should continue, not just as a visible U.S. commitment both to the U.S. scientific community and to ESA, but also because Spacelab science results will be critical for defining space station science.

Cooperating with the Russians on Mir may provide political, technological, and, possibly, scientific advantages (i.e., long-duration on-orbit experience). However, the extremely successful space life sciences and international microgravity missions that have flown on Spacelab indicate that Spacelab can provide more high-quality science than can Mir, at least in the near term. (Mir presently lacks some essential scientific capabilities: no freezer or storage facilities, no in-flight analytical capability, no sample return capability, no on-board computing capability, and no down-link video 7) For example, Spacelab's greater capability may be particularly evident in the case of SLS-4, Neurolab. This mission, planned in active cooperation between NASA and the National Institutes of Health (NIH), represents a new direction for space life sciences that has been strongly encouraged by both the research community and the Congress. With responses to the Neurolab Announcement of Opportunity now in hand, continued support for this mission is essential to strengthen cooperation between NIH and NASA. Cancellation of the mission or substitution of middeck experiments for a dedicated Spacelab mission would have serious consequences for meeting this objective and for the continued participation of the mainstream life sciences community that NASA seeks to attract.

The availability of a suitably equipped Spacelab on planned crew exchange missions would greatly enhance the science yield of the Mir missions. Repeated flights of similarly configured missions should be cost-efficient and maintain life and microgravity science research capabilities while the new international station is being developed.

Because plans for cooperative space science research efforts between the United States and the Russians have not yet been fully defined, the Board and its committees cannot explicitly address their potential effects on U.S. life and microgravity sciences research. However, it is realistic to infer significant impacts on the currently planned program. The Board and its committees strongly encourage NASA to thoroughly analyze, document, and discuss with the affected research community the current and potential research capability of Mir. Spacelab must be available for certain experiments. Research opportunities provided by the Shuttle-Mir flights should be carefully planned and should be used to maximum scientific advantage. Research opportunities with the Bion/Cosmos program should also be exploited. Data obtained from Shuttle-Mir flights and the Bion/Cosmos program, along with data from Spacelab, will help in planning for effective use of the space station for scientific research.

In summary, the Board, the CMGR, and the CSBM strongly recommend that until the space station becomes operational, Spacelab continue to be used for scientific

research in order to (1) maintain a forefront research program that is capable of contributing to design of a space station that can be used productively for life and microgravity sciences research; (2) maximize use of existing experiments, hardware, and technologies; (3) develop and test new hardware and technologies for their use on the space station; (4) facilitate interactions within the broader research community; and (5) provide an in-flight test facility to characterize and evaluate samples and subjects during flight and prior to reentry after long-duration missions.

As discussions and planning for the space station program evolve, the Board and its committees expect to continue to provide advice on maximizing the scientific return from the space station program and on the role of Spacelab in this regard. We look forward to continuing this dialogue as the space station program continues to evolve.

NOTES

1 Presentations by Daniel S. Goldin, NASA Administrator, Bryan O'Connor, Acting Space Station Program Director, Harry C. Holloway, Associate Administrator of the Office of Life and Microgravity Sciences and Applications, Joan Vernikos, Director, Division of Biomedical Sciences and Applications, and Robert Rhome, Director of the Microgravity Science and Applications Division, to a joint committee meeting of the Space Studies Board's Committee on Space Biology and Medicine and Committee on Microgravity Research, November 4, 1993.

2 Space Science Board Assessment of the Scientific Value of a Space Station and letter to NASA Administrator James Beggs, September 9, 1983; Space Studies Board Position on Proposed Redesign of Space Station Freedom Program, March 14, 1991; and Space Studies Board Assessment of the Space Station Freedom Program, March 30, 1992. Space Studies Board letter to Joseph Alexander, Assistant Associate Administrator for the Office of Space Science and Applications, NASA Headquarters, December 12, 1990.

3 Space Studies Board testimony to the U.S. Senate Subcommittee on VA, HUD, and Independent Agencies, Committee on Appropriations, May 1, 1987, and Space Studies Board testimony to the U.S. Senate Committee on Science, Space, and Technology, May 10, 1990. Space Studies Board testimony to U.S. House of Representatives Task Force on Defense, Foreign Policy, and Space, Committee on the Budget, April 28, 1992.

4 Space Studies Board, A Strategy for Space Biology and Medical Science for the 1980s and 1990s, National Academy Press, Washington, D.C., 1987; Assessment of Programs in Space Biology and Medicine 1991, 1991; Toward a Microgravity Research Strategy, 1992; and A Strategy for Microgravity Research for the 1990s, in preparation.

5 Committee on Space Biology and Medicine letter to Harry C. Holloway, Associate

Administrator, Office of Life and Microgravity Sciences and Applications, NASA Headquarters, April 26, 1993.

6 Final Report to the President, Advisory Committee on the Redesign of the Space Station, June 10, 1993, The President's Advisory Committee on the Redesign of the Space Station.

7 Vladimir Titov, Soviet Cosmonaut, Long-duration Experience on Mir, presentation to the Committee on Space Biology and Medicine, February 14, 1990; Marcia Smith, Congressional Research Service, The Soviet Manned Space Program-Overview, presentation to the Committee on Space Biology and Medicine, May 13, 1991; Samuel Keller, NASA Headquarters, U.S./USSR Cooperative Activities-Status, May 14, 1991; Frank Sulzman, NASA Headquarters, Description of Soviet Space Station Mir: Size, Resources, Utilization Issues, May 14, 1991; Richard Obermann, U.S. House of Representatives, Committee on Science, Space, and Technology, Feasibility of U.S./USSR Mir for Cooperative Life Sciences Research, discussion with Committee on Space Biology and Medicine, February 13, 1992; Frank Sulzman, NASA Headquarters, Research Potential and Issues Associated with U.S. Use of Mir-Options, Advantages, and Disadvantages, presentation to the Committee on Space Biology and Medicine, May 14, 1992; Frank Sulzman, NASA Headquarters Update-U.S./USSR Cooperation, Status of Facilities, presentation to the Committee on Space Biology and Medicine, September 29, 1992; Joseph Alexander, NASA Headquarters, Potential U.S./USSR Cooperative Life Sciences Research Using Shuttle-Mir, January 27, 1993; Joan Vernikos, NASA Headquarters, Update on Planning for Shuttle-Mir Missions, April 29, 1993; and Joan Vernikos, NASA Headquarters, Optimizing the Scientific Benefits of the U.S./Russian Shuttle-Mir Program, November 5, 1993.