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Thirtieth Space Congress
Space Station Freedom and the impact of its
International Aspects

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ABSTRACT

In the mid-1980s, the timeframe that the Space Station Freedom Program was born, it was believed that a new dawn of international cooperative relationships for all future, large-scale manned space initiatives was also born. The Space Station Freedom would be the first such program that would characterize international partnerships where intricate and highly dependent relationships were the norm. Programs in the next decade and of the 21st century could be expected to be multi-year, multi-billion dollars and multi-national. The advantages of multiple nations cooperating toward a common goal are clear in terms of the economic realities of sharing in the high costs of research and technology programs, particularly the cost of manned space endeavors. The opportunity for nations to contribute in areas of their specific strengths would aid in pushing to the edge of technology. But there are some fundamental political and management challenges that programs such as the Space Station and future ones of this magnitude will face. Unless these challenges are understood and met head on, the success of them is uncertain.

PAST INTERNATIONAL COOPERATIVE SPACE ENDEAVORS

International participation in space endeavors is not new. There have been numerous cooperative scientific programs between NASA and a large number of international organizations. Historically, these arrangements have been characterized by independent contributions of specific hardware (instruments or infrastructure) which are integrated into a single satellite or payload under the overall management and control of NASA. As the space programs of other nations have matured, NASA has also contributed hardware or services to programs managed by the space agencies of other countries. These programs shared common elements: each participant could plan and manage their activity relatively independently as long as agreed-to interface requirements, program milestones and overall schedules were met. But as the nature of these programs has evolved in scope, complexity, and cost the relationship among the players has begun to evolve from joint participation towards true partnerships in a relatively high stakes game.

Spacelab and the Remote Manipulator System are often cited as the first evolutionary step in international manned space programs. These programs do represent, for NASA, a major "sea change" in cooperation with an international entity (i.e., the European Space Agency and the Canadian Space Agency). NASA, however, was still clearly the dominant "partner," establishing the rules by which the junior partners could play. In these programs, NASA still maintained and demonstrated the U.S. space leadership role.

SPACE STATION FREEDOM "PARTNERSHIP"

With the initiation of the Space Station Freedom Program a fundamental difference from previous international space programs was introduced. From its inception, the Space Station Freedom Program was designed to be a partnership between nations where each participating government committed to carry the program through to completion. This commitment was formalized through Intergovernment Agreements (IGA's) executed on the part of the United States by the Secretary of State. In addition, Memoranda of Understanding (MOU's) were signed by the respective space agencies of each signatory nation. Thus a fundamental commitment was made both at the political level as well as the implementing level for this program.

The strength of this fundamental commitment has been "put to the test" several times in the life of the Space Station Freedom, and the results of the latest Clinton Administration pledge to honor the international partnership and commitments in the midst of major redesign are yet to be determined. In 1991, when the U.S. Congress came very close to canceling the Space Station Freedom Program, the three Partners, Japan, Canada, and the Europeans, issued a Joint Communique stating a "disbelief that the U.S.A. would now consider withdrawing from such an important international venture thereby effectively terminating the program." The hurdle of 1991 was tackled and the "partnership" was able to recover with the commitments in tact. This hurdle of 1993 appears to be even more of a challenge. The effort to "save billions" by redesigning the Station was directed by President Clinton. The impacts on the International Partners, although yet to be determined, have certainly caused the Partners to question the value of a U.S. "commitment."

Beyond the requirement of this fundamental national commitment, the evolution to an international space partnership relationship requires rethinking the ground rules by which such programs will be managed. The fact that other nations now have more to offer based on their growing maturity in the space business makes them more capable partners who are also less willing to simply sign-up under NASA dictates. By definition, a partnership involves close cooperation between parties having specified and joint rights and responsibilities. While it is easy to understand and define specific and individual responsibilities, the difficulty arises in defining and reaching agreement over the specific and joint rights

shared by the partners. This has been particularly difficult for NASA which comes from a tradition of "going it alone" as opposed to the European Space Agency which from its inception was organized around the concept of a multinational partnership where each partner's rights, obligations, and responsibilities were negotiated and agreed to "up front". The "going it alone" attitude seems to extend beyond a NASA tradition -- if political players have the power to rethink priorities to the point of impacting foreign commitments, a "partnership" will never truly be developed in the future space endeavors.

"PARTNERSHIP" CHALLENGES

The Space Station Freedom is unique when compared to past manned space flight endeavors but it has characteristics which will likely be shared by all future international manned endeavors.

COMMON ATTRIBUTES OF INTERNATIONAL MANNED PROGRAMS

- o Satisfies scientific, economic, and political objectives
- o Involves a large number of U.S. and foreign contractors and government agencies
- o Requires resources in the multibillion dollar range
- o Extended time periods in excess of ten years
- o Develops complex technology, sometimes reaching beyond the state of the art
- o Utilizes large force of scientists, engineers, technicians, and administrative personnel
- o Requires construction of extensive, expensive, and highly specialized facilities located across the world
- o Obtains direct and constant Executive and Congressional scrutiny (similar oversight in partners countries) throughout the life of the program

(TABLE 1)

For such partnership to survive, each partner must be sensitive to the variety of pressures and constraints acting upon the individual partners. Accommodations, both technical and political, must be found which will allow the partnership to be maintained. Several of these attributes may also be recognized as risks -- such as multi-billion-dollar price tag and the program life time in excess of ten years.

Political Challenges

A 1988 National Academies of Sciences and Engineering report stated that "partnerships with other nations and organizations can serve to demonstrate leadership, to forge productive relationships and to broaden the range of available opportunities, but only if international commitments are made carefully and honored fully...and be supported at the highest possible levels in the participating governments, with as much breadth as is feasible."

The political challenges that future partnerships may face seem to have all been experienced in the life of the Space Station Freedom Program. The political challenge of maintaining the original U.S. commitment from President Reagan in 1984 has taken a great deal of effort and the realities of 1993 indicate that the challenge will not be won easily. The White House has been occupied by two Presidents since Reagan and national priorities continue to change with every new Congress. No longer can the mere "excitement" of space exploration be the basis for maintaining commitment to manned space initiatives. For such programs to maintain a broad-based constituency over extended periods of time, these programs must serve the national interest, primarily economic interests.

This broad-based commitment must, as was stated above, be supported at the highest possible levels of participating governments. A program must then be prepared to maintain political support throughout the life of the program and "educate" the new political players about the program, the commitments, and the requirements as they enter into the process. The U.S. budget process, which requires NASA to justify their programs every year, may be the biggest hurdle large-scale initiatives face in the U.S. This process essentially allows Congress to reevaluate their "commitment" every year. To manage a program under this process is as challenging as it is inefficient when the commitment of a new Congress or an incoming Administration waivers, as it has in the Space Station Program. Each year, any individual has the opportunity to challenge whatever has previously been approved. The effort to regain and maintain political support has consumed a great deal of time and resources.

The broader the base of the original commitment, the easier it will be to maintain this support. The activities of the U.S. Space Station Freedom Program literally spread across 37 of the U.S. states. But given the diverse expectations concerning the Space Station and the "downscaling" due to budgetary constraints, not all expectations can be met with the initial capability. This has created a base of non-supporters.

The essence of a "partnership" can play a key role in a changing environment as well. A commitment made with an international entity is not made lightly and is not broken lightly. When one partner faces a threat that could impact another partner, politicians often respond to an international concern when they might have otherwise allowed the priority to slip lower. Although

the international aspect of the Space Station Freedom has NOT deterred the Congress or the President from directing major "restructuring" changes and the current "redesign" exercise, they have always stated that the U.S. will "maintain our international commitments." Although the impact can never be measured, the international commitment may have prevented out-right cancellation of the Program in the face of the U.S. priority shifts.

Programmatic Challenges

Beyond this fundamental challenge of obtaining and maintaining political commitment, large space initiative will face additional challenges.

The term "programmatic" has been used within the Space Station Freedom Program to incorporate all the non-technical activities - many of the requirements that exist because of the bureaucratic nature of the management of cooperative endeavors. The inter-relationship between the political, programmatic and technical considerations are very complex.

The essence of a "partnership" must be defined and agreed upon between partners at the outset of the program - not simply defining 'who is responsible for what' in the technical sense, but the definition and establishment of the ground rules for the management of the program. The top-level agreements and understandings of the management structure proved to be an enormous effort for the Space Station Freedom Program. It was January 1984 when President Reagan announced his commitment for a space station and extended the invitation to other countries to participate. It was a year before Canada, Japan and Europe accepted the invitation "in principle" and it was the Fall of 1988 before the IGA's and MOU's were signed. The fact that four years were required to achieve this initial agreement exemplifies the challenges faced.

Other programmatic concerns within an international endeavor are the laws of the countries involved. Two very specific challenges that are and will be faced in these big-ticket space programs are the headline issues of "Technology Transfer" and "Buy American/European/Japanese" laws that most countries have. There is a delicate balance between the positive aspects of a partnership and the potential to "give too much away" in terms of new technology or potential profitable business. It is critical that the "programmatic" policy is developed in the earliest stages of a joint program to avoid upsetting the balance with either the political and technical challenges. The technical development should not be side-tracked when programmatic issues must be resolved or revisited.

A partnership attitude and trust must be developed between all players. For the good of the program as a whole, it is important that the programmatic status of each partner's responsibilities of

the program is shared; i.e. the political or budgetary threats, issues within contractors, material availability, schedule delays. It is a challenge for each partner to know when an internal issue could effect the other partners and also when the other partners could have a positive approach to minimize a potential problem.

Technical Challenges

Although the expected management challenges of the future large-scale, manned space initiatives will be a major focus, a fundamental reason for establishing partnerships is to pool the technical resources and utilize the varied strengths of all partners in an effort to push the state of the art. A partnership will have been formed to approach a basic technical challenge. The technical immaturity of a space-related development goal introduces obstacles that will require a strong yet flexible management approach in order to progress. Development programs are evolving programs. The importance of establishing baseline is as important as establishing the means in which to change a baseline.

In the Memorandums of Understanding, each partner serves as a full member of the Space Station Control Board (SSCB). All partners have the opportunity to assess all design changes and submit impacts to the Board. The "partnership" is maintained by the programmatic requirement that ALL impacts must be addressed with recommendations to the SSCB chairman. Compromises often must be made at the Board.

An example of a recent design change and its unanticipated impact to the International Partner (specifically the European Space Agency, ESA) follows. The initial impact appeared to be a negative one on the partners, but at the conclusion of the assessment and solution proposal, the design change had positive effects in other ways.

A NASA technical decision was made to change to a "decentralized" avionics air cooling system. This decision resulted in an overall weight savings to the U.S. Laboratory at launch, additional savings in rack volume, and saving in the power usage -- all considered to be critical improvements to the development program. The central avionics air cooling ducting was deleted, thereby forcing each payload and core systems rack to contain its own fan-forced cooling and rack controller package ("rack essential package"). Prior to this design change, NASA and the Partners had signed an "International Standard Rack Agreement". By changing this standard rack configuration, the program was forced to reassess the desirability of a standard rack and the impact to the Partners to accept the design changes in their racks.

Through a series of teleconferences and face-to-face technical meetings, it was decided that it was in the best interest of the whole program to maintain a common standard rack. In order to minimize the design (and cost) impact of the decision to the

International Partners, NASA has agreed to provide to the Partners these "rack essential packages".

In addition, through these technical discussions, it became evident that decision to maintain common racks had the additional benefit of achieving a common fire detection and suppression system across all modules, therefore improving Space Station safety.

To implement the design improvements, the partners would have incurred significant additional costs arising from changing their industry technical baseline. The costs incurred by NASA for procurement of the "rack essential packages" would avoid the significant additional costs which NASA would otherwise incur for unique interfaces, unique integration and verification activities, unique maintenance and spares requirements and the extensive safety analysis of the fire detection and suppression systems.

SSFP APPROACH TO ACHIEVE TOTAL PROGRAM INTEGRATION

Joint Agreements

The Intergovernmental Agreement (between the U.S. Government and the Partner governments) and the individual Memorandums of Understanding (MOU) (between the government agencies -- NASA agreements with the European Space Agency (ESA), the Canadian Space Agency (CSA), and the National Space Agency of Japan (NASDA)) are the baselined, top-level agreements by which the partnerships are governed. The Intergovernmental Agreement provides the partnership objective and scope, international rights and obligations, and policy statements on such things as utilization, operations, liability, and exchange of data and goods. The MOU provides the basis for cooperation between NASA and its Partners with implementation details supporting the Intergovernmental Agreement policy statements.

Joint Management Mechanisms

There are also additional joint management mechanisms in the form of "living" documents (that are updated and grow with the program's maturity) and agreements that maintain programmatic, management and technical structure of the joint program.

Each MOU invokes a Joint Program Plan (JPP) to be signed by the program managers of the relevant agencies. This document addresses the Level I interrelationship between the NASA Program Director and the partner Level 1-equivalent manager. The JPP authorizes a Joint Management Plan (JMP) which defines the management process between the Level II SSFP Program Office and the respective partner Level II-equivalent program offices. This document defines all joint documentation, it defines all joint activities, and identifies organizational responsibilities associated with the Level II joint activities.

There is a significant level of importance to have early definition of these "programmatics" in order to insure that the technical community is aware of the unique requirements driven by a partnership relationship. NASA is accustomed to forging ahead and making decisions based on pure technical assessments. The more players, the more potential for unexpected impacts which we are committed to consider.

The Program Definition and Requirements Document (PDRD) contains requirements for space station flight element and ground systems hardware and software, and provides the technical basis for the overall conduct of Phase C/D. In order to assure a "partnership" relationship as opposed to one where NASA hands requirements to the international participants, a "Joint" PDRD (JPDRD) is maintained with each Partner. Each JPDRD addresses the applicability of EVERY requirement in the PDRD. All requirement changes that are brought to the Control Board (SSCB) must address the applicability to the JPDRD paragraphs. This ensures partner participation in all proposed design changes.

Additional joint management mechanisms take the form of meetings and reviews. The bilateral Joint Program Reviews (JPRs) are held between NASA Level II and each Partner twice a year. The JPRs serve as the highest level forum for discussion and resolution of matters that requires the direct attention of the respective program managers. These face-to-face meetings have proven to be very effective in maintaining the successful implementation of program development. The full contingent of NASA and its Partners have a multilateral Program Management Review on a quarterly basis.

On a technical level, Technical Interchange Meetings, multi-, or bi-lateral, are called when a need arises, and have been utilized very effectively and occur on a routine basis at the working-level environments.

Lines of Authority

As much as joint management and team work play a critical role in the development of the Space Station Freedom, clearly there must be a position that possesses the ability to make a final decision on issues where compromise was unobtainable. The importance of having an "honest broker" is evident. The Level II Deputy Director of the SSFP is the chairman of the SSCB and has the final vote concerning the Station technical baseline. But in his position, he is not only "brokering" between NASA and the IPs, but the Work Packages as well. This management system with an independent program office was set up deliberately, to obtain decisions that are the best for the program as a whole. The IPs benefit from this structure. Should a jointly-agreed-to solution not be achievable at Level II, an appeal avenue is possible via Level I. This appeal route has not been utilized to date.

CONCLUSIONS

The Space Station Freedom Program could represent the first of a potential wave of future space exploration international initiatives - for the near and far future. This program can represent how serious the U.S. is concerning international commitments.

This program does represent a transition for NASA as it deals with international partners on a more equitable basis than on previous cooperative programs. The technical success of these endeavors relies heavily on the establishment of the ground rules as early as possible in the program. The complexity of a program demands attention to the critical importance of working within those rules at all levels of the organizations. Close cooperation is not simply a desire, but a requirement at all phases of the program.

Each partner must recognize the complexities of the interrelationship between the political, programmatic and technical aspects of all programs and stand by the commitments established.