News

FIRST IN FLIGHT: The Mars helicopter Ingenuity underwent tests in March. Ingenuity could be the first powered aircraft to fly on another planet.

CORY HUSTON/NASA

A MARS HELICOPTER PREPS FOR LAUNCH

The first drone to fly on another planet will hitch a ride on NASA's Perseverance rover

If ever there was life on Mars, NASA's Perseverance rover should be able to find signs of it. The rover, scheduled to launch from Kennedy Space Center, in Florida, in late July or early August, is designed to drill through rocks in an ancient lake bed and examine them for biosignatures, extract oxygen from the atmosphere, and collect soil samples that might someday be returned to Earth.

But to succeed at a Mars mission you always need a little ingenuity, and that's literally what Perseverance is carrying. Bolted to the rover's undercarriage is a small autonomous helicopter called Ingenuity. If all goes as planned, it will become the first aircraft to make a powered flight on another planet.

Flying a drone on Mars sounds simple, but it has been remarkably difficult to design a workable machine. Ingenuity's worst enemy is the planet's atmosphere, which is less than 1 percent as dense as Earth's and can drop to -100 °C at night at the landing site.

"Imagine a breeze on Earth," says Theodore Tzanetos, flight test conductor for the project at NASA's Jet Propulsion Laboratory, in Pasadena, Calif. "Now imagine having 1 percent of that to bite into or grab onto for lift and control." No earthly helicopter has ever flown in air that thin.

Perseverance and Ingenuity are set to land in a crater called Jezero on 18 February 2021 and then head off to explore. About 60 Martian days later, the rover should lower the drone to the ground, move about 100 meters away, and watch it take off.

While the car-size Perseverance has a mass of 1,025 kilograms, the drone is just 1.8 kg with a fuselage the size of a box of tissues. Ingenuity's twin carbon-fiber rotors sit on top of one another and spin in opposite directions at about 2,400 rpm, five times as fast as most helicopter rotors on Earth. If they went any slower, the vehicle wouldn't be able to get off the ground. Much faster and the outer edges of the rotors would approach supersonic speed, possibly causing shock waves and turbulence that would make the drone all but impossible to stabilize.

Ingenuity is intended as a technology demonstration. Mission managers say they hope to make up to five flights over a 30-day period. No flight is planned to last more than 90 seconds, reach altitudes of more than 10 meters, or go more than 300 meters from takeoff to landing.

"It may be a bit less maneuverable than a drone on Earth," says Josh Ravich, the project's mechanical engineering lead at JPL, "but it has to survive the rocket launch from Earth, the flight from Earth to Mars, entry, descent, and landing on the Martian surface, and the cold nights there."

That's why engineers struggled through years of design work, trying to meet competing needs for power, durability, maneuverability, and weight. Most of the drone's power, supplied by a small solar panel above the rotors and stored in lithium-ion batteries, will be spent not on flying but on keeping the radio and guidance systems warm overnight. They considered insulating the electronics with aerogel, a super-lightweight foam, but decided even that would add too much weight. Modeling showed that the Martian atmosphere, which is mainly carbon dioxide, would supply some thermal buffering.

The team calculated that the best time of day for the first flight will be late in the Martian morning. By then, the light is strong enough to charge the batteries for brief hops. But if they wait longer, the sun's warmth would also cause air to rise, thinning it at the surface and making it even more difficult to generate lift.

To see if the drone would fly at all, they put a test model in a three-story chamber, filled with a simulated Martian atmosphere. A wire rig pulled up on it to simulate Mars's 0.38-*g* gravity. It flew, but, says Ravich, the real test will be on Mars.

If Ingenuity succeeds, future missions could use drones as scouts to help rovers—and perhaps astronauts—explore hard-to-reach cliff sides and volcanoes. "We've only seen Mars from the surface or from orbit," says Ravich. "In a 90-second flight, we can see hundreds of meters ahead." —NED POTTER

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U.S. CITIES PILOT CONNECTED-VEHICLE TECH

Enabling conventional vehicles to communicate could save lives right now

Drivers can use a number of signals to communicate with other drivers: taillights, high beams, the horn. But car manufacturers envision a future where cars themselves will exchange messages about where they're going and where they've been.

Connected vehicles—those fitted with technology that allows them to communicate with other drivers, pedestrians, and nearby infrastructure—are increasingly being tested around the world. In July, Columbus, Ohio, will be the latest city to launch a connected-vehicle pilot.

Connected vehicles have long been overshadowed by their more famous cousins—autonomous vehicles. Although all autonomous vehicles have aspects of connectivity, adding certain technologies to ordinary cars could prevent accidents and save lives in the near term.

The Connected Vehicle Environment project in Columbus will see up to 1,800 public and private vehicles fitted with special onboard units and dashboard-mounted head-up displays. Drivers will be able to receive messages from traffic lights at 113 intersections, including some of the city's most dangerous crossings. The aim is to study the impacts of connectivity on safety and traffic flow. Orga-