Mars robot helicopter completes first rotor-powered flight on another world

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Early Monday morning, the small robotic helicopter Ingenuity became the first aircraft in human history to successfully make a powered, controlled flight on another planet. The Ingenuity team at the Jet Propulsion Laboratory (JPL) received data from the successful flight at 6:46 Eastern Time, demonstrating vast technical achievements and scientific possibilities by flying through the atmosphere of Mars.

"We have been thinking for so long about having our Wright brothers moment on Mars, and here it is," said MiMi Aung, project manager of Ingenuity at JPL, amid celebrations by her fellow Mars explorers. "We will take a moment to celebrate our success and then take a cue from Orville and Wilbur regarding what to do next. History shows they got back to work—to learn as much as they could about their new aircraft—and so will we."

Ingenuity took off from the Martian surface, an "airstrip" now dubbed Wright Brothers Field, at 12:33 local Mars time. This time had been previously determined by Ingenuity's controllers in order to provide maximum sunlight and optimal flight conditions for the solar-powered rotorcraft. Data returned from its onboard altimeter and other instruments confirmed that every aspect of the flight went as planned: over 39.1 seconds, the helicopter spun its rotors up, took off, climbed to its maximum altitude of three meters, hovered, made a quarter turn, continued hovering, descended, and finally touched down on the Red Planet.

Imagery from Ingenuity's parent craft, the Perseverance rover, also confirmed a successful flight. The Mast Cam Z instrument on Perseverance made a short video of the helicopter's flight, capturing as it happened this new first in planetary exploration.

As with all achievements in space travel, the first successful powered flight on Mars was extremely demanding. One of these difficulties manifested last week, when the craft was first scheduled to fly, when an error was detected during a pre-flight rotor test. After several days carefully studying the issue, updated software was uploaded to Ingenuity, allowing its onboard guidance, navigation and control systems to take off and land flawlessly.

Moreover, Earth and Mars are currently about 288 million kilometers apart, meaning that radio signals take more than 16 minutes to cross that distance. This means that the helicopter can't simply be flown by joystick in real time and thus the flights must be autonomous. In addition, it had to be designed to fly in gravity that is about one third that of Earth in an atmosphere about one percent as dense as Earth's.

Ingenuity is one component of NASA's Mars 2020 mission, which also includes the Perseverance rover. While the main aspect of the mission is the rover and its extensive astrobiological experiment suite, Ingenuity was added as a test bed to provide insight into the difficulties of flying in the Martian atmosphere. In many ways, this is similar to the Mars Pathfinder mission and its accompanying rover, Sojourner, which landed in 1997 and were largely designed to test new technologies and lay the groundwork for future missions. Twenty-four years later, both Perseverance and Ingenuity are a product of and follow in that tradition.

Now that Ingenuity's basic capabilities have been validated, several more flights will be attempted. The first, scheduled for Thursday, will add a small lateral transfer of two meters while the helicopter is in flight, after which it will move back over its takeoff position and then land. Its third flight will extend this flight distance to 50 meters and back.

The plans for the fourth and possible fifth flight will

be finalized after the data from these initial flights is more fully analyzed. All initial indications show that the actual data collected closely matches the many hundreds of simulated test flights Ingenuity's team performed in the lead-up to this morning's success, meaning that it is likely that the flight profile will be greatly expanded for those final flights. Aung, during a post-flight press conference, expressed a desire to fly "600 or 700 meters" and fly "higher, faster and farther" to push the new technology as much as possible.

In addition to flying around, Ingenuity is equipped with a high-resolution downward-looking camera for navigation, landing and surveying the Martian terrain. The initial photos sent back were black and white, with color images expected to follow in the coming days. If longer flights are undertaken, subsequent images will be used to scout out possible areas of interest for Perseverance to travel to and further study.

Such flights, however, will be necessarily limited. Since Ingenuity was set down on Mars' surface by Perseverance on April 3, the rover's operations have been mostly focused on providing support for the helicopter, acting as a communications relay between it and Earth, as well as chronicling its flights. In order to ensure the test flights go as smoothly as possible, Perseverance, which is currently parked about 64 meters away at Van Zyl Overlook, is not undertaking its scientific tasks.

As such, the 30-day window for Ingenuity's operation closes at the beginning of May, when Perseverance is scheduled to resume normal operations. At that time, the helicopter will be decommissioned, possibly by pushing it well beyond its design specifications and crashing it, and the main Mars 2020 mission will continue.

Afterwards, the data collected from Ingenuity's flights will be carefully studied and analyzed for years to come, both to see what was learned by the craft itself and how it will inform the design of future extraterrestrial aircraft. There are already ideas to make a future Mars aircraft that will be larger and capable of communicating with orbiters without needing to go through a lander, allowing for a much longer and more involved mission.

What is learned from Ingenuity will also provide guidance for Dragonfly, a planned mission to Saturn's largest moon, Titan. Dragonfly is scheduled to launch in 2027 and is being designed to fly from point to point on Titan's surface and study that moon's extraordinarily unique and complex chemistry. It will do so in part based on all that has been and will be learned from Ingenuity.