



AIAA 2001-5121

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International Space Station Utilization – 2001 Conference and Exhibit

15-18 October 2001
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INTERNATIONAL SPACE STATION PAYLOAD TRAINING OVERVIEW

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Abstract

This paper describes payload crew training-related activities performed by NASA and the U.S. Payload Developer (PD) community for the International Space Station (ISS) Program. It describes how payloads will be trained and the overall training planning and integration process. The overall concept, definition, and template for payload training are described. The roles and responsibilities of individuals, organizations, and groups involved are discussed. The facilities utilized during payload training and the primary processes and activities performed to plan, develop, implement, and administer payload training for ISS crews are briefly described. Areas of improvement to crew training processes that have been achieved or are currently being worked are identified.

1. Introduction

Scientists and researchers from many countries will use the International Space Station (ISS) to accommodate their research. Training of astronauts and cosmonauts on payload operations is and will continue to be a challenging task. An overview of the processes for crew payload training is described in this paper.

2. Crew Payload Training Template

ISS payload training planning, preparation, and execution are driven by the payload development schedules and crew availability. Payload training is conducted between 18 to 4 months before increment start (I-18 to I-4). Re-flight payloads are trained early in the flow, while new facility-class payloads and sub-rack payloads

are introduced at ten or eight months before the start of the crews' on-orbit time (I-10 and I-8), respectively. This staggered approach allows operations products for new payloads to sufficiently mature prior to use in training. An overall schedule template of payload training is shown in figure 1.

3. Payload Training Facilities

Payload training for ISS payloads has been centralized at JSC in the numerous training facilities available. The majority of training is conducted in the Space Station Training Facility/Payload Training Capability (SSTF/PTC). This facility has the capability of providing integrated systems and payload training. There are various other facilities also capable of supporting payload training. Among these are the Space Station Mockup & Training Facility (SSMTF), the Neutral Buoyancy Lab (NBL), and various science labs. Using these facilities, most payload training can be accommodated at JSC, reducing the amount of travel required for the crews.

4 Payload Training Development

Payload training development includes defining training objectives, developing training simulators, developing lessons, and on-board training media, and testing and certifying the training.

4.1 Training Strategy Team (TST)

A NASA payload TST process develops payload training objectives and requirements. Using a collaborative team approach, the process allows for inputs from the various groups of personnel responsible for some aspect of training, whether it be training management, curriculum or lesson development, training simulator development, training delivery, training participation, training support, simulation planning

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and execution, or training administration. The official membership of the TST consists of Marshall Space Flight Center (MSFC) training personnel, Johnston Space Center (JSC) training personnel, training facility personnel, crew procedures and display personnel, Payload Developer (PD) Representatives, Crew Representatives, and Program Office personnel. Capitalizing on the broad knowledge base inherent in this team, the process provides a complete training strategy for each payload or experiment. This includes training objectives, media and tools, location and timeframe requirements. The TST begins its work early in the lifecycle of payload development and adjusts its findings as the payload matures. It is necessary to begin early in the process to guarantee training readiness when the crew is available for training.

4.2 Training Simulators

The PD is responsible for providing payload simulators, also known as trainers, to meet the program's requirement for training on the scientific and operational aspects of their payload or experiments as defined by the TST. The Simulation Engineer (SE), who is an MSFC training team member, ensures that the training simulator requirements meet both program requirements and payload training objectives.

A payload trainer consists of a complete mockup of the layout, appearance, and interconnections of all payload or experiment hardware, and shall provide physical interfaces and functional operations from the on-board crew's perspective. The trainer provides the functional and physical fidelity required to support crew nominal and routine maintenance operations, as well as support malfunctions involving crew or equipment safety, or involving failures deemed likely to occur.

Trainers may be a tabletop or a self-contained unit, requiring only power (120 volts-ac) or other standard service (e.g., air cooling, video monitors) from the host training facility. Note that sub-rack trainers may be physically attached into payload facility racks or EXPRESS racks to provide for a more realistic training environment when the appropriate capabilities exist.

Facility Class payloads and their sub-rack payloads that have special safety or time critical procedures involving ground support personnel or that require a station-provided laptop computer interface will be considered for trainers that

interface to the SSTF core systems software simulator. Alternate methods for meeting these training objectives will also be considered.

Verification of the trainers is required prior to shipment to JSC. A second verification test is performed once the trainer is received at JSC to ensure that no damage occurred during shipment and that the trainer operates in its new environment.

4.3 Payload Lesson Development

During the TST process, one of the early decisions to be made is who will be developing and delivering the lessons. While NASA offers this service, the PD has the option of being the instructor for the payload. PDs electing to use this option, agree to take on the responsibility of developing the lesson plans and lesson materials, supporting the lesson verification and instructor certification, and supporting the numerous training sessions. Depending on the lifespan and complexity of the payload, this could be a large undertaking. A PD may elect to hand over responsibility for the lesson to a NASA-provided instructor after the payload on-board configuration has stabilized and the lesson has been successfully developed and delivered.

Crew training lesson content is dictated by the "need to know" philosophy. Only material that the crewmember needs to know to operate the payload should be included in the required lesson material. This content should be reflected in the lesson plan. Supplemental, but not required materials may also be developed and provided to the crew to enhance learning. This material is considered optional training for the crew.

A lesson plan must be developed for each required lesson and delivered prior to lesson and instructor certification. A lesson plan blank book has been developed to ensure consistency across the many instructors developing training. Additionally, a blank book for developing overview training has also been developed to ensure completeness.

4.4 On-Board Training

In the space station training environment, On-Board Training (OBT) is becoming a significant part of the training flow. Due to the long duration of the increments, it is likely that the last training exposure that a crew may have is months prior to on-board execution of the payload. In order for the

crewmembers to stay proficient, on-board training is often required. The maximum allowable timeframe between proficiency training sessions is called a currency requirement. Payloads or experiments with a currency requirement less than 6 months should plan for on-board training. Since payload training ends at I-4 months, there is at least 4 months between the last training session and operation of the payload. In many cases, the timeframe is longer. OBT has become an important way for crewmembers to stay proficient.

While proficiency training is a primary objective for OBT, it can also be used for refresher training and "Just-In-Time" training that trains new material or tasks. OBT requirements will be defined by the TST, and the PD will be responsible for developing the OBT product.

OBT can be delivered in a variety of ways. A Media Requirements Document is under development to define the requirements for the development of the various media. Among them are computer based training, practice sessions, television conferences and procedure reviews.

4.5 Payload Training Dry Runs (PTDRs)

Payload training development culminates with a Payload Training Dry Run (PTDR). This occurs several weeks prior to the crew training event, and is conducted to certify that all equipment, courseware, crew procedures, and instructors are ready for training. The SE and Crew Representative are responsible for certifying the lesson and instructor, with the PD and JSC instructor as invited participants. Actions from the PTDR must be resolved prior to training.

5. Payload Training Integration

For each increment, the Payload Training Integrator (PTI) integrates the payload training requirements. Payload crew task assignments are developed by the PTI and are approved by the Expedition Crew Working Group. The task assignments are necessary because crew training time is a valuable resource and the crewmembers are not completely cross-trained. The task assignments are a critical tool used to plan and schedule the payload training.

Once the payload TSTs are complete, the PTI holds a Payload Complement TST to develop the integrated training requirements for the increment. This involves timeline training and training for payloads that have an on-board interaction.

Payload TST results, together with the payload complement training requirements are compiled to develop the payload training plan for the increment. The training plan and the readiness status of the lessons and trainers are presented in a Training Readiness Review prior to training.

6. Payload Training Implementation

The Crew Training Coordinator (CTC) leads training scheduling and facilitation. Once payload training sessions at JSC are placed on the schedule, the CTC will coordinate with the PD's training representatives, the payload instructor, and the facility support personnel to ensure that the payload/experiment training equipment, support equipment, and training materials are in place for the training. The CTC will also coordinate with the PD and the Payload Operations Data File (PODF) team to ensure that the required payload operating procedures and displays are available for training.

After successful implementation of a lesson and the payload on-board operations have stabilized, MSFC SE responsibilities for instruction and/or logistics coordination are handed over to JSC instructors. A detailed handover process has been developed to ensure the JSC instructor has the knowledge and skill to instruct and/or facilitate the lesson.

7. Recent Changes

Training the first three ISS crews for payload operations has been very successful, however, changes and improvements continue to be made in the training processes, lesson content definition, and training planning, development, and scheduling. Crew training time continues to be oversubscribed resulting in continuing pressure to meet training objectives as efficiently as possible.

An overall crew training budget template has been developed that includes an allocation for payload training. A "payload training week" approach and the "need to know" policy have been used successfully to make more efficient use of crew training time. These activities are improving the training planning process and should result in a more stable training schedule. These approaches will continue to be used and refined.

Since crew training is dependent on crew procedures and displays development, it became evident that training and the development of these products be more closely coordinated. This led to

a reorganization that brought these three functions under single management. The TST process was restructured to include crew procedures and display development as a key component of the training flow. As a result of efficiencies found during this process, PD deliverable dates were moved closer to launch allowing for more maturity in the products needed to support crew training.

An on-board training development process and standard on-board computer based training template are being used for OBT development. On-board training was first conducted on the Middeck Acceleration Characterization Experiment II payload and was very successful.

To date, only standalone trainers have been used for crew training. Based on the success of this approach and in order to cut cost, the program has changed its policy on the requirement of integrated trainers.

8. Summary

Crew training on payloads is a significant technical and management challenge. Limited crew time and training resources make efficiency essential and provides more focus to safety and the research objectives. As the ISS payload complement continues to evolve, challenges will continue to be met.

Figure 1. Crew Payload Training Template

