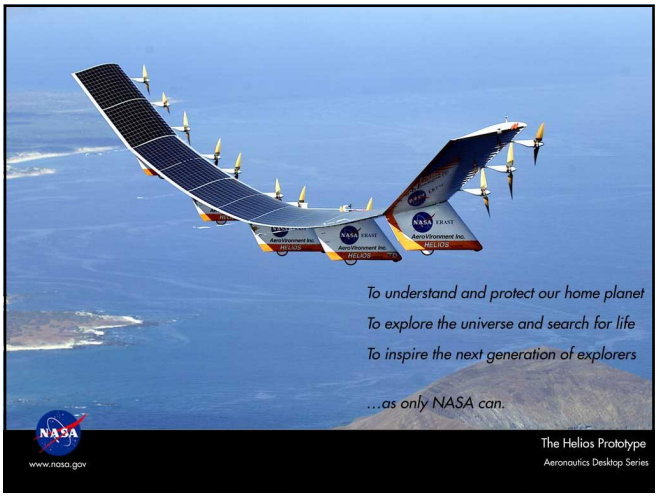
NASA Dryden flight Research Center Photo Collection
http://www.dfrc.nasa.gov/gallery/photo/index.html
NASA Photo: ED03-0152-4 Date: June 7, 2003 Photo By: Carla Thomas

NASA's Helios Prototype electrically powered flying wing began a checkout flight June 7 from the Navy's Pacific Missile Range Facility on the Hawaiian island of Kauai.



Why Solar Powered Aircraft

2) In contrast to air-breathing engines, solar powered aircraft have electric power-plants. So the need to compress oxygen-lean air at high altitudes is eliminated. Besides, the danger of a catastrophic explosion due to the presence of onboard fuel can be eliminated

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NASA Photo: ED01-0230-4 Date: August 13, 2001 Photo by: Carla Thomas
The Helios Prototype aircraft at approximately 10,000 feet flying above cloud cover northwest of Kauai, Hawaii.

Why Solar Powered Aircraft

1) In the case of solar energy, the solar power density increases with altitude from 80mW/cm2, on ground level, to 136.7mW/cm2 in space. This is the main advantage as compared to other sources of energy

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Why Solar Powered Aircraft

4) Solar powered aircraft are especially suited for reconnaissance or surveillance missions where high speed is not a requirement. An electric power-plant also ensures little infrared signature, low noise level, better reliability and low vibration levels

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Why Solar Powered Aircraft

3) Electric power-plants have no exhaust and therefore do not contaminate the environment

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Special Features

- Unlimited power—provided by the sun
- Extreme endurance/reliability—critical to low operational costs
- High altitude potential—critical to avoid weather and other aircraft
- Environmentally friendly—non-polluting
- Slow moving—provides continuous presence
- Rapid payload change out

Why Solar Powered Aircraft

5) Besides, these aircraft have a lower number of moving parts, which makes them more reliable. Also, the life expectancy of the solar panels is about 25 years with little maintenance requirements

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Applications

- *Monitor pollution, toxic gas releases, and effluents from volcanic eruptions*
- *Monitor the spread of an oil spill to aid containment and cleanup efforts*
- *Map resources such as minerals, oil, and geothermal power*
- *Measure high-altitude ozone levels and other atmospheric phenomena for studies of global warming*

Applications

- *Agricultural surveillance and decision support*
- *Atmospheric satellites*
- *Controlling traffic patterns of ships and aircraft*
- *Observing Hurricanes and other destructive weather systems in the Troposphere from above*

Some Projects

Project Name	First Flight
Centurion	1998
Pathfinder-Plus	1998
Helios	1999

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Some Projects

Project Name	First Flight
Sunrise I	1974
Sunrise II	1975
Gossamer Penguin	1980
Solair I	1980
Solar Challenger	1981
Pathfinder	1993
Icare II	1996
Solair II	1996

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Pathfinder

Records

- Sept. 11, 1995: Sets first altitude record for solar-powered aircraft at 50,000 ft during 12-hour flight
- October 21, 1995: Damaged in hangar mishap
- July 7, 1997: Sets new altitude record for solar-powered and propeller-driven aircraft at 71,530 ft
- Modified into the longer-winged Pathfinder Plus, still used for tests at NASA
- Aug. 6, 1998: Pathfinder Plus breaks old record with flight at altitude of 80,201 ft

Pathfinder

History

- Designed and fabricated by AeroVironment in 1981
- Determined technology insufficient to support mutli-day duration flights under solar power and Pathfinder was put into storage
- In 1993, brought back to flight by Ballistic Missile Defense Organization
- Transferred to NASA in 1994 to support Environmental Research Aircraft and Sensor Technology (ERAST) program
- ERAST program demonstrated that a high AR, solar-powered lightweight craft could take off and land at an airport and fly at extremely high altitudes (50-80K ft)
- ERAST also determines feasibility of such UAVs for carrying instruments used in scientific studies

Pathfinder

Specs and Performance

- W=550 lbs (includes 50 lbs payload)
- Solar array covers 75% of upper surface and can generate near 8000 W at solar noon
- Six gearless 1.5 kW electric motors consisting of fixed-pitched, 2-bladed 79-inch diameter props, brushless DC motor, nacelle, cooling fins, and composite mounting strut
- T/W=0.10 at 60,000 ft, P/W =13.6 W/lb
- Composed of carbon composite spar, lightweight composite ribs and transparent plastic wing skin
- Flight speed of 94 ft/s at altitude of 60,000 ft

Pathfinder

Configuration

- **Wingspan:** Pathfinder 29.5 m ,Pathfinder-Plus 36.3 m
- **Length:** 3.6 m
- **Wing Chord**: 8 ft
- **Wing Aspect Ratio:** Pathfinder 12 to 1 Pathfinder-Plus 15 to 1
- **Endurance:** About 14 to 15 hours, daylight limited with two to five hours on backup batteries.
- **Wing Area**: 792 ft^2
- **Glide ratio (power off):** Pathfinder 18 to 1; Pathfinder-Plus 21 to 1

Helios

Specs and Performance

- Helios Prototype is 2.5X the size of Pathfinder
- Helios can fly high using renewable energy for day/night operations
- It builds up the technologies developed by Pathfinder and Centurion but adds an energy storage system for nighttime flying
- Stores up to two-thirds of the energy received by its solar array during the day
- Because of long duration of flight, the Helios will be extremely economic in operation
- More than 60,000 high efficiency (22.5% at AM 1.5) solar cells produced by SunPower Corporation are used as an energy source for Helios

Helios

History

- HELIOS project is a part of NASA's ERAST program (Environmental Research Aircraft and Sensor Technology)
- Developed by NASA and Californian company AeroVironment Inc.
- Designed to fly to 30,000 m in 2001 using solar cells and batteries for short duration flights; first flight August 1999

Helios

Configuration

- **Propulsion:** 14 DC brushless electric motors (the power of each motor is 1,5 kW) with two blades, specially designed for high altitude flights. The weight of each motor is less than 5 kg. Length of both propeller blades is 1,7 m
- **Energy source:** Bifacial solar cells - dimensions 1.25" x 2.75" (Front side efficiency 22 %, backside efficiency 11 %) placed on transparent wings. Energy source in the dark are lithium batteries. Fuel cells will be used as main energy source in the dark in the future
- **Speed:** Typical flight speed is 30 to 40 km/h. The highest speed is 40.2 km/h

Helios

Configuration

- **Wing span:**75,3 m
- **Length:**3,6 m
- **Wing thickness:** 0.3 m
- **Height:** 2 m, without upper blades of the propellers
- **Wing area:** 186.6 m2
- **Mass:** 600 kg - unloaded plane
- **Allowed mass:** up to 930 kg, depends on flight purpose and available energy

Helios

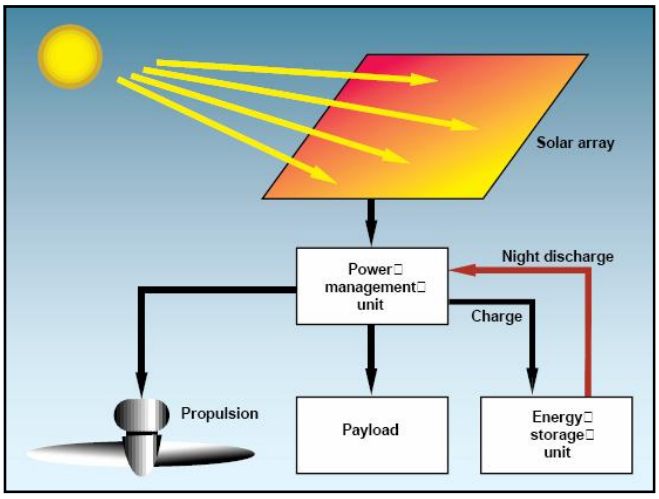
Specs and Performance

- **The peak power of solar cell array is approximately 30 kW**
- **Five pods containing computers, electronic equipment and landing gear**

Helios

Configuration

- **Flight height:** Maximum flight height is 30000 m typical height depends on flight mission and it is typical 15000 to 22000 m
- **Flight:** The anticipated autonomy in the future together with fuel cells will reach for uninterrupted flights (several months of autonomy)
- **Materials:** All main parts of the plane are made of carbon fibers and Styrofoam. Wings are covered with special designed and produced plastic sheet



Helios

Helios Power System

- Helios requires lightweight, high performance RFC system not available in the marketplace
- Closed cycle system with thermal control necessary for cold, HALE operations
- Basic fuels are water and sunlight
- Battery technology not sufficient

Aircraft	Pathfinder	Pathfinder Plus	Centurion	Helios
Wingspan (m)	30	36.89	62.78	75.29
Length (m)	3.65	3.65	3.65	3.65
Wing chord (m)	2.44	2.44	2.44	2.44
Gross weight (kg)	254.09	317.6	862.07	750
Payload (kg)	45.37	68.06	272.7	284.03
Cruise Airspeed (Kmph)	27.4-33.8	27.4-33.8	27.4-32.19	30.58-40.2
Power (W)	7,500	12,500	31,000	٣١،٠٠٠
Motors	kW x 6 ١.٢٥	1.5 kW x 8	2.2 kW x 14	1.5 kW x 14
Remarks		Transition between Pathfinder and Centurion	Onboard Lithium Battery	Onboard Energy storage system for night flying