

PANEL RESOURCE MANAGEMENT (PRM) IMPLEMENTATION AND EFFECTS WITHIN SAFETY REVIEW PANEL SETTINGS AND DYNAMICS

Robert W. Taylor⁽¹⁾, Sally K. Nash⁽²⁾

⁽¹⁾SAIC, 2450 NASA Parkway, Houston, TX, USA, 77058, Robert.W.Taylor@nasa.gov

⁽²⁾GHG Corporation, 2450 NASA Parkway, Houston, TX, 77058, Sally.K.Nash@nasa.gov

ABSTRACT

While technical training and advanced degree's assure proficiency at specific tasks within engineering disciplines, they fail to address the potential for communication breakdown and decision making errors familiar to multicultural environments where language barriers, intimidating personalities and interdisciplinary misconceptions exist. In an effort to minimize these pitfalls to effective panel review, NASA's lead safety engineers to the ISS Safety Review Panel (SRP), and Payload Safety Review Panel (PSRP) initiated training with their engineers, in conjunction with the panel chairs, and began a Panel Resource Management (PRM) program. The intent of this program focuses on the ability to reduce the barriers inhibiting effective participation from all panel attendees by bolstering participants' confidence levels through increased communication skills, situational awareness, debriefing, and a better technical understanding of requirements and systems.

1. BACKGROUND

In the late 1970's, research performed by NASA and the Federal Aviation Administration (FAA) found a number of preventable aviation mishaps resulting from the improper, ineffective, or nonexistent use of available cockpit/crew resources, resulting in the study, creation and their subsequent implementation of a new training tool: Cockpit/Crew Resource Management, or CRM.^[1]

The scenarios surrounding the applicability of CRM initially centered on the dynamic, high stress, cockpit environment, but eventually spread into other occupational fields to include medical emergency and operation rooms, and fire stations. Though the realm of system safety reviews rarely reaches the high intensity of flight emergencies, or medical procedures, the need to maintain an effective and involved system safety review often becomes hampered by many of the same breakdowns and barriers common within these group dynamics: Communication breakdowns, lack of situational awareness, poor or ineffective decision making, and teamwork.

To that aim, NASA's contracted Safety and Mission Assurance (S&MA) lead safety engineers supporting both the ISS Safety Review Panel (SRP), and Payload Safety Review Panel (PSRP), set out to confront these barriers to effective, multilateral discussions within a panel, altered the CRM training and implementation from a focus on high intensity environments, and created a tool better tailored for safety review panel settings and refer to this new tool as Panel Resource Management, or PRM.

As with any new program, the largest hurdle to overcome resides with that program's implementation and the subsequent evaluation of that program's effectiveness. To surmount this challenge, we utilize a phased PRM implementation approach adhering to the following six steps:

- Assessing the status of the panel before implementation,
- Receiving commitment from all managers (starting with senior managers),
- Customizing the training to reflect the nature and needs of the organization,
- Defining the scope of the program and implementation plan,
- Communicating the nature and scope of the program before startup,
- Instituting quality control procedures

In the process of implementing PRM, not only did we mold our common barriers training to familiar scenarios often manifested with safety reviews, but phased in a "back to basics" training for a concentrated study and application of core safety regulations and ISS systems.

1.1 NASA Safety Panel Structure

To best understand PRM implementation requires an understanding of basic panel structure. Multiple safety panels exist within NASA's Johnson Space Center (JSC), but for the purpose of this paper, we address the International Space Station Safety Review Panel (SRP), and the Payload Safety Review Panel (PSRP). Each of these panels are governed by their charters, the PSRP

¹ Cooper, White, & Lauber. *Resource Management on the Flightdeck*, Ames Research Center; 1980.

with JPC1152.4M - SSP/ISS Program Payload Safety Review Panel, and similarly so, the SRP.

Though different panels, they basically share identical responsibilities; the responsibility for conducting safety reviews in accordance with National Space Transportation System (NSTS)/International Space Station 13830, "Payload Safety Review and Data Submittal Requirements," and to assure the implementation of either SSP 50021 or NSTS 1700.7, "Safety Policy and Requirements for Payloads Using the Space Transportation System;" the "International Space Station Addendum;" and NSTS/International Space Station 18798, "Interpretations of NSTS/International Space Station Payload Safety Requirements."

The Panel assists hardware provider and payload organizations in assuring that safety critical payload subsystems are appropriately verified. Specifically, NASA tasks the Panels with the following functions:

- Assists payload organizations in the interpretation of safety requirements consistent with referenced NASA issuance, for each payload and provides recommendations for implementation.
- Conducts safety reviews as appropriate during various phases of payload development.
- Evaluates modifications to payloads that either affect a safety critical subsystem or create a potential hazard to the Orbiter, Space Station, or crew.
- Evaluates the safety analyses, safety reports, and waiver/deviation requests prepared by payload organizations.
- Assures the resolution of payload safety issues.

Due to similarity in nature, the basic panel construct for the purposes of this paper consists of:

- The Panel Chair, who maintains responsibility for the final disposition of hazard reports and non-compliance reports (NCRs)
- Safety and Mission Assurance Office (Safety Engineer function, who tracks assigned flight hardware, payloads, and operational safety assessments)
- Flight Crew Operations Directorate, representing the Astronaut corps
- Mission Operations Directorate
- Engineering Directorate
- Space and Life Sciences Directorate
- Space Shuttle Systems Integration Office
- Kennedy Space Center - Safety and Quality Assurance Directorate
- International Space Station Safety and Mission Assurance Office (for International Space Station Payloads)

- Extravehicular Activity (EVA) Project Office (for Extravehicular Activity Payloads)
- Safety and Mission Assurance Office (Executive Secretary Position) International Space Station Payloads Office (for International Space Station Payloads)

Each panel member plays an integral role bringing specific expertise in their designated arena essential for successful disposition an review of all hazard assessments brought before the panel. The remainder of this paper discusses methods to enhance the roles and responsibilities of each of these members for the benefit of the panel chairman, and flight safety as a whole.

2. UNDERSTANDING CRM

What is Crew Resource Management? Simply put, CRM is the effective use of all resources. Broken down into specifics, CRM promotes the effective use of resources by improving upon the following key factors usually responsible for breaking down a team's cohesiveness.

2.1 Communication

Communication is the key to success in any endeavor. Misunderstandings lead to errors and mistakes. CRM teaches people to focus on the communication model (sender-message-medium-receiver-feedback), speaking directly and respectfully and communicating responsibility.

2.2 Situational Awareness

Situational awareness conceptually discusses the need to maintain attentiveness during an event. It discusses the effects of perception, observation and stress on personnel. There is emphasis on the need to recognize that situations in the space systems reviews are particularly complex and require full attention.

2.3 Teamwork

Any group that fails to perform as a team is eventually doomed to fail. Failure in the safety review panel settings results in poor panel reviews potentially yielding the unthinkable loss of personnel and major flight hardware. CRM training emphasizes team performance through exercises in the awareness tier and panel interactions during the reinforcement tier. The training also focuses on "leadership-followership" so all members understand their place on the team and the need for mutual respect.

2.4 Decision Making

Decision making describes choices made based on the information at hand. Safety panel decision making relies heavily on risk/benefit analysis. Too little information results in poor risk assessment by decision makers and results in errors, and/or the acceptance of inadequate designs. Too much information overloads the panels and makes it difficult to make effective decisions. PRM training concentrates on giving and receiving information so safety review panels make appropriate decisions.

2.5 Debriefing

During any given flight, a great majority of “learning” or training occurs after the event during the debriefing. The briefer, typically the assigned safety engineer, or in flight terms, the formation commander and/or aircraft commander, structures the debrief to address any and all significant events (both positive and negative) that occurred during the safety review/mission for the benefit of all participants to understand and agree upon what occurred and recognize potential improvements.

3. CRM BARRIERS APPLIED WITHIN SAFETY PANELS

3.1 Barriers to Communication

The setting of a flight safety review, with a multi-member panel and hardware providers, is ripe for the opportunity of miscommunication or barriers that hinder the communication process. As with any conversation or negotiation, challenges arise from the set up of the discussion to negotiating an update for a hazard report. The panel with its diverse membership can vary in its direction of approach to a problem and work towards a solution. This can result in the panel being split with multiple discussions and decisions/assumptions being made. When this is combined with a hardware provider presenting new and difficult design modification, one may wonder how any conclusion or resolution is ever reached.

As the atmosphere and partnership in space business tend toward international relations, it is inevitable that cultural and language barriers can and do arise in a safety review. However, language barriers can also occur when communicating with people from your own country. Each Payload Organization or Hardware Providers that comes before a safety panel brings with him his own set of experiences and preferences that can challenge the communication process.

Barriers also come in the form of the logistics of the conference room. For example, a panel member that has

trouble deciphering some verbal noises choosing to sit in the back of the room, far away from the speaker.

Typically though, the major hindrance to the safety review process is the interaction between the presenters of the hardware information and the panel members. All too often reviews turn into a scenario such as: presenter talks, panel talks, presenter talks, panel talks. What is lost in this cycle is the basic principle of listening to what the presenter is saying. Without listening, there is no way to adequately understand what is being said before responding.

3.2 Situational Awareness Breakdowns

If the need to maintain attentiveness during an event defines situational awareness, then any derailment from one’s attention span creates a situational awareness breakdown. In order to establish situational awareness, human beings take in information through the 5 senses - touch, hearing, smell, sight and taste - and also sub-consciously or intuitively. This information is then transformed by the brain into a mental model of the situation, a process known as perception. The perceptive process depends not merely on current information for its evaluation of the situation but also takes account of past experience. Perception is therefore a product not only of immediate sensations but also of cultural and social influences acquired through a life-time of experiences. Accordingly, because of the different factors which have shaped their lives, individuals interpret situations differently. These same factors can negatively influence people through a loss of situational awareness by providing false information, quite simply by subjecting themselves to a number of degrading influences such as inattention, distraction, under-arousal, stress, boredom, fatigue, etc.

Try though we might, sometimes panel meetings just do not hold everyone’s attention all the time. Some meetings breeze through hazard reports to the tune of 4 an hour (generally for more benign causes such as materials compatibility, some structures and mechanisms reports, and simple electrical mating and de-mating), while the panel may spend 3 days on a single hazard report and 4 hours on one cause within a hazard report. Examples of these more complex reports include Guidance, Navigation and Control (GNC) with respect to collision with visiting vehicles and the International Space Station (ISS), or ground control and monitoring of robotic systems.

The trap panel members’ face under these circumstances is easy to spot if people know the causes for the loss of situational awareness. If a safety panel addresses multiple reports on multiple subjects, then

many different panel members are engaged at any given point in time. However, it becomes quiet easy for the human mind to wander over a prolonged period of disengagement.

Take the following example. During a portion of the ISS assembly sequence EVA crewmembers need to install an overboard Hydrogen Vent Valve in place of an existing water vent valve. For more than an hour, the conversation centered on the structural fatigue of the existing water vent valve and the required torque needed to replace it. Conversation then turned to verifying the number of existing seals on the pressure wall feed-through along with the intra-vehicular activity (IVA) tool and operations required for that procedure. Clearly, this conversation centered on MOD operations and engineering directorate opinion. However, the entirety of this operation centered on the amount of force an EVA crewmember could impart into the feed-through fitting with the EVA tool. The SRP chairman asked the EVA representative for the EVA crewmember force input requirement, and that panel member provided a response. Unfortunately, by the time the SRP EVA panel representative became engaged in the conversation, they'd not followed the entire conversation as close as necessary (recall, for over an hour the conversation centered around engineering and MOD responsibilities) and provided an incorrect input requirement. Luckily, after a poll of exiting actions required to close out the hazard report in question (a function of Debrief for later discussion in this paper), the panel member caught the mistake and the safety panel provided the hardware provider with the proper requirement.

It was a minor incident, but proves that loss of situational awareness is insidious, and difficult with potentially tragic consequences.

3.3 Teamwork Barriers

This section will address teamwork as it applies to the panel setting, in terms of leader/group interface.

3.4 Decision Making Challenges

Generally, the decisions made within a panel setting come nowhere close to intensity of decisions made in the high stress environment of flight operations or medical emergency rooms, but this does not relieve panels from making effective, timely and definitive decisions with respect dispositioning all the various reports and analysis brought before the panel.

Allowing panel members to participate in the decision-making process does not mean that all decisions have to be made by committee. The degree of participation in

the decision-making process depends to a considerable extent on the organizational culture, and in the context of safety review panels, is generally highly reflective of the technical competency of the participating panel members, the presenting hardware provider's hazard analysis and technical support, and the technical perception shared among NASA's departmental agencies.

Though not overly common, the ability to reach unanimous (or even near unanimous) consensus becomes impossible to reach sometimes within a respectable period of time, if ever. However, prolonging a decision in some instances, or the desire to "wait for consensus" similarly leads to unexpected negative consequences.

Take for example a set of continuously revisited hazard reports related to the ISS Regenerative Environmental Control and Life Support System (Regen ECLSS). In late 2005, the SRP received a set of very detailed, well written hazard reports addressing 13 unique hazards and over 100 different causes. Upon completion of that review, the SRP closed out many of the hazard reports, and over the course of the subsequent 5 months, closed all the remaining reports in time for a July 2006 launch to the ISS. However, with its impending, activation aboard the ISS drawing closer, the operations community (MOD) took a closer look and many of the initially agreed upon Operational Control and Agreement Document (OCAD) controls and rejected a good number, subsequently reopening 5 hazard reports.

Over the ensuing months, MOD held multiple day long and three day long meetings with the hardware provider who in turn updated the reports per MOD's direction. These reports then returned to the SRP with the requested modifications. The SRP expected these reports to face minimal confrontation during the panel meeting given the amount of pre-coordination these reports experienced. Surprisingly though, many of these reopened reports met stiff criticism during their subsequent review from MOD, thus leaving the reports "Approved with Modification". The hardware provider included the modifications, resubmitted the reports, and once again, met resistance. This cycle continued two or three times, frustrating both MOD and the hardware provider to the point where effective and constructive communication between the two agencies became abrasive at best, and at times quite heated such that now these two organizations require an additional mediator to preside between discussions with these two factions.

The irony of this situation is that just about every panel member agrees that some of the reopened hazard reports in debate actually only constitute marginal hazards at best, let alone something requiring months of debate

and argument between two NASA centers justifying the deterioration of inter-agency relationship.

In instances such as these, though an inability to reach “consensus” exists, the ability to discern necessary tasks from those deemed not important, and then make a solid, technically sound decision and defend that position preserves invaluable relationships while maintaining, if not enhancing credibility within the panel and safety community. In other words, know when to say “Enough”, and move on.

3.5 Debriefing Necessities

In general, a debrief consists of reviewing and discussing safety review accomplishments, recapping the achievements of the review, addressing the encountered barriers, and discussing how to better accomplish the review next time.

Admittedly, after a long review (much like after a long and exhausting flying mission or 18 car ride across the mid-west plains states), a serious case of “get home-itis” exists, and the last thing anyone wants is to prolong an already long, and sometimes quite tedious work day. Debriefing under these conditions then becomes difficult, but still necessary for the following reason: often, the greatest learning occurs upon the completion of the review during the recap of the day’s events. Thus, to prove the necessity and/or advantages of post review debriefs, consider this next example.

This paper already discussed the scenario surrounding a single incidence resulting from the loss of situational awareness and the debrief that eventually rectified the initial error, but better examples exist. During a recent safety review pertaining to an International Partner’s (IP) visiting vehicle, the SRP addressed what just about every panel member considers “the most challenging hazard report reviewed by the SRP, bar none”. Unfortunately, the SRP began reviewing this vehicle nearly 9 years ago and today only a few panel members still remain from the initial set of members. Even more challenging, the assigned safety engineers to this vehicle “swapped hands” three times with little to no continuity during the handoff. While the minutes from past reviews exist, understanding a vehicle, all its systems and hazard control logic with something so complex becomes difficult from a set of minutes becomes extremely difficult. In fact, a number of these reports complexity are such that the SRP needs to review them on a cause by cause basis as opposed to looking at the hazard report as a whole. While each panel member makes every attempt possible to prepare for such reviews, oftentimes hardware containing this much history is beyond many panel member’s ability to provide much technical input.

On multiple occasions I heard panel member quote “I just don’t have the history with (this hardware) to feel that I can provide much input, so I just sit back and listen”. Perhaps not the best attitude, but certainly an understandable one. While teamwork and pre-briefs help, a solid debrief makes most members feel comfortable because they at least confirm what they understood transpired, and if they disagree on a subject, a debrief offers one final opportunity to address a concern, issue, or clarification point.

Again, take the IP visiting vehicle example. With respect to its collision with the ISS, there are at least 21 different causes, and counting, most of which are considerably complex with multiple integrated hazards and concerns. Very few panel members can claim complete understanding of each and every cause, while some understand a small fraction of the discussion. With an effective debrief (after the end of a 3 day discussion on this one report alone), the safety engineer along with the chairmen discuss every action and issue driving each and every cause to remain open, or the supporting rationale discussing why the SRP agreed to close a cause with each panel member present. This invites discussion at a more basic level, or jogs memories of issues “earmarked” for future discussion. In the case of the above mentioned review, several panel members expressed great thanks for the ability to clarify their notes and in a non-threatening manner confirm, reaffirm, or just learn what took place once the three day’s worth of material was compressed into a final 15 minute discussion.