

FUTURE DEFINING

Soaring to New Heights

Innovation drives the creation of high-altitude aircraft and stratospheric “cell towers”

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When it comes to flying high, AeroVironment has led the way in sustained solar-powered, high-altitude flight with projects dating back more than 40 years. Building on its pioneering innovations — Gossamer Condor, Solar Challenger, Pathfinder Plus, and Helios — AeroVironment advanced these earlier technologies to develop a solar-powered, high-altitude platform station (HAPS) named Sun glider™.

“These earlier innovations made significant contributions to the current HAPS aircraft,” said Bob Curtin, HAPS business development director. “I think it’s reasonable to say that the development of today’s HAPS aircraft started with the Gossamer Condor in 1977.”

Dr. Paul MacCready, Jr., AeroVironment’s founder, designed and built many of the lightweight structural elements in Condor that were the

precursors for today’s Sun glider architecture. For instance, Condor’s lightweight ribs and tubular main spar are similar to Sun glider’s structure. These concepts were then refined with the addition of composite materials in the Gossamer Albatross.

“In the HALSOL [High-Altitude Solar] program, we developed the flying-wing concept used in Sun glider today,” said Curtin. “In order for a solar airplane to carry a useful payload weight and fly through the night at altitudes above wind and bad weather, it must be large and lightweight.”

The flying-wing concept and other technologies developed in the HALSOL program were transferred to Pathfinder and Pathfinder Plus under NASA’s ERAST (Environmental Research Aircraft and Sensor Technology) program in the 1990s. Pathfinder was upgraded with advanced electric motor and

NASA selected Pathfinder for its ERAST program in 1994 to assist in the development of research platforms for the stratosphere. Pathfinder flew to 50,567 feet at Edwards AFB in 1995, its first trip to the stratosphere. It then flew to 71,500 feet in 1997 performing a series of science missions over the Hawaiian Islands.

Today, Pathfinder Plus is on display in the Smithsonian’s National Air and Space Museum Udvar-Hazy Center in Virginia.

Gossamer Condor
Human Power (1977)



First successful human-powered airplane

Pathfinder
71,504 feet / (1997)



World’s first solar-powered high altitude UAS

Pathfinder Plus
80,201 feet / (1998)



World’s first 3G and HDTV connectivity from stratosphere

Helios
96,863 feet / (2001)



World’s highest flying aircraft in level flight

Sun glider
Next Gen HAPS (2019)



Photo credit: [some photos] courtesy of NASA: <https://apod.nasa.gov/apod/>

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avionics technology, as well as solar cell arrays to enable it to recharge its batteries from the power of the sun. The wingspan was increased from 100 to 120 feet.

Pathfinder Plus established several flying records, including soaring to a world altitude

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record for propeller-powered aircraft of more than 80,000 feet in 1998. The aircraft also completed a series of telecommunications tests, the world's first from more than 65,000 feet in the stratosphere, in 2002. From its position over Kauai, Pathfinder Plus transmitted several hours of next-generation mobile voice, data, and video services to off-the-shelf, handheld user devices on the ground, as well as high definition television (HDTV) broadcast signals. Pathfinder Plus' record-setting development and test flights led the way for its successors.

According to Curtin, “The Helios aircraft incorporated most of the structural technologies used on Sunglider today.” Helios was designed and built to achieve two goals under NASA's ERAST program: 1) to demonstrate sustained flight at an altitude near 100,000 feet, and 2) to fly non-stop for at least 24 hours, including

at least 14 hours above 50,000 feet. In August 2001, Helios reached an altitude of 96,863 feet, setting the world record for sustained horizontal flight by a winged aircraft. It also sustained flight above 96,000 feet for more than 40 minutes during a test flight near Hawaii. Helios was the fourth and final aircraft developed under the ERAST program.

After decades of designing and developing high-altitude aircraft, AeroVironment entered into a joint venture in 2018 with SoftBank Corp., a Japanese telecommunications firm, to create HAPSMobile, Inc. – the global,

next generation broadband telecommunications provider that plans to develop a constellation of solar HAPS aircraft to connect people around the globe.

In an interview with *Inside Unmanned Systems* (August 2020), Wahid Nawabi, AeroVironment's president and CEO, described the venture this way:

“We believe HAPS will disrupt the multi-billion-dollar global telecom cell tower infrastructure business. As an alternative to cell towers and satellites, [Sunglider] can deliver wireless connectivity to more people and devices around the globe.”

Designed to serve a 125-mile-diameter



Pathfinder Plus and Helios Prototype on the NASA Dryden ramp. October 14, 1999. NASA/Tom Tschida - <http://www.dfrc.nasa.gov/Gallery/Photo/Helios/Large/EC99-45210-1.jpg>



service area at more than 60,000 feet above Earth, SunGlider incorporates 10 electric motors powered by solar panels and flies at a cruising speed of 68 mph with an endurance of several months. With a wingspan of 262 feet, it can carry a payload weighing as much as 150 pounds that connects cell phones to the terrestrial telecommunications infrastructure.

“SunGlider is the first UAS that is large enough to carry the equipment normally found on a cellular phone tower while also incorporating a large rechargeable battery that allows it to fly through the night at high altitude,” Curtin stated. “The technologies on SunGlider are designed for multi-month flights throughout the year within tropical latitudes (near the Earth’s equator). In the future, when the specific energy of rechargeable batteries improves, they will be incorporated into SunGlider to allow the latitude band of year-round flights to expand.”

SunGlider is designed to fly at altitudes above 60,000 feet so it can stay above inclement weather and fly faster than strong winds in order to maintain position stability. SunGlider is equivalent to a geostationary satellite, but it is 1,000 times closer to Earth, able to reposition to different locations and readily available for payload upgrades.

The aircraft was assembled in 2019 and was put to the test in September 2020 at Spaceport America in New Mexico. The aircraft successfully achieved major test objectives relating to propulsion, power systems, flight control, navigation and datalink integrity, as



SunGlider in flight at Spaceport America, New Mexico, 2019.

well as structural performance during the most turbulent phases of the flight as it entered and exited the jet stream. It achieved other key test milestones, including reaching an altitude of more than 60,000 feet above sea level and successfully demonstrating mobile broadband communication.

Nawabi commented on the successful test, “In less than three years, AeroVironment and HAPSMobile have made incredible progress, developing two SunGlider solar HAPS unmanned aircraft and performing five consecutive flight demonstrations, culminating in this latest significant milestone...We look forward to maintaining our momentum toward aircraft certification and commercialization, working in close partnership with HAPSMobile as we establish a disruptive capability that offers tremendous value creation potential.”

Looking to the future, an important technology that will enable expansion of the business globally is the development of better batteries. According to Curtin, “As the specific

energy of batteries increases, we will be able to serve Earth’s population at higher latitudes year-round.”

Michael Cross, vice president and product line general manager for HAPS, says this product will have a huge impact on people around the globe. “Stratospheric, persistent flight will improve the human condition in many different ways. HAPSMobile seeks to make it possible for billions of people who lack even basic wireless communications to connect to the rest of the world. AeroVironment will also offer solar HAPS to defense customers around the world to enhance communication and situational awareness.”

In terms of innovative technology, Cross sees a great future for this aircraft. “AeroVironment’s 30+ years of experience in stratospheric solar aircraft, combined with advancements in battery and solar technology, have positioned AeroVironment and our partner HAPSMobile as industry leaders and accelerates the commercialization timeline significantly.”

With HAPS, we will continue toward our goal of revolutionizing wireless telecommunications by connecting people around the globe from a network of solar-powered, stratospheric platforms.