New Mexico State University - Advanced High-Altitude Aerobody (AHAB)

Peter Lobner, updated 10 March 2022

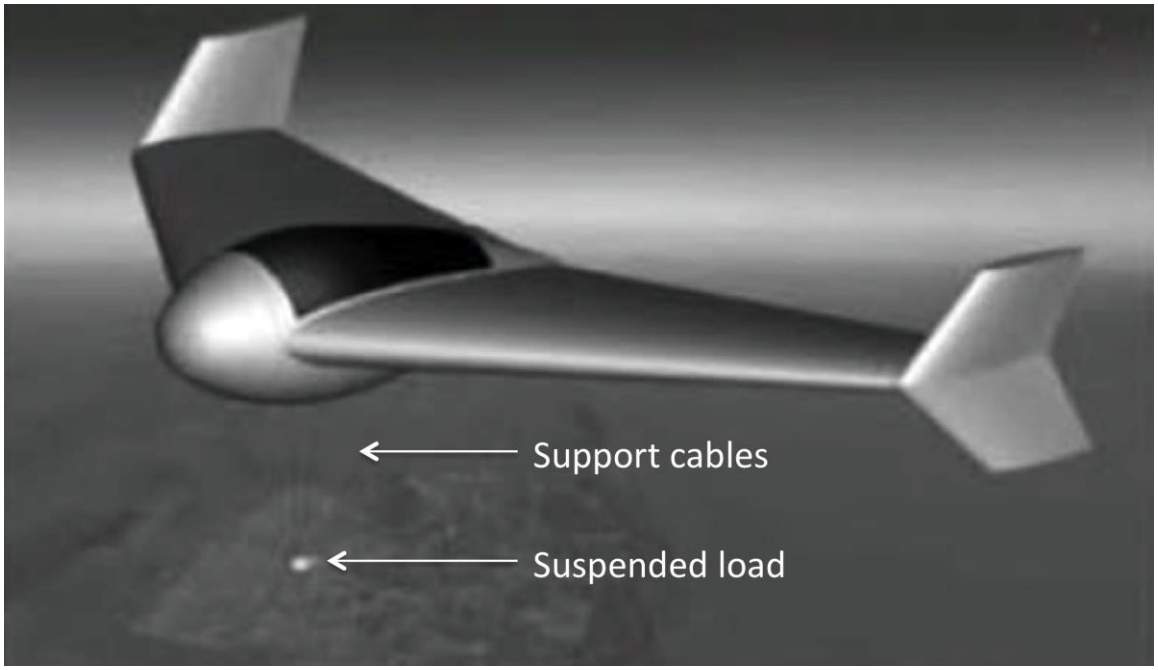
In the early 2000s, the Physical Science Lab at New Mexico State University was developing the Advanced High-Altitude Aerobody (AHAB), which was a solar-powered, non-rigid, helium super-pressure, aerodynamic airship designed to demonstrate variable buoyancy propulsion.

This type of propulsion was first demonstrated in in 1863, when Dr. Solomon Andrews first flew his hydrogen-filled *Aereon* airship over Perth Amboy, NJ. In the early 1960s, Aereon Corporation (not related to Dr. Andrews) built the *Aereon III* hybrid airship, which was designed with the capability to fly with variable buoyancy propulsion alone. *Aereon III* was badly damaged during taxi tests in 1966 and never had the opportunity to demonstrate its variable buoyancy propulsion capability.

Changing the buoyancy of an airship causes it to climb or descend. As with Solomon Andrews' *Aereon*, *AHAB* was designed to generate a forward propulsive force during each climb or descent maneuver in a repetitive porpoising flight profile. With this modest propulsion capability, *AHAB* was designed for station-keeping operations in near-space (very high altitude) where propellers would be ineffective.

Overall buoyancy of the *AHAB* airship was adjusted with an inner air bladder. When ready for flight, the airship has positive buoyancy and the helium super-pressure within the aerobody compresses the air bladder. As the airship flies a gliding ascent, a vent valve can be opened to release any air remaining in the air bladder, allowing the unballasted craft to reach its maximum altitude (pressure altitude). To transition to a gliding descent, a blower pumps ambient air into the bladder, increasing the weight of the airship until it becomes negatively buoyant. The descent is terminated by venting the air bladder to the atmosphere.

The *AHAB* aerobody carries a payload suspended below on several retractable cables. Changing the length of the cables moves the center of gravity and thereby controls the attitude of the aerobody.



The AHAB airship. Source: adapted from Air & Space Power Journal, Winter 2005, Volume XIX, No. 4, p. 47

In 2004, Mary Ann Stewart, et al., reported, “This superpressure balloon incorporates wing-like devices to give it a sleek aerodynamic shape. AHAB is designed to offset the effects of light winds by using a porpoising technique as necessary, trading altitude for horizontal motion.”

Lt. Col. Ed Tomme and Sigfred Dahl provided additional performance information, noting that such vehicles “will use a variety of unconventional buoyancy-modification schemes that allow vehicles to propel themselves by porpoising through the air at about 30 to 50 knots, enabling them to overcome all but the most unusual near-space winds.”

In the 1-14 July 2019 issue of Aviation Week & Space Technology magazine, former AHAB program manager, Mike Fisher, commenting on the new Phoenix UAV, provided the following historical insights:

"The Aerobody was a solar-powered lighter-than-air vehicle (non-rigid rather than semi-rigid, as in the Phoenix) that pioneered the idea of using a ballonet to cause buoyancy and changes in center of gravity to enable propeller-less forward flight.

We took the concept far enough to demonstrate the validity of the underlying physics by building a subscale prototype that we successfully tested in indoor flight tests. Ultimately, the then-existing limits to photovoltaic cell and battery technology kept us from going past the prototype stage."

For additional information

- Lt. Col. Edward Tomme & D. Phil, "The Paradigm Shift to Effects-Based Space: Near-Space as a Combat Space Effects Enabler," Airpower Research Institute, Research Paper 2005-01, 2005; http://www.au.af.mil/au/awc/awcgate/cadre/ari_2005-01.pdf
- Lt. Col. Edward Tomme & Col. Sigfred Dahl, "Balloons for Today's Military? An Introduction to near-Space Concepts," Air & Space Power Journal, Winter 2005, Volume XIX, No. 4, pp. 39 – 49; https://www.airuniversity.af.edu/Portals/10/ASPJ/journals/Volume-19_Issue-1-4/win05.pdf
- Mary Ann Stewart, Lt. Col. Kevin Frisbie & Gary Trinkle, "Geointelligence - High-Altitude Surveillance," Global Aerospace Corporation, 1 July 2004; http://www.gaerospace.com/press-releases/pdfs/HighAltitudeSurveillance.pdf
- Ravi Y. Purandare, "A buoyancy-propelled airship," Ph.D. thesis, May 2007, New Mexico State University, Las Cruces, New Mexico, USA: https://www.proquest.com/docview/304842506
- Ravi Y. Purandare, "A buoyancy-propelled airship – Powered flight without propellers or jets," VDM Verlag, ISBN-13 9783639138115, December 2009

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
    - Hunt Aviation – Gravity Plane
    - Phoenix
    - Solomon Andrews - Aereon I and Aereon II
    - Walden LTAS - VB propelled airships
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/