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The final chapter in the space shuttle's long journey of discovery will conclude when the four shuttles are on permanent public display at facilities around the United States.

In April, NASA announced which of a number of competing facilities would exhibit the retired shuttles. Boeing technical leads are working at Kennedy Space Center to support the "safing" of the shuttles as they complete their final missions. Technicians from the United Space Alliance, the joint venture

between Boeing and Lockheed Martin that oversees the day-to-day management of the space shuttle fleet, are following safing procedures that were developed by Boeing.

Bill Roberts, based at Huntington Beach, Calif., is project lead for the Transition & Retirement of the Space Shuttle Orbiter Fleet, a position he has held since 2005. His expertise includes 18 years as vehicle project manager for the shuttle *Discovery* and project manager for recertification of the shuttle

fleet after the *Columbia* accident.

Roberts and his team of transitional technical managers—former subsystems managers for the program—spent more than five years searching every piece of equipment in the shuttle design to identify potential hazards. The goal is to ensure that the retired spacecraft pose no threat to museum staff or the public while on display.

"One key challenge was to write

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Boeing personnel are working to ensure the safe display of retired space shuttles

By Bill Seil and photos by Bob Ferguson

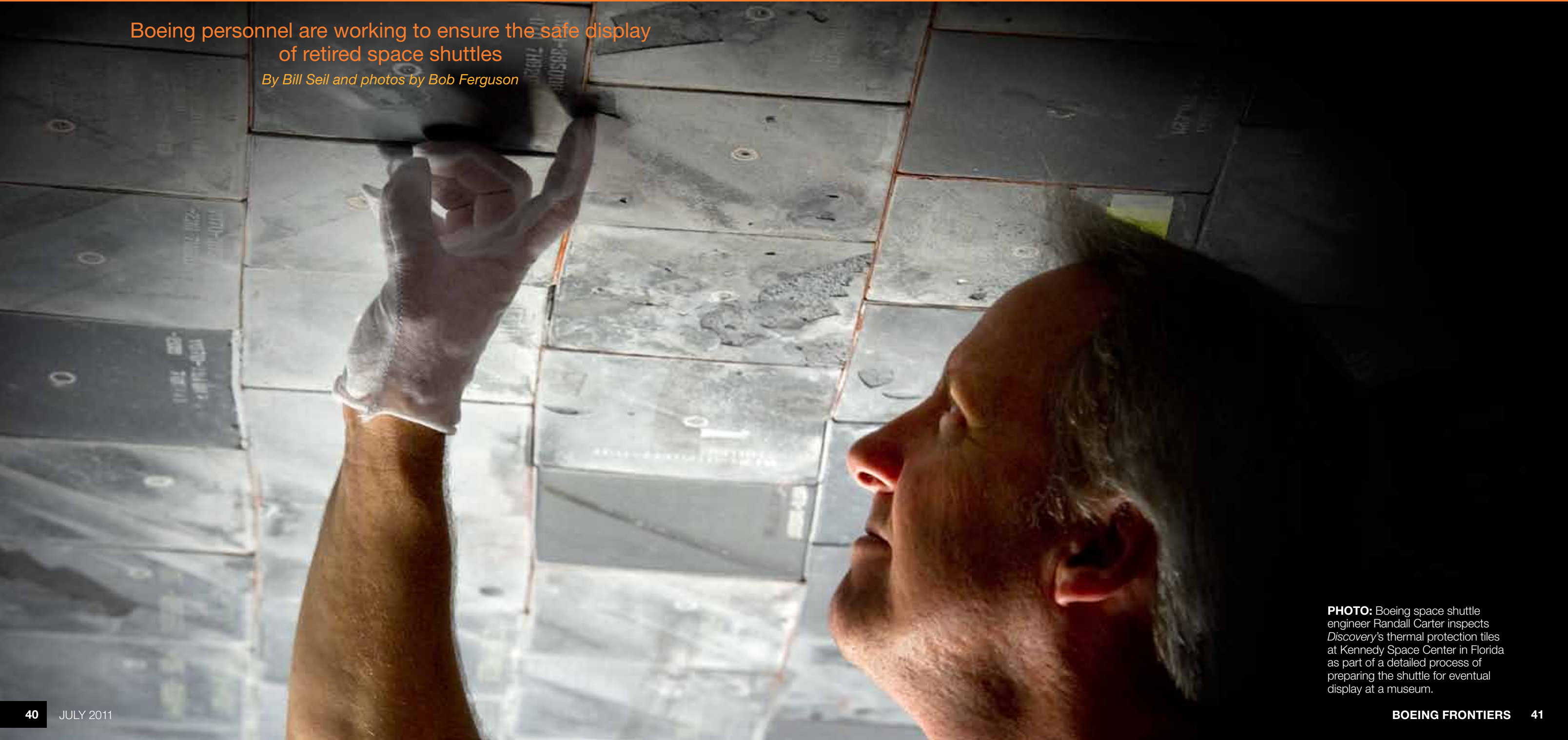


PHOTO: Boeing space shuttle engineer Randall Carter inspects *Discovery*'s thermal protection tiles at Kennedy Space Center in Florida as part of a detailed process of preparing the shuttle for eventual display at a museum.



PHOTOS: Boeing employees prepare *Discovery* for eventual display at the Smithsonian National Air and Space Museum's Steven F. Udvar-Hazy Center at Dulles Airport near Washington, D.C. Clockwise, from top left: Mike Tseghai, Rachel Wiedemann, Jim Melnick, Essam Esmail, Randall Carter and John Frazer. Also pictured is one of *Discovery*'s tires; the tires will be kept in the condition they were in following the shuttle's final landing earlier this year.

PHOTO ILLUSTRATION: (Far right) Boeing's proposed Crew SpaceTransportation, or CST-100, vehicle is shown approaching the International Space Station. If selected by NASA, it would ferry astronauts to low Earth orbit destinations. The space station photo was taken by a *Discovery* crew member. NASA



The next frontier

The space shuttle program is a tough act to follow, but Boeing visionaries are looking ahead to what comes next in manned spaceflight.

As NASA plans its spacefaring strategy for the coming decades, near-term programs are focused on immediate needs. One of the most pressing requirements is to have a U.S. spacecraft capable of transporting people to and from the International Space Station.

Boeing is competing to build a Commercial Crew vehicle—a reusable spacecraft capable of holding up to seven people. It will dock at the space station, serving as both a round-trip transport and, if needed, a lifeboat to return astronauts to Earth in case of emergency. It will also be available for other destinations in low Earth orbit.

Mike Burghardt, Boeing's manager of spacecraft development for Commercial Crew, said space enthusiasts will notice similarities between the Commercial Crew vehicle and the Apollo command and service modules of the 1960s and early 1970s. But the mission is different and the technology is new.

In April, the Boeing Commercial Crew concept passed an important hurdle when NASA selected

the company to continue into the second round of the vehicle's development program.

"Boeing has the experience and technology to support both NASA's near-term plans and help NASA to be successful in the long term as we reach out to explore beyond Earth orbit," Burghardt said.

Burghardt, who was part of the space shuttle team from 1987 to early 2010, notes that military programs also are setting the stage for future space exploration capabilities.

The X-37B orbital test vehicle, which Boeing built for the U.S. Air Force, is a good example of reusable spacecraft technology, he noted. Like the space shuttle, the X-37B is a winged vehicle that lands on a runway after returning from orbit. But the X-37B is unmanned and much smaller than the shuttle. It completed its first successful de-orbit and landing late last year after a 220-day experimental test mission.

Boeing will continue to work with NASA and the U.S. military to advance the future of space exploration, Burghardt said. But future programs could also involve more international collaboration and privately funded projects.

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the requirements for safing the vehicles without disturbing their airworthiness," Roberts said. "After the safing operations are completed at Kennedy Space Center, most of the orbiters must be ferry-flown by 747 to the areas where they will be displayed."

In 2004, then-President George W. Bush announced that the shuttle fleet would be retired following the completion of the International Space Station. *Discovery* and *Endeavour* have already been retired, and *Atlantis* is scheduled

to complete its final mission this month. *Enterprise*, which was not designed for orbital flight, has been on public display for several years and is not part of the current safing program.

Discovery will be displayed at the Smithsonian National Air and Space Museum's Steven F. Udvar-Hazy Center at Dulles Airport near Washington, D.C. *Enterprise*, which is currently on exhibit at the Udvar-Hazy Center, will be moved to the Intrepid Sea, Air & Space Museum in New York City. *Endeavour* will be dis-

played at the California Science Center in Los Angeles. *Atlantis* will only require ground transportation, since it will go on permanent display at the Kennedy Space Center Visitor Complex in Florida. The current schedule calls for all four shuttles being moved to their display locations during 2012.

Roberts said Boeing engineers also will be involved in the movement and final display of the shuttles. One of their chief responsibilities will be to ensure that the shuttles are protected

and that nothing is done to disturb their structural integrity.

"Positioning the orbiters for display is likely to be very challenging, because each display site will probably want to orient the vehicle in a different way," Roberts said. "As the vehicle is being prepared for display, our design team will be available to help resolve any issues."

Roberts noted that Boeing is preparing a data pack for each of the shuttles that will include a complete history of the vehicle—from assembly

through its various missions. The packs will be presented to the facilities that are displaying the vehicles.

"I look forward to getting out to the display sites and making sure that each of these vehicles is, number one, safe for display," Roberts said. "Secondly, I'd like to see them displayed in a manner that highlights their design, because this vehicle is unlike any other vehicle that has ever been constructed by man."

Jim Melnick, a Boeing mechanisms engineer, is among the technical leads

who are preparing the shuttles for display. The son of former shuttle astronaut Bruce Melnick, he has been working on shuttle missions since graduating from college in 2003.

"It kind of brings closure to the whole thing," Melnick said. "I've been able to see the program through to completion, and now I get to see the orbiters off to their final homes." ■

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PHOTO: John Frazer, Boeing Main Propulsion Subsystem Engineering manager, inspects *Discovery* at Kennedy Space Center for possible damage after its final flight.