October 2010

AEROSPACE AMERICA

X-51 scrams into the future

Conversations with Werner J.A. Dahm

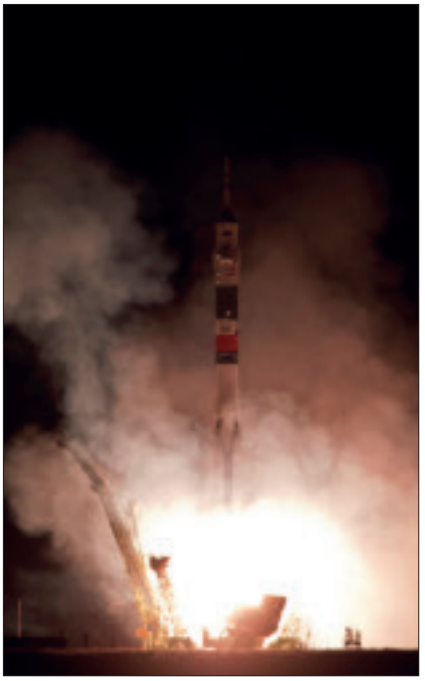
Critical times for India's space program

A PUBLICATION OF THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

Ad astra: The future of NASA's astronaut corps

"There is no easy way from the Earth to the stars" (Non est ad astra mollis e terris via) wrote the Roman philosopher Seneca the Younger in the first century A.D. Given the uncertain future of NASA's human spaceflight plans, the Stoic's words must resonate with present and prospective members of NASA's astronaut corps. They face the 2011 end of the space shuttle era, inaugurating a decade when perhaps only 40 U.S. astronauts may journey to Earth orbit. By contrast, when I first flew as a shuttle crewmember, NASA launched 84 astronauts in just two calendar years, 1994-1995. But those days are gone, and today's corps must grapple with shrinking flight opportunities, new training challenges, and serious questions about the future of human space exploration.

The Soyuz TMA-19 rocket launches from Baikonur Cosmodrome on June 16 carrying Expedition 24 NASA Flight Engineers Shannon Walker and Douglas Wheelock, and Soyuz Commander Fyodor Yurchikhin, to the ISS. Photo credit: NASA/Carla Cioffi.



From a high of about 140 astronauts when I left NASA in 2001, the Astronaut Office numbers today about 65 flight-qualified crewmembers. In addition, a dozen or more veteran astronauts continue to work for the agency in non-flying management roles, contributing hard-won operations experience. For the active astronauts, the mission is clear: To train for and fly expeditions aboard the ISS, and when not flying, to support their colleagues who do.

The six crewmembers of each ISS expedition generally serve six-month tours, and an average of a dozen astronauts and cosmonauts will live aboard the station annually. By partner agreement, Russian cosmonauts fill half those slots. This leaves two for other ISS partner astronauts and four for Americans, all of whom fly aboard the four Russian Soyuz spacecraft, launched annually to provide crew transport and emergency escape at the station. After 2012, the number of U.S. astronauts needed to crew ISS, fill the training pipeline, and cover office technical assignments is about 55, says Brent Jett, chief of flight crew operations at NASA Johnson.

Training for long-haul spaceflight

The ISS has been manned continuously for nearly a decade, starting with the November 2, 2000, arrival of Expedition 1. Supplying crewmembers to keep the station productive and operable for another 10 years is the challenge for the current astronaut corps. Jett, who flew four shuttle missions and commanded STS-115 in 2006, noted in an interview that he personally envies ISS crewmembers, who "really get a chance to 'live' in space," as opposed to just "enduring" the hectic, flat-out sprint of a shuttle mission.

But that long-duration experience has come at a high price. The normal ISS training flow has often exceeded three years, with half the time spent at Russia's Star City for systems classes, simulations, and, for the Americans, a steady diet of Russian language courses. The first few years of ISS expedition training followed the Mir-era "backup crew" model, with each crew of three shadowed by a replacement team that could step into the shoes of the prime crew right up through launch day.

But such last-minute substitutions seldom happened, and backup crewmembers were then fed back into the training grind for a year or more before their own turns came. Watching his prime crew rumble aloft from Baikonur on a trail of golden flame, one backup cosmonaut once turned to his U.S. colleague and wryly lamented the prospect of starting over: "We are now considered the dumbest cosmonauts on the planet."

ISS training managers have now instituted a concept called "single flow to launch," where the backup team trains with the prime crew through launch, then tackles only six more months of expedition-specific classes before flying. First-time flyers typically spend about 2.5 years training for an expedition, says Jett, with less than two years needed for repeat ISS flyers.

Although the travel and family separation burden is still hard on crewmembers, the single-flow streamlining reduces those stresses and makes it more likely that some astronauts will volunteer for a second long-duration flight. Repeat flyers include Peggy Whitson (now chief of the Astronaut Office) and Jeff Williams. Their colleagues Mike Fossum, Don Pettit, and Sunni Williams have all been assigned to their second ISS tours (29, 31, and 33, respectively).

Still hiring?

Shannon Walker, the last member of the 2004 class to fly, is now at the ISS with Expedition 24. Nearly all of the astronauts who will fly on the station in the next decade have already been hired. Will NASA shut down its astronaut selection process? Not at all, says Whitson—NASA will continue to hire them in small

Cosmonaut Fyodor Yurchikhin and NASA astronaut Shannon Walker, both Expedition 24 flight engineers, occupy their seats in the Soyuz TMA-19 spacecraft. On June 28 the crew relocated the Soyuz from the Zvezda service module's aft port to the Rassvet mini research module 1.

numbers, both to replace the few who will leave with the shuttle's final flight and to introduce younger crewmembers into the corps.

"We get literally thousands of applicants," says Whitson, who served on the 2004 selection board and chaired the 2009 panel. "We want a diverse group of candidates," she explains. "People with different backgrounds—pilots, scientists, engineers—can learn from each other." Test pilots share their operational and decision-making experience, while scientists teach their classmates about how research—on the ground or at ISS—gets done.

The 23 members of my 1990 "Hairball" group trained for the challenge of the space shuttle; in 1990, "Space Station Freedom" was just a stack of viewgraphs, and few of us imagined we would ever fly aboard an orbiting outpost called the ISS. The station is now the only flight opportunity available, and astronaut hiring and candidate training reflect that reality.

Formal astronaut qualifications are posted at http://nasajobs.nasa.gov/astronauts/. Jett says that in addition to meeting educational, professional experience, and medical standards, an astronaut candidate, or "ascan," must fit the part physically. Because Russia provides both the crew transport and emergency escape vehicles at ISS, "we won't select a candidate [who can't] fit in a Soyuz."

Who makes an ideal candidate? Whitson, who spent more than a year on orbit with Expedition 5 and as commander of 16, says she's looking for "people who are easy to work with and be around." Surveys of expedition crews, she says, have ranked traits such as "self-caring, team-oriented, good follower, and leadership" at the top of those desired in a future astronaut. A high-maintenance crewmember is poison on a long-duration flight, or even a shuttle mission.

My 1990 classmates were hired either as mission specialists or pilot astronauts. But when the nine new U.S. hires of the 2009 group complete their training, they will be termed astronauts. Only when named to an ISS expedition will they receive temporary designations such as "flight engineer," "U.S. segment lead," or "commander."

Always training

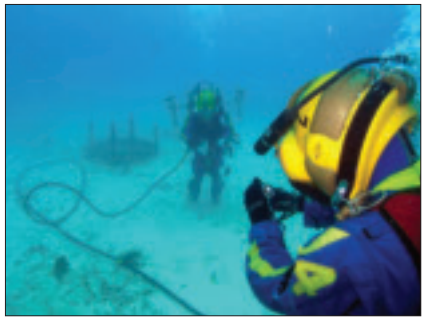
Although the hiring process is not perfect, Whitson thinks the training that candidates receive can confirm first impressions and produce astronauts with the right skills and temperament to succeed aboard ISS. Flight Crew Operations has already refocused astronaut candidate training for the coming decade of long-duration missions.

Jett says that "the astronaut corps is not immune to the fundamental changes that NASA is undergoing, the biggest in 30 years. But in many ways we were better prepared for change, because we already knew the shuttle era was ending." U.S. astronauts have also known since 2005 that Soyuz would be their ticket to LEO for years, pending the development of shuttle's successor. "Other than the current uncertainty [about NASA's long-range direction], not much has changed," says Jett.

The curriculum for the 2009 astronaut class reflects this reality. None of its members will fly on the orbiter, so except for a few ascent orientation sessions in the shuttle mission simulator, shuttle training has been supplanted by ISS and Soyuz systems training, long-duration skills in areas such as robotics and EVA, and Russian language classes.

The language classes are an integral part of Soyuz training. Jett says that he wants to see an experienced U.S. crewmember in the left, flight engineer's seat, working directly with the center-seat Russian commander on rendezvous, proximity operations, and emergency procedures. Shannon Walker took on this demanding engineer role during her June launch to ISS. The right-seater is less responsible for piloting tasks but still has duties in orbit operations and emergencies. Soyuz skills will carry over to

The class chosen in 2009 will train in the NEEMO subsea habitat.



Astronauts Stephen N. Frick (front) and Rex J. Walheim, STS-122 commander and mission specialist, respectively, prepare to fly a NASA T-38.

operations in new commercial or NASA-built vehicles when these appear.

For the past 10 years, ascans have also participated in expedition training. This exposes them to field experiences that showcase team-building and leadership, often under wilderness conditions. The 2009 class members will find themselves on physically demanding treks with the National Outdoor Leadership School, underwater at the NASA Extreme Environment Mission Operations (NEEMO) subsea habitat, or trekking through snow-laden forests with Canadian military survival experts. Instructors critique the candidates' performance in leadership roles, and expedition members see how their colleagues get along in a stressful work environment that demands effective teamwork.

My classmates and I began our 1990-1991 ascan training in the classroom, then practiced in part-task trainers, moving up finally to the mission simulator. Instructors gave few, if any, exams; we demonstrated our competence in practice, but this made it difficult for supervisors to assess individual performance.

Ascans today are evaluated systematically by experienced instructors and astronauts, and NASA is no longer shy about giving feedback. Those who cannot meet standards after supplemental training are dropped from the program before graduation. Throughout the ISS expedition training, right up through launch day, evaluations continue. Russian instructors sent the members of a recent Soyuz crew, a little rusty during their final simulator session, back for refresher training before clearing them for their station launch.

Value of the cockpit

One challenge for Whitson and Jett is exposing new ascans to the dynamic decision-making environment characteristic of spaceflight. Fast-paced emergency-filled sessions in the shuttle simulator in Houston were at the core of this process. But the ISS simulator is better suited to systems or facilities training, where problems unfold over hours or days, and maintenance or repairs might take weeks, as with the August coolant pump package failure.

But spaceflight emergencies do not always grant astronauts the luxury of time. Life-and-death situations can arise quickly, especially during launch and landing, or in the risk-laden hours of a spacewalk. The most effective generic training for those situations, says Jett, comes at the controls of an airplane.

"The value of aviation training is that decisions made in the cockpit have real-world consequences," he explains. No simulator offers that same dynamic environment, demanding a steady stream of critical thinking and decisions, small and large, that determine one's survival. Flying, or "spaceflight proficiency training," gives ascans from a wide range of backgrounds a common grounding in the art of good judgment.

During the shuttle era, astronauts flew T-38 Talon jet trainers, and shuttle pilots trained in the STA (shuttle training aircraft), a modified Gulfstream business jet capable of replicating the orbiter's approach performance and handling qualities. The STA will retire with the shuttle, and the T-38 complement at NASA's Ellington Field aircraft operation in Houston has already dropped from 30 to about 20 aircraft, reflecting the smaller size of the astronaut corps and the reduced need for high-performance jet proficiency in largely ballistic vehicles such as Soyuz, Orion, or many commercial designs.

As the T-38, originally an Air Force trainer, approaches 50 years in service with the astronaut corps, NASA is examining other aircraft to complement the Talon. Candidates include business jets for practicing crew coordination, or modern turboprop trainers like the T-6 Texan II, suitable for introducing the complex aviation environment to ascans without flying backgrounds.

21st-century astronauts

What mix of skills will a future astronaut corps need? Will there be opportunities beyond the current LEO/ISS/Soyuz operations? Jett says he had planned in 2012 to assign a cadre of about six experienced astronauts to flight testing of the Orion vehicle, but that plan is on hold until a firm schedule emerges for either a stripped-down, LEO-only Orion or commercial vehicles.

Veteran astronaut Linda Godwin, who works with Jett in Flight Crew Operations, says much depends on who will be doing the driving: Will commercial vehicles follow a "rental car" model, requiring NASA astronaut operators, or a "space taxi" concept, where commercial crews or ground-based operators deliver a NASA crew to the station?

The astronauts will be involved in the design and testing of any NASA-built spacecraft that emerges from current congressional and White House debate. They also stand ready to advise commercial designers on meeting human spaceflight standards and operations requirements. Beyond 2020, NASA explorers and their international partners may undertake exploration on NEOs, on the Moon, or at Lagrange points such as Sun-Earth L2. These tasks will require scientific exploration skills different from those needed on ISS.

Outside government, commercial access to space may lead to privately owned facilities in LEO. Employee astronauts would tend these, serving in positions ranging from adventure tour guides to researchers in orbiting industrial facilities.

Ken Bowersox, who led ISS Expedition 6 and is a veteran shuttle commander, is now SpaceX vice president

NASA astronaut Tracy Caldwell Dyson, Expedition 24 flight engineer, prepares to exit the Quest airlock of the International Space Station to begin the first of three planned spacewalks to remove and replace an ammonia pump module that failed July 31.

for astronaut safety and mission assurance. He says NASA will need ISS crewmembers who "have the right mindset for long duration [and are] able to deal with the ups and downs in the pace of an expedition."

In contrast to the short, high-intensity sprint of a shuttle mission, ISS crewmembers have the luxury of time. "You can't focus for six months on station with that same intensity," Bowersox says. "On ISS, you can afford to make a mistake, with the knowledge you have time to recover." He points out that the fundamental reason for flying an astronaut is to add value to that specific mission. "We'll need different types....perhaps with broader backgrounds, maybe more experience in the sciences or other activities than in operations."

Corps of Discovery

Today, NASA's projected human spaceflight manifest is relatively high on man-days in LEO, but low on individual opportunity. I waited just under four years for my first spaceflight; new astronaut hires may have to wait a decade, and future flight assignments depend on Washington decisions not yet taken.

If a new program crystallizes in the next few years—whether expeditions to near-Earth objects, a journey to Lagrange points, or pioneering the Moon—crews for testing new vehicles and flying operational missions will be drawn preferentially from the ranks of experienced ISS astronauts. In the tradition of Lewis and Clark, the nation will need a Corps of Discovery to challenge such new frontiers. While cruising the weightless modules of the space station, the astronaut corps is acquiring the judgment, leadership, scientific skills, and—perhaps most important—the stamina needed to navigate the uncertain corridors of NASA's future.

Thomas D. Jones
Skywalking1@gmail.com
www.AstronautTomJones.com