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Automation and Robotics For the Space Station: The Influence of the Advanced Technology Advisory Committee

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AUTOMATION AND ROBOTICS FOR THE SPACE STATION:
THE INFLUENCE OF THE ADVANCED TECHNOLOGY
ADVISORY COMMITTEE

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Abstract

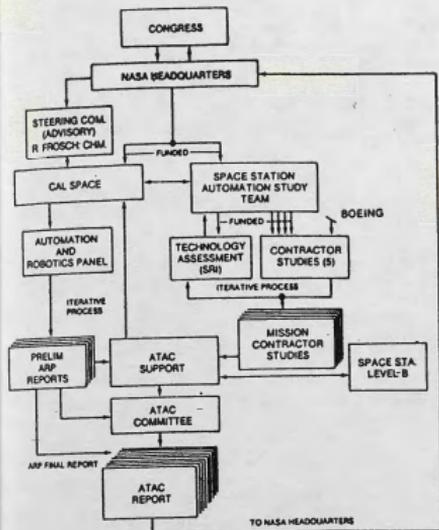
The creation of the Advanced Technology Advisory Committee (ATAC) was mandated by Congress in 1984 for the purpose of identifying specific systems of the Space Station which would advance automation and robotics technologies. The initial ATAC report, released in 1985, proposed goals for automation and robotics applications for the initial and evolutionary space stations, as well as recommendations for implementation strategies of these goals. These recommendations have been accepted as policy by NASA. Since that initial report, ATAC has continued to release semiannual reports on Space Station's progress in automation and robotics, including areas of concern and further recommendations. This paper will review the history of ATAC and its future. Previously ATAC has been an external force to push the use of automation and robotics on the Space Station. ATAC also promotes the development of state-of-the-art technology in automation and robotics, which is crucial due to the lack of off-the-shelf items. Now that we are approaching the final design and development stages of the Station, actual implementation on the initial Station and provisions for future incorporation of automation and robotics on the evolutionary Station are critical. Where ATAC goes from here and what possible impacts it will have, are discussed.

Text

The Advanced Technology Advisory Committee (ATAC) was formed as a result of strong interest on the part of the United States Congress that new technology be developed by the Space Station Program in the emerging field of Automation and Robotics (A&R), and that this new and evolving technology spin off to terrestrial applications in the American economy. Conference Report 98-867 of the House of Representatives, 98th Congress of the United States, was submitted as documentation of agreements by the two houses concerning funding for fiscal year 1985 (House of Representatives Bill S713). Amendment No. 39 establishes the Advanced Technology Program. The congressional desires were stated in the documented words of the mandate as follows:

"The ATAC is mandated to identify specific Space Station systems which advance technologies not in use in current spacecraft. Additionally, it is the intention of Congress that automation and robotics implementation will not only promote the efficiency of the Space Station, but by enhancing the technical and scientific base, will also lead to more productive terrestrial applications."

NASA Headquarters initially interacted with Congress and their staffers to implement the intent of the mandate. The figure below traces the process that took place prior to delivery of the first ATAC Report to Congress April 1, 1985.



A NASA advisory committee assisted NASA Headquarters in setting the process in motion by working with the California Space Institute (CAL Space) and a newly formed NASA Space Station Automation Study Team. The primary purpose of these parallel activities was to establish for reference the present state of the art for the fastly emerging and very promising field of Automation and Robotics. To achieve this objective, CAL Space formulated the Automation and Robotics Panel (APR) which called upon the A&R expertise of academia and industry to document their perception of the A&R state of the art in 1985. As indicated in the figure, several contracted studies with industry were initiated in parallel to establish the base reference for ensuring ATAC assessments. Stanford Research Institute (SRI) was funded to perform a technology assessment. Boeing's interest in this activity led them to perform and input the results of their own study into the process of

supporting the ATAC objectives. All NASA Centers provided strong support to the resultant iterative process. The NASA Johnson Space Center (JSC) Space Station Level B organization managed by Mr. Neil Hutchinson provided valuable day-by-day technical and administrative support to the entire process which by this time had drawn a great amount of interest with many experts and organizations involved.

The ATAC membership was drawn from each NASA Center, Jet Propulsion Laboratory and NASA Headquarters under the chairmanship of Mr. Aaron Cohen, Director for Research and Engineering, NASA--JSC. With the state of the art for the field of A&R being documented by the Nation's recognized experts, the ATAC held their initial meetings to discuss how they would conduct their mandated mission. The ATAC mission statement is to:

"Independently review the conduct of the Space Station Program and assess the integration of A&R technology. Based on assessments, develop recommendations, review the recommendations with consideration for safety, reliability, and cost effectiveness. Report assessments and recommendations twice annually to Congress."

It became exceedingly evident that while ATAC's mission was now clearly stated, the achievement of this mission could not be easily accomplished if the maximum benefit to the Nation was to be the result. The bottom line was that a group of NASA managers, who became the ATAC membership, were given the mission to assess how well a NASA organization (the Space Station Program) was planning and implementing the integration of Automation and Robotics technology into their design requirements and specifications. As we will see, the ATAC has been able to "walk this fine line" successfully because of the procedures ATAC has followed from the start and because of NASA's interest in implementing the intent of the Congressional mandate. Open and regular communications between those assessing, i.e., ATAC, and those performing, i.e., Space Station Program, proved to be the key in achieving success even though all ATAC Reports certainly were not

positive. However, with the effort put into exercising open communications the ATAC was able to do its job and NASA could clarify its own position about what it would (or would not) do relative to each ATAC recommendation. No surprises and a clear understanding of each ATAC recommendation and assessment has to date led to success. This, plus the strong support of the process by not only the Space Station Associate Administrator, Mr. Andrew Stofan, and Program Director, Mr. Thomas Moser, but the NASA Administrator, Dr. James Fletcher helped ATAC achieve its goals. With this process and management support maximum benefit will result and the intent of the Congressional mandate will be met. ATAC provides an assessment report to Congress every 6 months to chart progress of the Space Station activities and ATAC's assessments relative to integration of A&R. The nature of ATAC has changed with changes in the program phase of the Space Station Project. Initially ATAC reported assessments of what would be needed and based on the ARP Report and contractor studies what would be available. Following completion of the Space Station System Definition Studies and as the hardware phase (C/D) began, ATAC's assessment still addressed what they felt was needed, but now instead of discussing what was available, the reports assessed the suitability of what was being proposed. The present ATAC membership is: Robert R. Nunamaker, Chairman, Director for Space, Langley Research Center; Henry H. Plotkin, Assistant Director for Development Projects, Goddard Space Flight Center; William C. Bradford, Director of the Information and Electronic Systems Laboratory, Marshall Space Flight Center; Jon D. Erickson, Assistant Chief for Automation and Robotics, Lyndon B. Johnson Space Center; J. Stuart Fordyce, Director of Aerospace Technology, Lewis Research Center; Lee B. Holcomb, Director of Information Sciences and Human Factors Division, NASA Headquarters; Henry Lum, Chief of Information Sciences Office, Ames Research Center; Walter T. Murphy, Deputy Director of Engineering Development, Kennedy Space Center; Giulio Varsi, Manager of Automation and Robotics Office, Jet Propulsion Laboratory; Carl Solloway, Automation and Robotics Manager, Strategic Programs and Plans Division, Office of Space Station, NASA Headquarters.

The ATAC recommendations as shown below were documented in ATAC Report No. 1 and traced through Report No. 5 (September 1987) assessing progress.

1. A&R should be a significant element of the Space Station Program.
2. The initial Space Station should utilize significant elements of A&R technology.
3. The initial Space Station should utilize significant elements of A&R technology.
4. Criteria for the incorporation of A&R technology should be developed and promulgated.
5. Verification of the performance of automated equipment should be stressed, including terrestrial and space demonstrations to validate technology for Space Station use.
6. Maximum use should be made of technology developed for industry and government.
7. Automation should be used to enhance NASA's management capability.
8. NASA should provide the measures and assessments to verify the inclusion of A&R in the Space Station.
9. The initial Space Station should utilize as much automation and robotics technology as time and resources permit.
10. An evolutionary station should achieve, in stages, a very high level of advanced automation.
11. An aggressive program of long-range technology advancement should be pursued, recognizing areas in which NASA must lead, provide leverage for, or exploit developments.
12. A vigorous program of technology transfer to U.S. industries and research and development communities should be pursued.
13. Satellites and their payloads accessible from the Space Station should be designed, as far as possible, to be serviced and repaired by robots.

The implementation of the ATAC process to date has brought forth an understanding of several key factors that

must be addressed when recommending integration of A&R requirements. And it is these same factors which must be considered before the Space Station supports or does not support (with specific reasons) the ATAC recommendations. These key factors are: (1) A&R is a new field promising great benefits; however, great missions of the past have not been built on promises; (2) commitment and cost are up front, benefits are downstream for technical performance and cost; (3) recommendations will not be implemented unless confidence can be developed, and this can only be done by demonstration and testing; and (4) A&R is essential for the evolutionary station, but also would make the baseline station more productive. The Space Station program managers know for certain they have a very constrained development budget and therefore it would be natural to dedicate all moneys and energies to make the initial Space Station complex operational and not pay for the "niceties" that primarily provide benefit downstream beyond the baseline configuration. However, A&R is essential for the evolutionary aspects and objectives of the Space Station, so moneys, energies, and schedule time must be dedicated to testing and demonstrations that "prove their value" before Space Station managers integrate A&R designs into the Space Station system to evolve and improve performance.

Therefore, in conclusion, the ATAC has developed a modus operandi that has provided it with the capability to successfully achieve the 1985 Congressional mandate. ATAC recently completed Progress Report No. 5 as the Space Station Program moves into its C/D (hardware development/operational) phase. ATAC will maintain a certain flexibility to change with the changing characteristics of the Space Station program phases to ensure successful achievement of the intent of the mandate. However, the ATAC experience to date has established that while there is intent, the "proverbial shelf" that all good program managers use to acquire as many designs for their spacecraft as possible, is sparse with A&R systems. Therefore, there is a real challenge to the A&R community to design, develop, and demonstrate A&R systems/subsystems that can be considered for integration into the selected contractors proposed

designs. Needless to say the timing is severe. ATAC will continue to push for A&R integration and they will continue to receive NASA upper management support because of the important benefits A&R systems will provide to the evolutionary Space Station, but the A&R community must work expeditiously to move innovative ideas from the laboratory to the system designer's "shelf."