Out-of-this-world engineering

Astronaut Ron Garan, STS-124 mission specialist, conducts a spacewalk outside the International Space Station during last month's mission. Behind him are the blackness of space and Earth's atmosphere. With ISS assembly nearing completion, Boeing engineers are focused on keeping the station functioning properly.

NASA PHOTO

Boeing employees in Houston provide solutions implemented 200 miles above Earth

By Adam Morgan

The largest, most complex engineering feat in history is the International Space Station. Its astronaut crews rely daily on Boeing, the prime contractor for this massive undertaking, to keep it operating flawlessly and to keep them safe in the challenging space environment.

In addition to designing and building the major U.S. components for ISS, engineers from Boeing's Space Exploration division are responsible for integrating the work of an international network of 15 participating countries and hundreds of contractors. Now, with ISS assembly nearing completion, Boeing engineers are focused on keeping the vehicle functioning properly to meet mission objectives.

"We helped develop and now sustain the many systems that operate the ISS. Our engineers integrated these subsystems into a vehicle that has performed exceptionally well on orbit," said Mark Mulqueen, ISS Vehicle director, Boeing Space Exploration. Boeing's role on the ISS includes command and control, communication and tracking, data handling, software development, electric power generation, thermal heating and cooling systems, environmental control systems, and maintaining the structural and mechanical backbone of the ISS to sustain life on orbit.

ISS sustaining engineering teams are intimately aware of the design of the station and stay closely connected to daily vehicle performance, which includes sitting side-by-side with NASA in Mission Evaluation Rooms. MERs are the engineering rooms that analyze data from systems on orbit to identify anomalies. Indeed, last September Boeing engineers in the MER were the first to spot a problem with a giant rotating joint for the solar arrays.

Boeing analyzes more than 400,000 signals such as pressure, temperature and valve positions necessary to operate the ISS. The engineers receive these signals as part of approximately 1.5 million lines of flight software code running on 44 computers communicating via 100 data networks—all designed and produced by Boeing.

Another task is assisting the NASA customer with extravehicular activities, or spacewalks, as well as intravehicular activities, which happen inside the station's pressurized modules.

Boeing engineers ensure the activities go smoothly and help NASA operations understand the intricacies of the system's hardware and software.

"Our engineers take into consideration the human elements involved with many of the tasks," said Terri Puckett, manager, Extravehicular Activity & Crew Systems Integration for Space Exploration. "Our intimate knowledge of the design of the U.S. elements and interfaces with the international elements helps us ensure proper positions for the astronaut performing the work—bolts are reachable, handrails accessible, visible worksites, etc."

There are also times when the team is called on for their expertise on very short notice.

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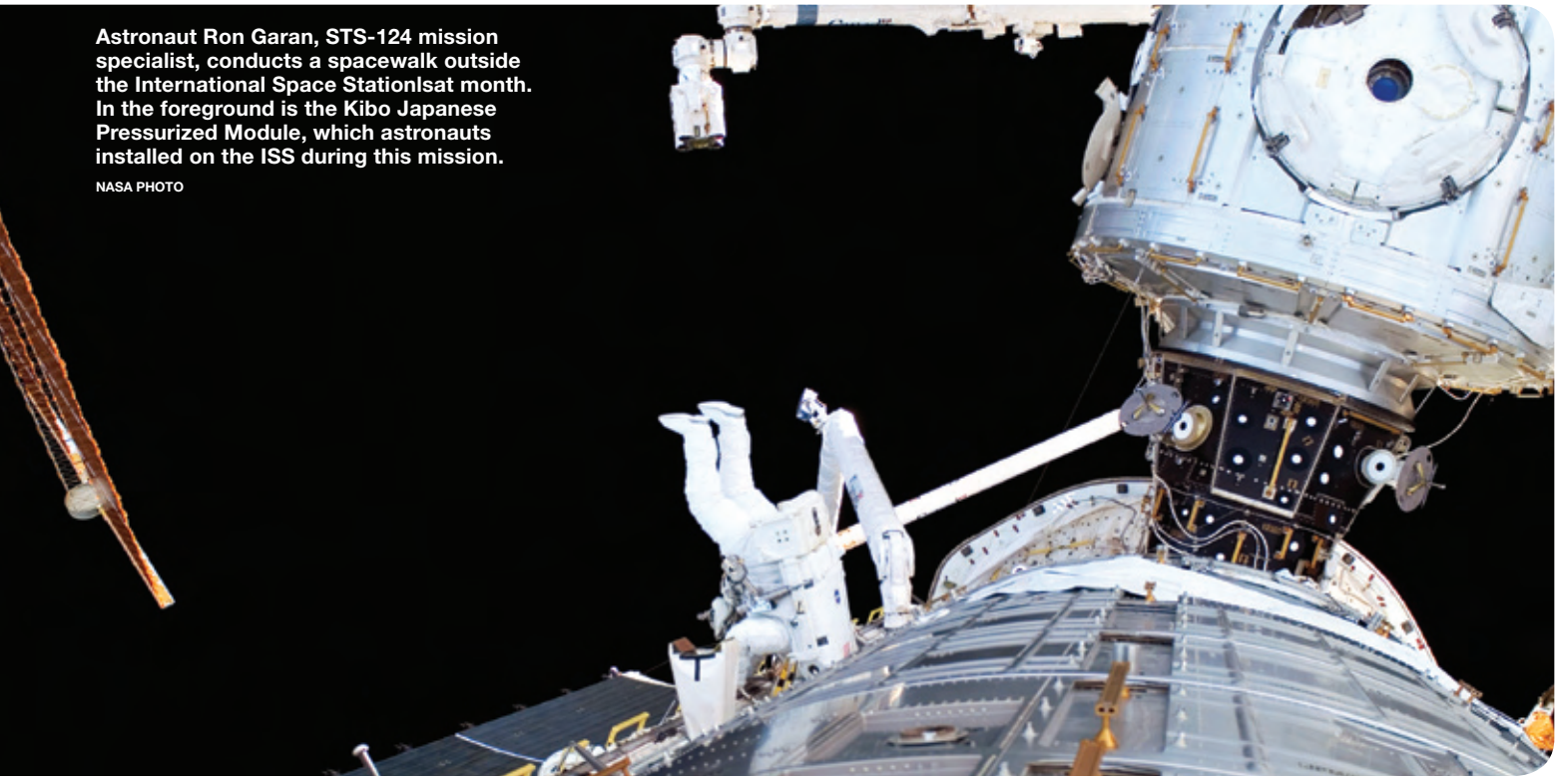

Astronaut Ron Garan, STS-124 mission specialist, conducts a spacewalk outside the International Space Stationlsat month. In the foreground is the Kibo Japanese Pressurized Module, which astronauts installed on the ISS during this mission.

NASA PHOTO

the station," said Patricia Schmidt, Systems engineer, Extravehicular Activity & Crew Systems Integration. "There are interesting engineering challenges to figuring out what already exists on orbit and how to make that work to solve the problem. It can be really exciting."

For example, what if an astronaut is trying to drive a bolt, and that bolt doesn't turn at the recommended torque settings? "It's our job to work with all the engineering groups to resolve that issue," Schmidt said. "When you're performing tasks 220 miles above Earth, you have limited time to complete the tasks, so every minute counts. We have the inherent knowledge and the skills to provide safe, effective solutions very quickly."

The Boeing teams also work with the customers on various mission operation procedures that help maintain the station at its full operating capacity. Some of these procedures involve ensuring that new systems being added are not harming the vehicle or the crew members.

The team helps establish requirements for things such as handrail clearance (crewmembers have enough clearance to grab the handrail), working volume (astronauts have enough working area so they don't become entrapped) and pinch points (areas that could cut a crewmember's glove).

The teams use graphical analysis, mockups and visits to NASA's Neutral Buoyancy Laboratory, the giant pool where astronauts train for upcoming missions in simulated weightless conditions, to work with astronauts on procedures for performing tasks. Some Boeing engineers are certified divers and assist crew members in the 40-foot-deep pool to provide "hands-on" training.

The Boeing team always is looking for opportunities to leverage advances in technology to update station components. Because Boeing has intimate knowledge of the current ISS configuration, and how that configuration is integrated, it is in a good position to analyze where and what kinds of improvements will add the most benefit.

"There is nothing more expensive than launch-to-orbit costs. If we can use technology to extend the life of our parts or subsystems and reduce the need to replace them, or replace larger components with smaller ones, then that's a great benefit to our customer, because it reduces their launch costs," Mulqueen said. "We are in a good position to extend the life of the subsystems because we know how they operate and how to control, repair and improve them." Mulqueen added that the engineering knowledge learned from ISS can also be applied to future spacecraft.

The ISS is scheduled to be in service until 2016 and likely will be extended by NASA to 2020 or beyond. Boeing's thorough knowledge of the station, its rich history in space, and the company's ability to use knowledge from around the enterprise will keep the ISS in step with advances in technology. That will ensure it's operating safely and efficiently throughout its scheduled life and beyond. ■

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