Walden Aerospace / LTAS - Exotic Hybrid Airship Concepts

Peter Lobner, updated 8 February 2022

1. Introduction

In 1976, Michael K. Walden founded Lighter Than Air Solar (LTAS) Corp. in Nevada, where he served as Chief Technology Officer (CTO). In 1997, the firm was rebranded as LTAS / CAMBOT LLC, and in 2003, to LTAS Holdings LLC and LTAS International LLC. Michael Walden and the LTAS firms developed and demonstrated an impressive range of technologies and design concepts for lighter-than-air (LTA) craft, including a range of particularly exotic hybrid airship design concepts that defy simple categorization.

After leaving LTAS in 2005, Michael Walden founded Walden Aerospace where he is the President and CTO, building on the creative legacy of his work with the former LTAS firms. The Walden Aerospace website is here: http://walden-aerospace.com/HOME.html

In this article, we'll take a look at several of Michael Walden's exotic hybrid airship design concepts:

- Entertainment airships:
  - LTA-1701-D
  - Klingon Bird of Prey (BOP)
- Hybrid rocket / balloon ("Rockoon") for suborbital space tourism:
  - Walden Aerospace Vertical Exploration System (W.A.V.E.S.)
- Stratospheric habitat and shuttle:
  - Earth Station One (ES-1)
  - Silver Dart hybrid airship / rocket shuttle
- Airships as a route to orbit:
  - HYPER
  - EARTHBALL

Special thanks to Michael Walden for his thoughtful input for this article.

2. LTA-1701-D & Klingon Bird of Prey LTA entertainment airships

In the early 1990s, Michael Walden developed the design concept for a lighter-than-air (LTA) entertainment airship that resembled a scaled-down, fictional *Enterprise* (NCC-1701-D) Galaxy-class starship, which was popular in the *Star Trek: The Next Generation* television series. The goal was to create a realistic entertainment experience on a flying replica of the starship *Enterprise*, with many interior entertainment venues that were true to the layouts and designs of the Star Trek franchise and would be recognized by Star Trek fans around the world.

Walden's entertainment airship concept was in stark contrast with an unrelated 1992 proposal from Gary Goddard and a team of designers at Landmark Entertainment to build a static full-size replica (a building) of the original *Enterprise* (NCC-1701-A) Constitution-class starship as part of a Las Vegas downtown redevelopment project. Goddard's proposal lost out to the "Freemont Experience," which continues to operate in downtown Las Vegas.

Artist's concept of the LTA-1701-D entertainment airship flying over Rio de Janiero. Source: Walden Aerospace

Walden's LTA-1701-D entertainment airship design concept was scaled down from the *Enterprise* NCC-1701-D to the size of the *Enterprise* NCC-1701 in the original TV series. Even at this smaller size, the LTA-1701-D could comfortably accommodate 300 passengers and crew on 3-hour flight tours and/or longer duration cruises in luxury suites. The result was a spectacular airship measuring about 750 feet (228.6 m) in length and 21 stories (about 227 feet / 69.2 m) tall.

Artist's concept of the bridge on the LTA-1701-D entertainment airship. This was one of many entertainment venues planned for the airship. Source: Walden Aerospace

The LTA-1701-D entertainment airship would use Walden's Density Controlled Buoyancy (DCB) active aerostatic lift control system, which provides the following important operational functions:

- Overall buoyancy management throughout the flight regime.
- Distributed buoyancy management to balance the irregularly-shaped airship and maintain the center of lift.
- Vertical takeoff and landing (VTOL).
- Rapid loading and off-loading of passengers and supplies without having to exchange external ballast.

The saucer section of the LTA-1701-D resembles the shape of a typical Walden lenticular airship. As such, the following technologies developed by Walden would be readily applicable:

- Rigid, composite aeroshell
- Mass transfer unit (MTU) for non-aerodynamic pitch / roll stability control.

A business goal for the for the LTA-1701-D entertainment airship was to redirect tourist interest from the Las Vegas Strip to downtown, where the base of operations would be located.

Artist's concept of the LTA-1701-D entertainment airship after landing on the Las Vegas strip. Source: Walden Aerospace

You'll find more information on the LTA-1701-D entertainment airship on the Walden Aerospace website at the following link: http://walden-aerospace.com/USS_Enterprise_LTA.html

Also see the 2020 article on the LTA-1701-D written by Michael Walden and Frank Eubanks here: https://lynceans.org/wp-content/uploads/2021/05/Walden-LTA-1701-D-article.pdf

The broader business concept included developing a second entertainment airship configured to resemble a Klingon Bird of Prey starship, which would offer different entertainment venues and adventures and could engage in mock air battles with the LTA-1701-D.

Artist's concept of a Klingon Bird of Prey (BOP) LTA entertainment airship. Source: Walden Aerospace

3. Walden Aerospace Vertical Exploration System (W.A.V.E.S.) hybrid rocket / balloon (“Rockoon”)

W.A.V.E.S. is a design concept for a combination rocket and balloon (ROCKet – ballOON, ROCKOON) designed to lift a passenger-carrying, pressurized gondola to the edge of space, at an altitude above 100 km (62 miles), and return for a safe landing on Earth. Other competitors for this type of space tourism mission are Virgin Galactic’s SpaceShip 2 and Blue Origin’s New Shepard, both of which are rocket-propelled. Unlike its competitors, W.A.V.E.S. uses a combination of buoyant lift and hybrid rocket propulsion to fly a low-acceleration flight profile to a comparable apogee. Aerostatic lift enables vertical takeoff and landing and flight in the lower atmosphere, while rocket power enables the final ascent into, and descent from, the upper atmosphere.

The W.A.V.E.S vehicle is a 350 feet (106.7 m) long, elliptically shaped, vertically-oriented rigid airship. The W.A.V.E.S vehicle is supported on the ground by a set of landing legs. A large, pressurized gondola at the bottom of the W.A.V.E.S. vehicle is designed to carry about 20 passengers, each with a front-row seat at a large viewing window.

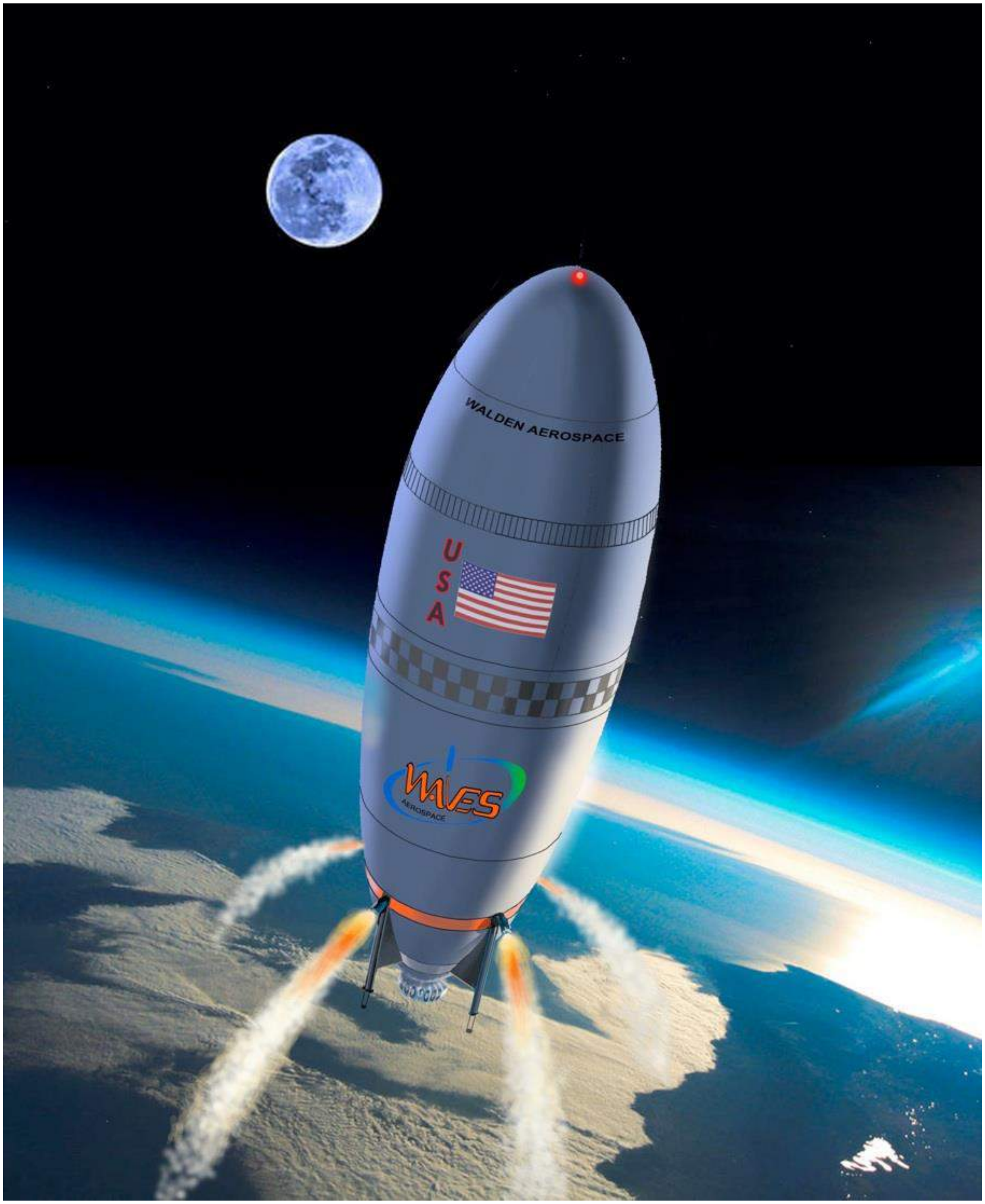
During flight, W.A.V.E.S. make use of the following systems:

- **Density-controlled buoyancy (DCB) active aerostatic lift control system:** The DCB system controls the aerostatic lift of the vehicle, enabling vertical takeoff and landing (VTOL) and buoyant flight between the ground and the “float” altitude. For W.A.V.E.S., this is the maximum altitude the vehicle can reach with full fuel and payload and the available inventory of helium lift gas at ambient temperature. At the float altitude, the helium lift gas cell is not fully expanded within the rigid hull. To reach higher altitudes, lift gas heating is used to fully expand the lift gas cell within the rigid hull, which is designed to handle a small superpressure. Once the lift gas cell is fully expanded, helium pressure is controlled at high altitude by the combined actions of the DCB system (managing helium inventory in the lift gas cell) and the lift gas heating system (modulating lift gas heating).

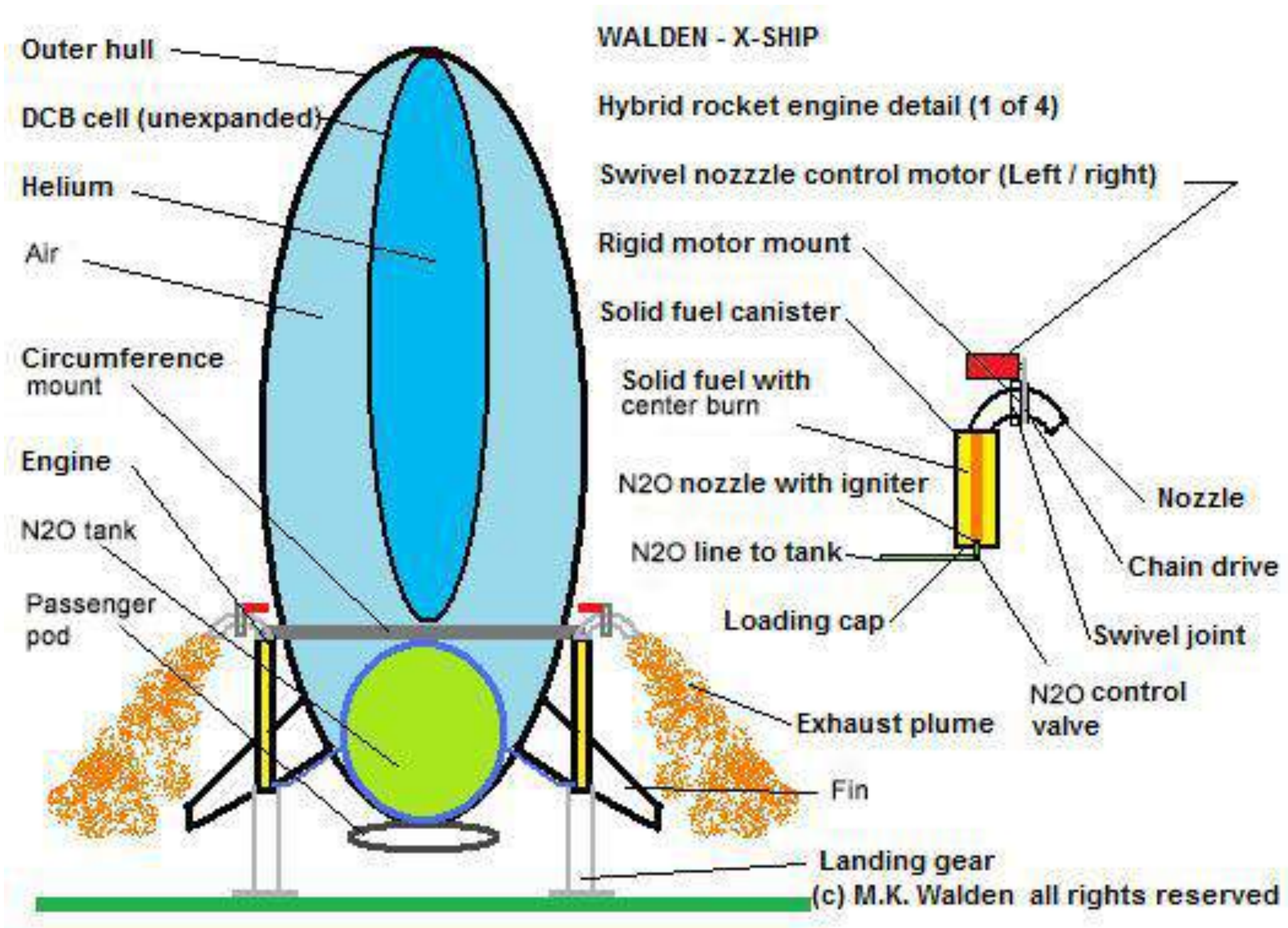
- **Hybrid rocket propulsion system:** Four throttleable, thrust vectoring, hybrid rocket engines are installed at 90º intervals around the “circumference mount” and are supported by the landing gear structure near the base of the W.A.V.E.S. vehicle. The propellants are nitrous oxide (N_2O) and a rubber-based solid compound. This hybrid engine is throttleable from an “idle” setting to full thrust. The solid propellent canisters exhausts upwards into a curved nozzle that redirects the exhaust flow diagonally downward and away from the vehicle. Each exhaust nozzle has an outer section that can be vectored left or right. The four engine thrust vectors (magnitudes and directions) are controlled to propel the vehicle on a low-acceleration flight path to apogee during the burning ascent phase and then continue providing reduced thrust to control vehicle speed in the upper atmosphere during the burning descent phase.

- **Lift gas heating system:** This system diverts a portion of the hybrid rocket exhaust into a heating duct in the circumference mount that supports the engines. During hybrid rocket operation (from idle to full thrust), the heating duct can be opened to heat the duct structure, which radiates heat into the lift gas cell and increases aerostatic lift. The duct can be closed when heating is not needed.

- **Cold gas maneuvering system:** This system uses pressurized nitrous oxide (N_2O) as a monopropellant for four thrusters (vent ports) discharging perpendicular to the hull. The gas thrusters draw from the same N_2O supply as the hybrid rocket engines and are installed at 90º intervals around the vehicle, near the elevation of the circumference mount. This system is used for directional control during the warm lift gas descent phase, after the thrust-vectoring hybrid rocket engines have consumed all of their solid fuel and are no longer operating. During this mission phase, the cold gas thrusters can push the base of the W.A.V.E.S. vehicle enough to generate a controlled yaw angle relative to the direction of flight. The resulting aerodynamic forces during descent will “fly” the airship in that direction, refining the flight path toward the designated landing site.



Artist's concept of a W.A.V.E.S vehicle under hybrid rocket power.
Source: Walden Aerospace



W.A.V.E.S. vehicle & hybrid rocket engine schematic diagrams. Source: Walden Aerospace

A W.A.V.E.S. high-altitude mission is divided into the following phases:

- **Float ascent phase**: Vertical takeoff and buoyant ascent is accomplished using the DCB system. Hybrid rocket engines are OFF until reaching float altitude (about 10 km / 6.2 miles).

- **Warm lift gas ascent phase**: Hybrid rocket engines are brought online at IDLE and the lift gas heat duct is opened to raise lift gas temperature and fully expand the lift gas cell. Thereafter, lift gas pressure is controlled by the combined actions of the DCB system and lift gas heating system.

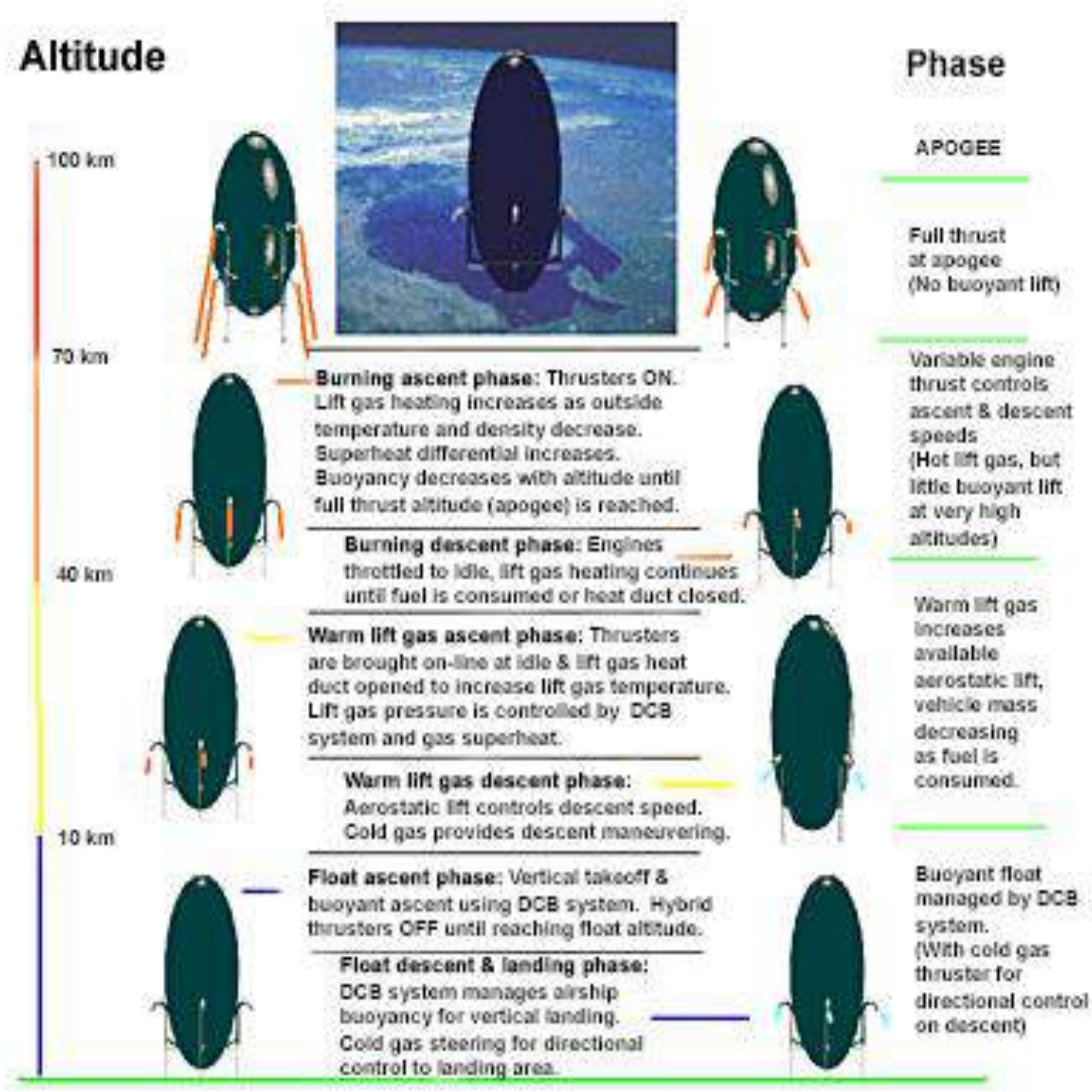
- **Burning ascent phase**: At an altitude of about 40 km (24.8 miles), the hybrid rocket engines are throttled up to provide the greater thrust needed to continue the ascent. Lift gas heating increases as outside temperature and density decrease. Superheat differential increases. Buoyancy decreases as altitude increases. The apogee is reached at an altitude of more than 100 km (62 miles), with little or no buoyant lift and the hybrid rocket engines operating at full thrust.

- **Burning descent phase:** After apogee, the hybrid rocket engines are throttled back to IDLE to control vehicle descent speed in the upper atmosphere and to continue lift gas heating at high altitude until the rocket's solid fuel is consumed at an altitude of about 40 km (24.8 miles) or the heat duct is closed.

- **Warm lift gas descent phase:** Aerostatic lift increases as atmospheric density increases at lower altitudes, even though the lift gas is gradually cooling during this phase. Cold gas steering thrusters are used to maneuver toward the landing site.

- **Float descent & landing phase:** The airship is considerably lighter during final descent than it was during the initial ascent. The DCB system manages airship buoyancy during descent and for the vertical landing. Cold gas steering may continue until landing.

A W.A.V.E.S. high-altitude mission is shown schematically in the following graphic.



W.A.V.E.S vehicle mission profile.
Source : Walden Aerospace

Artist's concept of the passenger gondola suspended under the W.A.V.E.S. vehicle. Source: Walden Aerospace

Interior view of the W.A.V.E.S passenger accommodations.
Source: Walden Aerospace

In an emergency, the gondola can be detached from the airship and descend with parachutes for a safe landing.

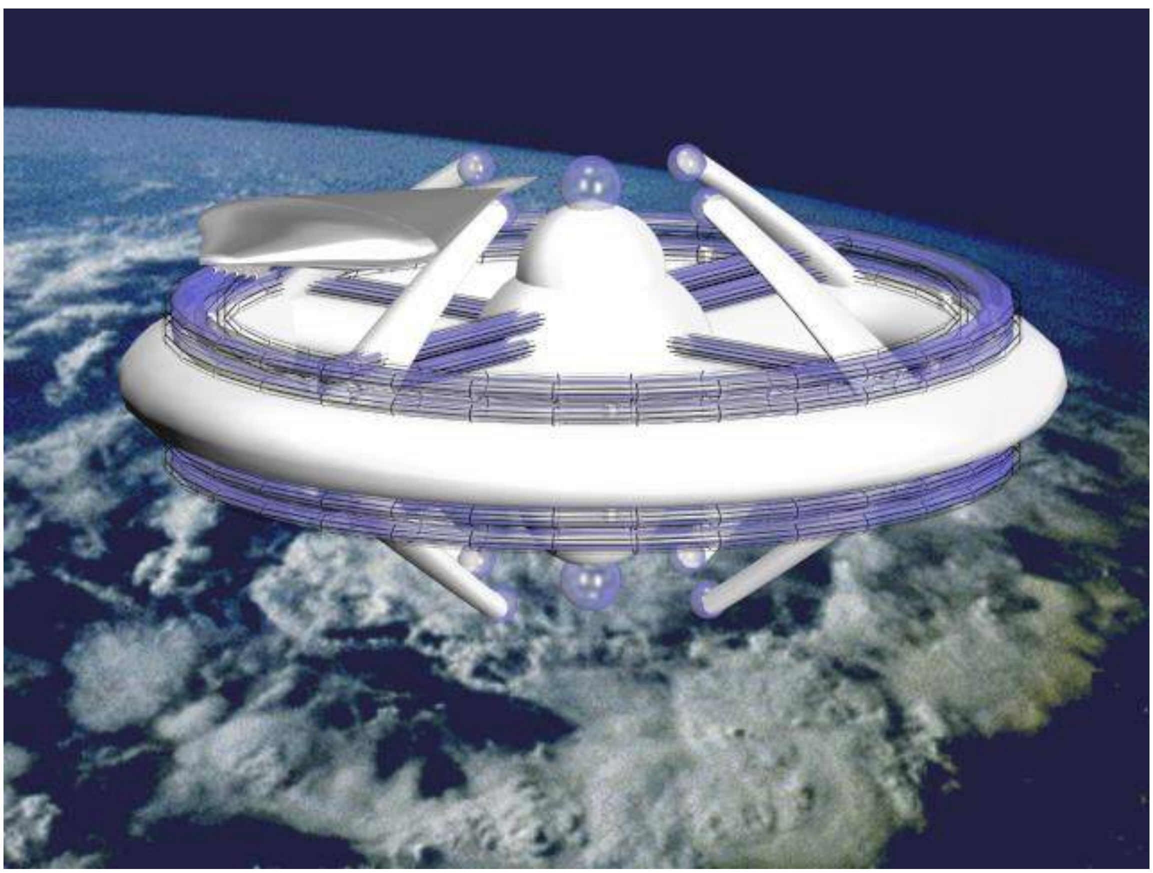
The gondola could be adapted to enable properly equipped passengers to base jump from the gondola from an extreme altitude.

You'll find more information on W.A.V.E.S. on the Walden Aerospace website at the following link:
http://walden-aerospace.com/W.A.V.E.S..html

4. Earth Station One (ES-1) stratospheric habitat and Silver Dart stratospheric shuttle

Michael Walden explained that, once his Sub-Orbital Solar Collection and Communications Station (S.O.S.C.S.) had established the near-space technologies for unmanned LTA operations, the next step would be to start development of Earth Station One “Aerostadt” habitats (self-contained airborne communities) and their associated closed-loop life support systems needed for continuous manned stratospheric / near-space operation with crew and clients.

Walden’s design for the first ES-1 unit has the general appearance of a space station with a diameter of over 1,400 feet (427 m). It was designed to accommodate up to 1,250 people (1,000 guests and 250 crew) at high altitude or up to 5,000 people at low altitude.



Artist’s concept of ES-1 at high altitude
with a Silver Dart shuttle docked at an upper pylon.
Source: Walden Aerospace

Walden’s S.O.S.C.S. is designed for long-term, unmanned operation at very high altitudes between 100,000 to 120,000 feet (18.9 to 22.7 miles, 30.5 to 36.6 km). In comparison, ES-1 would be designed for manned operation at altitudes between 50,000 to 60,000 feet (9.5 to 11.4 miles, 15.2 to 18.3 km), where it could still offer “curve of the Earth” views. ES-1 would operate just above the prevailing jet stream, which usually is in the 5 to 9 mile (8 to 15 km) altitude range. At the lower altitude, the ES-1 would be resupplied on station by Silver Dart hybrid airship / rocket shuttles operating from the ground.

Artist’s concept of the ES-1 operating at low altitude over Las Vegas with the LTA-1701-D entertainment airship docked. Source: Walden Aerospace

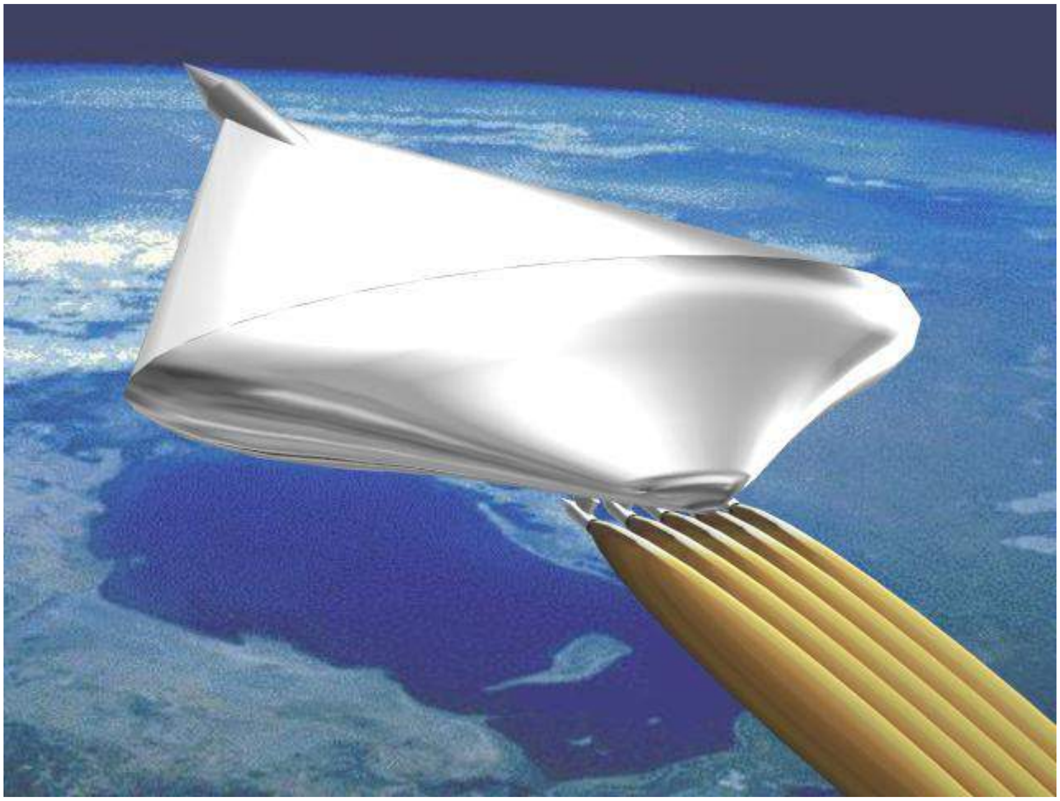
Both S.O.S.C.S. and ES-1 have Walden’s density controlled buoyancy (DCB) active aerostatic lift control system that would be used for ascent, altitude station keeping and descent. In the event of an emergency, the DCB system can be used to lower the entire ES-1 vessel back to low altitude or to the ground. In an extreme emergency, the crew and passengers can bail out of the ES-1 with appropriate protective gear and be recovered on the ground.

To maintain the airship at a prescribed geo-location, both S.O.S.C.S. and ES-1 would use an electro-kinetic (EK) propulsion system that is well suited for operating in the very low-density air at high altitude. This EK propulsion system builds on experience with EK systems demonstrated by Walden and LTAS during subscale airship test flights in the mid-1970s and in 2003.

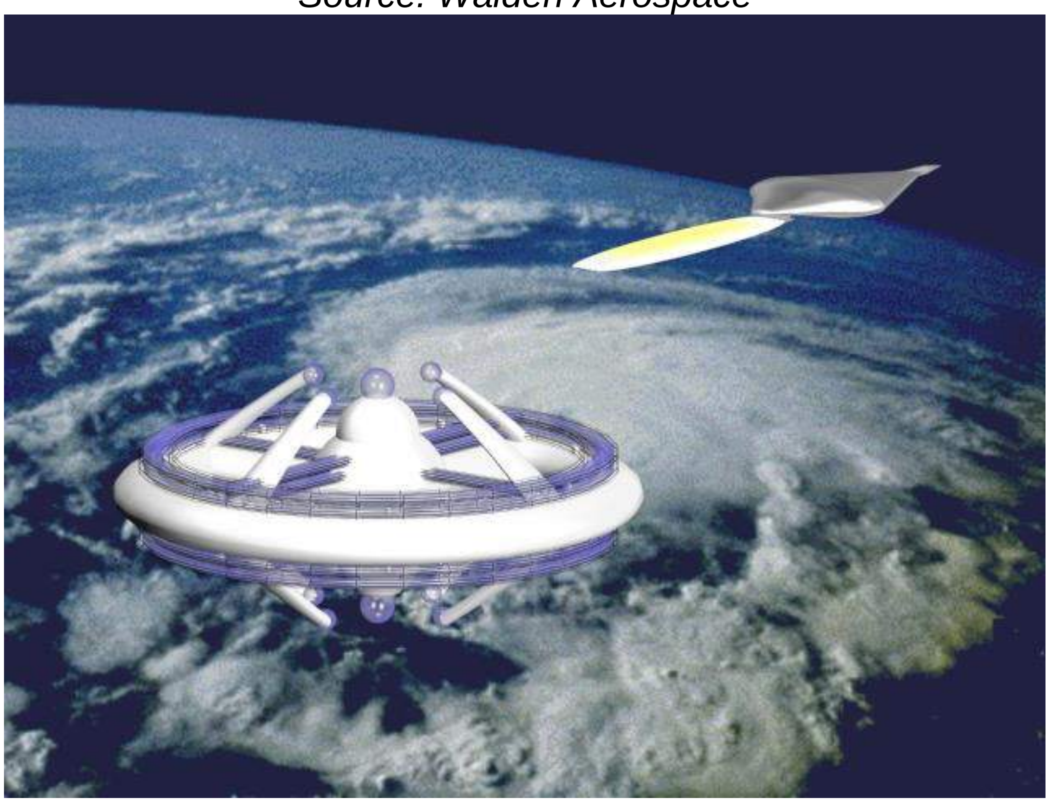
The first commercial business application of ES-1 is expected to be as a venue for a high-end entertainment / gaming resort. The ES-1 would be stationed over international waters, but in close proximity to one or more densely populated metropolitan areas. From its high altitude station, ES-1 also could provide commercial communication services similar to S.O.S.C.S.

At the ES-1's intended operating altitude, the outside environment is similar to low Earth orbit, except for weightlessness in orbit. Therefore, ES-1 also could function as a research test bed for structural and support systems and best operating practices that ultimately could be employed on similar orbital stations. ES-1 also could serve as the launch point for a hybrid airship / rocket vehicle destined for low Earth orbit.

Unlike an orbital station, ES-1 would have continuous passenger service and a supply of goods from the ground using the Silver Dart hybrid airship / rocket shuttle or some other airship that can reach the ES-1's operating altitude. With its DCB system, the Silver Dart shuttle would routinely make vertical takeoffs and landings (VTOL) at its base of operations on the ground and exchange passengers and cargo without having to exchange ballast. The shuttle is designed to dock with the ES-1 upon arrival and transfer passengers and cargo through a pressurized airlock.



Artist's concept drawings showing the general configuration of the Silver Dart shuttle (above) and a Silver Dart departing ES-1 (below). Source: Walden Aerospace



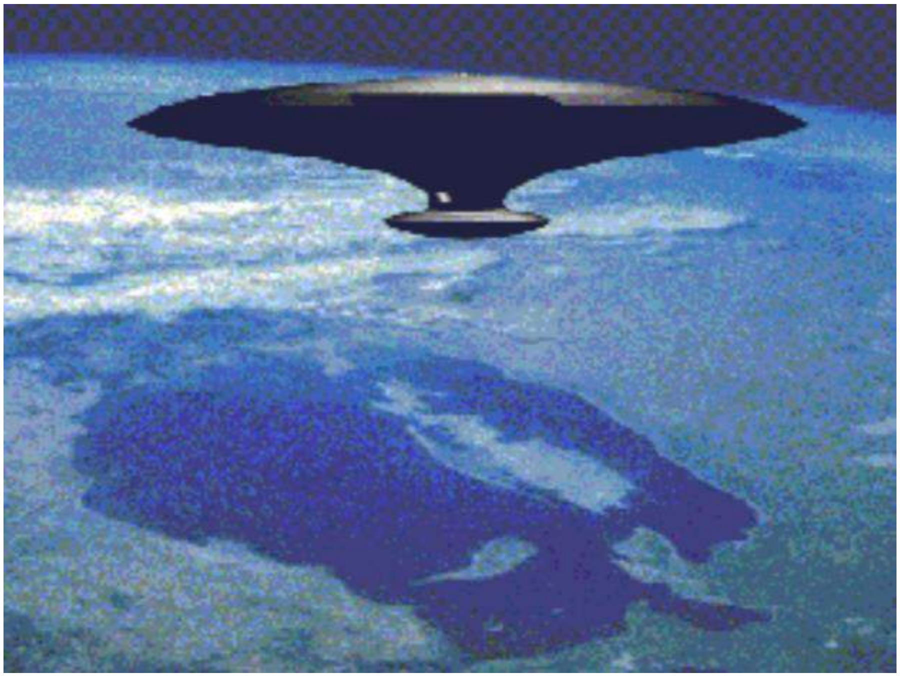
Artist's concept drawing showing the scale of the
Silver Dart shuttle relative to a Las Vegas casino building.
Source: Walden Aerospace

5. Airships as a route to orbit

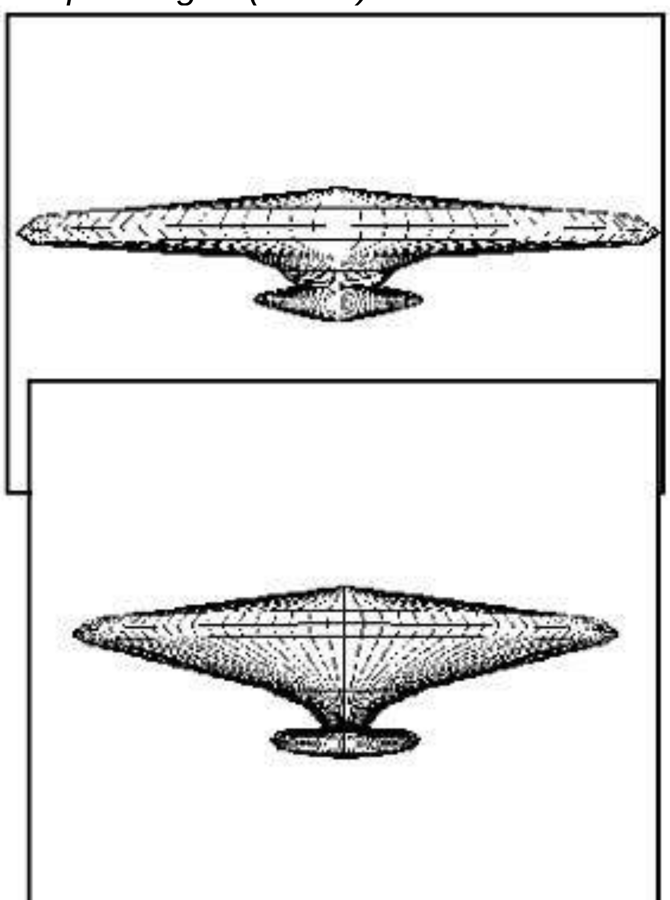
Michael Walden has developed several advanced concepts for high-altitude airships as a route to orbit. Two concepts, HYPER and EARTHBALL, are described briefly below.

HYPER

In the late 1970s, Walden developed the concept for a single-stage-to-orbit (SSTO) vehicle named HYPER, which was an airship with a broad, thin lenticular hull form with a smaller lenticular engine module mounted below the main hull. HYPER was 300 feet (91.4 m) in diameter with the aeroshell made of titanium-aluminum honeycomb sandwich material. Using Walden's DCB active aerostatic lift control system, HYPER was able to take off and land vertically as an airship, with vectorable fan thrusters for low-speed propulsion and control.



Rendering of HYPER at high altitude (above). Two profile views of HYPER concept designs (below). Source: Walden Aerospace

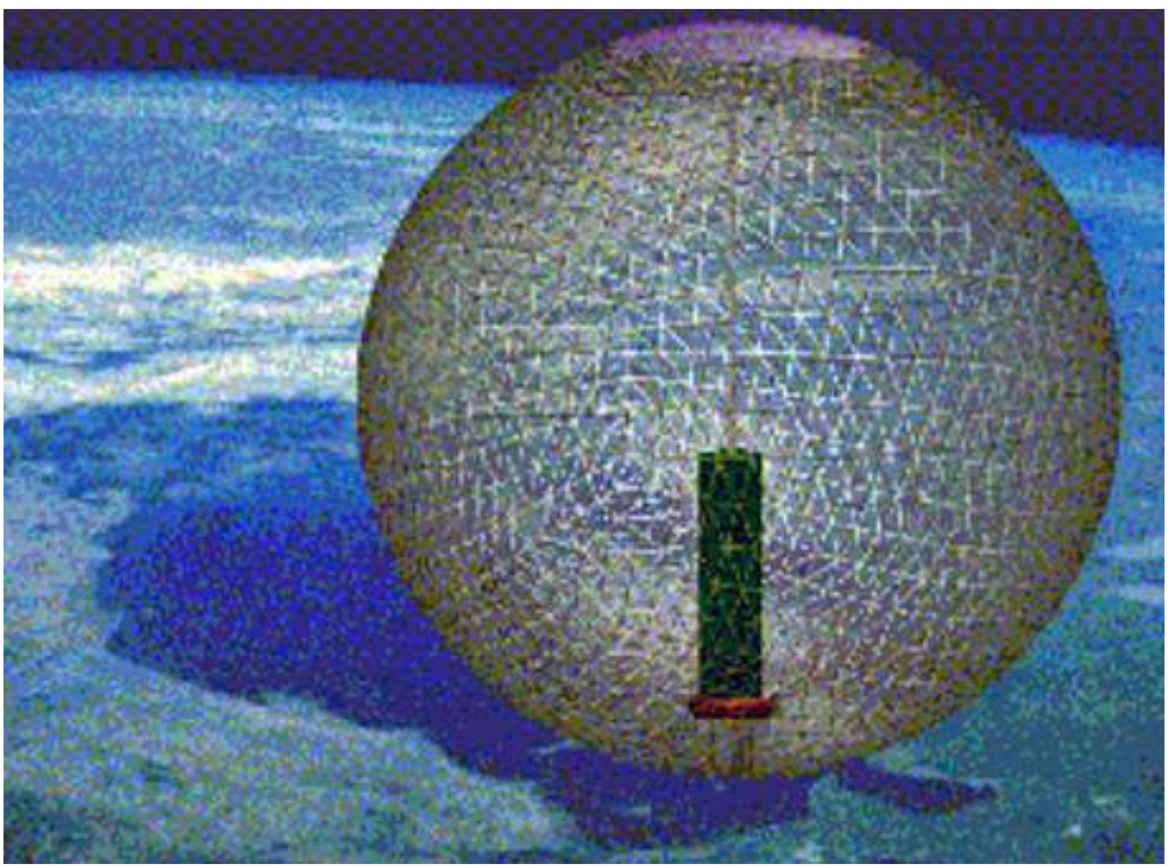


After reaching a high altitude as a buoyant airship, propulsion to orbit would be provided by an advanced engine, which Walden characterizes as a hydrogen-fueled “vectorable engine module containing a dual-cycle, laser-fired, pulse scramjet / rocket engine.”

At the end of an orbital mission, aerobraking brings the HYPER craft out of orbit and decelerates the craft to a point at about 50 miles (80.5 km) altitude where the engines can be restarted and the craft can fly back to any desired point and land vertically. See Michael Walden’s 1977 article, “Slowly Up the High Road – Airships to orbit,” for more details on the HYPER’s operation and propulsion system.

EARTHBALL high altitude spheroid airship station

EARTHBALL is airship that serves as a very high altitude, reusable launch platform for a rocket with a payload destined for Earth orbit or beyond. The rocket is carried in, and launched from a central tube.



Artist’s concept of an EARTHBALL launch platform at high altitude. Source: Walden Aerospace

By lifting a launch vehicle to an altitude of about 20 miles (32 km), the EARTHBALL accomplishes much of the work normally done by the first stage of a multi-stage booster rocket (albeit the high altitude launch occurs at zero velocity). The energy required to reach orbit after a high altitude launch is much less than a launch from the surface of the Earth, allowing a smaller rocket to lift a particular payload into orbit.

6. For additional information

LTA-1701-D entertainment airship

- Michael Walden & Frank Eubanks III, "The Walden Entertainment Airship Concept LTA-1701-D (Entertainment Venue and Ultimate Private Luxury LTA Super-Yacht)," Walden Aerospace, 2020: https://lynceans.org/wp-content/uploads/2021/05/Walden-LTA-1701-D-article.pdf

Airship route to orbit

Michael Walden developed several advanced concepts for airships as a route to orbit. For more information on this subject, see the following articles written by Walden:

- Michael K. Walden, "Slowly Up the High Road – Airships to orbit," Lighter Than Air Solar (LTAS) Corp., 1977, updated 1998: https://lynceans.org/wp-content/uploads/2020/12/Walden_1977_Slowly-up-the-high-road-aer.pdf
- Michael K. Walden, "Bootstrapping the Space Infrastructure - A financing plan for going from the stratosphere to orbit using LTA," https://lynceans.org/wp-content/uploads/2020/12/Walden_Bootstrapping-the-space-infrastructure-paper.pdf

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
    - Walden LTAS - Lenticular toroidal density controlled buoyancy (DCB) airships
    - JP Aerospace - Ascender airships & Dark Sky Station
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
    - Walden LTAS - Electro-kinetically (EK) propelled airships
    - Walden LTAS - Variable buoyancy (VB) propelled airships
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/