

**IAC-05-A1.5.05**

**OPERATING THE ISS: CULTURAL AND LEADERSHIP CHALLENGES**

**James L. Clement, Jr., P.E.**  
NASA Johnson Space Center, USA  
james.l.clement@nasa.gov

**Jennifer B. Ritscher, Ph.D.**  
University of California/San Francisco and Department of Veterans Affairs Medical Center, San Francisco, USA  
ritsher@itsa.ucsf.edu.

Abstract

The task of working with a multi-national team during the 24-hour-a-day, 7-day-a-week operation and continued assembly of the International Space Station (ISS) presents a daunting array of leadership and cultural challenges for managers supporting this enterprise. Here we present key challenges and approaches for addressing them, based on preliminary data from an ongoing survey of senior NASA flight controllers. The main leadership challenges relate to 1) geographic dispersal of work teams, 2) historical differences between partner organizations, 3) extra effort required to maintain morale of local teams, and 4) constant change. The main cultural challenges pertain to: 1) cultural differences in relative importance of values, 2) bilateral approaches not necessarily being suited to multilateral situations, 3) language differences, and 4) cultural differences being more disruptive for ground teams than for space crews. The top five leadership approaches for successfully addressing this overall set of challenges were identified as: 1) ensuring effective communication, 2) cultivating robust relationships, 3) fostering flexibility and open-mindedness, 4) expanding cultural awareness, and 5) seeking and providing training. Our survey data are also rich with examples of specific strategies that embody these approaches, and we summarize these and give overall recommendations based on the results.

Background

The International Space Station, or ISS, is the largest international scientific and technological endeavor ever undertaken. The ISS is a technological marvel, consisting of tons of hardware, miles of wire, and millions of lines of computer code, all orbiting the Earth 220 miles above the facilities that control it. Equally impressive is that since October of 2000, international crews of astronauts and cosmonauts have been living and working on board the ISS while it continues to be assembled and re-supplied by visiting vehicles and crews.

The safe and effective ongoing operation of the ISS requires an unprecedented level of teamwork across sites, organizations, and countries. Sixteen countries spread over four continents have joined a team led by five space agencies for the common goal of performing research on long-duration space missions. The ISS mission control team at the NASA Johnson Space Center in Houston, Texas works closely with colleagues at the NASA Marshall Space Flight Center in Huntsville, Alabama and with centers operated by Canadian, European, Japanese and Russian space agencies. The task of working with a geographically dispersed, multi-national team during the 24 hour-a-day, 7 day-a-week operation presents a

daunting array of cultural and leadership challenges for the flight control team supporting this enterprise.

Some of the most challenging assembly operations for the ISS are yet to be completed, and the operation of the ISS has yet to be transitioned from mainly a bilateral operations team concept to a truly multi-lateral team as European and Japanese elements arrive later in the assembly sequence. It is critical to help the leaders of this important international endeavor determine if they are effectively using what has been learned to date in working with another culture to prepare the ISS operations team for a more thoroughly multi-cultural operation in the very near future. Mission success and crew safety not only hinge on the technical competence of the ISS team, but equally on team members' ability to work seamlessly together in a multi-cultural geographically dispersed environment.

Success depends upon the relationships established among members of the operations team, both within NASA and with colleagues at ISS international partner organizations. The core of the ground operations team is the flight controller, who is the source of leadership and direction for the commitment of operations resources within his or her specialty area or technical discipline [1]. To achieve

the overall ISS Program goals and objectives, flight controllers direct and implement the plans that are constructed by teams of specialists [2]. It is crucial for the flight control team members and leaders to maintain mutually beneficial relationships with the Program office, engineering and safety organizations, international partners, and NASA managers [1]. Since the ISS is so much more complex than any previous space program, the current cadre of ISS flight controllers have had to be pioneers in finding ways to meet the leadership and cultural challenges inherent in their expanded role.

In this study, we sought to capture the expertise these individuals have developed, in order to help them learn from each other and guide the way for others. A recent survey of NASA flight controllers revealed a serious level of concern about communications problems with the International Partners [3]. The present study sought to gain more insight into the nature of this problem and what can be done about it. Focusing exclusively on senior flight controllers who work directly with International Partners, we asked for examples of the key leadership and cultural challenges these pioneering leaders have faced as well as the strategies that they have found effective for surmounting them.

In this paper, we present our initial formulation of these lessons. The paper gives preliminary results from our survey of flight controllers, integrated with conclusions drawn from a literature review and from our own experience. Usually these sources agreed with one another, but we note where this was not the case. In future work, we intend to collect more data and to present more quantitative results from this ongoing study.

### Methodology

Participants. Study participants included 14 senior flight controller personnel involved in various aspects of mission planning and the conduct of day-to-day operations on-board the ISS. Each participant was chosen on the basis of having had significant experience with space operations involving the ISS international partner community. Consistent with the demographics of the population of senior flight controllers, the sample included 13 men and 1 woman, all 14 were white, all appeared to be from the American cultural mainstream, and they ranged in age from their late 20s to late 40s. Two of the 14 speak Russian, and none of them speak Japanese. Five have experience in integration of international detailed crew activity plans. Five have worked with all of the international partners in developing station

operation procedures. Nine of these flight controllers have been deployed to the Mission Control Center—Moscow (MCC-M) in Russia for extended periods of time to provide operations liaison between the American and Russian mission control teams. Five had experience in working with European and Japanese flight control team members in developing plans for upcoming ISS operations involving hardware, and all had worked with their international partner flight controller counterparts in developing ground and on-board procedures for crewmember activities.

Study participants were anonymous in the sense that records of their identities were not kept, and identifying information was removed from their data, although their identities were known to the senior author (JLC). All participants provided informed consent, and the study procedures were approved by human subjects committees at the University of California/San Francisco, and at the NASA Johnson Spaceflight Center.

Procedure. Participants were requested to describe their observations and perceptions of the cultural and leadership challenges associated with the job of operating the ISS. All participants received a written copy of the interview questions as well as a verbal explanation of the goals of the study. At a minimum, the following six questions were asked:

1. What are the leadership challenges/issues you have had to deal with associated with the multicultural and 24/7 aspects of your part of the Operations Division ISS assembly/ops job?
  - Consider complex human interfaces, cultural factors, crew preferences, IP driven constraints, and policy considerations.
2. Discuss leadership skills, strategies, tactics, techniques you developed and/or used.
3. What worked and what did not and why? Success stories? Failures?
4. What challenges still remain? What do you think could be done to address them?
5. Discuss challenges associated with flight controllers working 24/7 on ISS. Specifically address the multicultural considerations of working with the IP's as well as the considerations in the 1<sup>st</sup> bullet above.
  - What role do cultural differences play? Examples of issues and "fixes" found.
  - What are your leadership "lessons learned?"
6. What additional leadership skills or training do our employees and managers need?

Both written and verbal responses were accepted. Additional unstructured discussion or follow-up

questioning took place as needed to achieve clarity. Verbal responses were transcribed as verbatim notes by the senior author (JLC). The content of the 14 transcripts (written responses and/or transcribed verbal responses) was independently categorized by the authors into emergent themes, and the two resulting coding systems were integrated through discussion until consensus was achieved about the categories. The entire dataset was then recoded using the final coding system. The scientific literature was also consulted about the topics raised by the participants and integrated into the material presented below.

The present paper is an initial report on an ongoing project. We intend to continue to interview additional participants in the US and also in Russia, and to analyze the results in greater detail.

### Results

Survey participants were consistent and substantially in agreement in identifying key leadership and multicultural challenges associated with the ISS. They identified leadership approaches that they considered to be essential for meeting these challenges. Table 1 lists our consensus issues and the percent of respondents mentioning at least one example of the issue.

Table 1  
Leadership and Cultural Challenges Involved in Operating the ISS, and Leadership Approaches for Successfully Addressing Them

	% of 14 respondents
<u>Leadership Challenges:</u>	
• Team members dispersed across sites, organizations, time zones	100%
• Historical differences between partner organizations	100%
• More effort required to maintain morale and motivation of local team	86%
• Constant change	64%
<u>Cultural Challenges:</u>	
• Cultural differences in relative importance of values	100%
• Bilateral approaches/workarounds may not work for multilateral situations	86%
• Language differences	50%
• Cultural differences being more disruptive for ground teams than for space crews	7%
<u>Leadership Approaches:</u>	
• Ensuring effective communication	100%
• Cultivating robust relationships	93%
• Fostering flexibility and open-mindedness	86%
• Expanding cultural awareness	57%
• Seeking and providing training	86%

### Discussion

These responses are specific to operating the ISS and limited to the American point of view, but they mesh well with the more general scientific and professional literatures on spaceflight behavior and performance, cultural psychology, and managing geographically dispersed multicultural teams. Our results compare well with a broader study of ISS flight controller ratings on organizational risk performed by the Human Factors and System Safety group of the Ames Research Center [3]. Their responses also fit well with what we have observed from our vantage points as a senior NASA manager (JLC) and a cultural psychologist (JBR). Next, we describe each item in turn below, giving more detail about the survey results as well as contextualizing it with a brief synopsis of relevant research in the area.

### Leadership Challenges in Operating the ISS

Operating the ISS involves the same fundamental leadership challenges as any large project, but here we set those aside in order to focus on the special challenges that are posed by the extra complexity of operating the ISS versus previous space missions. We make a distinction between leadership and cultural challenges because the following leadership challenges affect ISS flight controllers regardless of whether they work with international partners or in multicultural teams. Participants highlighted four main types of leadership challenges.

#### Team members dispersed across sites, organizations, time zones

The first leadership challenge (noted by 100% of our respondents) is that team members are dispersed across sites, organizations, and time zones. Working in a dispersed team has two main ramifications. First, it makes communication more difficult [4]. As one controller put it, “sometimes the biggest challenge is getting five computer support personnel at five different locations around the world on the same telecom.” Since the ISS team is split over many time zones, this often means communicating via e-mail or having team meetings that occur outside of normal business hours for at least one party. Important nonverbal cues are lost when communication is not face-to-face, and synergy and timeliness may be lost when communication is not “live” in real time. The probability of misunderstandings is dramatically increased when communication is impaired in such ways. These difficulties are further compounded by the fact that they are occurring in the context of dissimilar organizational structures and cultures.

Several respondents stressed that in some organizations, it is the norm to spread information across coworkers and up and down organizational levels routinely, but in others, workers will not spontaneously share information unless specifically told to do so or unless someone higher in the chain of command does it for them. Information may also fail to spread because of differences in access to shared resources such as email and intranets. ISS leaders who are not aware of such differences between sites may incorrectly assume that every team member at a remote site has information that was given to only one of them.

All of these communication difficulties result in the second ramification of working in a dispersed team: difficulty cultivating strong working relationships. Trust and team spirit develop slowly, and it takes longer to adjust to working with less personal contact [5]. Our respondents reported that the NASA flight control team learned that there was no prescribed formula for gaining trust and credibility with remote team members, but rather it had to be earned through demonstrated hard work and a willingness to listen and try their ideas. The closest thing to a formula for developing trust was generally felt to be travel to meetings for face-to-face contact. This was believed to be very important and well worth the cost. The Ames survey results also found this to be uniformly agreed to by the larger flight controller group that participated in their study [3]. Early on, the American flight planning team recognized the Russian experience in long duration human spaceflight, and deferred to their ideas in the initial phases of ISS planning. Initially, each group mainly valued its own processes and products and this stance hampered the development of trust and productive team functioning. Even when communication is good and individuals are well bonded into a cohesive team, their working relationship is still constrained by the fact that ISS team members report to different organizations and must represent differing overarching policy requirements that are driven by national interests. As one leader in our study put it, "I have very little in the way of carrots or sticks" with which to motivate team members from other organizations.

Although having a dispersed team has its drawbacks, a well functioning dispersed team that has strong communication and strong working relationships can have major advantages. For example, it may mean that a responsive and responsible team member is always on duty somewhere in the world if a relevant issue arises [6]. To date, our survey data do not mention any such advantages, but the literature and

our professional experience support this possibility, so we highlight the issue here as an area of potential opportunity for ISS leadership.

#### Historical differences between partner organizations

The second main leadership challenge identified by 100% of our respondents is that the Russian and American space programs each have long histories and different ways of doing things that they are reluctant to alter since they have proven successful in the past. Both organizations have mounted successful international missions and both have operated successful space stations, but their partnership with one another is relatively new [7]. Our respondents noted that very early in this partnership, it became apparent that the two countries' teams approached the same problem from significantly different ideological bases. The US heritage was based on experience with short-duration Space Shuttle missions with some recall of the Skylab space station operations, whereas the Russians entered the ISS program with a wealth of long duration space station operations experience with a 30-year continuity from Salyut through Mir. The US entered into discussions with concepts and processes originally outlined for the Freedom program plus some experience from the Phase 1 Program with US astronauts onboard the Mir. Senior members of both teams had been trained in the military during the Cold War and had started their careers during the Space Race. When the joint ISS teams began, both the Russian teams and the American teams felt that their own approaches to manned spaceflight were more relevant than the other's. By becoming more open to new concepts, the NASA group realized the relevance of the Russian approach, and together the international team modified the overall process and products to the workable approach in use today. The senior flight controllers participating in this study observed that in the years since the beginning of the ISS partnership, common ground has been reached. By showing an increased recognition and respect for the accomplishments of the long duration mission experience of the Russian program, discussions and negotiations are much more effective compared to the difficulties experienced early on in this working relationship.

Although some differences in procedures have been solved by compromise, others must be worked around. For example, it is the norm in the Russian space program to have flight controllers stay together as a group and work one long shift every few days, while the American shifts tend to rotate more frequently. Therefore, even when international

colleagues get to know each other, their work shifts are not compatible. Furthermore, it is the norm at NASA for a member of each specialty area to be on duty at all times and able to make decisions while on duty, but it is the norm in the Russian program for responsible specialists to be available only during the normal work day, and for decisions to be deferred until the chief expert is available. These two staffing approaches, although different, tend to balance each other. A challenge for the future will be to integrate the staffing philosophies of the European and Japanese partners, which also differ from the NASA approach, into the ongoing operation of the ISS.

#### More effort required to maintain morale and motivation of local team

The third leadership challenge is the increased amount of sheer effort required to conduct ordinary leadership tasks in this more complex and stressful leadership environment. Aspects of this issue were raised by 86% of our sample.

One reason why leading ISS teams requires extra effort is that unlike Apollo, Skylab and Shuttle missions, ISS missions are continuous and scheduled to go on indefinitely. The task is no longer a sprint but a marathon. It is now more difficult to maintain a sustained level of enthusiasm and morale among team members, even those who are at the same site. The ISS operations team works in a 24 hour a day, 7 day a week, 365 day a year environment. The most often mentioned challenges associated with this long duration aspect of the job by the flight controllers surveyed in this study were team staffing, motivation, and fatigue considerations. The increased complexity of ISS operations coupled with the ongoing nature of the mission produce cumulative stress without providing a built-in mechanism for relieving that stress. Although the ground controllers maintain their role indefinitely, the ISS crewmembers are still associated with a particular mission. In response to this challenge, the American ISS team has recently evolved so that teams of ground controllers are now more specifically linked to each ISS mission, allowing them to orient their work around its life cycle and feel a sense of closure and accomplishment at the end more like ground controllers were able to do in the past. Another stress-reducing strategy that respondents mentioned is to make an effort to distribute tasks in such a way that they mesh with each individual's personality and motivation structure.

Another reason that leading ISS teams requires extra effort is that working in a multi-national, multi-

organizational team means that there are often ambiguities and frustrations that are never resolved. This is an added source of stress on local team members that was not there when missions were operated entirely in-house. Many of our respondents mentioned that it creates lingering stress and frustration for them when other teams seem to agree to do something one way but then do it another way, and an explanation is never given to the local team. Although many respondents said that it was critical to develop the capacity to "not sweat the small stuff," letting questions go unanswered is stressful, and likely to be particularly so for the personality types found in engineering professions represented by ISS teams. In short, extra effort is required to maintain the morale of ISS team members over the long term.

#### Constant change

The fourth leadership challenge is that even if leaders manage to successfully meet the above three types of challenges, their efforts must be unflagging because they are working in the midst of constant change. This issue was mentioned by 64% of our respondents. Just in the past few years, NASA headquarters has reorganized itself twice and had 2 new administrators; the Japanese Aerospace Exploration Agency (JAXA) was formed from the merger of three other organizations (the Institute of Space and Astronautical Science [ISAS], the National Aerospace Laboratory of Japan [NAL], and the National Space Development Agency of Japan [NASDA]); and the Russian Aviation and Space Agency, or Rosaviakosmos, became the Federal Space Agency, also with a new leader. Job turnover is another type of constant change that respondents mentioned, and they said that it particularly occurs among Americans and Japanese. Since the controllers operating the ISS are pioneering a newly expanded role in this extraordinarily complex system, the education process is lengthy since these skills are primarily learned on the job. Thus, the education of new team members is an additional strain on the team. Job turnover among international team members is especially stressful for the Russian partners, who tend to prefer having a personal working relationship with their foreign counterparts before feeling comfortable working with them. Furthermore, engineers who are already stretching beyond their technical training in order to succeed in the complex interpersonal tasks necessary in multicultural dispersed teams can find it exceedingly difficult to face the additional stress of being uncertain whether their management will back their decisions (such as to hold their ground during a disagreement with an international partner) since the

ground is shifting for management as well. Power struggles between countries, between organizations, and between factions can cast a shadow on lower-level negotiations, such that team members feel like pawns in a game that they don't understand since they are unable to see the bigger picture from their vantage point. On top of all those sources of change and ambiguity is the fact that Russian culture itself is changing very rapidly, much more so than that of the other ISS partner countries.

### **Cultural Challenges in Operating the ISS**

The leadership challenges reviewed above affect ISS leaders whether or not they work directly with international partners. Next, we review cultural challenges that affect ISS personnel who do work with international partners, whether or not they are leaders. Our respondents consistently emphasized the importance of a good appreciation and awareness of the impact of cultural considerations in working with the ISS international partners. Their observations are consistent with other assessments that found that ignorance of cultural considerations can lead to communications breakdowns and other unforeseen problems [5,7,8].

#### Cultural differences in relative importance of values

Although all of the ISS partners share the basic values of safety, professionalism, teamwork, and excitement about space exploration, they also must contend with cultural differences in values or in the relative importance of specific values. Some aspect of this issue was raised by 100% of our respondents.

For example, many respondents noted that it is more important to Russians than Americans to establish a personal relationship with coworkers before feeling comfortable working with them. Thus, although Americans also value bonding with coworkers, they don't see it as an integral part of the job itself, which is what it must become in order to work effectively with Russians. This type of bond allows for greater accuracy in perceiving what the other person needs and wants, and being able to come up with creative "win-win" solutions to difficulties. If it is viewed as part of the work rather than something extra, then workers will not feel like they are wasting time when they spend time on it, and it will become a routine part of training and evaluations of employees. The relationship issue was one of the most important and productive lessons learned by the respondents to this study. They stressed the importance of initial face-to-face meetings with international partners in order to establish working relationships. It should not be

expected that substantive work get done in such meetings – to the contrary, the relationship-building should be considered to be a critical work task in itself at that stage. Respondents also noted that efficiency was particularly important to Americans, whereas checking with superiors before making decisions or taking time to cultivate relationships (such as writing carefully crafted emails or congratulating one another on recent achievements) may have a relatively higher priority for Russians and other international partners.

Moreover, cultures differ in how values are expressed. Both Russians and Americans value safety and scientific evidence, but our respondents believed that there was a difference in philosophy such that the Russians considered something safe until proven dangerous, whereas Americans considered something dangerous until proven safe. Although put in stark oversimplified terms here for the sake of discussion, this difference has major ramifications for the way that space operations are planned and implemented, and respondents gave numerous examples. Another key difference that affects the space program was the way that expertise is managed. Respondents mentioned that Russian expertise tends to remain with the expert and not to be documented in writing or distributed widely to coworkers, whereas openness and documentation are core values for Americans. Similarly, making contingency plans in advance is highly valued on the American side, and being able to make repairs and react effectively to surprises is highly valued on the Russian side. Creativity takes the form of openly going beyond one's job duties for Americans, and quietly working around constraints for Russians.

Again, it is important not to stereotype [9], but an awareness of differences in value structures may help avoid confusion and enhance the behavioral repertoire and flexibility of multicultural teams [7,10]. There are many other cultural differences and rules of etiquette (such as not shaking hands in a doorway in Russia) that may affect the work of ISS teams, but these are already the subject of generic cultural training offered by consultants, or are reviewed in more detail elsewhere [7,11,12], so we will not delineate them here.

#### Bilateral approaches/workarounds may not work for multilateral situations

The second cultural challenge identified by 86% of our respondents is a small but critical point: bilateral approaches and workarounds may not be adequate in multilateral situations. The challenges that have

surfaced in bilateral work between Russians and Americans are difficult but will be further complicated when the Japanese and Europeans step up their involvement with the ISS, as they are expected to do soon when their modules are launched and attached to the ISS. ISS crews have so far included only US-trained astronauts and Russian-trained cosmonauts. Even aside from cultural differences, there are thorny technical issues that will be exacerbated as more partners are included in core activities. For example, each space program has its own activity scheduling software. It has been difficult but possible to make an interface so that the Russian and American systems could work together, but it will become much more difficult to integrate additional systems.

#### Language differences

The most obvious culture-related difference affecting international teams is the language difference, although language issues were only mentioned by 50% of our respondents. English is the official language of the ISS, but Russian translators and interpreters are used in many aspects of the day-to-day operation of the ISS to preclude any misunderstandings that could affect mission success or flight safety. Plans call for the European and Japanese flight control team to communicate in English during ISS operations, without interpreters.

It is important to understand that language differences are not solved simply by the international partner using English. The American side must also be skilled at working with those who are speaking English as a second language. Respondents noted that the international partners often had trouble understanding jargon or idioms even if they were fluent in English. The language barrier still causes statements to become misinterpreted and discussions or email exchanges to be prolonged.

It was interesting that few of the respondents mentioned the challenges involved in speaking a foreign language, suggesting that none of them speak Russian or Japanese at a working level, even though classes are offered at NASA, and existing foreign language skills may be a factor considered in hiring flight controllers. Several respondents noted that flight control team members who did take advantage of language training opportunities found that any effort at learning the language of an international partner paid back large benefits from a team building standpoint. American crewmembers are routinely taught Russian if they don't already speak it, but this

seems not to be the norm for flight controllers who work with Russians.

#### Cultural differences being more disruptive for ground teams than for space crews

The fourth cultural challenge was only mentioned by one respondent but we highlight it because it is a critical point: cultural differences may be more disruptive for ground and crew-ground interfaces than for crew-crew interfaces [13]. Much attention is currently being paid by psychologists and trainers as to how cultural differences may affect the behavior and performance of international teams of crewmembers in space [12,14-19]. Space crews are small and train together in advance of their mission, so cultural differences are attenuated by adjustments that individuals make in these teams based on personal experience with one another over time. Also, crewmembers will make further adjustments based on the cultural training that they receive, and such training is expected to improve dramatically for upcoming ISS crews as plans under development become implemented.

However, ground controllers working in international teams have none of these advantages. They often must work together with neither extensive personal experience nor cultural training, yet the outcome of their work may have major repercussions for the successful and safe operation of the ISS. Therefore, it is crucial for ground controllers to receive cultural training so they do not have to learn these lessons the hard way, as our respondents did and are still doing. Some of the responses that we received revealed an ongoing lack of cultural awareness that could be rectified by further training, and our respondents are probably among the most culturally aware of American flight controllers.

#### Leadership Approaches for Successfully Addressing these Challenges

Given the extraordinary nature of the leadership and cultural challenges presented to the individuals charged with the operation of the ISS, how have they done it? What are the requisite skills that individuals need to possess to work in this environment day after day? And equally important, what are some of the specific strategies that have been developed by the ISS team to ensure the continued successful operation and assembly of this technological marvel? Each of the general approaches identified by our participants would be helpful in any leadership situation, but they are especially critical and they require specific skills in the ISS context. The top five leadership

approaches were identified as: 1) ensuring effective communication, 2) cultivating robust relationships, 3) fostering flexibility and open-mindedness, 4) expanding cultural awareness, and 5) seeking and providing training. Our survey data are also rich with examples of specific strategies that embody these approaches, and some are summarized in bullet points in each section below.

#### Ensuring Effective Communication

All of the study participants identified communicating effectively as the key to working with the large, geographically dispersed team charged with operating the ISS. For effective communications in such situations, careful attention must be paid to listening and to presenting one's thoughts in a clear and concise manner [4]. In addition, dispersed teams tend to require increased information flow and more frequent communications than local teams, and it is helpful if such communication occurs redundantly over multiple modalities, such as email and telephone [6]. This type of "over-communication" makes members of the team who are at remote locations feel included and also improves the quality of their support to the team [20]. Face-to-face meetings are optimal for communicating sensitive information [4].

The following are some of the strategies that respondents found helpful in communicating effectively with the ISS operations team:

- Ensuring all key persons and groups have the same information at the same time even if it requires over-communication at different levels through the team.
- Keeping communications clear and concise, which may require that interpreters are briefed in advance about relevant terminology.
- Using summarization and reiteration to verify that other team members have a clear understanding of the situation and any action to be taken or plan to be made.
- Conducting face-to-face meetings where possible, both for initial team building and to communicate new requirements which impact the content of the plan for on-orbit operations. Face-to-face communications are facilitated by having a small number of flight controllers from the MCC-Houston detailed to the International Partner Mission Control Centers. This approach has been used very effectively to date with the Russians and is planned for the European and Japanese control centers in the future.

#### Cultivating Robust Relationships

Building relationships and establishing trust are important for any team, but they assume a critical importance in this particular team environment where the lives of astronauts and cosmonauts are at stake on a daily basis in an international research facility orbiting the Earth. Research on the social climate of mission control teams in the US and Russia has found that they are more cohesive if the leader is perceived to be supportive [21,22]. Numerous texts identify the ability to establish trust as the one factor that determines success or failure in multi-cultural geographically dispersed teams [e.g., 4-6,23]. These types of teams are highly dependent on trust, but paradoxically, they typically operate under conditions that are not supportive of trust building. Relationships were mentioned by 93% of our study participants, and they gave numerous examples of how this issue plays out on ISS operations teams.

The following are some of the strategies which respondents found to be valuable in building robust working relationships across the ISS operations team:

- Recognizing that trust is built slowly by setting a personal example and earning trust.
- Using a "prime the pump" approach of initially giving without expecting an immediate return.
- Demonstrating a positive attitude and showing respect for all team members and for the international aspect of the operation. For example, congratulating international partners on their agency's recent accomplishments or milestones. Search for common ground and eliminate any "us vs. them" mentality.
- Exercising patience and calm under pressure to ensure the team's confidence.
- Remaining tactful and empathetic by "placing oneself in the other's shoes."
- Doing it "their way" - accepting or integrating processes or products developed by the international team members.
- Seeing the "big picture" - focusing not only on what is right for NASA, but for the bigger international program.

#### Fostering Flexibility and Open-Mindedness

As noted by 86% of our sample, flexibility and open-mindedness are crucial for successfully leading multicultural, multi-organizational, geographically dispersed teams. Paradoxically, flight controllers must both cultivate a tolerance for ambiguity and spend extra effort resolving ambiguity. Many



respondents mentioned the value of “not sweating the small stuff” and making peace with the fact that they may never know some of the behind-the-scenes reasons for behaviors that they observe among their international partners. Letting go of non-essentials allows time for creative and thorough solutions to essential tasks. Respondents learned that flexibility and adaptability could mean abandoning their own group’s established practices in order to take on others’ style of working, in order to achieve joint goals. At other times, it meant standing their ground about how to do things, but using creativity in finding ways to get the message across diplomatically. Working to develop accurate empathy for the partners’ situations allowed for solutions to be developed that all sides could understand and accept [23].

The following are some of the strategies that study participants found to be effective in maintaining the flexibility necessary to deal with the differences associated with operating the ISS:

- Tolerating ambiguity about non-essential issues or complex open questions – “not sweating the small stuff” and avoiding premature closure.
- Eliminating ambiguity – once a decision has been made, making extra efforts to confirm mutual understanding.
- Thinking outside one’s usual comfort zone to understand the nature of a problem and help formulate the best solution. For example, it may be especially uncomfortable for highly trained engineers to realize that there may be multiple right answers or correct approaches in such a complex interpersonal environment.
- Maintaining awareness of context – see ones’ group in the context of the overall operation and the way that the organizational elements fit together.
- Adapting the rules to the situation and constructing creative work-arounds.
- Considering partners’ organizational politics and context when choosing the timing of making requests.
- Realizing that interpersonal mistakes and blunders are unavoidable in a multicultural context, and that it is important not to view these as failures but to learn from them and move forward, and to allow enough time to let them surface and get resolved so that mission safety is not affected.
- Adapting to changing situations and remain open to the need to recalibrate or repeat a process.

### Expanding Cultural Awareness

Over half (57%) of our respondents said that they learned how important it is to be aware of specific cultural differences, such as about expected behavior during meetings or outside of formal work time. It was also mentioned that it might be helpful to collect more information from partners about what the US side can do to improve joint teamwork. Similarly, some said it might be helpful to ask both the US side and the partners about what partners can do to work better with Americans.

We were surprised that many respondents did not mention culture-related strategies at all. Interestingly, none of our respondents to date mentioned speaking or even beginning to learn a foreign language themselves, nor did they mention numerous other established skills for working in international teams that probably would further enhance their effectiveness. We believe that unless ISS leaders make cultural awareness a priority, they are guaranteed to experience exasperation and stress. Our data did include the following strategies that respondents have found helpful:

- Attending to speaker, not interpreter. Write notes during the translation, not when the international partner is talking. This shows respect and also increases overall communication accuracy because nonverbal cues are conveyed. Brief the interpreter on key terminology before discussions, to keep interpreter in background and to improve accuracy during discussion.
- Simplifying speech when not everyone is a native speaker of English – keep statements short and free from jargon, slang, and idioms. This increases accuracy and also minimizes partners’ and interpreters’ fatigue during long discussions.
- Learning culture-specific do’s and don’ts, such as the level of formality expected during a meeting, or the strategic value of socializing at the workplace. Respondents did not appear to be aware of many specific helpful tips such as to avoid shaking hands with a Russian across the threshold of a doorway.

### Seeking and Providing Training

Most study participants (86%) stressed the importance of being well prepared for the job of interacting with the international partner team members. Acquiring the necessary knowledge and skills is a lengthy and time consuming process, especially when all learning is done on the job. Mentoring of new employees in cultural do’s and

don'ts and specific training in best practices for working with IP's was felt to be critical in helping to reduce stress, not only for newer flight controllers, but also for senior flight controllers, who may have learned some of these lessons on their own but could still benefit from a systematic review. Moreover, it is also important for the lessons learned by the flight controllers to be spread to others who interact with them, so that their expectations are appropriate.

The following are some of the training-related strategies the study participants identified:

- Seeking additional training for themselves. Current senior flight controllers said they would benefit from additional training in areas such as negotiation, managing stress, and job-relevant cultural do's and don'ts.
- Providing training to new flight controllers. Current flight controllers would like to pass on what they have learned about best practices for working with international partners, so that new flight controllers can get "up to speed" quickly.
- Providing training to other groups. Flight controllers benefit when those who interact with them have accurate expectations about what is possible to achieve in what time frame in this type of setting. For example, questions that require input from international partners may have a longer turn-around time.
- Seeking international partners' feedback about how to further improve teamwork, and rolling this new information into ongoing training and mentoring strategies.

### Conclusion

The ISS operations team has come a long way in understanding how to successfully operate a long-duration manned spacecraft in a geographically distributed, multicultural environment. Establishing a workable operations concept for the ISS in a few short years has not only been an outstanding technical accomplishment, but a triumph of leadership and cross-cultural cooperation. An important factor in this success has been the ability of the individuals on the team to effectively resolve the many leadership and cultural challenges identified in this study.

Our results showed that the day-to-day operational management of the ISS requires a variety of leadership and interpersonal skills that may not be readily acquired in traditional engineering school curricula. In this 24/7/365/global/multicultural/multi-

organizational ISS program, leaders will be frustrated unless they realize that these leadership and cultural challenges are as integral to their job as the technical challenges that they were trained for and that they had expected to face. Fostering the development of these leadership and cultural skills in those charged with operating the ISS will continue to be critical for addressing future challenges associated with completing the ISS assembly, working more closely with European and Japanese partners, and preparing for missions to the Moon and Mars. The leadership approaches identified in this study will be useful in selecting, training, and supporting the teams involved in these future missions. Just as studying the travails of historical terrestrial exploration teams inspires and educates current leaders [24,25], studying the challenges and triumphs of these pioneering ISS leaders can help prepare future leaders for expeditions outside Earth's orbit.

### Limitations

Limitations of this study include the small sample size and our inability to test the degree to which participants are typical of other US flight controllers. Also, we do not know what their international counterparts would say about challenges in working with them, but we intend to study that in future work. Due to our small sample size, we have not yet presented detailed quantitative numerical results, but we intend to do so after collecting additional data and conducting further analyses.

### Recommendations

1. Use the results of this study as a basis for establishing an educational program focused on improving leadership approaches and cultural awareness of US flight control personnel selected for positions of leadership in long-duration space missions involving interaction with multi-cultural teams. For example, make cultural awareness and basic language familiarity courses a part of the Individual Development Plan concept currently under review for all Mission Operations personnel. These courses could be a requirement for individuals heavily involved in International Partner operations.
2. Collect feedback from international partner organizations involved in joint space mission operations on (a) how they perceive the leadership and cultural challenges in working with their American counterparts and (b) what can be done by the US and Partner teams to further improve communication and teamwork.

### References

- [1] NASA JSC, Memo DA-05-028. In: Flight Controller Manifesto, June 2, 2005.
- [2] D.H. Korth, T.P. LeBlanc, International Space Station Alpha Operations Planning. In: International Workshop on Planning and Scheduling, AIAA, Houston, TX, 2002.
- [3] B. Parke, J. Orasanu, Overview of ISS Flight Controller Ratings on Organizational Risk and Tool Development Survey, Feb 2004, Ames Research Center
- [4] J.A. Thompsen, Leading Virtual Teams, Quality Digest September, 2000.
- [5] L. Credé, Getting high performance with a globally dispersed team, retrieved 8/5/2005 from <http://www.sheppardmoscow.com>, 2001.
- [6] M.E. Kossler, S. Prestridge, Going the distance: The challenges of leading a dispersed team, *Leadership in Action* 23(5) Nov/Dec 2003, 3-17.
- [7] J.B. Ritscher, Cultural factors and the International Space Station, *Aviation, Space, and Environmental Medicine* 76, 2005, B135-B144.
- [8] R. Vinaja, Major challenges in multi-cultural virtual teams. In: Proceedings: Southwest Case Research Association, March 7, 2003, pp. 341-346.
- [9] L. Tomi, Critical analysis of American representation of Russians, *Pragmatics* 11(3), 2001, 263-283.
- [10] M. Janssens, J.M. Brett, Meaningful participation in transnational teams, *European Journal of Work and Organizational Psychology* 6(2), 1997, 153-168.
- [11] Y. Yasin, "Russian soul" and economic modernization. In: *Russia in Global Affairs*, Vol. 3 July/September, 2003. <http://eng.globalaffairs.ru/numbers/4/489.html>.
- [12] D.J. Kealey, Research on intercultural effectiveness and its relevance to multicultural crews in space, *Aviation, Space, and Environmental Medicine* 75(7), 2004, C58-C64.
- [13] A. Holland, Culture, gender and mission accomplishment: operational experience. Proceedings from: The 12<sup>th</sup> Man in Space Symposium, Washington DC, June 8-13, 1997.
- [14] J.B. Ritscher, N. Kanas, V.I. Gushin, S. Saylor, Cultural differences in patterns of mood states on board the International Space Station. Proceedings from: 56<sup>th</sup> International Astronautical Congress, Fukuoka, Japan, October 17-21, 2005.
- [15] N.O. Kraft, T.J. Lyons, H. Binder, Intercultural crew issues in long-duration spaceflight, *Aviation, Space, and Environmental Medicine* 74, 2003, 575-578.
- [16] G.M. Sandal, Culture and tension during an International Space Station simulation: Results from SFINCSS'99, *Aviation, Space, and Environmental Medicine* 75, 2004, C44-C51.
- [17] N. Inoue, I. Matsuzaki, H. Ohshima, Group interactions in SFINCSS-99: Lessons for improving behavioral support programs. In, Vol. 75, *Aviation, Space, and Environmental Medicine*, 2004, pp. C28-C35.
- [18] O.P. Kozerenko, V.I. Gushin, A.D. Sled, V.A. Efimov, J.M. Pystinnikova, Some problems of group interaction in prolonged space flights, *Human Performance in Extreme Environments* 4, 1999, 123-127.
- [19] L.M. Tomi, J. Hosein, K. Rossokha, Cross-cultural training and selection effectiveness: Lessons for the ISS from studies on expatriate personnel, *Aviation, Space, and Environmental Medicine* 73(3), 2002, 231-232.
- [20] J.F. Geurts, The Special Challenges of Leading Geographically Dispersed Teams. In: *Defense AT&L*, Vol. May-June, 2005, pp. 50-66.
- [21] N. Kanas, J. Ritscher, Leadership issues with multicultural crews on the International Space Station: Lessons learned from Shuttle/Mir, *Acta Astronautica* 56, 2005, 932-936.
- [22] N. Kanas, V. Salnitskiy, J. Ritscher, V. Gushin, D. Weiss, S. Saylor, C. Marmar, Psychosocial interactions during ISS missions. In: 15<sup>th</sup> *Humans in Space Symposium: Benefits of Human Presence in Space*, Graz, Austria, May 22-26, 2005, pp. 21, Book of Abstracts.
- [23] R.L. Hughes, R.C. Ginnett, G.J. Curphy, *Leadership enhancing the lessons of experience*, McGraw-Hill/Irwin, 2006, 608 pp.
- [24] J. Stuster, *Analogue Prototypes for Lunar and Mars Exploration*, *Aviation, Space, and Environmental Medicine* Vol 76 (6), Section II, 2003, B78-83.
- [25] M. Morrell, S. Capparell, *Shackleton's way: leadership lessons*, Penguin Putnam Inc., New York, 2001.