

ON-BOARD TRAINING FOR US PAYLOADS

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ABSTRACT

The ISS crew follows a training rotation schedule that puts them in the United States about every three months for a three-month training window. While in the US, the crew receives training on both ISS systems and payloads. Crew time is limited, and system training takes priority over payload training. For most flights, there is sufficient time to train all systems and payloads. As more payloads are flown, training time becomes a more precious resource. Less training time requires payload developers (PDs) to develop alternatives to traditional ground training. To ensure their payloads have sufficient training to achieve their scientific goals, some PDs have developed on-board trainers (OBTs). These OBTs are used to train the crew when no or limited ground time is available. These lessons are also available on-orbit to refresh the crew about their ground training, if it was available. There are many types of OBT media, such as on-board computer based training (OCBT), video/photo lessons, or hardware simulators. The On-Board Training Working Group (OBTWG) and Courseware Development Working Group (CDWG) are responsible for developing the requirements for the different types of media.

ON-BOARD TRAINING

Since November 2, 2000 there has been a continuously manned outpost in space, the International Space Station (ISS). At this point in assembly, most of the crew's time on board is spent doing maintenance, construction, and daily "household" tasks, all of which are system tasks. However, the crewmembers are also responsible for the science experiments and their operations. Since most of the on orbit time is spent on system tasks, the majority of training time is related to systems training.

At this time, all of the Expedition crews are made up of

American astronauts from NASA and Russian Cosmonauts from RSA. Just as the crew is a mixture of nationalities, so are the modules built for station. To facilitate training on both Russian and American systems and payloads, the Expedition crews are placed on a training rotation schedule that puts them in the United States about every three months for a three-month training window.

As mentioned above, most of the training time is devoted to system tasks. For most payloads, there is sufficient time to train the crew about their operations on the ground. However, as more payloads are added to the payload manifest, the amount of time allotted to each payload will decrease causing payload training time to become a more precious resource. Less training time requires Payload Developers (PDs) to develop alternate methods to train the crew. Some alternate methods include self-study handouts and on-board trainers (OBTs). OBTs can be used when limited or no time is available on the ground. The crew can also use an OBT to refresh themselves about specific parts of a payload, such as a specific science skill.

There are many types of media contained within an OBT. Some examples are On-Board Computer Based Trainers (OCBTs), Video/Photo Lessons, Hardware Simulators and Models, and Drills and Practical Exercises. Standards for each type of media have been developed or are currently under development. The On-Board Training Working Group (OBTWG) and the Courseware Development Working Group (CDWG) are responsible for developing these standards. Both the OBTWG and the CDWG are working groups of the International Training Control Board, a group of International Partners and NASA representatives that serve as a control board for International Space Station payload and system training. These standards can be found in the ISS Document: SSP50503, International Space Station On Board Training Media Requirements.

On-Board Training can be used on the ISS for three purposes: refresher training, proficiency training, and just-in-time training. Refresher training is training requested by the crew to "refresh" what they have

already been taught on the ground. There is also a 15-minute refresher period for payloads before initial operation of that procedure on-board the ISS. If the crew chooses, they can use an OBT (if the payload provided one) to refresh themselves on the payload. Proficiency training is training the crew is required to complete to maintain their ability to perform a skill. The PD and other members of the training team decide exactly how often the crewmembers should take the training to maintain the skill they have already learned.

Just-in-Time training is used to train the crew on a skill that they have not previously performed. Often just-in-time training is used to train the crew to perform a malfunction operation or some other off-nominal type skill.

PAYLOAD OBT

The most common types of OBT media used by PDs are OCBTs and Video/Photo Lessons. Both of these lesson types are web-based. Since payloads most commonly use those media types, they will be the only types of media discussed in depth in this paper. Other types of media and the scenarios in which they might be used by payloads will be discussed at the end of this

paper.

PAYLOAD OCBT

Of OCBTs and Video/Photo Lessons, OCBTs are the most common on-board payload training media. An OCBT lesson can incorporate both the science and skill objectives that might be taught during a ground lesson. In turn, it might only contain one specific science skill or task the crew may need to perform.

The science information is often presented in a bulleted list, lecture type format. The science information is similar to, or exactly like, the information that would be presented in a ground introduction to a payload. Only with an OCBT, there is not an instructor and the classroom is the ISS. As seen in Figure 1, the information in this picture was taken directly from a crew handout given during ground training.

The skills objectives covered in an OCBT are often presented using the crew procedures developed for the skill. This method is very similar to the method that would be used in a ground lesson. However, the crew doesn't necessarily have ready access to the payload hardware on-board the ISS. Therefore, the crew

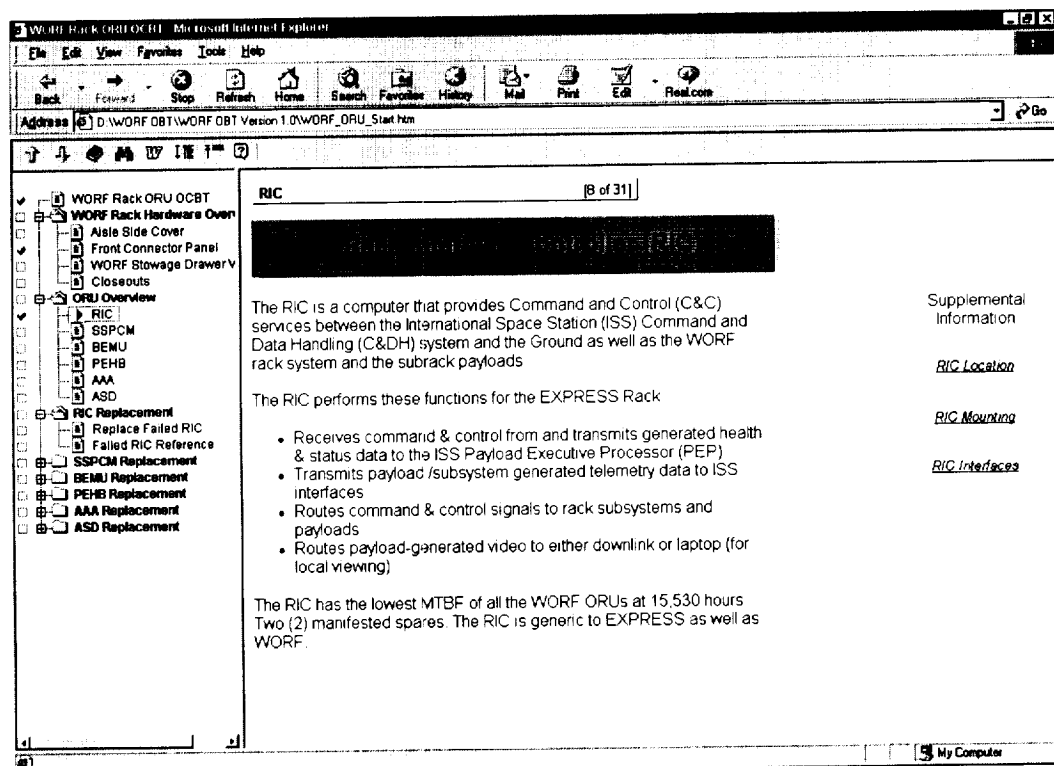


Figure 1- Example of OCBT Science Information Presentation

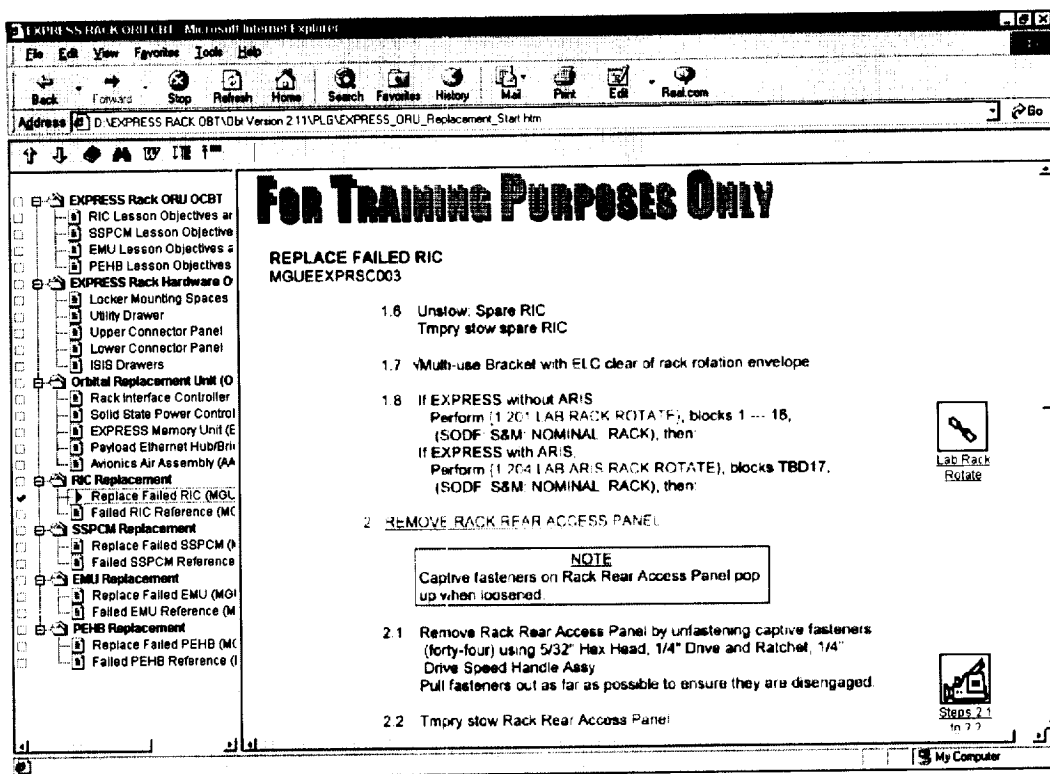


Figure 2 - Example of OCBT Skill Information Presentation

procedures are supplemented with videos and pictures that help orient and teach the crew the proper methods to perform the required skill. An example of the procedural based OCBT training can be seen in Figure 2.

PAYLOAD VIDEO/PHOTO LESSONS

Video/Photo lessons were common on the SpaceLab shuttle flights, especially to train the crew on In-Flight Maintenance (IFM) procedures. IFMs are written during a mission to correct an unforeseen problem on board the shuttle. Until recently, no ISS payload had used a Video/Photo lesson for an OBT. The first Video/Photo lesson created for ISS is a refresher course for a video camera being used on the station. Most Video/Photo lessons are skill intensive and do not include much science information.

An OCBT and a Video/Photo lesson are very similar in appearance and present their information in similar ways. This is to aid the crew in using a Video/Photo lesson since they are already familiar with the layout of the OCBTs. The major difference is that the majority of the text included in a Video/Photo lesson is incorporated in the captioning of video and the transcript of the entire video segment. Science

information, if presented, is not presented in a bulleted format. Instead, the instructor in the video or the video itself presents it. Skill information is presented in the video or photos and is accompanied with captioned audio telling the crew what is occurring, as can be seen in Figure 3. In some cases, the audio may be a narrator reading the actual procedures or a synopsis of the procedures.

OCBT AND VIDEO/PHOTO LESSON STANDARDS

As mentioned earlier, the standards for all OBTs will be contained in the ISS document SSP 50503. However, at this time, only the section pertaining to OCBTs has been approved by the ITCB. Therefore, the following information in the OCBT section is the standard in place now, and the section pertaining to the Video/Photo Lesson is the proposed standard.

Both OCBTs and Video/Photo lessons are designed to run on the Station Support Computer (SSC) on-board the ISS using Microsoft Internet Explorer™ version 5.5. The SSC is an IBM ThinkPad 760XD with the Windows 98™ operating system.

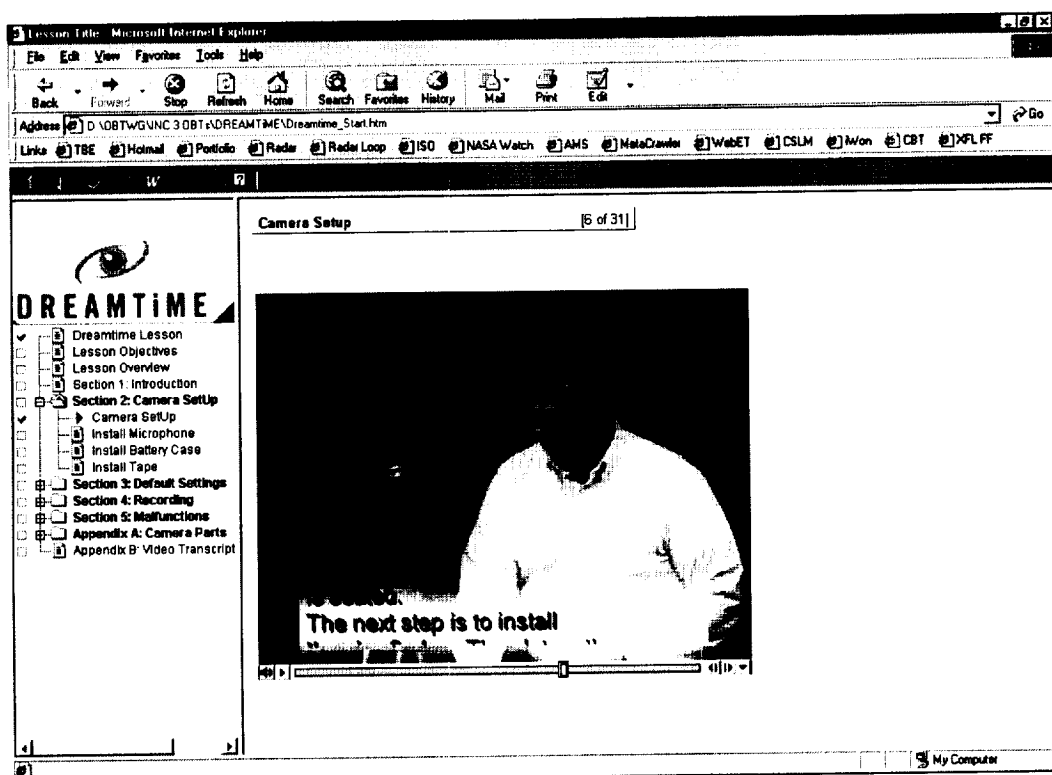










Figure 3 - Example of Video/Photo Skill Information Presentation

The OBTWG developed a template for developers to use when building CD-ROM-based OBT products. The template was used in the lessons used in the figures in this paper and will be shown during discussion of the standards for the OBT lessons.

As seen above in Figure 3, both types of lessons use a frame-based web page format to present the lesson material. The top frame shows icons to be used by the crew. Each icon has a specific purpose. The following explains each icon:

- The  icon takes the user to the previous page in the lesson.
- The  icon takes the user to the next page in the lesson.
- The  icon opens the lesson glossary for the user.
- The  icon opens the OBTWG provided search engine that searches all the text in the lesson.
- The  icon opens Microsoft Word™ for the user to input any notes he would like to keep from the lesson.

- The  icon expands the entire lesson map in the left frame.
- The  icon collapses the entire lesson map in the left frame.
- The  icon allows the developer to incorporate a help file with the lesson.

The left frame of the OBTWG template contains the lesson map. This is a listing of every page of the lesson. The menu map is a three-tier system and allows the developer the opportunity to show the crew the level of detail for each page. As seen in Figure 4, the folder icon is often used to represent a high level overview, the page icon is used for a level of greater detail, and the bullet is used for the greatest detail about the topic. The menu map is designed to be similar to the folder structure associated with Microsoft Windows Explorer™.

The menu map is set up to allow the crew the quickest access to the information they need. By expanding the menu map, the crew can directly click on the topic they want to access. Also, the Payload Communications Officer (PAYCOM) can instruct the crew on which pages they should review, if required.

The lesson content is created using the programming language HTML. Once the lesson pages are developed in the HTML format, they can be easily incorporated into the OBTWG provided template to create an OBT product. The actual lesson space is in the right frame of the web page. This is where the major difference between an OCBT and a Video/Photo Lesson can be easily seen. An OCBT has text and pictures to train the crew, but a Video/Photo lesson teaches with a sequence of pictures or movie clips in the lesson space.

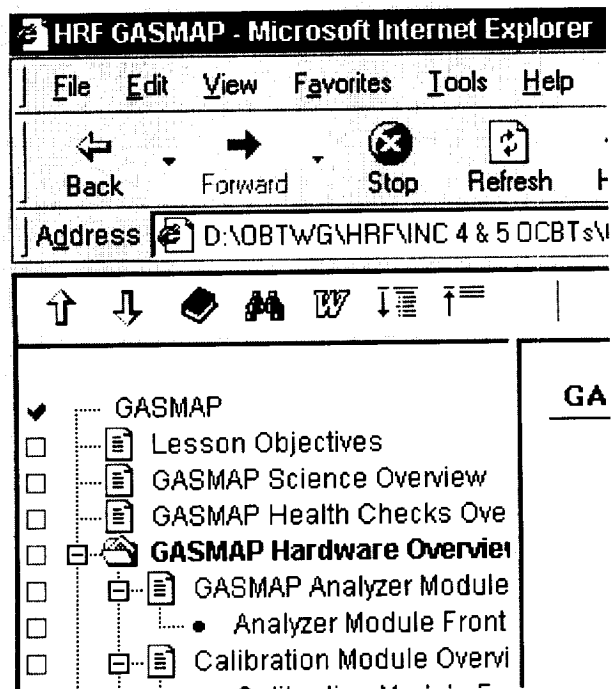


Figure 4 - Menu Map Hierarchy

PAYLOAD OBTs IN ORBIT

At this time, there are thirteen payload OBTs on-board the station. Of those OBTs, all but one are OCBTs. The other lesson on-board is a Video/Photo lesson.

Of the thirteen OBTs, four of them can be used as Just-in-Time training. Of these four OBTs, three of them are used only as Just-in-Time training if no ground time was available. To this point in time, ground time has been available. Therefore those three lessons are currently being used as refresher training. As less ground training time is available, these OBTs will shift to their Just-in-Time role.

Eight OBTs were created for scheduled refresher training, and one was created as a crew requested

refresher. The difference between scheduled and crew requested refresher training is that a PD can opt to use part of her operations time to ask the crew to review the payload's OBT before the actual payload operations. This is charged to the PD's operation time and comes out of the allotment of payload hours.

OTHER PAYLOAD OBT TYPES

As mentioned previously, there have been only OCBT and Video/Photo lessons created for on-board payload training. However, there are some other OBT media types that could be used in the future.

A PD could create Physical or Simulator Models. An example could be a virtual front panel of a payload. If the crew doesn't open the payload and only interfaces with the front panel, then a virtual front panel could be created to allow the crew to simulate operations during a procedure walk-through before actual operations.

Another type of media that a PD may choose to use is On-Board Operational Equipment. An example of this type of OBT media might be supplying the crew with an extra sample and allowing them to walk-through the procedures with that sample before using the actual "science" sample.

Another type of media a PD may choose to use is Teletraining. This media is not readily available because of minimized uplink and downlink capabilities during the assembly phase of ISS. Once assembly is complete or the bandwidth for up and downlinking increases, a PD can conference with the crew to instruct them as if the lesson were taught in a classroom. This method would be the least favorable for a scheduled training session but it would be better to support an in-flight maintenance procedure or other unforeseen training scenario.

CONCLUSION

As available time decreases on the ground for payload training, more OBT products will need to be developed to train the crew. Using the standards developed by the OBTWG, PDs can create products with controls and features already familiar to the crew. This will decrease the amount of time needed to train the crew on orbit, and will increase the crew's training productivity at the same time. Although OBT is not the best way to train the crew to operate payloads, it is the best viable source for training with limited ground time available.

