Structuring Future International Cooperation: Learning from the ISS

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Abstract

As the largest, most complex international scientific and technological co-operation ever undertaken the Space Station program offers numerous valuable lessons that can be applied in structuring future large-scale international co-operative space endeavors. This paper analyzes the functioning of the co-operation and the lessons learned, both as regards the way the program has been structured and the way in which it has operated to date. Based on practical experience the authors, all of whom have been professionally involved in the development and implementation of the SSF and ISS programs, have attempted to determine what elements of the co-operation warrant replication and what elements could be improved, in future cooperative space program programs.

The analysis includes topics such as management, operations, cost sharing, partnership expansion, etc. The original agreements that established co-operation on the then the Space Station Freedom (SSF), between the United States, Canada, Japan and ten European nations, members of the European Space Agency, were signed in September 1988. Renegotiated agreements, which brought Russia into the co-operation and established the International Space Station (ISS) program, were signed in January 1998. The first element of the ISS was launched in December 1998 and permanent occupancy of the complex started in December 2000. Barring problems, the fifth Expedition Crew will be in residence when the ISU Symposium takes place.

1. Background

When President Reagan took office, NASA promoted a space station to the Administration and, importantly, at the same began preliminary discussions with its Canadian and European Shuttle partners, and also with the Japanese. Following extensive programmatic, political and policy efforts by NASA, the President announced in his January 1984 State of the Union address that he was directing NASA to "develop a permanently manned space station and to do it within the decade" and simultaneously that NASA would "invite other countries to participate so we can strengthen peace, build prosperity and expand freedom for all who share our goals."

Although the space station was originally envisioned to be on-orbit to celebrate the 500th anniversary of Christopher Columbus' 1492 discovery of America, the first element of the International Space Station was not launched

until December 1998, and permanent occupancy of the complex was not initiated until December 2000. By that time, the station had evolved from a Cold War demonstration of US leadership and alliance solidarity and technological might, into an icon of post-Cold War cooperation with the new Russia. It is arguably the largest, most complex international scientific and technological cooperation ever undertaken.

The authors of this paper are individuals from the US, Canada and Europe who have been involved with the space station program from its beginning as a NASA proposal. They have seen first-hand the triumphs of international collaboration and technology success and they have also experienced the difficulties caused by international misunderstandings and miscommunications. In this paper, they attempt to extract some of the numerous valuable lessons that might be beneficially applied in structuring future large-scale international space endeavors.

2. The Partnership

In seeking partners for the space station program in the 1980's, the US began discussions with a rather small group of space-faring nations that had both the technical and financial capability to contribute substantially to the program. Canada had an excellent track record from the development of its Remote Manipulator System for the Space Shuttle as well as Canadian astronauts training in the US and flying on the Shuttle. The European Space Agency (ESA) had developed its human space flight experience through the SPACELAB modules that had flown on the Space Shuttle. Similar to Canada, a number of Europeans were in the astronaut corps and had flight experience. Japan was a slightly different case. It had chosen not to take a major role in the Space Shuttle and thus had not developed a human-rated facility, but had some experience in human space flight through its astronaut corps and flight of experiments on the Shuttle. The Soviet Union was never seriously considered as a partner at the inception of the program regardless of its capabilities.

President Reagan's announcement in January 1984 contained two decisions: that the US would build a permanently manned space station and, that it would invite the nation's friends and allies to join. The fact that US policy provided two distinct goals led to a very specific US approach to the international Partnership. The US would build what NASA called, in the early days, "a fully functional space station," and the non-US Partners would provide additions that would create "a more expansive international space station with even greater benefits and capabilities for all to use."

The Critical Path

Consistent with the above directives, international components were not to be on the critical path to completion. When the original space station Partnership was first being established, it was made clear that proposed contributions on the part of Canada, Europe and Japan should be aimed at enhancing the capability of the US-built station. This restriction was subsequently waived to allow Canada to contribute Canadarm2, which plays a critical role in station assembly.

Later when the Russians were being brought into the program, many attempts were made by the US Congress to ensure they were not on the critical path. However, the reality is that they were placed there. Their involvement has allowed earlier permanent human presence than might have been achieved and their operational experience has been invaluable. But, this critical path role also gave the Russians much leverage to drive a hard bargain and secure a senior seat at the table. And, the precedent having been established, further revisions in program structure and content have resulted in additional contributions from Europe and Japan that are critical to Station construction and operation.

The Station has thus matured into a "genuine partnership" in which each Partner is dependent on the performance of all other Partners for the program's implementation and operation. It is to be expected that if such large-scale partnerships are to be put together in the future, potential partners will expect that they be structured on this "genuine partnership" principle.

The Partners' Differing Interests

To all the Partners, the space station meant an opportunity to stimulate technology development, to do real microgravity science and to begin understanding the long-term impacts of the space environment on humans as a precursor to more aggressive exploration of the solar system. Beyond this was a myriad of political and economic motivations.

For the United States, the initial motivating factor in undertaking the space station was Cold War politics. But with the dissolution of the Soviet Union, there was an interest in the West to engage Russia across a broad range of issues, and to bring Russia into multilateral frameworks. Simultaneously, the financial aspects of the program changed. In 1993, the US space program was faced with budget reductions that threatened Space Station Freedom. The US Congress was not convinced of the value of the program and almost cancelled it. The substantial capabilities of Russia in human spaceflight, launch capacity

and space station operations were seen as a means of offsetting US costs while retaining the planned capabilities of the space station. The US finally needed the non-US Partners to take on critical items rather than enhancements. Thus, the role offered to Russia was substantially different from the role of the original Partners. At the same time that the US experienced this re-evaluation and the Partnership embarked on new negotiations of the agreements to incorporate Russia's participation in the program, other Partners reflected on their roles in the program.

Canada had originally seen the potential for an economic return-on-investment. In 1984, the House of Commons Estimates Committee voiced its concern that the government "will drag its feet and we will lose out on an opportunity that would appear to be a golden egg for Canada in high-technology and aerospace work." But in 1994, a newly elected Canadian government faced with having to take draconian measures to reduce the nation's deficit came to the brink of withdrawing from the Program.

A primary motivating factor for Europe was to use their involvement in the space station as a means to pursue a degree of autonomy in manned space activities and to further amortize their investment in the SPACELAB program. Europe had aspirations for independent manned access to space and embarked on development of the Hermes space plane. However, by the early 1990's political changes in two major space station contributors, France and Germany, caused questions to be asked about continuing in the program. Europe eventually abandoned development of both the Hermes space plane and the Man Tended Free Flyer laboratory (MTFF) cited in the station agreements. Involvement in the station thus became Europe's sole human space flight program.

Japan was interested in developing human space flight capabilities and independent access to space. Japan also placed a high political priority on conducting its space program with international cooperation. However, the Japanese were in a different position not having participated in the Space Shuttle program – there was a sense that Japan had missed the boat and wasn't going to let that happen this time around. But by the early 1990's, Japan too was starting to find itself in the same financial difficulties as the other Partners.

Russia's motivations to join the program are perhaps the most complex of all the Partners. Following the end of the Cold War, at the initiative of the first President Bush, the US and Russia began tentative cooperation in space activities. President Clinton took these first tentative steps a great deal further, following another redesign of the station in 1993. The station could bring

Russia into the "free world" and at the same time help the Partners with its years of experience in space. A three-phase International Space Station program was undertaken. Phase 1 would be the Shuttle-Mir program while the original space station Partners continued to build the ISS elements, Phase 2 would bring the ISS to permanent habitation capability; and Phase 3 would result in assembly complete with all Partners' elements. The Russians were justifiably proud of their achievements in space, but their economy was in the doldrums. One might postulate that a motivating factor for them was that joining the ISS program was the only way to keep their space program alive and their aerospace engineers employed.

International Agreement Structure

International participation is governed by an Intergovernmental Agreement (IGA) signed by all of the participating nations. The IGA records the political commitment of all the parties and the high level programmatic commitments and obligations. Under the IGA is a structure of four separate Memoranda of Understanding (MoUs), one between NASA and each of the Partner implementing agencies: the Canadian Space Agency, ESA, the Japanese Foreign Ministry acting for Japan's National Space Development Agency (NASDA), and Rosaviakosmos, the Russian Space Agency. The MoUs in turn allow for Implementing Arrangements, which can be multilateral or bilateral arrangements.

The original agreements covering international cooperation on the then-Space Station Freedom (SSF) were signed in September 1988. The Partners included the United States, Canada, Japan and ten European nations, members of the European Space Agency -- the circle of space-faring "friends" in the Cold War. In 1993, following the end of the Cold War and the demise of the Soviet Union, US President Clinton decided to shift the underlying Cold War rationale for the Space Station and convert the facility into a tangible demonstration of US-Russian cooperation in the post-Cold War world. All of the Partners agreed to invite Russia to join. The International Space Station (ISS) was established and the renegotiated agreements were signed, by all Partners, in January 1998.

3. Accepting that which cannot be changed

Partners' Individual Interests: The Nature of Politics and Partnerships

Long-term, expensive space infrastructure programs have an inherent characteristic that causes problems. Decisions to undertake them are political decisions made at the highest governmental levels, with concomitant claims of leadership, vision and legacy. From the point of decision, the program is

identified with the initiator – Kennedy and Apollo, Nixon and the Space Shuttle, Reagan and the space station. But the duration of these big programs transcends the terms of office of their owners.

It is absolutely necessary in constructing any cooperative program to recognize that each partner has national priorities that must be accommodated. An international partnership brings together willing partners seeking political and economic leverage on their investments. A successful partnership must satisfy the individual interests and needs of each. Thus, while compromise is necessary, it cannot go beyond a certain point – the point where any partner's individual national interest is jeopardized. As difficult as it is to accommodate separate national interests in a relatively short-term program, implementing a long-term program such as space station adds the complexity of priorities that change as national political landscapes change.

Despite cost and schedule problems, despite various threats to the survival of the program, and despite geopolitical changes that rocked the program's foundations, the space station has evolved to accommodate the changing interests and priorities of all of the Partners. It is tempting to wish that all these changes could have been anticipated and accommodated in the negotiation of the original international agreements governing the space station program. But the reality is that some of the national and global changes that have taken place since the early 1980's were probably beyond imagining.

That the Space Station has survived numerous changes in the political landscape in some 15 countries over 20 years is a tribute to the manner in which the program was put together and to the way in which it has been implemented. Each Partner's interests (albeit not necessarily the original interests!) have been respected, and all have stayed involved.

Peaceful Purposes: The Value of Constructive Ambiguity

In addition to dealing with each partner's individual economic and political needs, a partnership must find ways to accommodate policy differences among the partners. Some policies can be changed, but some can't. In the case of the space station, the Partners differed in their interpretations of what activities in space honored the commitment all had undertaken in the 1967 Outer Space Treaty to use space for "peaceful purposes." This exact meaning of this phrase had been debated among the space station Partner nations in different venues without resolution long before the space station negotiations.

In the SSF negotiations, the US Department of Defense insisted they be able to utilize the station ("to conduct national security activities on the US elements of the station without the approval or review of other nations"), consistent with the US interpretation of the term "peaceful purposes" which permits non-aggressive military activities in space. Canada, Europe and Japan, on the other hand, demanded the agreements to refer to "a civil space station for exclusively peaceful purposes" implying no military-sponsored activity whatsoever. The US negotiators knew that, because of the vested interest of the US Department of Defense, the US position was not going to be changed – even if it meant the dissolution of the international participation in the space station program. However, the other Partners felt strongly enough about the issue to pursue it and seek resolution in the context of the space station negotiations. Interestingly, the issue arose again in the ISS negotiations, with the Government of the Russian Federation adopting much the same position as the US.

The eventual solution in both negotiations was that each Partner would define "peaceful purposes," as related to the utilization of the elements it supplied, in its own manner. The importance of this principle can be demonstrated by the example of the laboratories supplied by Europe and Japan. Any US plans for utilization of these modules have to be approved by Europe or Japan, respectively, based on their own interpretation of peaceful purposes. This accommodation was not recorded in the original IGA or the later revision; rather it is memorialized in an exchange of "side letters" that were exchanged in conjunction with the IGA signing ceremonies.

The lesson learned from the space station negotiations (a lesson that runs counter to the experience and practice of scientists and engineers!) is that sometimes difficult topics need to be finessed with the use of less-than-precise language – language which is open to interpretation, or language which may require future negotiation, but language which allows the negotiators to get beyond an impasse. Such "constructive ambiguity" is not original to the space station agreement, but is a standard device used to bridge otherwise insurmountable divides in many negotiations. In the case of peaceful purposes, the use of this technique allowed the Partners to side-step the issue in a way acceptable to all, rather than tackling it head-on in what all knew would be protracted negotiations with implications far beyond the Space Station program.

Controlling Costs: Risks vs. Benefits

The story of NASA cost over-runs in the space station program is well known, as are the perturbations that these over-runs have caused within the US Executive Branch and the US Congress and the impacts that these perturbations

have caused among the Partners. The Partnership is currently grappling with a budget-driven unilateral decision by the US to reduce the capabilities of the ISS in ways that the non-US Partners claim are unacceptable.

The NASA space station experience has probably demonstrated that annual appropriations are not the answer for long-term complex and technology-intensive programs such as the space station; reductions in single year costs have been taken at the expense of overall program costs. However, the US has not been able to surmount this approach which is driven by political realities at the expense of programmatic ones. The European and Canadian multi-year appropriations processes have resulted in smaller cost growth in the overall program for these two Partners. Significantly, both the European and Canadian programs also started with more realistic budget estimates. The European approach supports activities long enough to have realistic estimates before entering the higher cost manufacturing phase. In the case of Canada, it was able to start earlier with reliable estimates because its contribution to the space station program, the mobile robotic system, had a strong industrial heritage from the Space Shuttle Canadarm program.

NASA has had a much more difficult problem. The complexity of its space station elements far exceeds that of anything the non-US Partners are providing. Furthermore, in 1994, NASA found it necessary to change the fundamental management structure of the program midstream from four separate prime contractors to a single prime, and to provide repeated minor and major management tweaks, all changes with cost and management implications for the non-US Partners. Furthermore, while it was politically the right thing to invite Russia into the Partnership and was seen at the time as a cost saving measure, the initiative came at a price in dollars for the United States (notwithstanding the benefit to the program in terms of long duration space flight operations experience and accelerating an early permanent human presence on orbit).

It would be simple to say that future large infrastructure projects conducted on an international basis must control costs better to increase the reliability of the partners' commitments to one another. But some of the station problems are unique to the program and others are endemic in the governance systems of the Partners involved. The reality is that in any future cooperation, the partners will probably have to assess the risks and the benefits anew and decide whether they are acceptable.

4. Learning from experience

Operations Cost Sharing

In order to carry out a long-term program, participants must commit not only to a significant development phase for their hardware contributions and the costs of launching and integration of this hardware, but also to an extended period of operation. In the case of the space station, Partners agreed not only to take responsibility for their own elements, but also to bear a portion of the so-called "Common System Operations Costs" (CSOC), costs related to operations that support all of the partners, including mission control and crew support. For SSF, NASA was providing virtually all of the common system operations. For the ISS, such operations are shared between the US and Russia. As a result, for the non-Russian portions of the station, the CSOC are initially borne by NASA, with a formula for Canada, Europe and Japan to reimburse NASA for these expenses. By way of example, Japan is required to provide 12.8% of the CSOC of the station. Once Russia was added to the program, negotiations began with the goal of integrating Russia's contributions into the existing operations cost approach. However, calculating values in an emerging market economy was not possible. The negotiators were unable to find an acceptable way to integrate Russia into the approach used by the existing partnership. Instead, it was agreed that the Russian contributions to the program infrastructure and other activities either provided or offset the Russian share of CSOC (the so-called "keep what you bring" concept), thus establishing a new operations cost sharing approach.

In any future large-scale cooperative program the apportionment of operations costs will be a matter of major importance, particularly as such programs can be expected to have a very long operational phase. A lesson learned from the US/European collaboration on SPACELAB was that it was important for a partner to have a vested interest in the continuing operations, not just the development. That led to the decision to share operations costs in the station program. However, this is tempered by the political desire to spend money in one's own country. As a result, although Canada, Europe and Japan have financial obligations for these costs, they have preferred to use barters (see below) to offset the costs by providing goods and services. In the case of Russia, its economic situation made it virtually impossible for Russia to make payments, and the emergence from a non-market economy made it hard to reach agreement on the costs for capabilities and services. Reaching agreement on how Russian-provided common system operations would be accounted for was critical.

Barters

Early in the negotiations leading to the establishment of the space station cooperation it was recognized that there would be a need for Partners to reimburse each other for various goods and services required for successful program implementation. In addition to CSOC (as discussed above), payment would be required for launch services, such as the launch of the European and Japanese modules to the station. Based on a realization that the political processes in the various Partner States would look unfavorably on the transfer of actual funds to cover such reimbursements, language was included noting the intent to minimize the exchange of funds, and permitting barters of goods and services.

As the program developed further, and financial obligations loomed nearer, specific barter arrangements were established. By way of example, the European Partner requires a Shuttle launch to deliver its Columbus laboratory module to the Station. NASA is providing this launch and associated services. In return, ESA is financing the development of two Station Nodes by European industry and is delivering them to NASA along with certain other hardware items. Europe's investment gets "spent" within European industry, NASA gets two station Nodes that it does not have to pay for from the space station budget and the Columbus laboratory gets launched, a win-win situation.

Central to the creation of such a network of arrangements is the agreement among all Partners that they are not established on a "dollar value versus dollar value" basis, but on a mutually acceptable perceived equality of the goods and services to be exchanged.

To date all barters related to the space station program have been established and carried out within the program itself. However, finding barter options within a program may not always be possible. Mechanisms therefore need to be found to allow for barters related to a program to take place outside of the program itself.

Consensus Management / First Among Equals

The current space station program has its origin in an initiative of the United States. As such the US had an acknowledged role as "leader" in the original Freedom program. In the current ISS program the situation is not quite so clear. While the IGA recognizes "the lead role of the United States for overall management and coordination," the nature of the Russian contributions and Russian's vast experience in human space flight before joining the ISS give them a particularly strong voice in the program.

Whether the program has a leader or leaders, there is an important principle that has been incorporated in its operation from day one. This is the principle of "consensus management" under which the Partners are equals when it comes to taking decisions with respect to the program and its implementation. The IGA and the MoUs all embody the principle that decisions will be taken on the basis of consensus and not on the basis "one man one vote" or of each Partner "voting its share".

Deadlock however, particularly during the operational phase of a program such as the station, would be unacceptable (e.g. it could result in "life threatening" situations for the crew). In the station program this situation is accounted for by recognizing the US leadership role and according it a "first among equals" status. NASA chairs key decision-making bodies. In the event that consensus cannot be achieved on a specific issue NASA, as Chair, has the right/obligation to take a decision. Other Partners, should they disagree with this decision, then have the right to appeal it at the next highest level in the decision hierarchy.

To date the consensus principle has operated very successfully and there have hardly been any instances where NASA has had to take a unilateral decision.

Bringing In New Partners

If there was one major oversight in the development of the original set of agreements that established the SSF cooperation it was that there was no defined mechanism for enlarging the partnership. Such an oversight is understandable however when looked at in terms of the political context of the time. President Reagan's invitation of January 1984 was directed to "friends and allies" of the US and was accepted by those possessing the necessary capabilities to meaningfully contribute to the program. The only other major space power possessing a wealth of manned space flight experience was the Soviet Union, which did not pass the "friends and allies" test of the time.

In addition, the nature of the program also made it difficult to easily accommodate new Partners. The ISS is a single, integrated facility. It has finite resources – especially volume, power, and crew time. As a result, a sharing concept was devised to take into account on-orbit elements contributed by the Partners and to allocate the resources among the Partners. Because of this construct, the ISS is not a program that additional countries can simply join.

Not surprisingly, when Russia was invited to join the partnership they analyzed the IGA and came up with a number of modifications they wanted to

see incorporated. Once the principle of revising the IGA was established other Partners came forward with suggested revisions (at both the IGA and MOU levels). At the MOU-level, significant renegotiation was required to account for the role of Russia in providing significant infrastructure to the program.

What was originally hoped to be a minimalist exercise then became a complete re-negotiation that lasted about as long as the original negotiation!

Non-Partner Participation

When the agreements were negotiated, non-Partner participation was envisaged, with additional players becoming "participants" and not "Partners." This distinction has to do with the legal structure of the program. Partners are signatories to the IGA, and the IGA is not open to additional signatories (with the exception of ESA Member States not currently part of the program). Therefore, other countries that participate must do so through the sponsorship of a Partner and through that Partner making available a share of its resources to the participant. However, the reality has come in ways not foreseen. Consequently, additional guidelines had to be developed by the Partners to cover these unanticipated situations. To date two countries have entered into Participant arrangements with NASA, Italy and Brazil.

The IGA and MoUs provide that Partners may at any time barter for, sell to one another, or enter into other arrangements for any portion of their utilization allocations, and are free to market the use of their allocations. However, ownership of equipment on the ISS by a non-Partner, or the transfer to a non-Partner of ownership of any flight element listed in the Annex to the IGA requires prior notification and concurrence of the Partners. Furthermore, use of the ISS by a non-Partner requires prior notification and timely consensus among the Partners.

Common procedures for the content of the notification and the mechanism for confirming concurrence or consensus in cases involving equipment ownership and utilization have been negotiated among the Partners and are in the final stages of approval by the Partners.

Visiting Crew

The IGA notes that each Partner has the right to provide qualified crew on an equitable basis, and requires a Code of Conduct for crew. The MoUs elaborate further on matters related to crew, but the focus is clearly on crew being provided as part of a Partner's role in operating and utilizing the ISS. This proved to be shortsighted. In the agreed sequence of flight rotations by the

Space Shuttle and the Soyuz to deliver crew and supplies, or to replace an on-orbit Soyuz with a new one due to limits on its design life, Russia has unallocated seats on the Soyuz. Russia chose to use its first extra seat to fly an American private citizen who paid for the trip to the ISS in April 2001. This situation served as the pathfinder for a range of issues that had not previously been dealt with, such as the degree of training required for such a visitor, what legal arrangements needed to be in place, what activities such visiting crew could carry out, and the impact on ISS safety and operations. Following a well-publicized dispute on when and under what conditions visiting crew should be allowed to fly to the ISS, the Partners reached consensus on the draft criteria for such cases and how to apply them to the first case. They also agreed to finalize the criteria and procedures for future cases. The group tasked with this was the ISS Multilateral Crew Operations Panel. The final outcome of their work was agreed "Principles Regarding Processes and Criteria for Selection, Assignment, Training and Certification of ISS (Expedition and Visiting) Crewmembers" which was released publicly in January 2002. These new procedures have been applied to the second non-Partner visiting crewmember, a citizen of South Africa, who flew on a Soyuz to the ISS in late April 2002.

Commercialization

Another unexpected evolution in the program relates to the matter of commercialization. The space station agreements fully expected and provided for commercial use of the station, with the Partners assuming that such commercial activities would be for use of station research capabilities in the unique microgravity environment. Commercial applications were expected to be in such fields as medicine and manufacturing that would benefit from advances in crystal growth, fluid physics and other areas of fundamental research. However, the commercial interests in the station, to date, have been quite different and have included advertising and sponsorship, space tourism and other areas unrelated to the research capacity of the station.

This has led to yet another dilemma for the Partners. Should each partner permit such commercialization according to its own rules, or is there merit in a common set of guidelines for the types of sponsorship and advertising activities carried out on the Station? Another question is whether the ISS can be marketed as a "brand," similar to the way the Olympics have a recognized brand that can be marketed globally, or regionally, by different companies in return for a fee under an established set of rules. Should the ISS be exploited for advertising, or is that an inappropriate use of a facility funded by taxpayers? Russia is the Partner pushing the envelope as they have already filmed commercials onboard the station and have a program for flights of paying

customers, private citizens with the money to afford such an opportunity. Another opportunity is under discussion – a visit to the ISS as a "prize" for the winner of a contest. In this case, the financing would be through television marketing of the contest. Again, is this legitimate commercialization, or inappropriate exploitation of a government-funded facility? The Partners have agreed to discuss common guidelines for commercialization, but have not yet reached closure on this matter.

5. Looking to the Future: How to Structure Future Agreements

It is simplistic to think that one could craft the perfect agreement to flexibly accommodate all contingencies. However, the political decision-makers who will be approving large investments need to understand and commit to specific program elements or goals. A framework without specifics will not be concrete enough to obtain and sustain approval. Therefore, some key parameters need to be established. However, flexibility can be provided in such areas as changes to or evolution of the program and the addition of partners. It is interesting to note that the space station agreements do contain provisions for evolution since the original negotiators wanted to allow for additional elements and new functions. However, the changes to configuration have come, not as evolution, but as modifications to the early station development and assembly. The space station agreements noted that non-Partner use of the station was possible, but did not provide for how this would be arranged. However, in spite of the fact that the original concept of non-Partner participation did not include visiting crew, the boards and panels established by the partnership to deal with various issues were able to develop implementing procedures to accommodate this development.

The framework of the program remains valid and implementing arrangements are being developed to deal with real cases as new issues arise. Based on the space station experience, perhaps the most important lesson is that future changes and requirements are not easily predicted and therefore, the flexibility should be in established by defining the process for addressing downstream changes rather than trying to craft language for every possible new development. Many of the adjustments to the space station agreements have been made through the use of implementing arrangements or guidelines approved by authorized decision-making bodies, without having to amend the IGA or MOUs.

Below are some elements future negotiators may wish to keep in mind.

The analogy often used during the negotiations was one of a wheel with the US at the hub, the MOUs as the spokes, and the IGA as the rim that tied all the partners together. This agreement structure allowed NASA, as the partner that had originated the program and the one that had the largest financial stake, to better control the four individual negotiations of programmatic details (management arrangements, decision-making mechanisms, etc.) in the MOUs. It also allowed Partners to raise issues bilaterally with NASA that they did not wish to address in the larger group. On the other hand, the Partners could exercise control in the negotiation of the more political overarching IGA by forming coalitions around key issues. A question to be addressed for future international ventures with multiple partners is whether the agreement structure should be thoroughly multilateral or whether bilateral approaches remain advantageous.

In future cooperation, the benefits of the consensus principle in giving all Partners a voice should be recognized and incorporated in the decision hierarchy, but the need of avoiding decision deadlock, especially on operational matters, must also be taken into account.

If a future partnership would like to allow for additional participants, they might establish a means for other nations to accede to the agreement, apply for membership, or be sponsored by an original partner. The ideal would be to structure these terms and conditions so that bringing a new Partner on board creates the minimum perturbation for the program and the existing partnership. The concept of non-Partner participation could prove crucial for involving nations that are not major space powers, but who wish to be involved in a future large scale human space flight program.

It is unlikely that, for the foreseeable future, there will be a major change in the willingness of governments to support any significant transfer of funds to other governments to carry out large cooperative programs. A future program will need to determine whether to start from the basis of contributions and financial obligations that can be offset, or to revert to the prior model of establishing responsibilities of each side with no financial offsets or exchange of funds anticipated. The operations cost-sharing scheme for the space station is based on on-orbit element contributions. Future programs may wish to calculate operations support into the sharing approach, taking into account the increased capabilities of nations from experience on the space station. Unless defined contributions from the outset are considered the complete "deal," the principle of bartering to offset financial obligations can be expected to play an important role in the establishment of future large-scale space endeavors.

Regardless of best intentions, some aspects may simply have to be renegotiated. In the second round of negotiations with Russia added as a partner, the allocations of crew were clearly defined in the case of a three-person crew and also for a seven-person crew. The keys to achieving a seven-person crew were the habitation and life support capabilities and the crew rescue capabilities for the entire crew. The potential for an interim stage of a six-person crew was envisaged and provided for in an implementing agreement between NASA and Rosaviakosmos, by noting that NASA could request additional Soyuz in return for compensation to be negotiated. In spite of the clear possibility of a six-person crew option, the difficulties in allocating the crew among the Partners led the negotiators to leave this up to future negotiations should it become necessary. Ironically, the current budgetary difficulties in the U.S. have led to the deferral of the crew rescue vehicle development and made a six-person crew option more likely and therefore, one the Partners will probably have to face after all.

6. Conclusion

From the above discussion it can be seen that the space station program has produced many lessons that merit serious consideration when subsequent large-scale cooperative endeavors are being developed. These lessons have resulted from numerous sources, including evolution in the political landscape worldwide, conflicting political and fiscal realities of those nations involved and evolution of the program in directions not originally foreseen. If there is one overarching lesson that should be carried into the future it is that those involved in structuring and implementing large scale partnerships must approach matters with an open mind. They must realize that they will not be able to identify every contingency in advance and hence must structure their cooperation with built in "flexibility".