

Launching to Mars Soon...

AeroVironment Team Collaborates with NASA/JPL for Mars Helicopter Launch in July

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It wasn't enough for AeroVironment engineers to design drones for use on Earth — they had their sights set on something even bigger.

Since 2013, AeroVironment's team of innovative engineers from our MacCready Works laboratory has been working with NASA/JPL to design and develop the first Mars drone – a helicopter that will be carried by the Mars 2020 rover. Its name is Ingenuity. The rover was designed and built by NASA/JPL and was recently named Perseverance, or Percy for short. Percy is scheduled to launch in July 2020 and arrive on Mars in early 2021.

The Mars helicopter is a small, autonomous rotorcraft that weighs 4 lbs. (1.8 kg). Its purpose is to demonstrate the viability of aerial robots for planetary exploration.

According to Ben Pipenberg, AeroVironment's design lead and aeromechanical engineer, the aerial exploration of Mars with rotorcraft "allows exploration at visual resolutions comparable to that of landers and rovers but over much longer ranges in a shorter amount of time."

There are other possibilities as well. Here is an excerpt from the team's paper written in early 2019 for the American Institute of Aeronautics and Astronautics (AIAA): "Such vehicles could also carry small scientific payloads and land at designated targets in a controlled manner. Rotorcraft could serve as scouts for rovers and human explorers, identifying safe routes and interesting scientific targets. They could operate as standalone science-craft or in conjunction with other landed assets. Mars rotorcraft may also be used for the timely retrieval of small science samples back to a Mars ascent vehicle for return to Earth."

Right from the start, the team faced many challenges and considerations for helicopter flight on the Red Planet. A significant challenge was the thin, carbon dioxide-filled Martian atmosphere, which is approximately 1% of the density of Earth's atmosphere – comparable to flying at approximately 100,000 feet above sea level on Earth. The team developed subscale prototypes to test and demonstrate the feasibility of lift in the Martian atmosphere.

The first full-size prototype flew in a simulated Mars environment in 2016, followed by a pair of engineering development models, which were used to validate the flight-like design through a series of flight and environmental tests. The flight model finished acceptance testing in early 2019.



Artist Rendering of Mars Helicopter







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AeroVironment's contributions to the first Mars drone include design and development of the helicopter's airframe and major subsystems, including its rotor, rotor blades, hub and control mechanism hardware. Specifically, AeroVironment engineers designed and developed:

- » The rotor system: rotor blades, hub mechanism, propulsion motors, swashplates and linkages, control servos, and primary helicopter structure
- » The landing gear system: 4 deployable legs, landing feet, and suspension mechanisms
- » Auxiliary structures: Helicopter Warm Electronics Box and the solar array substrate that serves as the structural element of the solar panel system



Parts of the Mars Helicopter Designed and Developed by AeroVironment

The team also developed and built highefficiency, lightweight propulsion motors, power electronics, landing gear, load-bearing structures, and the thermal enclosure for NASA/JPL's avionics, sensors, and software systems.

It was a unique history of innovation that cemented AeroVironment's selection to collaborate with NASA/JPL on this planetary mission. Pipenberg states that several factors made the company exclusively qualified for this collaborative effort.

"AeroVironment has accumulated a lot of knowhow designing and building high-performance unmanned systems throughout the years, and we leaned on experience from projects like the Nano Hummingbird and HALE (high-altitude, longendurance) programs to make the Mars helicopter successful. Our team had expertise in ultralight aircraft design and fabrication, but we're also used to fast-paced iterative design cycles, which was critical in the early stages of the program."

Two-and-a-half months after Perseverance settles onto the surface of Mars, and after traveling 330 meters from its landing sight, the Mars Helicopter will separate from its host and attempt its maiden voyage. Its short hop over the surface of the Red Planet will represent a giant leap for drone technology. The helicopter's team of designers and creators will be following every moment, millions of miles away in Simi Valley, Calif.



The Mars Helicopter, visible in lower center of the image, was attached to the belly of NASA's Perseverance rover at Kennedy Space Center on April 6, 2020. The helicopter will be deployed onto the Martian surface about twoand-a-half months after Perseverance lands.

Image credit: NASA/JPL-Caltech

