Phoenix – gravity-propelled drone airship

Peter Lobner, updated 28 July 2023

1. Introduction

In March 2019, the UK Phoenix team demonstrated variable buoyancy propulsion with a small, remotely controlled airship flying a short distance in an indoor environment. While this was a noteworthy modern achievement, it occurred 156 years after Solomon Andrews first flew the much larger *Aereon* variable buoyancy propulsion airship with passengers in Perth Amboy, NJ, and almost two decades after the indoor test flight of the subscale Advanced High-Altitude Aerobody (AHAB) variable buoyancy propulsion prototype airship at New Mexico State University.

The Phoenix Unmanned Aerial Vehicle (UAV) was a small, autonomous airship designed to serve as a very long endurance, high-altitude “atmospheric satellite” that was capable of station keeping using an innovative variable buoyancy propulsion system. The UAV was intended for use in telecommunications and a range of other civil and military applications.

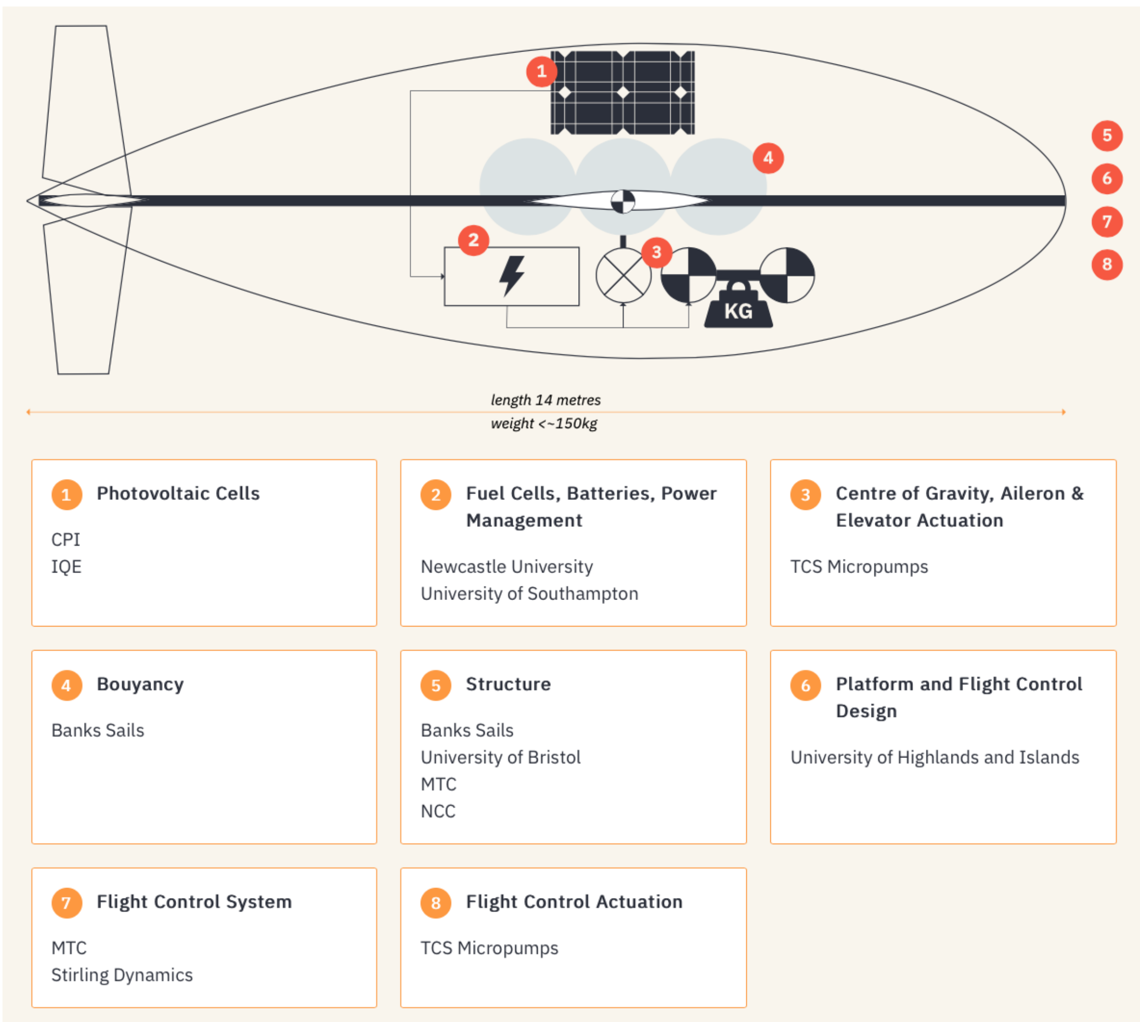
Phoenix development was lead by a consortium of UK universities, businesses, and innovation centers, with a distribution of roles and responsibilities as shown in the following graphic.

This project ran for three years. It was one of several projects supported the UK’s Department for Business, Energy & Industrial Strategy (BEIS), through the Aerospace Technology Institute (ATI) and Innovate UK, to invest in “research and technology projects to deliver world leading aerospace technologies in the UK.

In 2023 the Phoenix project website was no longer online.

2. Description of the Phoenix airship

The Phoenix UAV was a small, variable buoyancy, semi-rigid airship measuring 15 meters (49 feet) long, with a wingspan of 10.5 meters (34 feet). The UAV's teardrop-shaped fuselage was constructed from a Vectran fabric, with short wings and a cruciform tail made of carbon fiber composite material. Thin film solar panels on the wing and horizontal stabilizer surfaces generate electric power for the UAV's systems and to charge an onboard battery that provides continuous power at night and during inclement weather.



Phoenix subsystems and responsible organizations.
Source: Phoenix project

Source, both photos: Phoenix project

The fuselage contained 120 cubic meters (4,238 cubic feet) of helium lifting gas (hydrogen is an alternative), a supply of lifting gas, and a separate inflatable 6 cubic meter (212 cubic feet) ballonet cell containing heavier air. Phoenix was ballasted for near neutral buoyancy so that the control span of the small buoyancy control system could produce both positive and negative buoyancy.

3. Variable buoyancy propulsion

To increase buoyancy, air in the inflatable ballonet cell is released to the atmosphere via a vent in the tail. If needed, lifting gas could be released to the gas envelope to gain positive buoyancy. As the lighter-than-air Phoenix gains altitude, the aerodynamic surfaces generate forward momentum, propelling the UAV forward during the unpowered climb.

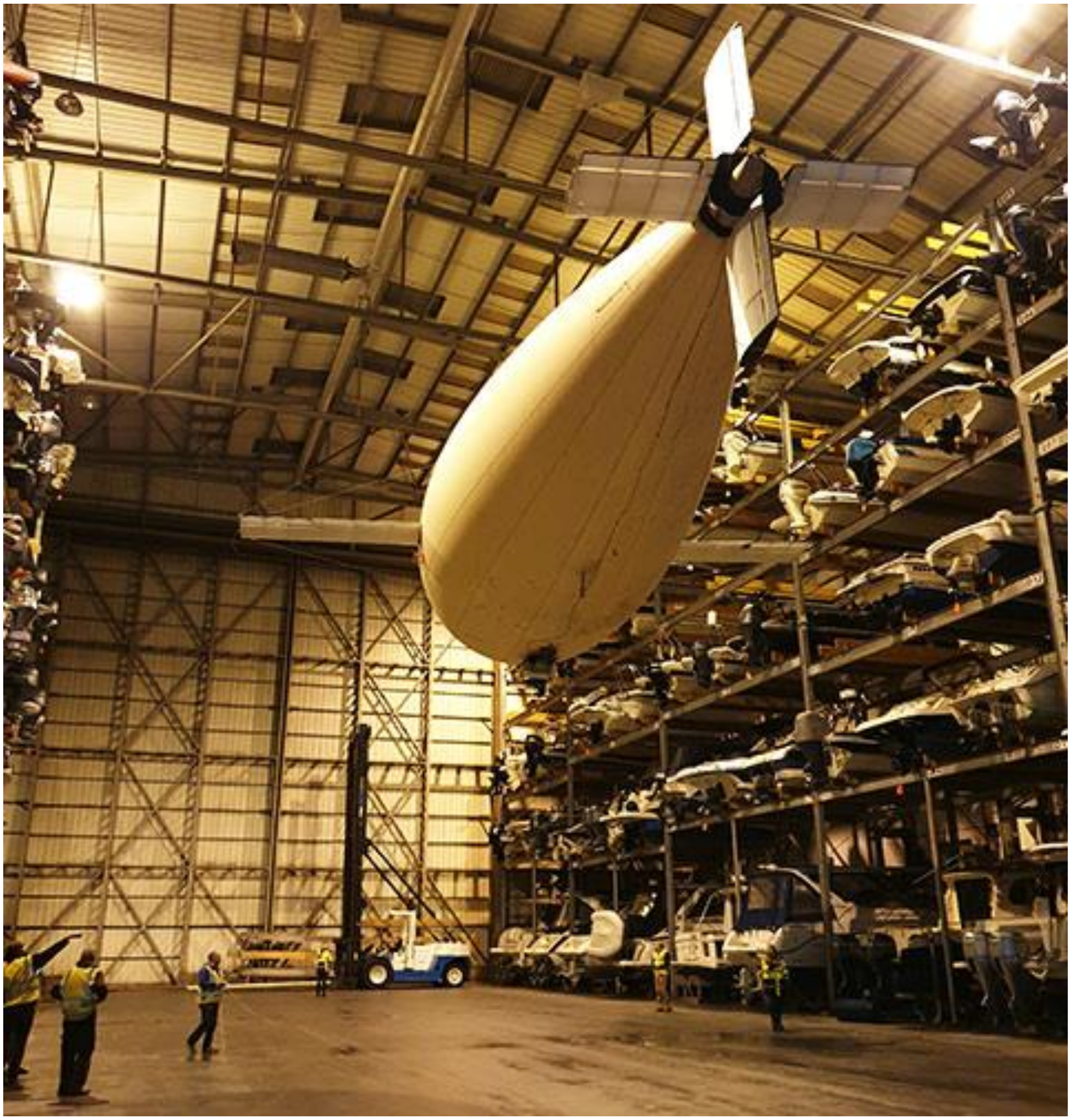
At the top of the climb, buoyancy is decreased by pumping outside air into the inflatable ballonet cell, increasing the gross weight of the UAV. As the now heavier-than-air Phoenix enters an unpowered dive, the aerodynamic surfaces continue generating forward momentum to propel the UAV.

During an extended mission, the climb-dive cycle would be repeated as often as needed to provide propulsion for controlling the position of the UAV.

On 21 March 2019, the Phoenix UAV made its first successful flight indoors, covering about 120 meters (394 feet). In doing so, *Phoenix* joined Solomon Andrews' *Aereon* and *Aereon II*, and New Mexico State University's *AHAB* on the short list of airships that have flown and demonstrated variable buoyancy propulsion.

Phoenix UAV outdoor tests were planned after the UK Civil Aviation Authority certified the UAV. As originally configured, the developers expected that Phoenix could operate at altitudes up to about 914 meters (3,000 feet). However, no subsequent flight tests were reported by the Phoenix team.

You can watch a short video of the first flight here:
https://www.youtube.com/watch?v=jcqPvKfZjac



First indoor flight. Source: Phoenix project

4. For additional information

- Kyle Mizokami, “This Drone 'Breathes' Air To Propel Itself and Has Unlimited Range,” Popular Mechanics, 26 April 2019: https://www.popularmechanics.com/military/aviation/a27287428/phoenix-drone-uav/

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