University of Virginia (UVA) Charlottesville - Solar Airship Program

Peter Lobner, 11 March 2024

1. Introduction

Initiated in 1995, the University of Virginia (UVA) Charlottesville Solar Airship Program (known as SECAP) had the goal of developing a solar-powered airship capable 24-hour-a-day, remotely-controlled or autonomous flight. The program was run out of the University's Engineering Office of Undergraduate Programs. Over the course of the program, about 80 students were responsible for designing, building, and flying incrementally more complex experimental airships.

The size and shape of the airships developed by the UVA team were constrained by the manufacturing and indoor test space available in the small aircraft hangar the team used at UVA's nearby Milton Field.

The UVA team gave some consideration to competing in the October 1996 World Solar Challenge which requires participants to traverse a north-to-south route across central Australia. Solar-powered aircraft were allowed to participate for the first time in 1996. However, realistic time constraints led the UVA team to not participate in this Challenge, and to focus instead on their own development and testing program.

UVA's Solar Airship Program ran for more than seven years and appears to have been well-funded, with a broad base of sponsorship, including: University of Virginia, Nations Bank Virginia, Lockheed Martin, Crutchfieid, Waverly Enterprises, Du Pont LP, MJ Systems, Bosch Aerospace, Oklahoma Science Foundation, Kirkpatrick Foundation, Solarex and Gibbens & Associates. The program ended in the early 1990s.

2. The Phase I airship - Dunkin

The Phase I airship, known as Dunkin, had a broad, pressure-stabilized, gas envelope that was similar to the shape of contemporary hybrid airships. This envelope shape was a good fit for the relatively low ceiling in the hangar available at Milton Field.

The detailed hull shape was developed through computer modeling and wind tunnel testing. The pressure-stabilized, semi-rigid, hybrid hull operated at an internal pressure of 15 to 20 inches of water (0.54 to 0.72 psig), controlled by an internal ballonet. In forward flight, the hull was expected to generate aerodynamic lift equal to about 10% of the static weight of the airship. The airship is reported to have had an internal frame structure similar to that used in the semi-rigid Zeppelin NT. The flat top of the broad hull was designed to accommodate a future installation of a solar array. However, none was ever installed.

UVA's Dunkin team, with project leader George Weinmann at the far right. Source: T. Avak (1997)

Dunkin had three aft aerodynamic control surfaces in an inverted-Y configuration, with a central rudder and two elevators with significant anhedral (resembling ruddervators). Two independently-controlled, stern-mounted propellers provided propulsion and were reported to be capable of delivering 8 pounds (3.6 kg) of thrust each when cruising at half-power. Differential power to these propellers provided a limited thrust vectoring capability.

General characteristics of UVA's Dunkin airship

Parameter	UVA Dunkin airship
Type	Hybrid, semi-rigid
Length	30 ft (9.1 m)
Width (max)	13 ft (4.0 m)
Height (overall)	8 ft (2.4 m)
Envelope	Non-rigid, pressure-stabilized helium lifting gas volume with an internal frame and air ballonet
Internal pressure	15 to 20 inches of water (0.54 to 0.72 psig)
Weight	110 lbs (49.9 kg)
Propulsion	2 x stern-mounted, independently-controlled, AstroFlight Cobalt 60 electric motors, each directly driving a 20-inch (51 cm), 2-bladed, fixed pitch pusher propeller
Aerodynamic control surfaces	Servo-driven inverted-Y tailplanes
Power source	• 3 x 12-volt, 17 amp-hour gel-type lead acid batteries • No solar photovoltaic system
Ground crew	Minimum of 5 persons
Endurance	• About one hour at cruise power • About 15 minutes at maximum power

Dunkin aloft on a tether. Source: T. Avak (1997)

The UVA airship team, led by UVA senior George Weinmann, held an open-house on 17 August 1996 and gave a short series of flight demonstrations. Dunkin had a minimum five person ground crew, including a pilot, a crew chief, two line handlers and a person

responsible for a battery box. Total outdoor flight time was about an hour.

Flight tests revealed that Dunkin was somewhat unstable in yaw control. During the open-house flight demonstration, ground crew reportedly ran along with the airship and used long tethers to pull the airship away from nearby trees surrounding the small airfield.

Future development of Dunkin included possible installation of ducted propellers in place of the original two-bladed pusher propellers.

(Left) Dunkin airship in flight.
(Below) Dunkin airship stern view. Note the broad gas envelope and the simple mounting of the two electric motor-driven pusher propellers. The rectangular helium inflation port is visible behind the cross-bar between the propellers.
Source, both photos: T. Avak (1997)

3. The Phase II airship - Aztec

The Phase II airship produced under the UVA Solar Airship Program was known as Aztec. This was a larger, 52.5-ft (16-meter) long, solar-powered airship that was expected to be certified by the Federal Aviation Administration's (FAA) in the experimental aircraft category. After the 1996 flight test of Dunkin, Aztec was expected to fly in 1997.

In September 1999, aviation author Roland Escher reported:

> "Aztec is the second iteration of the UVA Solar Airship Program's Advanced Airship Design (AAD) program. [Aztec] is being built to correct the problems encountered in the first AAD airship named Dunkin -- namely stability and control. [...] The purpose of Aztec is to demonstrate controlled flight and solar powered capabilities in an airship."

A semi-autonomous control system was developed for the Aztec, including the derived control algorithms, flight hardware, and operating software for the airship. Aztec began test flights in the summer of 1998.

4. The Phase III airship – Inca

In 1996, T. Avak reported that the UVA Solar Airship Project team hoped to present an 82-ft (25-meter) long Phase III airship at the 1998 Compétitions Internationales d'Engins Légers (CIEL) (http://c.i.e.l.pagesperso-orange.fr/presentation.htm) International Airship Races centennial celebration in Paris, sponsored by the Aero Club de France.

In 2004, author Arnold Nayler referred to the third UVA airship by the name of Inca.

5. For more information

- T. Avak, "The Dunkin Project: University of Virginia Students Build an Electric Airship," Model Aviation, Vol. 6, pp. 50 - 52, 1997: https://library.modelaviation.com/article/dunkin-project-university-virginia-students-build-electric-airship

- Roland Escher, “Airship and Blimp Resources - Airship News,” Archived News Reports, 1999 2nd half, “UVA Solar Airship Program Update,” 11 September 1999: http://www.myairship.com/news/1999_h2.html
- Andrew Turner, “Development of a semi-autonomous control system for the UVA solar airship Aztec,” 3rd International Airship Convention and Exhibition, Friedrichshafen (Germany), July 2000:
- Arnold Nayler, “Airships Today – 2004,” p. 10, “University of Virginia,” Airship Association Ltd, London: https://www.aerall.org/docs-colloque2004/intervention_Arnold-NAYLER.pdf

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