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# The stakes of reusability



Astronauts aboard the International Space Station greet colleagues after they arrived on the SpaceX Dragon Endeavour capsule.

NASA TV

The space frontier can't be settled with throwaway rockets and spacecraft. Last month's Crew-2 mission to the space station showed that it's possible to re-fly components on missions with people aboard, but the flight also illuminated the great care that SpaceX and NASA had to take to achieve this first. Refinements in processes will be needed to achieve longer-term cost savings without adding unacceptable risk. **Ben Iannotta and Cat Hofacker report.**

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**The SpaceX Dragon Endeavour**  
approaches the  
International Space  
Station.

SpaceX

1 The SpaceX Falcon 9 carrying the Dragon Endeavour and four astronauts is launched from Kennedy Space Center in Florida.

NASA

2 Japan Aerospace Exploration Agency astronaut Akihiko Hoshida eats aboard the Dragon Endeavour as it flies toward ISS.

ESA/NASA-Thomas Pesquet

3 Dragon Endeavour viewed from Dragon Resilience, which docked at the International Space Station in November carrying the Crew-1 astronauts.

SpaceX

4 SpaceX founder Elon Musk, left, and Acting NASA Administrator Steve Jurczyk (backs to camera) watch the Crew-2 astronauts before they ride to the launch pad in Teslas.

NASA

5 NASA managers watch from a firing room as the crew prepares to board the Dragon Endeavour. From left are Steve Stich, manager of NASA's Commercial Crew Program; Kathy Lueders, associate administrator for NASA's Human Exploration and Operations Mission Directorate; and Phil McAlister, NASA's director of commercial spaceflight.

NASA

6 Crew, at left near the NASA worm logo, prepares to walk over to the Dragon Endeavour capsule atop its Falcon 9 rocket.

NASA

**S**oot is not a dirty word to SpaceX. The first stage of the SpaceX Falcon 9 rocket that lofted four astronauts on their way to the space station last month still bore streaks of carbon particles from its launch in November. In fact, commentators before the launch took pains to highlight the soot, showing a photo of the astronauts holding up dirty fingers after scrawling their names in it.

It was a colorful way for SpaceX and NASA to market the broader significance of the pre-dawn liftoff. By safely sending astronauts to the International Space Station on a previously flown booster inside a previously flown capsule for the first time, SpaceX and NASA demonstrated a capability they view as essential for driving down the extraordinary costs of human spaceflight, a strategy that could open up human travel to the moon, Mars and beyond.

Benji Reed, SpaceX's senior director of human spaceflight programs, underscored the point during a briefing ahead of the Crew-2 launch. Reusability is the "holy grail" that will help "make life multi-planetary," he said. Founder Elon Musk provided an exclamation mark during the livestreamed post-liftoff press conference at Kennedy Space Center in Florida: "We don't want to be one of those single-planet species, we want to be a multiplanet species," he said, speaking through a black bandana shrouding his nose and mouth.

NASA has so far certified the "SpaceX transportation system," as it calls the Falcon 9 and Dragon, for a single re-flight, and the mission was in reality just a small step in what Musk has in mind: Rockets and spacecraft must be turned around even more quickly and without sacrificing reliability. "If that can be done, then the cost of access to orbit and beyond

can be reduced by potentially a factor of 100 or more. That's really what is most important about — somebody's got to do this, and if you have rapid and complete reusability, that is the gateway to the heavens."

NASA felt good but not cavalier about entrusting the lives of astronauts to the booster and capsule because of a 10-month-long certification process to clear them for a single re-use under the agency's Commercial Crew contract with SpaceX. The process included observing SpaceX workers on site as they readied the rocket and capsule flown today.

"It's not that we don't trust them. It's just an additional safety measure," said NASA's Tom Simon, the certification manager for the SpaceX crew transportation system, in a pre-launch video interview from NASA's Johnson Space Center in Houston.

SpaceX's Bill Gerstenmaier said the company would not "get lulled into thinking this is fully operational and we're ready to just continue this in an easy manner. This is still very much a learning experience for us."

Adding to NASA's confidence, SpaceX has landed and refurbished individual Falcon 9 stages multiple times to launch its Starlink broadband satellites, among other payloads. In fact, SpaceX is preparing to reuse an individual Falcon 9 booster for the 10th time on an upcoming Starlink launch. The company once considered 10 flights as the maximum for a Falcon 9 booster, but after the Crew-2 launch Musk said he'll now seek to find the limits of reusability on flights when human lives are not at stake: "We do intend to fly the Falcon 9 booster until we see some kind of failure."

SpaceX's streak of launching its satellites without failure has left an impression on NASA: "I think



SpaceX has proven they're pretty darn reliable with the number of launches they've had," said Bob Cabana, director of Kennedy Space Center, in a pre-launch briefing.

As with the company's satellite launches, 10 minutes after the Crew-2 liftoff, SpaceX's John Insprucker confirmed that the booster "successfully landed" on the company's Of Course I Still Love You drone ship in the Atlantic Ocean.

Yet another reusability milestone was scheduled for April 28, when the Crew-1 Dragon capsule and its crew were scheduled to depart the space station for a splashdown in the Atlantic Ocean off Florida. The capsule contains a design improvement that NASA has entrusted for cargo missions but not yet astronauts. Here's the back story: After the Demo-2 capsule splashed down in August, inspectors found heat damage associated with the gaps under the heat shield's surface and the panels over the locations where the four landing legs in SpaceX's original Crew Dragon design would have gone. Years ago, NASA expressed discomfort about the landing leg approach, at least for the time being, so SpaceX shifted to a landing at sea under parachutes and elected to cover the leg holes with panels and thermal protective materials rather than conduct a redesign.

When Demo-2 returned, "we saw a little damage, nothing critical," said Justin Kerr, manager of the Commercial Crew program's spacecraft office, which ensures that the Crew Dragon and in-development Boeing Starliner capsules meet the agency's requirements. SpaceX decided to plug the gaps with a silicon material with iron embedded in it. "Think of it like caulking in your bathroom," except the requirement here is avoid allowing hot gas in during entry, Kerr explained.

SpaceX plans to refurbish the Crew-1 capsule, named Resilience, for the Inspiration-4 mission, scheduled to launch in September. The three-day orbital flight would mark the first time SpaceX has launched private citizens.

With three NASA crew launches completed, "this about the right time to start bringing some commercial folks in and some private astronauts in," Gerstenmaier said.

For his part, Crew-1 commander Mike Hopkins said he was excited to hand over command of Dragon Resilience to a civilian.

"It's an amazing experience, and as we look to kind of transition low-Earth orbit to the commercial industry, this is a big step along that way," he said during a farewell briefing aboard ISS on April 26. ★

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