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National Aeronautics and Space Administration's
Planned Use of Information Technology

for The Space Station

Statement of
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Before the Subcommittee on HUD-
Independent Agencies,
Committee on Appropriations
U.S. Senate

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Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to comment on the National Aeronautics and Space Administration's (NASA's) plans for developing information technology for the Space Station. At the request of the House Committee on Science, Space, and Technology, we recently issued an interim report[1] on this subject and other space programs. In our report we have identified several issues related to the development of information technology for the station that we believe NASA and the Congress might want to consider.

The Space Station is one of the most challenging projects that NASA has ever undertaken. The agency is pursuing an aggressive plan to build the station, with "man-tended" capabilities now planned for 1995. A major issue facing NASA is the need to make a substantial early investment in order to develop extensive advanced information technology to run the station efficiently and effectively over its life versus the need to hold down initial development costs. A second issue relates to the schedule that NASA is pursuing to design and build the station's physical structure as compared to its slow pace of developing information technology, particularly automation. Concerns expressed by the scientific community and NASA representatives lead us to raise

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[1]Space Operations: NASA's Use of Information Technology, GAO/IMTEC-87-20, April 17, 1987.

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questions about the development of information technology for the
Space Station and the effect that this development could have on
the station's operating costs and capabilities.

NASA's use of information technology is significant,
accounting for about 10 per cent of the agency's $7.8 billion
fiscal year 1986 budget. From 1987 through 1991, NASA plans to
spend about $4.1 billion on new information technology projects,
with about $177 million, or 4.3 percent, supporting the Space
Station. NASA has developed, and the Congress is now considering,
changes to the Space Station program. These include revised cost
estimates, a phased deployment of capabilities (for example, the
delay in deploying the U.S. coorbiting platform and the servicing
facility), and an extended timeframe for the detailed design,
development, and operation of the station. Once these cost and
timing issues are resolved, the adequacy of NASA's plans for
developing Space Station information technology may take on even
greater importance than before, especially if previously planned
initial capabilities are delayed and NASA decides to allocate most
of the available funding to the station's physical design and
development.

PROGRAMS TO DEVELOP INFORMATION
TECHNOLOGY FOR THE STATION

NASA documents and studies by the scientific community show
that the successful development of information technology for the

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station, including the use of advanced automation and robotics,[2] and high-quality software will play key roles in achieving specific objectives and program effectiveness and in controlling life-cycle costs.

Advanced automation, if developed and implemented properly, can improve both ground and on-orbit operations. It can also increase computer systems' abilities to support innovation, allow the Space Station to operate autonomously, lower operating costs, and increase crew productivity. For example, on the basis of the Skylab and Shuttle experiences, individual crew members have about 10 productive hours per mission day. Of this, approximately 4 hours per day or 40 percent of productive time are used to verify and calibrate on-board instrument readings. NASA studies show that these activities could, in large part, be accomplished by automation.

The use of robotics may reduce risks to humans in performing hazardous tasks associated with space flight. Additionally, the use of high-quality software is important to controlling software maintenance costs and will facilitate the eventual transfer of ground-based functions to the station.

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[2]Advanced automation and robotics can be defined as the use of machines, either computers or robots or both, to perform pre-designated tasks largely without human intervention.

NASA's Automation and Robotics Technology Development Program, the Space Station Information System, and the Technical and Management Information System are three key programs currently under way to develop and implement advanced automation and high-quality software for the station. The automation technology program focuses on development of the technology base for advanced automation and robotics, while the Space Station Information System and Technical and Management Information System projects deal mostly with system design and implementation, including the design of high-quality software.

CONCERNS ABOUT AUTOMATION AND SOFTWARE

Concerns have been expressed by the scientific community and NASA representatives that the agency's automation plans and advanced information technology development efforts were not progressing as quickly as the efforts to design and build the station. As a result, the station's initial capabilities may include only limited advanced automation, making initial operations expensive and inefficient. Further, studies we reviewed showed that if NASA does not design the station so that it can incorporate advanced automation over time, subsequent rebuilding of information systems to include more automated designs could be extremely costly.

One organization that has expressed concern about the development of automation and robotics for the station is the Advanced Technology Advisory Committee. This committee was created by law[3] to identify specific Space Station systems that advance the state-of-the-art in automation and are not in use in existing spacecraft. The committee noted in its first report issued in 1985[4] that, although the station would not initially have significant on-board automation, it was critical that the station's design be flexible enough to accommodate future automation enhancements. The advisory committee reported, however, that much complex research and development of several key advanced technologies had to be addressed long before they could be used for either the station's initial or later configurations.

A recent advisory committee progress report[5] stated that, although NASA's planned use of robotics was promising, planning for some kinds of advanced automation technology was not progressing quickly enough to significantly influence station design. To underscore its concern, the committee noted that the results of the automation work to date had not been incorporated into design control documents that NASA would include in the requests for proposals for the detailed design and development contracts for the

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[3]Public Law 98-371 (98 Stat. 1227), July 18, 1984.

[4]Advancing Automation and Robotics Technology for the Space Station and for the U.S. Economy, NASA-TM87566, March 1985.

[5]Advancing Automation and Robotics Technology for the Space Station and for the U.S. Economy-Progress Report 3, NASA-TM89190, October 1986.

station. The advisory committee believed that the primary inhibitor of automation planning for the station was NASA's constraint to design the station to an initial target cost, without giving balanced consideration to operational (life-cycle) costs.

The advisory committee recommended that NASA (1) set aside funds for advanced automation or (2) consider both the estimated life-cycle costs and the initial development costs when evaluating the proposals submitted by contractors competing for the station's detailed design and development contracts. Without NASA's commitment to one of these alternatives, the committee reported that it expected to see limited advanced automation on the initial station; an excessively costly process to incorporate evolutionary growth in advanced automation; a station that would be expensive to operate with a large dependence on ground stations; and a station that could not support autonomous operations.

In responding to these concerns, NASA stated that it would ensure that the final requests for proposals for the detailed design and development contracts addressed the importance of automation and robotics. The four draft requests for proposals issued by NASA for the detailed design and development contracts tend to support the advisory committee's basis for concern about the design control documents. Specifically, two key automation requirements documents that had been developed earlier in the Space Station's program were not properly updated or, in three of the

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four proposals, were not included as documents that would be binding on the contractors who will do the detailed design of the Space Station's information system architecture. These design control documents are important because they addressed requirements for the growth and incorporation of expert systems[6] in the Space Station. At the time we prepared our April 17 report, NASA had not issued the final proposal requests. We recently learned that these requests were issued on April 24; however, we have not yet been able to determine if NASA has changed the requests to incorporate the advisory committee's recommendations.

The advisory committee has not been alone in expressing concerns about information technology for the station. For example, a 1985 Office of Technology Assessment study[7] conducted for the Congress expressed concern that, unless NASA funds automation research and development at levels substantially greater than currently projected levels, the Space Station would not include significant automation and its eventual evolution beyond initial capabilities would be hampered. More recently, NASA officials expressed concerns to us that the tools and procedures that will guide contractors in developing high-quality software for the station may not be ready when needed.

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[6]An expert system is a computer program that performs at the level of a human expert in solving specific problems.

[7]Automation and Robotics for the Space Station: Phase B Considerations, An OTA Staff Paper, 1985.

NASA has taken some action to address these concerns, including appointing a Division Director in the Office of Space Station with direct responsibility for automation and robotics. In 1985 the agency intensified its program for research and development of the use of automation and robotics technology. Funding for this program has increased from $4.9 million in fiscal year 1985 to $18.2 million in fiscal year 1987, with $25.4 million requested for 1988. This amount is, however, about $55 million less than the fiscal year 1988 level recommended by the Automation and Robotics Panel,[8] to provide a minimally effective automation and robotics technology program for the station.

NASA will soon be making important trade-off decisions that could significantly affect the cost and operational capabilities of the station, possibly for its estimated life span of 30 years. In light of the large investment that the agency is planning, there are several key questions that we believe NASA and the Congress might want to consider, including:

-- If NASA remains committed to its cost and timeframe goals for designing and developing the station, will it have to use a "minimal risk approach," which would involve, in large part, the use of existing technologies for most station systems?

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[8]Automation and Robotics for the National Space Program, Automation and Robotics Panel, Administered by the University of California, California Space Institute, Report CSI/85-01, February 25, 1985.

-- If a minimal risk approach is taken, will this force NASA to rely primarily on proven, existing information technology that may be seriously outdated by the time the station is placed in operation?

-- Will NASA be incurring the risk of building a less effective station with excessive operating costs and extensive dependence on ground stations for its long life?

Given NASA's revised plans for a phased deployment program, the importance of the agency's development of information technology for the Space Station takes on added significance and warrants close attention. NASA may now have a "window of opportunity" that could allow it to bring more advanced information technology into the final design process for the station. This could lead to a more economic operation of the station over its proposed life and permit incorporation of automation and robotics capabilities for more autonomous operations and reduced dependency on ground support.

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That concludes my testimony Mr. Chairman. I will be happy to answer any questions you or Members of the Subcommittee may have at this time.