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Inspiration4 commander and financier Jared Isaacman, right, and Hayley Arceneaux, a pediatric cancer survivor, take in the view from 360 mi. above Earth through a domed window SpaceX developed and flew for its first private spaceflight.

Irene Klotz Cape Canaveral

After flying astronauts three times for NASA, SpaceX entered the commercial spaceline business, becoming the first company to stage trips to low Earth orbit for paying civilians.

Jared Isaacman, Sian Proctor, Hayley Arceneaux and Christopher Sembroski were not the first private citizens to reach orbit, of course. Civilians without scientific or government roles have flown aboard Russian Soyuz spacecraft, the Mir space station and the International Space Station (ISS) as far back as 1990, when the Tokyo Broadcasting System paid to fly a TV journalist.

But the people aboard the SpaceX Dragon Resilience from Sept. 15-18 were the first to fly sans professional astronauts—just four adventurous Americans, ranging in age from 29 to 51, aboard a fully autonomous spacecraft overseen by SpaceX in Hawthorne, California.

SpaceX actually had three Dragon capsules in orbit during that time—two docked at the ISS along with the Resilience private charter circling as high as about 365 mi. above Earth—the farthest humans had been since the final U.S. space shuttle servicing call to the Hubble Space Telescope in 2009.

SpaceX spent six months preparing Isaacman and his guests, none of whom had previously met. Isaacman, 38, the billionaire founder and CEO of Shift4 Payments, is an accomplished pilot who wanted the experience of commanding a spacecraft in orbit. When the opportunity to fly with SpaceX opened in late 2020, Isaacman signed a contract and chose a philanthropic partner—the high-profile St. Jude Children's Research Hospital—to parlay publicity around the mission into a charitable fundraising campaign.

The project, which he named Inspiration4 (I4), was announced in a TV commercial that aired during the Feb. 8, 2021, Super Bowl.

Isaacman gave one crew seat to the hospital to fill and created two contests for the remaining positions. St. Jude quickly settled on 29-year-old Arceneaux, a physician assistant who was treated at the Memphis facility for bone cancer when she was 10. Arceneaux became the youngest person to fly in orbit and the first with a prosthesis.

Sembroski, 42, a Lockheed Martin data engineer from Everett, Washington, clinched the top prize in a St. Jude Hospital fundraiser sweepstakes after the winner, his college friend, declined the trip and gave Sembroski his spot.

Proctor, 51, a community college science professor, artist and pilot from Tempe, Arizona, joined the crew after winning a business contest sponsored by Isaacman's e-commerce company, Shift4. Proctor became the first African American woman to pilot a spacecraft.

On Sept. 15 the quartet climbed aboard the SpaceX Crew Dragon Resilience—a capsule developed in partnership with NASA—and lifted off from Kennedy Space Center (KSC) Launch Complex 39A atop a SpaceX Falcon 9 rocket.

It was just the fourth human spaceflight for SpaceX and its first without NASA oversight. To prepare the crew, SpaceX used the same training programs and procedures it developed for NASA astronauts, culminating in a 30-hr. simulation at SpaceX headquarters. "At the end of that 30 hr, I was like, 'I don't want to leave you guys.' So we're excited to have a little bit longer when we're actually in space," Arceneaux told reporters before launch.

Isaacman added several crew-bonding activities, including a 9.5-hr. climb and camping trip on snow-covered Mount Rainier in Washington state. "We worked on getting comfortable with being uncomfortable," Isaacman says.

He also treated the I4 crew to a Zero Gravity Corp. parabolic flight to experience microgravity and flew them several

times aboard his fleet of fighter jets. Isaacman is the founder of Draken International, a defense company that trains Air Force pilots and owns the world's largest private fleet of military aircraft. He sold a majority stake to the Blackstone investment firm in 2019.

"During the last couple of days," Isaacman said the day before launch, "we've been tearing up the skies with some fighter jets—which I put at relatively higher risk than this mission—so we're nice and comfortable as we get strapped in [for liftoff]."

In a prelaunch interview with Aviation Week, Isaacman was nonchalant in describing how he went about forging four strangers into a high-functioning team capable of spending

as long as five days inside the tight confines of the Dragon capsule. The spacecraft has an interior volume of 328 ft.³—slightly larger than a minivan.

"I've run a company for a really long time, and a lot of that is managing personalities and rallying everybody around a common cause despite different backgrounds and priorities in life," Isaacman says.

From flying air shows, Isaacman gleaned the value of

stronger, and talk it out," he adds. "None of us are superheroes, none of us are 'Top Gun'—we weren't the best-of-the-best selected for this. We're all lucky to be here, and we owe [that] back to others."

For Isaacman, who dropped out of high school at age 16 to work full time on his first computer services business, the most immediate philanthropic payback was to underwrite a \$200 million fundraising campaign for St. Jude Children's Research Hospital, which focuses on treating pediatric cancer.

Isaacman donated the first \$100 million, and by the time he and his crewmates splashed down on Sept. 18 after three days in orbit, the high-profile charity had raised about \$160 million. Later that day, SpaceX founder and CEO Elon Musk joined the campaign, pledging on Twitter to contribute \$50 million.

"We completed all of our on-orbit objectives, but the best part was after splashdown finding out that the \$200 million fundraising goal was surpassed. That was the real 'mission complete, moment,'" Isaacman wrote in an email to Aviation Week.

More private astronauts are on their way to orbit. Next month, Russian actress Yulia Peresild and filmmaker Klim Shipenko will join cosmonaut Anton Shkaplerov for a Soyuz ride to the ISS to record scenes for an upcoming movie.

They will be followed in December with another chartered Soyuz flight to the ISS carrying Japanese e-commerce entrepreneur Yusaku Maezawa and his broadcast production assistant, Yozo Hirano. Separately, Maezawa is paying SpaceX for a lunar flyby mission aboard the company's still-in-development Starship.

While in orbit, the I4 crew spoke with actor Tom Cruise, who also plans to shoot on-location aboard the ISS. SpaceX already is training two more crews for private sorties to the station for Houston-based Axiom Space. The first of those,

Ax-1, is slated to launch in January.

It was this sort of commercial activity that NASA had in mind when it launched the Commercial Crew Program a decade ago and awarded initial development contracts. SpaceX (which was not part of that first funding round)

Inspiration4 crew (from left) Hayley Arceneaux, Jared Isaacman, Sian Proctor and Christopher Sembroski returned to Kennedy Space Center via helicopter after splashdown in the Atlantic Ocean on Sept. 18.

and Boeing went on to win Commercial Crew Transportation Capability (CCtCap) contracts, currently worth a combined \$7.1 billion. The companies, which retain ownership and intellectual property rights to their systems, supplemented taxpayer dollars with undisclosed amounts of corporate funds.

SpaceX is first to leverage its investment by selling orbital flight services to customers beyond NASA. Last year, SpaceX completed a 64-day crewed flight test of its first Crew Dragon capsule, Endeavour, flying two NASA astronauts to the ISS. After receiving NASA certification of its Falcon 9/Crew Dragon system, SpaceX in November began the first of six ISS crew-rotation missions under its NASA



discipline and the need to build trust. "I tried to bring a lot of that to Inspiration4," he says. "Some of the things that were helpful were setting expectations right at the start, seeing where there [were] going to potentially be some issues and getting out in front of them. It builds trust that way.

"There will be problems and stressors that will try and fracture us, and that's when we need to come together, even

contract, worth \$2.725 billion as of Aug. 31. The agreement also covered development and flight tests.

SpaceX is preparing for its third ISS crew ferry flight in late October, using a new, as-yet-unnamed Dragon capsule—the third in the fleet. The company will evaluate its manifest to determine if additional Dragon capsules are warranted, says Benjamin Reed, SpaceX director of human spaceflight.

Boeing, meanwhile, continues to wrestle with technical issues that have delayed its commercial space taxi, the CST-100 Starliner. Its uncrewed orbital debut ended early and without an ISS docking in December 2019 due to software and communications issues. A second uncrewed flight test was scheduled for this August but was delayed when engineers found stuck valves in the Starliner service module propulsion system. Boeing is working toward launching the Starliner late this year or in early 2022, followed by a crewed flight test with NASA astronauts in 2022.

Once operational missions begin in 2022-23, Boeing's CCtCap contract—valued at \$4.376 billion as of Aug. 31—with NASA includes the option of a fifth, fare-paying passenger flying along with a four-member ISS crew.



SpaceX's fourth human spaceflight—and its first for a customer besides NASA—concluded with a splashdown in the Atlantic Ocean about 30 mi. northeast of Cape Canaveral on Sept. 18.

With the I4 mission, SpaceX not only launched orbital flights for non-government customers, it expanded the operational capabilities of the Dragon, which began flying as an ISS cargo resupply ship in 2010 under a separate NASA contract.

Lifting off from KSC at 8:02 p.m. EDT on Sept. 15, the Falcon 9 rocket vehicle placed the Crew Dragon spacecraft into a 360-mi. orbit—about 100 mi. above the altitude of the ISS.

The rocket's second stage completed a faultless orbital insertion as it reached an altitude of 124 mi. just over 9 min. after liftoff. The first stage, which was on its third flight following two GPS satellite-deployment missions last November and this June, also successfully returned to SpaceX's drone ship, "Just Read The Instructions," stationed in the Atlantic Ocean.

The Crew Dragon Resilience also was a repeat flyer, following the November 2020 launch and April 2021 landing of

the NASA Crew-1 astronauts. With Resilience back in orbit, the Crew Dragon Endeavour parked at the ISS to support Crew-2 and a cargo Dragon at the station, SpaceX for the first time operated three capsules simultaneously from its flight control center in Hawthorne.

Unlike any previous Dragon, the Inspiration4 vehicle configuration included a viewing cupola in place of the standard ISS docking mechanism. Measuring 46 in. high X 18 in. wide, the dome is made of a single piece of glass, providing the largest continuous viewing area ever launched into orbit, according to SpaceX. The European Space Agency-provided cupola on the ISS is larger but includes seven individual windowpanes.

SpaceX said it began work on the Dragon window in December and had it ready for flight in six months. "I was not aware that the cupola was in the works at the time Inspiration4 was created," Isaacman says. "To see something in aerospace go from a concept through development, analysis, testing and be flight-ready within essentially six months is unheard of, especially something as significant as the largest continuous window in space."

Shortly after the Dragon separated from the Falcon's second stage, which occurred just over 12 min. into flight, the capsule's nosecone was opened to reveal the cupola. Using its Draco thrusters, the Dragon then performed two circularization burns to transfer to a stable 360-mi.-high orbit.

SpaceX could have increased the Falcon 9's performance and the Dragon's altitude by flying directly east from KSC but opted to stick with the 51.6-deg. inclination that all Dragon missions have flown since the capsule's first flight to the ISS in May 2012.

"It's a road well traveled at this point—the ground station coverage, the recovery forces—it's a route SpaceX is incredibly familiar with," Isaacman says. "There are quite a few differences between our mission and the NASA ones. . . . So I guess the question is: 'How many things are you willing to change for just a first step?' Let's keep some things consistent, from just a safety perspective."

As the crew reached just over 3g during ascent, SpaceX's live video feed showed Isaacman pumping his fists with excitement. "Few have come before and many are about to follow," he radioed to flight controllers in Hawthorne. "The door is open now. It's pretty incredible."

The live feed from Resilience was limited, but the crew participated in several air-to-ground video and phone calls—some of which were rebroadcast—to support St. Jude Children's Research Hospital fundraisers, talk with children being treated at the hospital and perform other activities, including ringing the closing bell of the New York Stock Exchange on Sept. 17. Isaacman's company, Shift4, which handles payments for one-third of U.S. restaurants and hotels, has been trading on the exchange since June 2020.

"There were a lot of critiques about why there weren't more livestreams, since people are used to seeing that from NASA, but we had big gaps in communication coverage," Isaacman said in a post-landing interview with Aviation Week. "As a commercial mission, we were not even close to a high priority for government resources."

In addition to enjoying the view and experience microgravity, the crew took time for some private pursuits—Proctor sketched and wrote poetry; Sembroski played a ukulele. The private astronauts also conducted a series of medical and science experiments in collaboration with

SpaceX, the Translational Research Institute for Space Health at Baylor College of Medicine, and investigators at Weill Cornell Medicine.

The arrival of the I4 crew marked a new—albeit brief—record for the number of people simultaneously in orbit, bringing the total to 14, including crews onboard the ISS and China's Tiangong station. China's three taikonauts returned from an inaugural 90-day mission aboard Tiangong on Sept. 17, two days after the I4 crew reached orbit.

On Sept. 18, it was time for the I4 crew's departure. Flying autonomously as it had throughout the mission, the Dragon capsule's flight computer fired the capsule's Draco braking rockets at 6:20 p.m. EDT. The 15-min. burn slowed the capsule by about 250 mph, allowing its orbit to slip into the atmosphere and setting up a southwest-to-northeast descent across Central America and the Florida peninsula, before splashing down at 7:06 p.m. EDT in the Atlantic Ocean about 30 mi. northeast of KSC.

"Welcome back to planet Earth," Space Operations Director Kris Young radioed to crew. "You've shown that the world of space is for all of us and that everyday people can make extraordinary impacts in the world around them."

"Thanks so much SpaceX," Isaacman replied. "It was a heck of a ride."

Thirty minutes later, SpaceX recovery teams hoisted the Dragon capsule out of the ocean. Following preliminary medical checks, the crew was flown by helicopter back to SpaceX facilities at KSC, where their families awaited.

"It was very emotional," Jason Hehir, director of a documentary series about the mission airing on Netflix, tells Aviation Week. "The feeling of relief was palpable when they walked into that hangar. There's a mixture of exhaustion, jubilation, relief and more than anything gratitude and appreciation from each of them for what they were able to accomplish for not just themselves but also to hit that \$200 million goal for St. Jude."

SpaceX already has some ideas how to improve the spaceflight experience for future travelers, including a food warmer, Wi-Fi and an upgraded toilet. "We had some challenges with it this flight," Musk wrote on Twitter.

The company should have lots of opportunities to test upgrades. "There's tons of interest, and it's growing now a lot," says Reed, who is looking at transitioning to 5-6 Crew Dragon missions per year. "And on the horizon is Starship, which will be able to carry a lot more people at once."

"Ultimately, we want to make life multiplanetary, and that means putting millions of people in space one day. So the long-term vision is that spaceflight becomes airline-like—you buy a ticket and you go," Reed says.

For the immediate future, SpaceX will continue preparing private space travelers with the same training it provides professional astronauts. "It was way more intense than I expected," Isaacman tells Aviation Week. "When you learn



The Inspiration4 crew took a look at the Falcon 9 booster that would launch them into orbit and then land on a drone ship on Sept. 15.

to fly a new jet, you get the manual—the Dash-1—you read through it a few times, take some notes and demonstrate competency, and then you go fly. It can happen pretty quickly.

"I had in my mind—I don't know why—that you'd get one big manual on how to go to space and how Falcon and Dragon work. It turns out it's like 60 PDFs and PowerPoints and a lot of academics," Isaacman says. "Obviously, there are a lot of differences between flying an aircraft in an atmosphere and a spacecraft without one, so it was a lot to learn."

Isaacman says learning how to operate the Dragon was very intuitive. "Sitting down in front of Dragon and navigating through the screens, they present information in a very logical way. I expected it to be awesome, and it was."

Adds Reed, "We'll look at how we can cut back on the amount of

training that's necessary to ensure safety, but right now the appropriate thing is that we still train people like astronauts."

Though NASA had no oversight on the I4 mission, it did provide support services, for which SpaceX paid about \$1 million. They included:

- Integrated communications support among ground control sites and between the ground and space through the Tracking and Data Relay Satellite System (TDRSS) and other Near Space Network relay services.
- Flight operations data communications and transfer services between the Dragon spacecraft and the SpaceX Control Center via TDRSS, including use of NASA spare pseudo-noise code.
- NASA Standard Initiators and Detonators (sold to SpaceX at fair market value under a Commercial Space Launch Act agreement).
- Providing opportunities for the I4 crew to observe Commercial Crew program simulations and providing WB-57 aircraft support for parachute imagery (in exchange for NASA preflight/postflight inspection of chutes).
- Kennedy Space Center launchpad rescue support, flight hardware transfer and security support.
- Propellants, pressurants and hypergolic fuels/oxidizers, equipment and related ancillary laboratory support services.
- Life-support equipment and environmental health services.
- Unmanned aircraft systems imagery service.
- Launch-day helicopter surveillance support.
- Contingency readiness for emergency operations and fire rescue support.
- Guest operations support, including badging and transportation. 📞

—With Guy Norris in Colorado Springs

Check 6 Jared Isaacman shares thoughts on the I4 mission with Space Editor Irene Klotz: [AviationWeek.com/podcast](https://www.aviationweek.com/podcast)