NASA Facts

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ERAST:
Environmental Research Aircraft and Sensor Technology

Helios Prototype, built by AeroVironment Inc.

The Environmental Research Aircraft and Sensor Technology (ERAST) project is a joint NASA-industry initiative to develop and demonstrate aeronautical technologies that could lead to a family of remotely or autonomously operated uninhabited aerial vehicles (UAVs) to carry out long-duration Earth science and environmental missions at high altitudes.

UAVs offer great promise to meet the needs of both science and industry for airborne sensing and imaging in a cost-effective manner while alleviating the constraints of mission duration, altitude and flight over inhospitable terrain faced by aircraft with on-board crew. Such long-duration, high-altitude UAVs can be flown on upper-atmospheric science missions to collect data and images which would help scientists identify and monitor environmental and climatic changes. They also could carry telecommunications equipment to high altitudes, serving much like satellites for a fraction of the cost of putting a traditional satellite in space.

ERAST Goals and Objectives

The primary objective of ERAST is to develop and transfer advanced technology to an emerging American UAV industry, and to conduct flight demonstrations of those technologies in controlled environments to validate the capability of UAVs to fly operational science missions. A concurrent ERAST effort is the development, miniaturization and integration of special-purpose sensors and imaging equipment for UAVs.

The project's goals are in line with the Revolutionary Vehicles element of NASA's Office of Aerospace

Technology Aeronautics Blueprint, to create environmentally compatible aircraft with revolutionary capabilities for unprecedented levels of performance and safety. ERAST's goals also align with those of NASA's Earth Science Enterprise to expand scientific knowledge of the Earth system using NASA's unique capabilities from the vantage point of space, aircraft and on-site platforms.

ERAST Project Management

Begun in late 1993, the ERAST technology demonstration project is managed by NASA's Dryden Flight Research Center, with significant contributions from NASA's Ames, Langley and Glenn Research Centers. The project is operated as a joint NASA-industry alliance under a Joint Sponsored Research Agreement. Four small aircraft manufacturers are members of the ERAST Alliance, including AeroVironment, Aurora Flight Sciences, General Atomics Aeronautical Systems and Scaled Composites. Other partners in the alliance include Thermo-Mechanical Systems, Hyperspectral Sciences, and Longitude 122 West. American Technology Alliances (AmTech) is serving as facilitator for the Alliance.

As project manager, NASA Dryden is responsible for establishing overall priorities and technical approaches toward meeting project objectives, providing funding, individual project oversight, coordination of facilities for UAV operations, development and coordination of payloads for demonstration flights, and ensuring that actions taken by ERAST Alliance partners meet NASA's future needs for UAVs. NASA also conducts independent reviews of the vehicle systems and provides input to the builder/operator to improve the aircraft design and operations while reducing overall risk.

NASA is working with the Federal Aviation Administration on the long-term issues related to operations of these vehicles in the national airspace and developing technology such as "see and avoid" sensors/processors and over-the-horizon communications equipment to make operations in civil airspace practical.

ERAST also has a significant educational outreach component intended to foster student interest in science, math and aeronautics.

ERAST Aircraft & Milestones

Several remotely controlled prototypes have been evaluated or have served as flying testbeds for propulsion, aerodynamics, structures, materials, avionics and sensor technology. Among these have been the conventionally-powered Altus□ II and Altair, developed by General Atomics Aeronautical Systems; the Perseus A and B, developed by Aurora Flight Sciences; the Demonstrator 2 and the "optionally piloted" Proteus, developed by Scaled Composites; and the solar-powered Pathfinder, Pathfinder-Plus, and Centurion/Helios Prototype, developed by AeroVironment.

A number of flight milestones have been achieved during the ERAST project to date, including:

- A 26-hour flight above 20,000 feet altitude by the Altus in late 1996;
- Sustained flight above 55,000 feet for four hours by the same aircraft in 1999 after being equipped with a powerful turbocharger;
- An altitude of over 60,000 feet achieved by the Perseus B in 1998, an unofficial record for a turbocharged conventionally fueled single-engine, propeller-driven craft;
- An altitude of 80,201 feet achieved by the Pathfinder-Plus in August, 1998, at that time an unofficial world record for both propeller-driven and solar-powered aircraft.
- An unofficial world-record altitude of 96,863 feet achieved by the Helios Prototype in August, 2001, more than two miles higher than any non-rocket powered aircraft had ever flown.

In addition, two highly successful science demonstrations have been flown—a crop, forest and coral reef imaging mission by the Pathfinder over the Hawaiian island of Kaua'i in 1997 and the Atmospheric Radiation Measurement series flown by the Altus in 1996 and 1999. These missions demonstrated the utility of the aircraft for science experiments and local crop management.

ERAST Current Focus

In its second phase, ERAST narrowed its project-completion focus to three high-priority areas: further development of solar-electric propulsion, development of a consumable-fuel aircraft capable of meeting specific mission requirements of NASA's Earth Science Enterprise, and further development of UAV subsystems technologies. That includes development of "detect, see and avoid" and over-the-horizon communications systems, as well as operational concept and draft FAA certification roadmaps.

For the first, emphasis was placed on improving systems reliability which allowed the solar-powered Helios Prototype to demonstrate flight near 100,000 feet altitude, and development of supplemental energy systems based on fuel cell technology which would enable the craft to perform multi-day sustained flight day and night at altitudes above 50,000 feet.

For the second, NASA selected General Atomics-Aeronautical Systems Inc. (GA-ASI) to develop the Altair, an extended-wingspan civil variant of its turboprop-powered Predator B military reconnaissance UAV, to exceed the minimum payload, duration and altitude requirements established by NASA's Earth Science Enterprise. The Altair will also be required to demonstrate operational reliability and redundancy requirements suitable for "over-the-horizon" operations in unrestricted airspace.

In the third area, subsystem technologies under development include a detect, see and avoid system which would allow UAVs to fly safely in national airspace. The systems, including radio, radar and infrared sensor devices, would enable UAVs to fly in the same airspace as other aircraft without risk of collision. A flight demonstration using the Proteus aircraft to evaluate promising see-and-avoid technologies was flown in spring, 2002 over southern New Mexico.

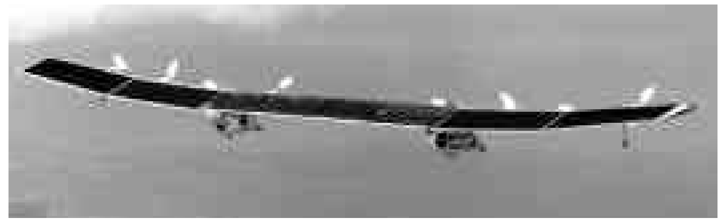
The Pathfinder-Plus is also flying several demonstration missions in 2002 to confirm the practical utility of high-flying, remotely piloted, environmentally friendly solar aircraft for commercial purposes. A two-flight series in July emphasized its potential as a platform for telecommunications relay services, and another demonstration in September will find the Pathfinder-Plus soaring aloft on a three-flight coffee harvest optimization imaging mission.

Completion of the above flight-demonstration milestones will support commercial application of UAVs for such areas as telecommunications, resource and disaster relief management.

Helios Prototype/Centurion/Pathfinder

Designed to reach extreme altitudes of up to 100,000 feet on single-day flights and continuous flight for several days at lower altitudes, the Helios Prototype is a fourth-generation solar-powered flying wing designed by AeroVironment.

First came the 98-foot wingspan Pathfinder which set unofficial world records for solar-powered and propeller-driven aircraft, leading to in a flight to 80,201 feet altitude in mid-1998 by the extended-wingspan Pathfinder-Plus.



Pathfinder-Plus, built by AeroVironment Inc.

The Dryden Flight Research Center hosted the initial test flights of the 206-foot span Centurion flying wing in late 1998. A second series of flights in late 1999 validated the flying characteristics of the extended 247-foot span version, renamed the Helios Prototype. Designed and built by AeroVironment, Inc., this aircraft is propelled by eight to 14 electric motors, depending on its mission. Although its initial low altitude test flights at Dryden were flown on battery power, it is now covered with solar cells and powered by energy from the Sun. The Helios Prototype flew into aviation history in August, 2001, when it reached 96,863 feet during a maximum-altitude demonstration flight near Hawaii. Certification of that milestone as a world altitude record for non-rocket powered aircraft is pending.

Lightweight supplementary energy systems for the Helios Prototype based on fuel cell technology are well along in their development. When perfected, the systems will allow production versions of the Helios to remain aloft from a week to nearly indefinitely, storing sufficient energy received from the Sun during the day to power the aircraft through the night. The Helios will be able to perform many functions of communications satellites with greater flexibility and at far less cost, and provide a platform for continuous monitoring of the atmosphere and ground imaging.

Altair (Predator B)

The Altair, a civilian variant of the enlarged, upgraded version of the RQ-1A Predator military reconnaissance UAV called the Predator B, has been developed by General Atomics-Aeronautical Systems Inc. (GA-ASI) to meet specific requirements of NASA's Earth Science Enterprise for a flight-validated consumable-fuel UAV to perform on-location science missions. Under a cost-sharing agreement with NASA, GA-ASI built three prototypes, two Predator Bs and the extended-wingspan Altair. The Altair is powered by a 700-hp. turboprop engine and capable of carrying a 660-lb. payload for up to 32 hours at altitudes ranging from 42,000 to 52,000 feet. In addition to exceeding minimum performance requirements set by NASA's Earth Science Enterprise, the Altair has enhanced avionics systems to better enable it to to fly in FAA-controlled civil airspace and demonstrate "over-the-horizon" command and control capability from a ground station.

Altair, being built by GA-ASI.

Perseus B

The Perseus B is the third generation of the Perseus design developed by Aurora Flight Sciences Inc., having been preceded by the Perseus proof-of-concept demonstrator and the Perseus A aircraft. Aurora flew the Perseus B aircraft to an altitude over 60,000 feet in 1998, meeting an ERAST milestone. The Perseus B utilizes a triple-turbocharged Rotax piston engine for power. With external fuel tanks and engine upgrades, the Perseus B is capable of carrying a 176-lb. payload at an altitude of 55,000 feet for a duration of four hours, a mission milestone set by the ERAST project for the aircraft. Under ERAST, Perseus-B helped to validate and mature propulsion, avionics and command and control systems technology.

Perseus B, built by Aurora Flight Sciences.

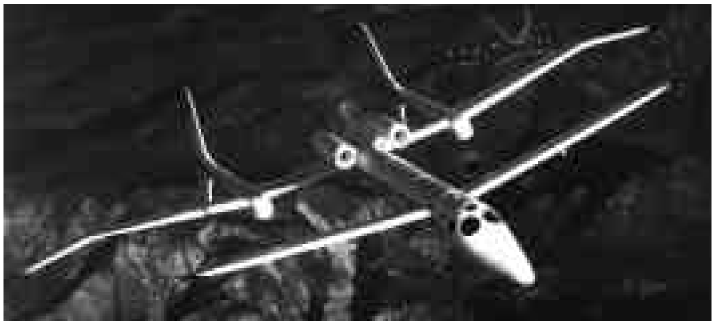
Altus II

General Atomics/Aeronautical Systems also produced the dual-turbocharged Altus II aircraft, a modified version of the RQ-1A Predator military reconnaissance UAV designed for civilian environmental science missions. The Altus II is also powered by a small four-cylinder Rotax piston engine driving a rear-mounted pusher propeller. The Altus II expanded its flight envelope to the point where it met an ERAST mission requirement for four hours flight duration at 55,000 feet altitude, and also maintained flight above 50,000 feet for eight hours in 1999. The Altus has successfully completed several science missions for the Department of Energy's Atmospheric Radiation Measurement/UAV project, including a flight series at high altitudes over Hawaii in 1999 and a lower-altitude ARM study flight lasting in excess of 26 hours over Oklahoma in 1996. Under ERAST, the Altus II was used to validate propulsion system technology as well as other flight systems such as avionics, command and control.

Altus II, built by General Atomics/Aeronautical Systems Inc.

Proteus

Scaled Composites produced the Proteus aircraft as a piloted aircraft primarily designed for commercial telecommunications relay purposes, but it is also capable of completing many of the ERAST missions. First flown in mid-1998, the twin turbofan-engine



Proteus, built by Scaled Composites Inc.

aircraft is larger and heavier than other consumable-fuel aircraft involved in ERAST. The Proteus is a tandem-wing design intended to carry payloads of up to 2,000 pounds to altitudes above 60,000 feet and to remain on station up to 14 hours. Development of the Proteus under ERAST focused on supporting development of the aircraft's flight control system to allow it to be an "optionally piloted" aircraft, capable of being flown either by an onboard pilot or autonomously. Proteus was also utilized to validate many of the technologies required for UAVs, including over-the-horizon command and control communications.