International Space Station Operations

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Those sustaining the International Space Station (ISS) from the Mission Control Center are known for their ability to monitor a tremendous amount of data; prioritize work; make important decisions quickly; communicate information clearly, concisely, and accurately; and, above all else, work together as a team in an environment requiring constant support. Behind the scenes are the instructors who train both flight controllers and astronauts in individual systems (e.g., power, thermal, communications, etc.); these also require in-depth knowledge of the system and an ability to communicate and convey that knowledge to others while integrating knowledge between systems (figure 1). All of this support is costly. Therefore, to reduce cost while maintaining quality and integrity, we developed a new operations concept for the ISS systems teams.

Fig. 1. *ISS instructor training an Increment flight crew.*

The traditional organization structure for the ISS systems divided flight controllers and instructors into separate groups. This generated separate training programs for the same technical content and introduced the potential for discrepancies in knowledge between groups. The traditional approach to supporting and training the core systems of ISS typically involves three positions: a backroom flight control position (Multipurpose Support Room (MPSR)), a front room flight control position (Flight Control Room (FCR)), and an instructor for each system. A new person in training would enter either the MPSR or the instructor training flows, spend years working towards a certification, and then begin gaining experience in his or her area. The MPSR would then begin additional training for the FCR position. Unfortunately, this method results in an inexperienced instructor training flight controllers to do a job the instructor has never done.

The new organization structure for ISS systems merges the flight controller and instructor groups by consolidating their training and taking the best of these personnel and assigning them to train the crew members and new flight controllers. This method ensures a common level of knowledge between positions and allows the most experienced personnel to become instructors. This creates a more defined career path and ensures a streamlined training process.

In addition to the reorganization of groups, we redefined the positions. A traditional FCR constantly supports console operations, with some positions using MPSR support for routine operations and all positions requiring MPSR support for complex operations (e.g., shuttle missions, extravehicular activities, and visiting vehicle activities). This design results in FCR flight controllers spending a significant amount of time on console during routine operations that do not require their in-depth level of knowledge (figure 2).

Operators, specialists, and instructors make up the new operations concept. An operator supports all routine and quiescent operations on board the vehicle and is trained to “safe” the vehicle in an emergency or off-nominal situation. A specialist is similar to the traditional FCR; this individual provides support during complex operations. If a specific complex operation requires more support than can be provided by a single specialist, the console is either staffed with a specialist in the front room and an operator in the backroom or with a specialist in the front room and a second specialist in the backroom. The complexity of the operations defines which configuration is used.

A specialist undergoes additional training, based on needs and the individual’s aptitude, to certify as an instructor. The specialist already possesses detailed knowledge of the vehicle systems, but requires training in advanced instructional techniques.

To consolidate operations further, we have redefined the division of the core systems. Traditional systems are divided into six disciplines: (1) command and data handling, (2) communications and tracking, (3) electrical power, (4) environmental control, (5) motion control, and (6) thermal control. These six "single" systems have been combined into four "dual" systems. We have therefore combined the command and data handling system with the communications and tracking system, the electrical power system with the external thermal control system, and the environmental control system with the internal thermal control system.

Fig. 2. *ISS specialist flight controller supporting real-time operations.*

Achieving this dual-system configuration requires many changes to the traditional way of doing business. A number of necessary tool improvements for both the operational and the training areas were made to enable this concept. The risk associated with increasing the amount of data being monitored by an individual during routine operations and decreasing that individual's depth of knowledge must be mitigated. This is being done with the development of smart tools that enhance the operator's awareness of his/her system.

Another challenge associated with reducing the cost of operations is reducing the time required to certify an individual in a particular position. We have addressed this by developing a structured training program for each of the dual-system positions. Rather than having individuals progress through a documented training flow at their own pace, this structured training program has a group of new hires train together in formal classes to participate in a shortened standardized training flow. This ensures a standard minimum level of knowledge, provides exposure to senior personnel and their knowledge, and promotes the team environment essential to working in operations.

This new operations concept not only reduces operational costs; it also better aligns with an employee's personal/family life. It allows our newest employees to certify as operators and support the majority of the constant console shifts. These operators are able to accumulate experience in the control center and gain real-time experience as soon as possible after being hired. As they progress, they gain more experience as operators, learn more about the vehicle and its operations, and then train and certify as specialists. The specialist is on a rotation that requires being on call 24 hours a day, 7 days a week, but he/she only supports console during complex operations, when called in for an anomaly, or to maintain console proficiency. As the specialist progresses to being an instructor, he/she is no longer routinely on call. However, the instructor can fill in as a specialist or an operator and will periodically work console to maintain proficiency. The majority of ISS operations are performed by recent college graduates, so the reduced amount of time spent on console as their careers progress fits well as their personal lives evolve to account for families and other changes.

In the end, this operations concept enables a reduction in training time and the number of people required to support operations while, hopefully, increasing morale.

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