

INTEGRATING SPACE FLIGHT RESOURCE MANAGEMENT SKILLS INTO TECHNICAL LESSONS FOR INTERNATIONAL SPACE STATION FLIGHT CONTROLLER TRAINING

Evelyn Baldwin

United Space Alliance LLC, 1150 Gemini, Houston, Texas, 77058, USA, Email: evelyn.baldwin-1@nasa.gov

ABSTRACT

The Johnson Space Center's (JSC) International Space Station (ISS) Space Flight Resource Management (SFRM) training program is designed to teach the team skills required to be an effective flight controller. It was adapted from the SFRM training given to Shuttle flight controllers to fit the needs of a "24 hours a day/365 days a year" flight controller. More recently, the length reduction of technical training flows for ISS flight controllers impacted the number of opportunities for fully integrated team scenario based training, where most SFRM training occurred. Thus, the ISS SFRM training program is evolving yet again, using a new approach of teaching and evaluating SFRM alongside of technical materials. Because there are very few models in other industries that have successfully tied team and technical skills together, challenges are arising. Despite this, the Mission Operations Directorate of NASA's JSC is committed to implementing this integrated training approach because of the anticipated benefits.

1. INTRODUCTION

Space Flight Resource Management (SFRM) has been a part of the Mission Operations Directorate (MOD) training program for the past eight years [1]. SFRM was originally modeled after the airline industries' and military's Crew Resource Management. It was designed to address the team skills required during time-critical scenarios found throughout a Shuttle mission [1, 2, 3].

1.1 Brief History of ISS SFRM Model

In 2004, a survey of senior International Space Station (ISS) flight controllers found that many believed a poor execution of or an outright lack of team skills amongst the Flight Controller Team (FCT) would be the root cause of any onboard accident, if one were to occur [4]. Through this survey and the collective experience gained from commanding and monitoring the station for the past nine years, it became apparent that the execution of team skills needed for ISS flight controllers is different than that needed for Shuttle flight controllers. ISS flight controllers operate under the assumption of "routine

operations" where events happen over long periods of time. On the other hand, the Shuttle flight controllers operate during highly scheduled, short discrete periods and dynamic conditions such as launch, deorbit and landing.

Additionally, due to design differences in the vehicles, the ISS FCT routinely sends more commands to the Station than the Shuttle team sends to the Shuttle. For example, between January 2005 and March 2008, the ISS FCT sent approximately 600,000 commands. While, in the span of almost 3 years, the ISS FCT successfully sent the proper command 99.94% of the time, the data shows that the ISS FCT do make errors. Although the ISS FCTs have never made a major error, the potential of making an error that impacts crew safety or mission success does exist.

After reviewing the results of the survey, the ISS SFRM Working Group researched and benchmarked several other 24/7 operational control centers including: Southwest Airlines, Shell Oil, University of Texas-Medical Branch, Air Traffic Control at Hobby airport in Houston, Texas, the Naval Air Warfare Center Training Systems Division in Orlando, Florida, and AmerenUE Callaway Nuclear Power Plant near Fulton, Missouri. They also consulted with human factor and human behavior experts at NASA Ames Research Center and Wylie Laboratories. Using lessons learned from these industries and experts, and building off the current Shuttle SFRM model, the ISS SFRM Working Group developed a new model tailored to the specific needs of the ISS program.

1.2 ISS SFRM Model Description

Designed in 2005, the ISS SFRM model, shown in Fig. 1, resembles a star and emphasizes eight inter-related team skills: Communication, Cross-Culture, Team Work, Decision Making, Team Care, Leadership/Followership, Conflict Management, and Situation Awareness (SA). The eight team skills making up the beams of the ISS SFRM star model were derived from the ISS Human Behavior and Performance Training Working Group (HBPT WG) [5, 6]. In fact, the skills are the same but the

definitions were modified to fit the FCT versus long duration flight crews. For a more detailed explanation of the skills, see O’Keefe. The star model is a visual reminder that the eight skills are interrelated and equally important.



Figure 1. ISS SFRM Model

Furthermore, the interior of the model represents the expected individual approach to any given situation, event or task: Stop, Think, Act, Review (STAR), a tool borrowed from the AmerenUE Callaway Nuclear Power Plant. Before reacting to an event or beginning a task, the flight controller should “Stop” and take the time available to focus on what he or she is about to do. Next, the controller should “Think” about the situation at hand. What are the defining factors and critical circumstances of the situation? How is the situation similar and different from previous situations the controller has experienced? Once the controller has gained a clear awareness of the task or situation, he/she then should develop options including: risks, consequences, worse case scenarios and contingency plans for each option. After deciding on an option, the flight controller must “Act” on the option using error-prevention techniques. During and at the completion of each step of the selected course of action, the controller is expected to “Review” the process and outcome. If the option does not go according to plan (or starts to show signs of veering from the expected), then the controller starts the STAR process over again.

1.3 Project Motivation and Goals

Starting in late 2006, MOD began looking at ways to increase efficiency in the training flows for ISS flight controllers. At the end of the training flows, the flight controller is considered certified. Average certification times for controllers spanned from 18 months to three years. MOD challenged the Improved Certification Enterprise (ICE) project’s team members to research and develop creative solutions that would reduce the time to a mere 12 months. Additionally, previous flight controllers participated in upwards of 30 to 50 eight-hour integrated simulations before becoming certified. An integrated simulation is conducted in a facility very similar to the actual Mission Control Center (MCC) and consists of the entire FCT. While these simulations were the prime training facility for SFRM skills, running them proved costly. Thus, ICE was also tasked with finding a more efficient and cheaper method to train these skills with the goal of reducing the number of eight-hour integrated simulations to somewhere between three to five integrated simulations total.

Ultimately, MOD wants a training program that will produce flight controllers that are able to perform as a highly effective team. This means that each certified flight controller is able to work together to make the right decisions for the success of the mission and crew safety, and to do so in the shortest amount of time. If this approach to training proves to be effective, the same methodology will likely be applied to future programs.

2. IMPLEMENTATION

To meet the needs of the ICE project, the ISS SFRM Working Group again consulted with outside industry, including human factor and human behavior experts at NASA AMES Research center, Wylie Laboratories and Naval Air Warfare Center Training Systems Division in Orlando, Florida. Consultations and research showed that team skills are best learned when they are taught and practiced within the operational context in which they will be used [7, 8]. In other words, they should be trained together with other technical skills. In doing so, the flight controller will not think about the technical side of his/her job without also thinking about the SFRM side. Hence, the team skills will become a way of life and, thus, performed well and without hesitation. Because of the anticipated benefits of using a holistic approach to training in which technical and SFRM skills are integrated, ICE embraced the new training concept.

The first step for implementing the ICE project was to conduct a thorough task analysis of the ISS flight controller’s roles and responsibilities. Likewise, an

explicit list of required team behaviors and skills were determined, stemming from the HBPT WG. These lists are the requirements taught in the new technical training flows for ISS flight controllers. Emphasis is placed on integrating SFRM skills into the technical lessons developed for the flows.

2.1 ISS SFRM Flow Design

The technical flows are divided into three segments: initial training, technical training and post certification. SFRM elements are threaded throughout all three segments.

2.1.1 Initial Training

All newly hired ISS flight controllers, despite the discipline they were hired for, begin their initial training together. Here they learn the common skills required of all flight controllers. This segment is estimated to take two months. The ISS SFRM Working Group developed three stand-alone SFRM lessons designed to introduce SFRM concepts, two integrated SFRM lessons where the student is able to immediately apply the SFRM skill with their newly acquired technical skills and one table-top simulation for initial training.

The three stand-alone SFRM lessons are: ISS SFRM Skills, ISS SFRM STAR, and Gaining and Sharing Situation Awareness. In the first lesson, the ISS SFRM model and the On-console Aid (developed to remind the FCT of the SFRM skills) are introduced. Students are encouraged to draw upon their personal team experiences to define team skills and discuss good and bad examples of those skills. They also review several clips from the made-for-TV movie, *Challenger* (Hearst Entertainment Inc., 2001). The clips are used to generate more discussion on good and bad examples, give the students practice in applying the console tool and practice with identifying cues that the team is moving in a bad direction or becoming ineffective.

The second stand-alone SFRM lesson is the ISS SFRM STAR lesson. Specifically, this lesson focuses on individual performance and decision making: how the flight controller personally can do a better job and have a better chance of not adding a link to a chain of events that could lead to a bad situation. The STAR tool is introduced and the students have an opportunity to practice using it in MCC-specific cases.

The final stand-alone SFRM class taught during initial training is Gaining and Sharing SA. In this lesson, the

students learn the basic theory of situation awareness, how to build it using available resources in the MCC, the importance of building Team SA and skills for doing so successfully. The students also practice sharing individual SA with team members via a handover.

Initial training provides the opportunity for the first two integrated SFRM lessons: Active Listening and Effective Communication and DVIS Operations. These two lessons integrate the team skills necessary to communicate effectively with the technical communication skills required to communicate via the Digital Voice Intercommunication System (DVIS) used in MCC.

In the Active Listening and Effective Communication, the students learn the difference between “hearing” and “actively listening”. The instructor discusses the theory of active listening and why it is even more important in MCC. The lesson includes the challenges of actively listening and communicating effectively in MCC and then goes over techniques to avoid or ease the challenges. The class specifically discusses proper DVIS protocol including standard phrases and the phonetic alphabet. Finally, the instructor discusses the Flight Controller Performance Criteria’s (FCPC), the current evaluation tool for all flight controllers, definition of good communication and then enforces this idea with examples of good, bad and in-between communication.

The follow-on lesson, DVIS Operations, reviews this material and teaches how to operate DVIS in MCC, including hands on practice. The student first learns how to operate DVIS, and then the instructor will define the commonly used loops and when the flight controller would want to talk on the loop. A loop is a communication channel that allows several users to communicate with each other. The student will also practice using proper DVIS protocol, including the phonetic alphabet and standard phrases, and active listening techniques learned in the previous Active Listening and Effective Communication class. Finally, the students demonstrate their DVIS operations and flight loop communication skills to complete an activity requiring effective communication. All objectives are emphasized through hands-on activities and instructor-facilitated discussions.

Finally, initial training is capped with an eight hour table top simulation giving the flight controllers a chance to practice the different team skills. The table top simulation was adapted from a similar table top developed at Ames Research Center. Specifically, the

purpose of the table top simulation is to provide a non-technical, low-fidelity scenario where flight controllers can practice SFRM skills, while also providing opportunity for them to practice and receive feedback on facilitative debriefs and self-correction techniques and finally, provide an opportunity to instill the MOD culture into the newly hired flight controllers.

The lesson begins with a review of the SFRM Skills and expectations for their pre-briefs and debriefs. The flight controllers are then allowed time to pre-brief/pre-plan their strategy for the simulation, using the STAR tool. After presenting their plan to the facilitators, the flight controllers begin the simulation. At the completion of Run #1, the team is lead through an instructor-facilitated debrief focusing on the execution (or lack of) SFRM skills in the run. Learning from Run #1 and the previous debrief, the team pre-plans for Run #2. At the completion of Run #2, the team is again debriefed. However, the team is expected to take a more central role in leading the debrief the second time around. Again, SFRM skills are the central theme to the debrief. Finally, the team is asked to set goals for improving any lacking SFRM skills.

The premise of the runs is a Moon-Base scenario. There are up to four field crews (FC) and one control center (CC). Each FC can be made up of two or more individuals. The CC is only one person. The four FCs all begin at separate launch pads and must traverse to the Moon-Base and back to a launch pad, different from the one they began at within a set window of time, carrying a set range of supplies. Along the way, conditions occur that require the teams to work together and make

decisions while also managing time and resources.

The structure of the table-top’s review of SFRM skills and instructor facilitated debriefs mimic the training taught at the Naval Air Warfare Center Training Systems Division in Orlando, Florida [9]. More specially, the debrief structure is a modified version of their Force of Four where students are asked to identify positive and negative examples of a specific SFRM skill and its consequences, explain the trigger of why that skill was needed, and how the student and/or team could improve that example the next time it happened.

2.1.2 Technical Training

The core of the technical training component of the ICE ISS flight controller training flows is the technical courses designed for each specific discipline. Individual disciplines, combined with other disciplines, also participate in mini-simulations on a weekly basis. Finally, seven SFRM themed mentoring sessions are conducted between senior flight controllers and the flight controllers in-training. In total, this segment is estimated to take approximately 10 months to complete.

As mentioned previously, SFRM elements are found throughout every technical lesson. Furthermore, the knowledge level of the technical skills should match the knowledge level of the SFRM skill addressed, see Fig. 2. For example, if the technical skill is taught at an application level (the student is actually running a procedure) then the SFRM skills addressed should also be at the application level (the actual calls should be made, the student should be required to gain SA prior to

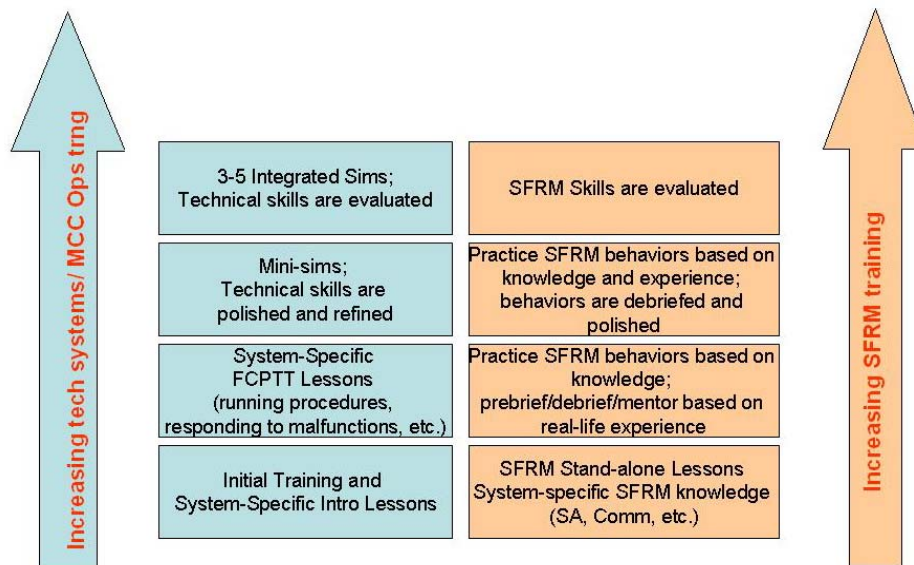


Figure 2. SFRM mapping to technical lessons.

starting the procedure, etc.). Most knowledge level lessons occur in the classroom environment, a computer-based trainer or a workbook. SFRM skills, at a knowledge level, are expected to be integrated into each of these learning environments. Comprehension and application knowledge levels are mostly taught in the Flight Controller Part-Time Training (FCPTT) facility where the student can interface with a model simulating flight software and the MCC environment. In these classes, the student should be demonstrating the SFRM skills required for the task at hand as well as actively participating in the debriefing of these skills at the conclusion of the class.

All flight controllers in-training will participate in mini-simulations on a weekly basis. In the mini-sims, one flight controller per discipline will complete timed tasks and respond to multi-discipline malfunctions as if they were real-life scenarios. The scenarios are the ideal place for the flight controllers to practice both their technical and SFRM skills simultaneously. These simulations differ from the integrated simulations in that they do not require the “big-rig” facilities, are shorter runs typically lasting two to four hours, and, most importantly, are scripted to highlight SFRM skills. In other words, each mini-sim has a specific SFRM “theme”. An SFRM theme is defined as a grouping of two or more SFRM skills. An example for a theme would be a scenario that is scripted to demonstrate conflict management, leadership/followership, and decision making. The event might be one where the designated leader (the flight director, who is role-played by an instructor) makes a poor decision. The pre-brief focuses the team on the specific SFRM theme for the day while the malfunctions and timed items are placed in such a way to give the players plenty of opportunity to practice. Finally, the debrief again focuses on the SFRM theme. The debriefs for the mini-simulations will have a similar format as the debriefs used in the Moon-Base table-top simulations: encourage the students to provide positive and negative examples of a specific SFRM skill, explain the event that caused the skill (or should’ve caused the skill) to occur, explain the impacts of the example and finally set both individual and team goals for the next run.

The technical classes and mini-simulations are punctuated by seven SFRM mentoring sessions focusing on: Personal Factors, Cross-Culture, Conflict Management, Situational Leadership, Self-Care and Team-Care. The seventh mentoring session is completed after the student actively observes the different Communication, Teamwork and SA techniques and

styles used in three different scenarios: handovers, emergencies and routine operations. The mentoring sessions provide an opportunity for senior flight controllers (the mentors) and the students to have a focused discussion about each individual topic. It provides a forum for the mentor to build on the general concepts taught during initial training. Each topic is examined at a more detailed level using science and theory, along with real-world examples provided by the mentor. The mentoring sessions are intended to aid in the transition from classroom lessons to real-world application.

2.1.3 Post Certification

Once certified, the formal training is complete for this particular certification level. However, the SFRM training is an on-going endeavor. The goal is to set the culture so that the newly certified flight controllers understand that their team skills will always need to be debriefed, examined and improved. To help instill this culture, post certification mentoring sessions between the newly certified flight controllers and their previous mentors are scheduled at one month, three months and six months post certification.

At these mentoring sessions, the mentors will discuss how the newly certified flight controller has used and observed SFRM skills when working on-console. At one month, the session is mainly a sync point for the newly certified flight controller to discuss how he/she is using the skills learned during their train flow and ask for additional help in areas where the previous training did not adequately. As the mentor sessions progress, they start shifting from how the newly certified flight controller is currently using the SFRM skills he/she learned during training to discussing observations of the application of SFRM skills used by flight controllers with a more advanced certification. The purpose of these sessions is to start preparing the newly certified controller for his/her next certification training flow.

2.2 Training Technical Lesson Developers

The vast majority of SFRM material found in the flight controller’s certification training flows is embedded into technical lessons. These lessons are written and taught by the technical Subject Matter Experts (SMEs) who are not necessarily experienced in training SFRM skills. Furthermore, training technical concepts alongside SFRM concepts is a paradigm shift from the old training flows where SFRM was only formally discussed in SFRM stand-alone lessons and evaluated in the

integrated simulations. Therefore, providing support and training to the technical SMEs developing the technical lessons is essential.

The training provided to the technical SMEs was three-pronged. First, the ISS SFRM Working Group led discussions about expectations and general guidance was to groups of five to 10 SMEs within the same discipline. Secondly, the ISS SFRM Working Group created and then distributed “one-pagers” or “SFRM cheat sheets” to every lesson developer. Finally, ISS SFRM Working group representatives were assigned to offer assistance and feedback on a one-on-one basis with technical SME lesson developers.

Prior to any lesson development, the ISS SFRM Working Group met with discipline representatives and a number of assigned lesson developers to brainstorm how to best integrate SFRM into technical lessons. These discussions were facilitated by the ISS SFRM Working Group and designed to communicate the expectation that every technical lesson would have SFRM pieces embedded throughout. They were also aimed at guiding the lesson developers to understand that the most natural way to tie together SFRM and technical content is to teach skills and tasks within a mission context. Basically, the goals of these discussions were to set the expectation and present/brainstorm ideas of how to successfully achieve the desired outcome where SFRM and technical skills were taught simultaneously.

After the meetings with each discipline, the ISS SFRM Working Group distributed “one-pagers” or “SFRM cheat sheets” to the assigned lesson developers. The one-pagers were developed by the ISS SFRM Working Group to serve as tools that would give examples of how to integrate SFRM into the various lesson types: Introductory lessons, Nominal Operation lessons and Malfunction-Based lessons. Each one-pager gives suggested discussion points in a typical lesson of that type, suggested questions, and examples of each. It also explicitly maps the suggested discussion and questions to the specific SFRM skill(s) they address. Additionally, each one-pager gives examples of how to include SFRM skills globally within the lesson objectives. The Nominal Operations and Malfunction-Based lessons are assumed to be taught in the FCPTTs and offer suggestions for how the prebriefs and debriefs can also bring out a discussion of SFRM skills.

Finally, ISS SFRM Working Group representatives were assigned to specific disciplines as a point of contact for further assistance and feedback. Each discipline went

about designing their technical segments of the certification training flows a little differently. Thus, having one to two ISS SFRM Working Group representatives assigned one specific flow allowed for a consistent flavor of suggestions and feedback tailored to the needs of each discipline. The amount of assistance requested varied greatly from discipline to discipline. However, feedback regarding the amount and quality of SFRM integrated into each technical lesson was provided at least once for approximately 90% of all lessons developed for the technical segment.

3. PROJECT STATUS

September 2008 marked the start of the newly designed flight controller certification training flows under the ICE project. Because several other factors, aside from the SFRM training flow, were changed or altered through the ICE initiative, it is difficult to measure the impact of integrating SFRM into technical training. However, the feedback and responses received from students participating in dry-runs of the integrated lessons are positive.

3.1 Future Work

While the first round of students begins the newly established certification training flows September 2008, the ISS SFRM Working Group is still tackling future work to support the ICE project. This work includes: developing two additional SFRM stand-alone classes, developing advanced runs of the Moon-Base table-top simulation, and working with ICE and MOD management to determine a standardized method of evaluating SFRM in the technical lessons as well as during simulations.

Two additional SFRM stand-alone classes will be taught during the technical segment of the certification training flows. These two lessons are: Problem Solving Methods and ISS SFRM Case Studies. Problem Solving Methods is conceived as a “just-in-time” lesson taught prior to the student entering into his/her Malfunction-Based technical lessons. In Problem-Solving Methods, the students would learn about various methods for solving problems, which methods work best on-console and how to apply the suitable method to various examples.

The final SFRM stand-alone lesson is ISS SFRM Case Studies. This lesson was taken from the previous SFRM training flow. Currently, the lesson builds upon the various SFRM skills taught in the ISS SFRM Skills lesson. The case studies show examples of how the

SFRM skills were not utilized, and an accident occurred as a result. Specifically, the lesson objectives are:

Given an accident scenario, perform the following:

- Identify the error chain that caused the accident.
- Identify how heightened Space Flight Resource Management (SFRM) skills would have helped break the error chain
- Use the On-Console Tool to determine how the accident could have been prevented

The lesson objectives will not change. Instead, the cases examined will be updated to reflect realistic scenarios that the students may face when on-console.

Aside from developing the two remaining SFRM stand-alone lessons, the ISS SFRM Working Group is currently brainstorming and designing different conditions or rules to apply to the Moon-Base table top simulation. The goal is to create at least two to four more runs of the simulation, with each run requiring more advanced SFRM behaviors to successfully complete the objectives of the scenario. Ideas presently being considered include: changing out teams or team-members mid-run, causing longer periods without communication between team-members, punctuated with short opportunities for communication, and conditions where team-members have conflicting individual goals or objectives. Once these advanced runs are fully developed, they will potentially be added to the certification training flows within the technical segment but prior to the addition of the mini-simulations.

Finally, the ISS SFRM Working Group plans to work with ICE and MOD management to develop a standardized evaluation tool that can be used to provide consistent feedback to students regarding their application of SFRM skills following technical lessons and simulations. Likewise, the tool could be used to reliably evaluate and measure the flight controller's ability to contribute as an effective team member prior to certification. MOD currently uses the FCPC, a list of individual behaviors expected of a flight controller, to evaluate their performance on-console. While the FCPC has behaviors that overlap with the SFRM skills and behaviors identified at the onset of the ICE project, it does not completely encompass every SFRM skill or behavior. An example is communication. The FCPC lists the behaviors expected of the transmitter or the speaker, while the SFRM list of skills and behaviors also lists the behaviors expected of the receiver.

Other potential future work includes: designing a continuum SFRM training flow mapped to the technically advanced certification flows, designing and implementing a method to measure the effectiveness of the newly designed SFRM training flow, creating a new, more standardized method of training lesson developers in how to better integrate SFRM into their technical lessons, and reworking any lessons based on feedback from the first class of flight controllers to certify to the new training flows.

3.2 Identified Challenges

Because this is a new endeavor, challenges are arising. These challenges include: providing the optimal level of training for mentors, lesson developers, and instructors, ensuring that the technical lessons embed the optimal amount and level of SFRM content, ensuring that each explicit SFRM skill is trained at the optimal frequency throughout the training flow, developing a methodology for evaluating the controller objectively for each SFRM skill or behavior, and measuring the effectiveness of integrating SFRM into the technical training flows.

Once it was established that integrating SFRM into the technical flows was the best approach to increase the efficiency and effectiveness of the certification training flow, the first challenge emerged: What is the most effective method of training mentors, lesson developers, and instructors so they have enough understanding of SFRM theory to integrate it into technical lessons, as well as, teach, mentor and debrief the skills? The three-pronged approach described in section 2.2 partially worked. It allowed the expectations to be clearly communicated to every discipline and gave the developers initial ideas and examples of how to integrate the concepts. However, it did not give the developers, mentors or instructors additional SFRM training. They were forced to use their real-time experiences to fill in any theoretical gaps. While real-time experiences often prove to be more applicable than theory, this may lead to skills trained inconsistently from instructor to instructor or discipline to discipline.

Furthermore, the three-pronged approach, coupled with the lack of clearly outlined certification standards (all lessons are certified prior to being taught to the flight controllers in-training), led to another challenge: How is it ensured that the technical lessons embed the optimal amount and level of SFRM content and how is it ensured that each SFRM skill is trained at the right frequency? The first part of this challenge is determining the optimal amount, level and frequency of the SFRM skills that

should be covered in each technical lesson. Until this challenge is addressed, it is impossible to ensure each lesson is achieving this amount. However, more thought should be given to determining a method to track the amount and types of SFRM covered in every technical lesson.

Two final challenges that need to be addressed are determining the best method of objectively evaluating the flight controller on the SFRM skills and also measuring the effectiveness of integrating SFRM into the technical training flows. Because the application of SFRM skills changes with each given scenario, it is hard to determine a purely objective set of behaviors expected from a flight controller. The ISS SFRM Working Group is researching and working on this challenge at the current time. If a good evaluation tool is developed, then, one may be able to use the tool on the students at the beginning of the flows and then again at several points along the way. Using a methodology similar to this may be the solution to measuring the effectiveness of the new ISS SFRM training flow.

4. REFERENCES

1. Pruyn, P., and Sterling, M. (2006). Space Flight Resource Management: Lessons Learned from Astronaut Team Learning. *Reflections: The SOL Journal of Knowledge, Learning, and Change*. 7(2), 45-57.
2. Rogers, D.G., Jenkins-Todd, D., Kempton, R., Miller, B., Bauer, J., et al. (2002). NASA's Spaceflight Resource Management Program: A Successful Human Performance Error Management Program. In *AIAA SpaceOps Conference*.
3. Dillon, S. (2005). Space Flight Resource Management: Mitigating Human Error in Human Space Flight. In *AIAA Space 2005 Conference*, AIAA-2005-6625, Long Beach, California.
4. O'Keefe, W. (2008). Space Flight Resource Management Training for International Space Station Flight Controllers. In *AIAA SPACE 2008 Conference and Exposition*, AIAA-2008-7614, San Diego, California.
5. Bessone, L., et al. (2008). International Space Station Human Behavior & Performance Competency Model, Vol 1. NASA/TM-2008-214775 Vol 1.
6. Bessone, L., et al. (2008). International Space Station Human Behavior & Performance Competency Model, Vol 2. NASA/TM-2008-214775 Vol 2.
7. Allen, J.M. (2006). Advanced Qualification Program. FAA AC No. 120-54A.
8. Seamster, T.L., Boehm-Davis, D.A., Holt, R.W., and Schultz, K. (1998). Developing Advanced Crew Resource Management (ACRM) Training: A Training Manual. FAA AAR-100.
9. Smith-Jentsch, K. A., Zeisig, R. L., Acton, B., and McPherson, J. A. (1998). Team dimensional training: A strategy for guided team self-correction. In *Making decisions under stress: Implications for individuals and team training* (Eds. J. A. Cannon-Bowers & E. Salas), American Psychological Association, Washington, DC, pp.271-297.

Integrating SFRM into Technical Lessons for ISS Flight Controllers

Evelyn Baldwin

United Space Alliance

IAASS Conference 2008

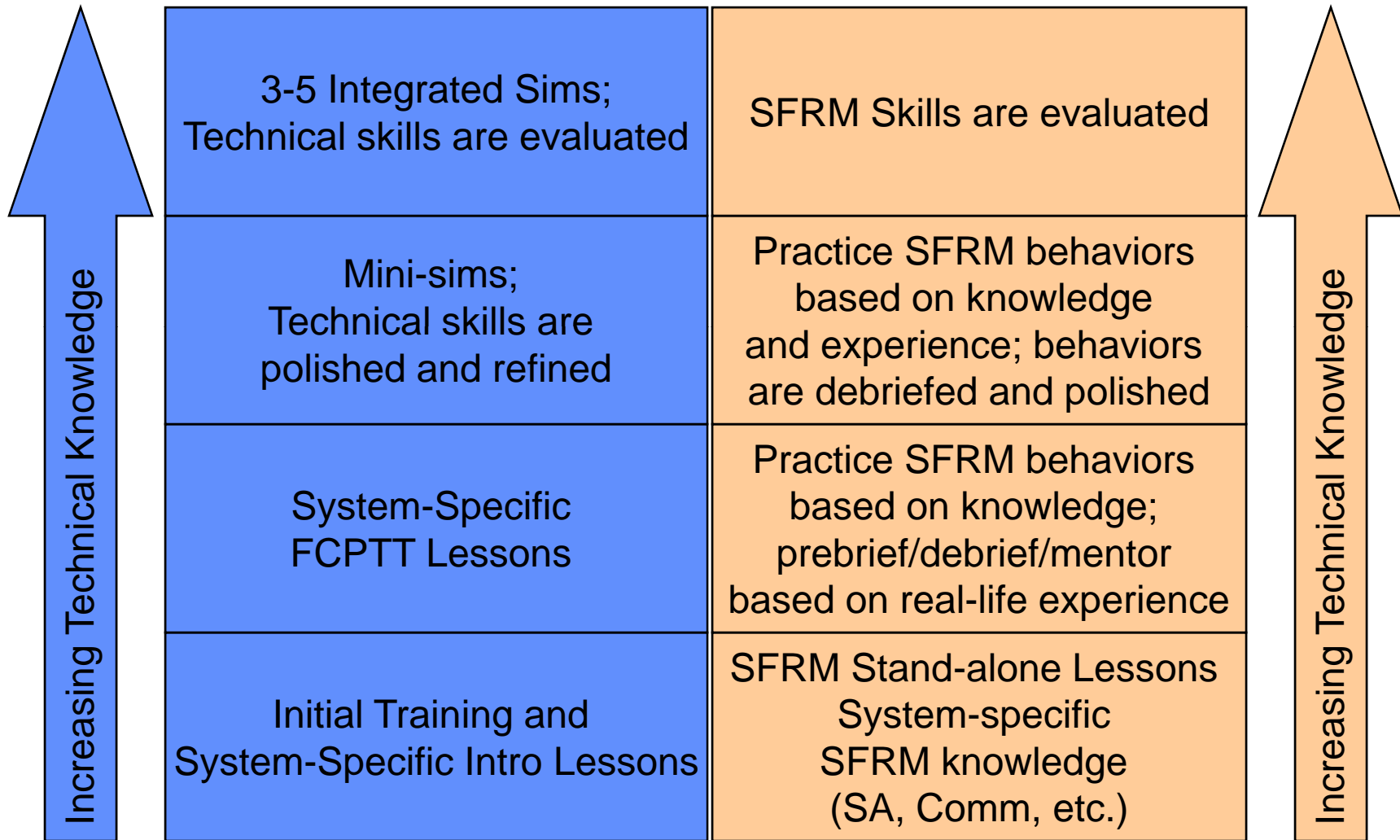
Overview

- **ISS SFRM Model**
- **Project Overview**
- **Identified Challenges**

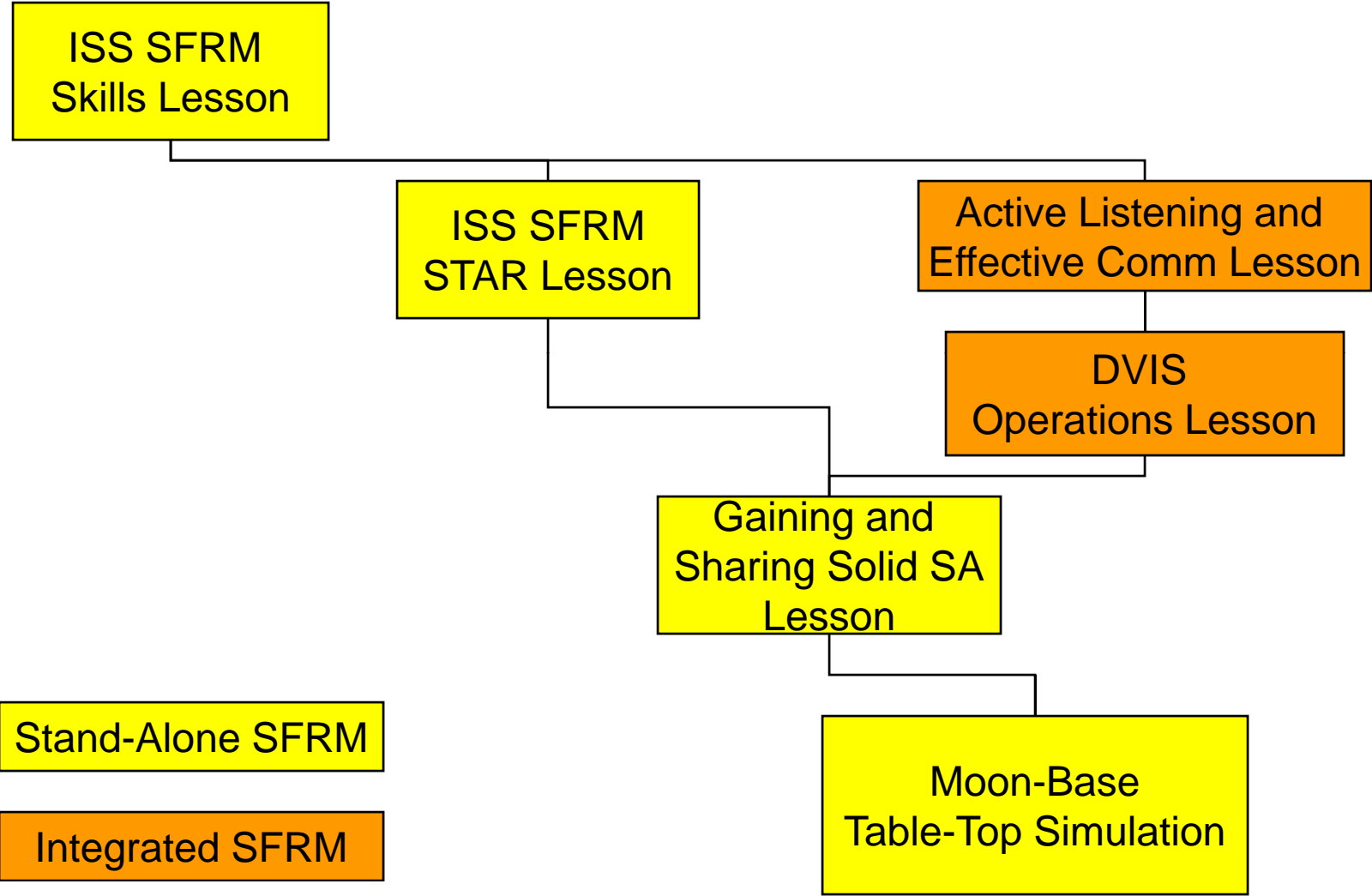
ISS SFRM Model



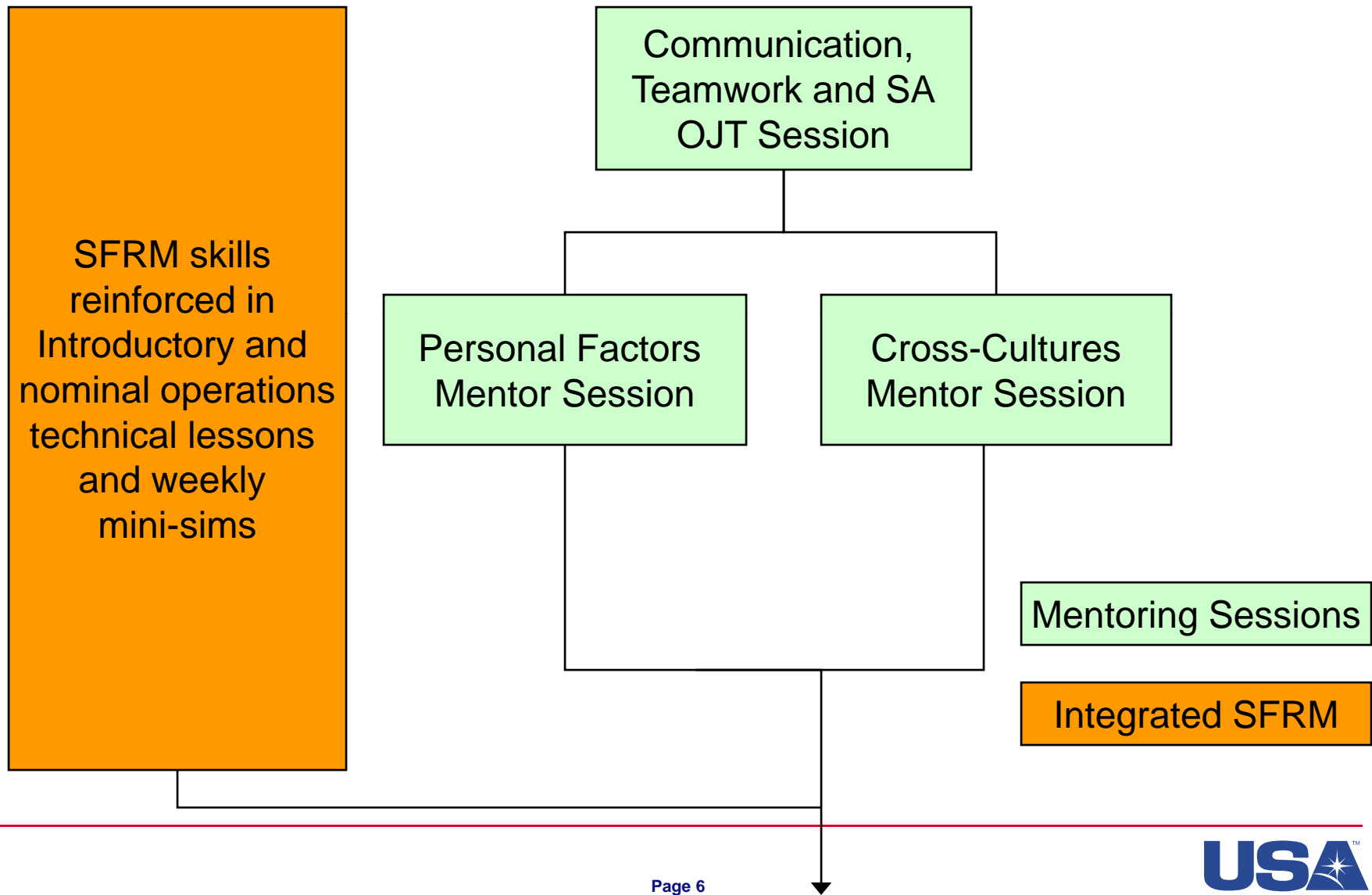
Project Overview



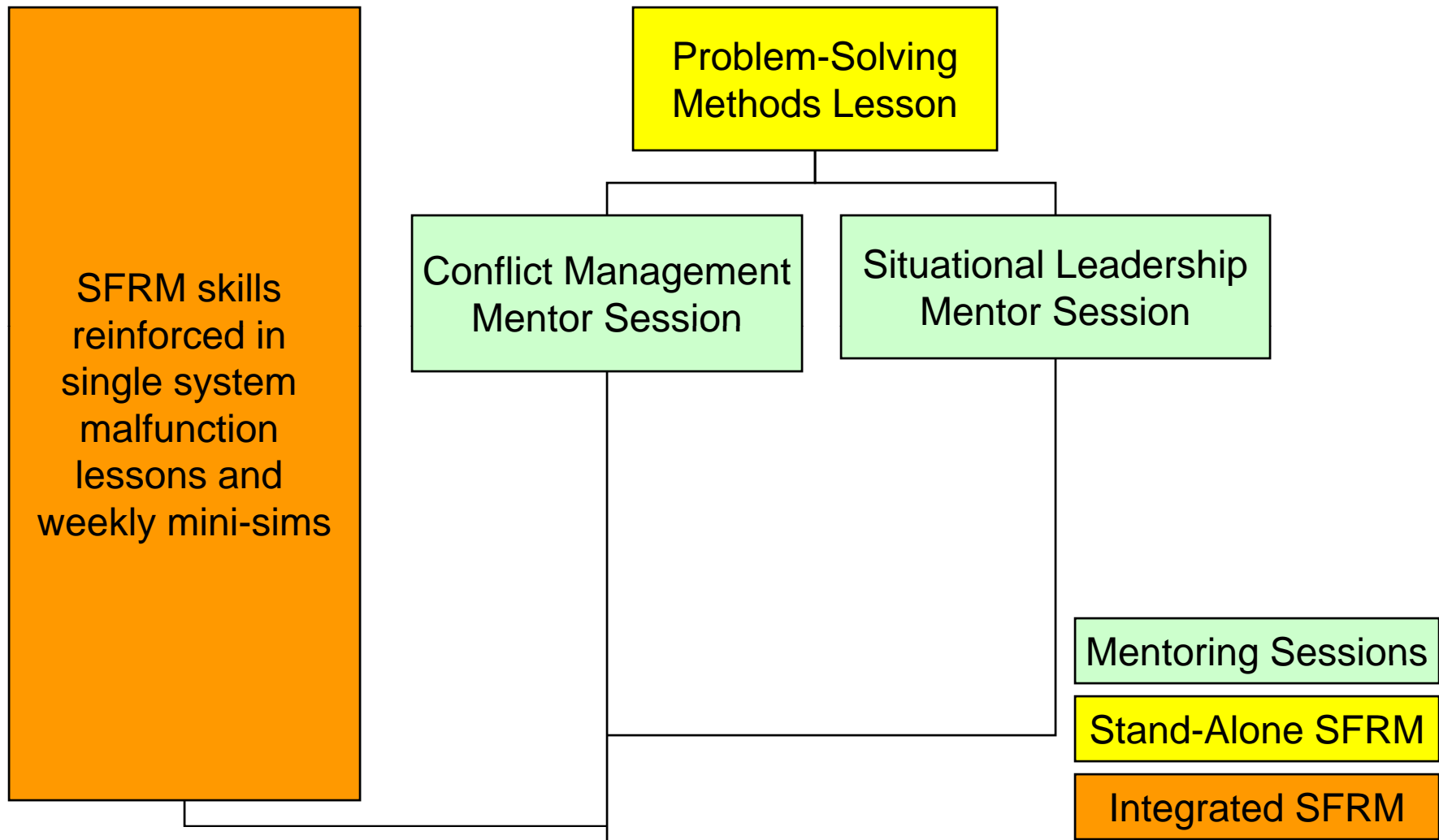
Initial Training



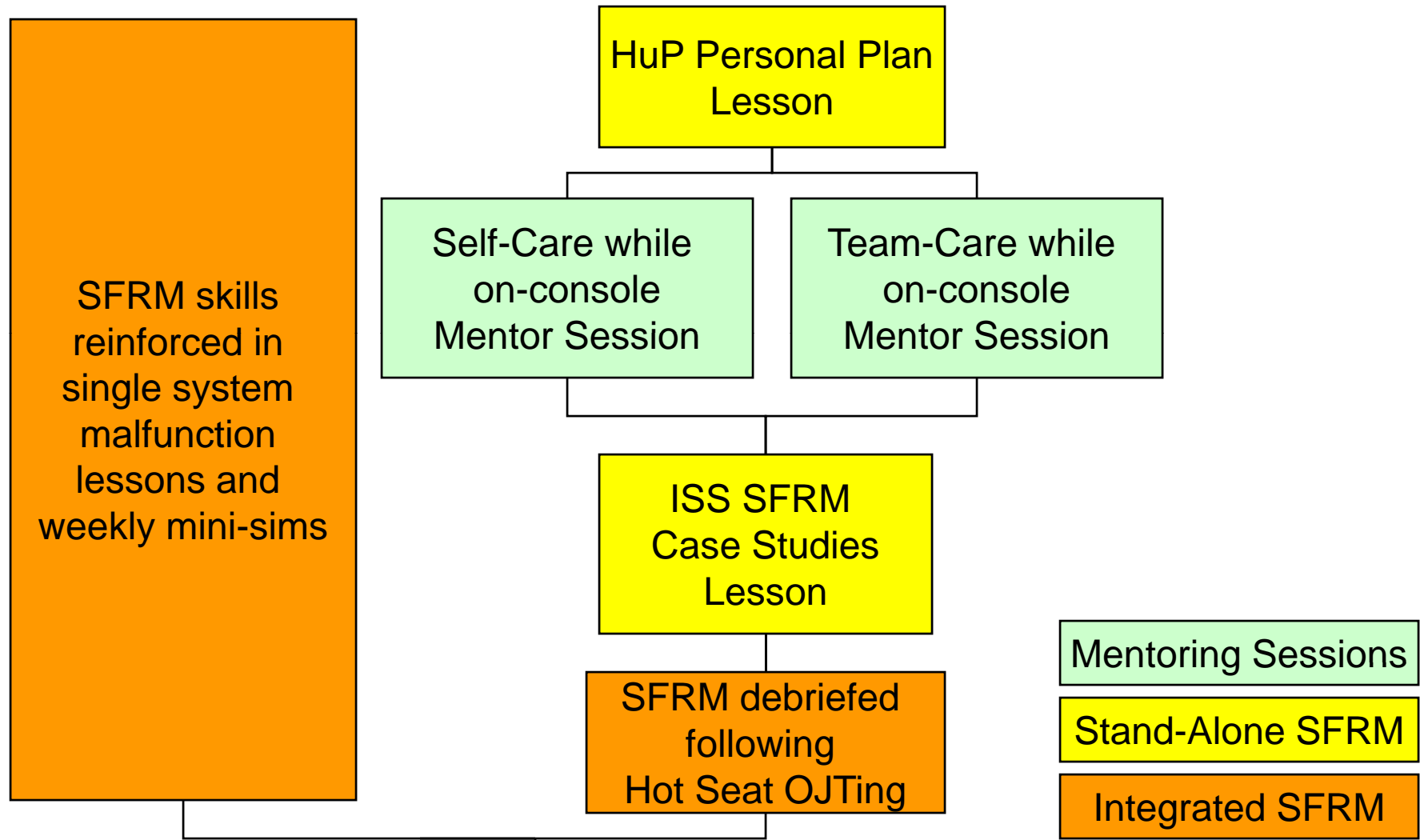
Technical Training: Intro Lessons



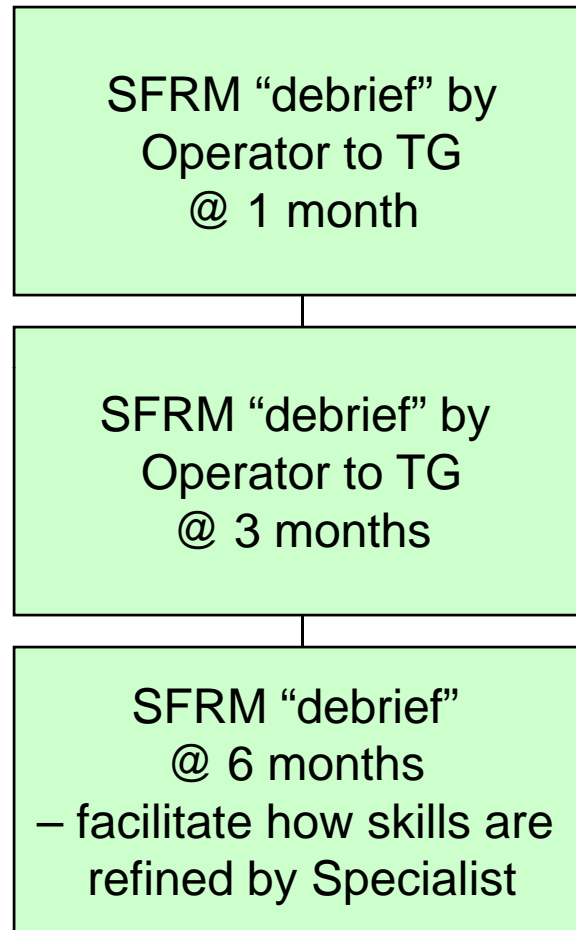
Technical Training: Single System Malfunctions



Technical Training: Multi-System Malfunctions



Post Certification



Identified Challenges

- **Training the lesson developers, instructors and mentors**
- **Ensuring optimal amount and level of SFRM content in each technical lesson**
- **Ensuring that each explicit SFRM skill is trained at the optimal frequency throughout the training flow**
- **Developing an objective SFRM evaluation tool**
- **Measuring the effectiveness of integrating SFRM into the technical training flow**