Ohio Airships Dynalifter semi-buoyant hybrid aircraft

Peter Lobner, updated 8 March 2022

1. Introduction

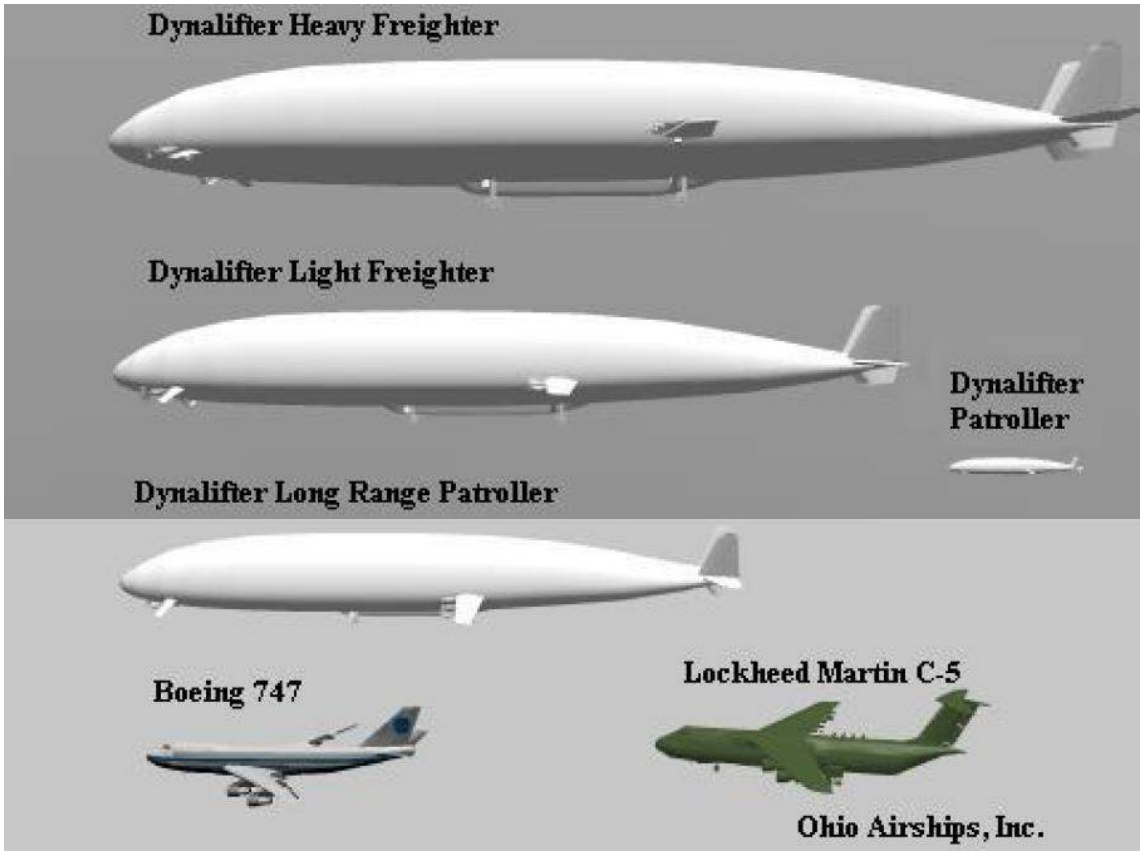
Ohio Airships, Inc. is a research and development company focused on developing the Dynalifter line of semi-buoyant, hybrid aircraft. The firm was formed in 1999 by Bob Rist and Brian Martin and since 2009 has been based in Toledo, Ohio.

Robert Rist and Brian Martin, founders of Ohio Airships
Source: combatreform.

The Ohio Airships website is here:
http://www.ohioairships.com/about-us.html

Ohio Airships subcontracted conceptual design engineering to a team of three contractors: Conceptual Research Corporation, Analytical Methods, and Composite Engineering. Together, these companies

completed conceptual designs for four different sizes of Dynalifters, ranging from the 120 foot (36.6 meter) Dynalifter Patroller to a 990 foot (302 meter) Dynalifter Heavy Freighter. These conceptual designs have been evaluated using computational fluid dynamics and wind tunnel testing, initial fabrication selection and cost analysis.



Dynalifter scale comparison. Source: Ohio Airships

The Dynalifter concept was addressed during the Defense Advanced Research Projects Agency's (DARPA) Project Walrus, which started in 2004, and sought to develop a very heavy lift airship for strategic military airlift applications. However, Dynalifter development was not funded by DARPA.

2. General characteristics of a Dynalifter

The Dynalifter is described as "a fuel-efficient hybrid of fixed-wing airplane and helium airship, providing a set of features unavailable with any single aircraft." These features include:

- A Dynalifter has a large, cylindrical fuselage containing the helium gas cells, which are free to expand or contract within the fuselage. A surrounding air volume connected to the atmosphere fills the balance of the fuselage interior not occupied by the helium gas cells.
- The helium and air cells surround a patented semi-rigid, load-bearing structure running the length of the aircraft and supporting the wings and propulsion units, control surfaces, landing gear and a large gondola for passengers and/or cargo.
- The unique, patented design of the semi-rigid, load-bearing structure enables a Dynalifter aircraft to carry concentrated loads (i.e., compact and heavy) in the cargo hold without risking structural collapse.
- Dynalifters derive about 50% of their lift from helium buoyancy and the balance from aerodynamic lift.
    - This combination provides high fuel efficiency and allows airplane-like handling in the air and on the ground.
    - In comparison, hybrid airships derive a greater fraction of lift from helium, typically 60 – 80%.
- Dynalifters are capable of carrying bigger payloads, further, and cheaper (but slower) than comparable fixed-wing aircraft.
- Dynalifters can operate from smaller airports than comparable fixed-wing aircraft. With their lighter ground loading, Dynalifters may be able to operate from grass or dirt landing strips.
- A Dynalifter remains heavier-than-air when empty of cargo. Therefore, there is no complicated ballast system needed to manage net buoyancy during load exchanges (i.e., when discharging or receiving cargo / passengers). Cargo can be unloaded with no further action and the aircraft will remain in place, like a conventional fixed-wing aircraft.
- On the ground, the heavier-than-air (but semi-buoyant) Dynalifters are stable in moderate winds up to 30 knots. In higher wind speeds, some action must be taken to stabilize the aircraft, such as adding weight (fuel or cargo), pointing the aircraft into the wind, and/or tying it down.

- Dynalifters are rugged enough for all-weather operation.
- Dynalifters can fly without helium.
- Dynalifters cannot hover.

You'll find a more complete introduction to the Dynalifter here: https://lynceans.org/wp-content/uploads/2020/11/Ohio-Airships-Introduction-to-the-Dynalifter-Aiircraft.pdf

You can watch the short YouTube video, "Dynalifter," here: *https://www.youtube.com/watch?v=3EI6OEtcH3o*

3. Dynalifter patent

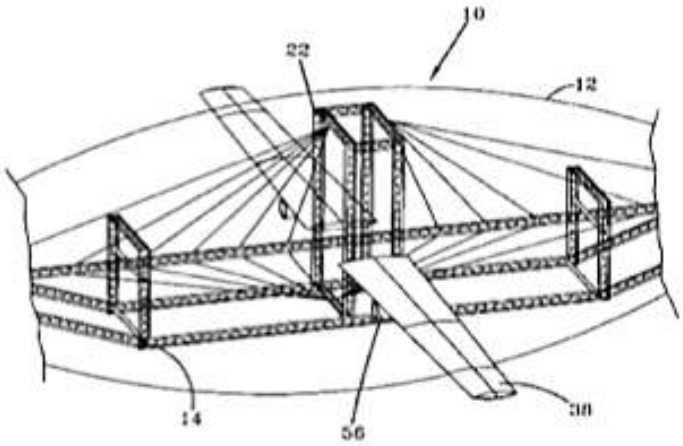
The key patent for the Dynalifter is US 6,311,925B1, "Airship and method of transporting cargo," which describes the semi-rigid structural design and the helium lift system. This patent also describes the design of detachable cargo pods and other features that simplify ground handling and load exchange, and minimize the turnaround time for a Dynalifter. You can read this patent here: https://patents.google.com/patent/US6311925B1/en

Cable-stay bridges use a mechanical design technology that is well-established in the field of terrestrial bridge construction. Patent US 6,311,925B1 applies that same technology in the design of cable-stay structural towers (22, called vertical "plumb members") as part of the semi-rigid airframe of the Dynalifter aircraft. These cable-stay structural towers enable the lightweight aircraft structure to carry concentrated loads (i.e., a compact / heavy load in the cargo bay and transverse static and dynamic structural loads from the wings) without risking structural collapse. This basic design feature is shown in patent Figure 1.

> "This internal structure gives the airship sufficient structural integrity so that wings may be added to the airship. Thus, the airship of the present invention enjoys the advantages of dynamic as well as static lift. This gives the current invention outstanding performance characteristics that are vastly superior to those of the related art. The preferred embodiment of the

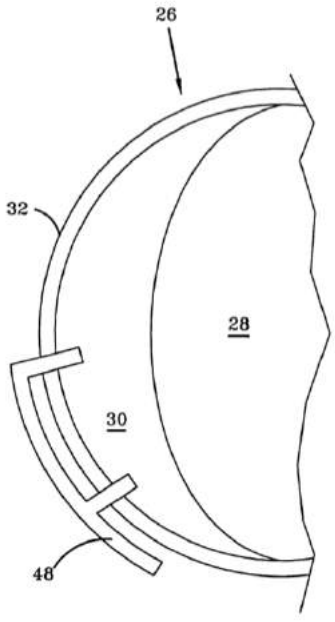
current invention may carry hundreds of tons of cargo. This may, for example, be equivalent to multiple loaded semi-tractor trailers or thousands of people."

U.S. Patent #US 6,311,925



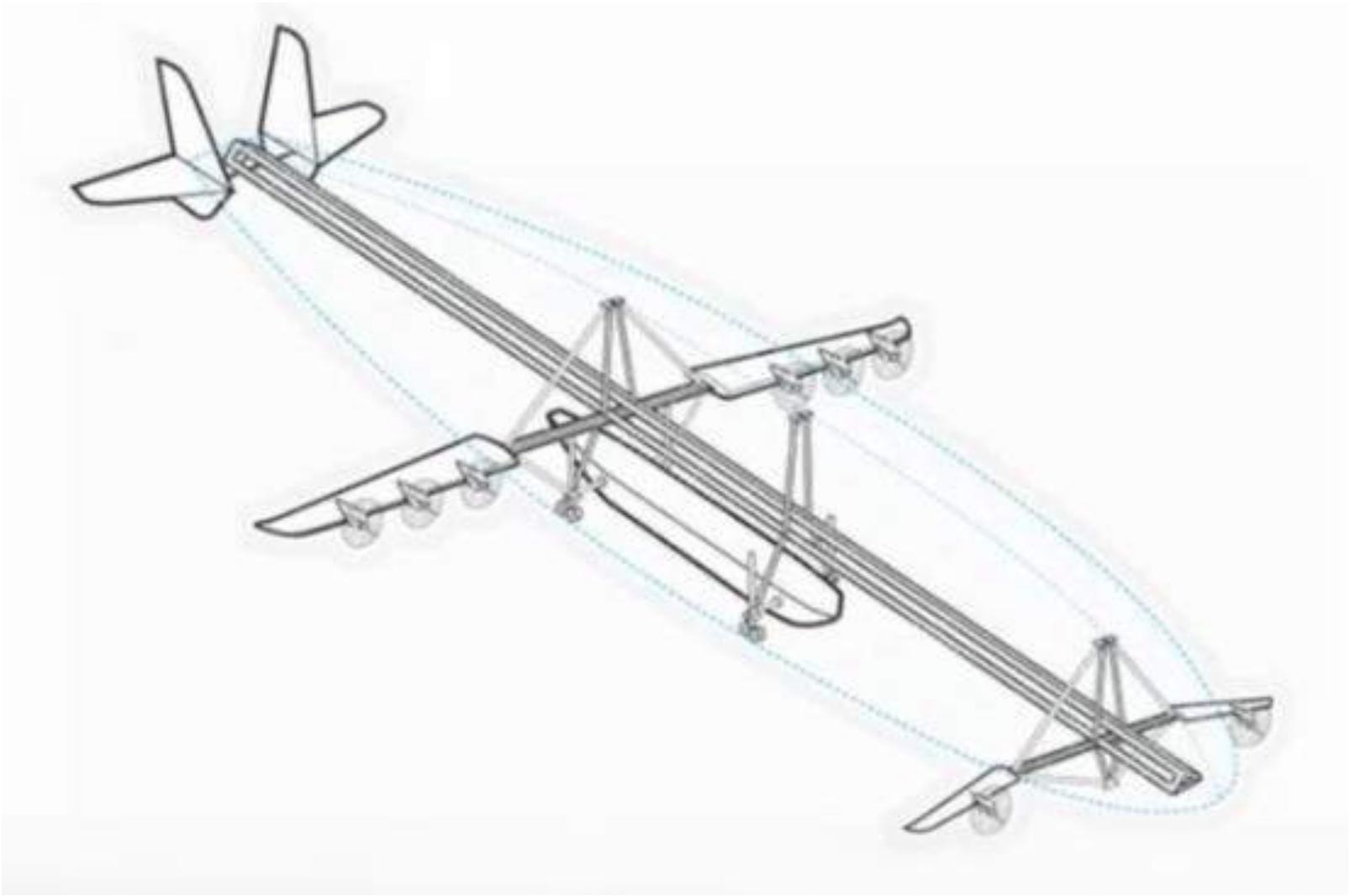
FIG–1

In patent Figure 1, cable-stay structural tower (22) supports the tensioned support cables and carries the loads from the longitudinal weight supporting structure (14) and transverse loads from the wings (38).

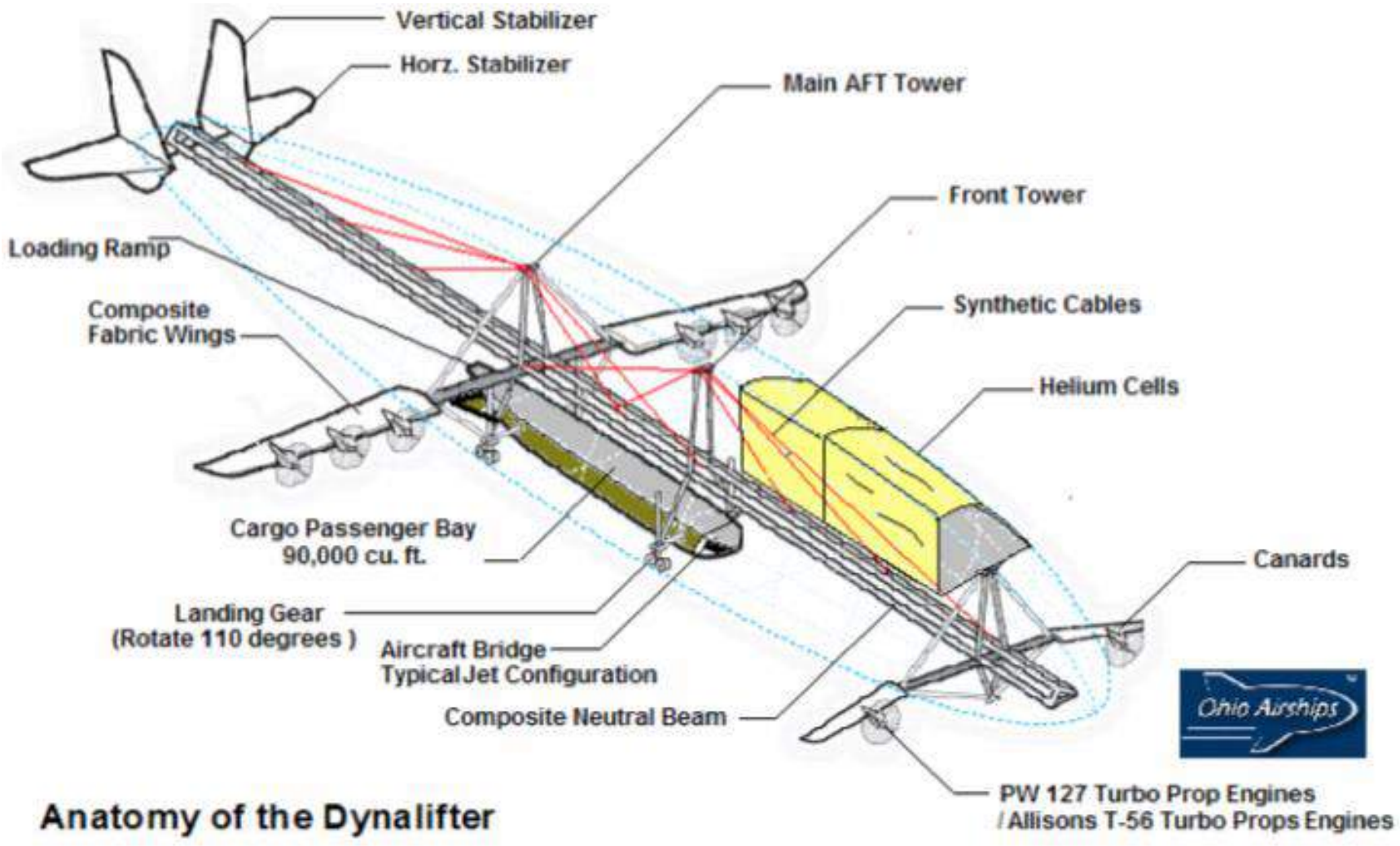


FIG–4

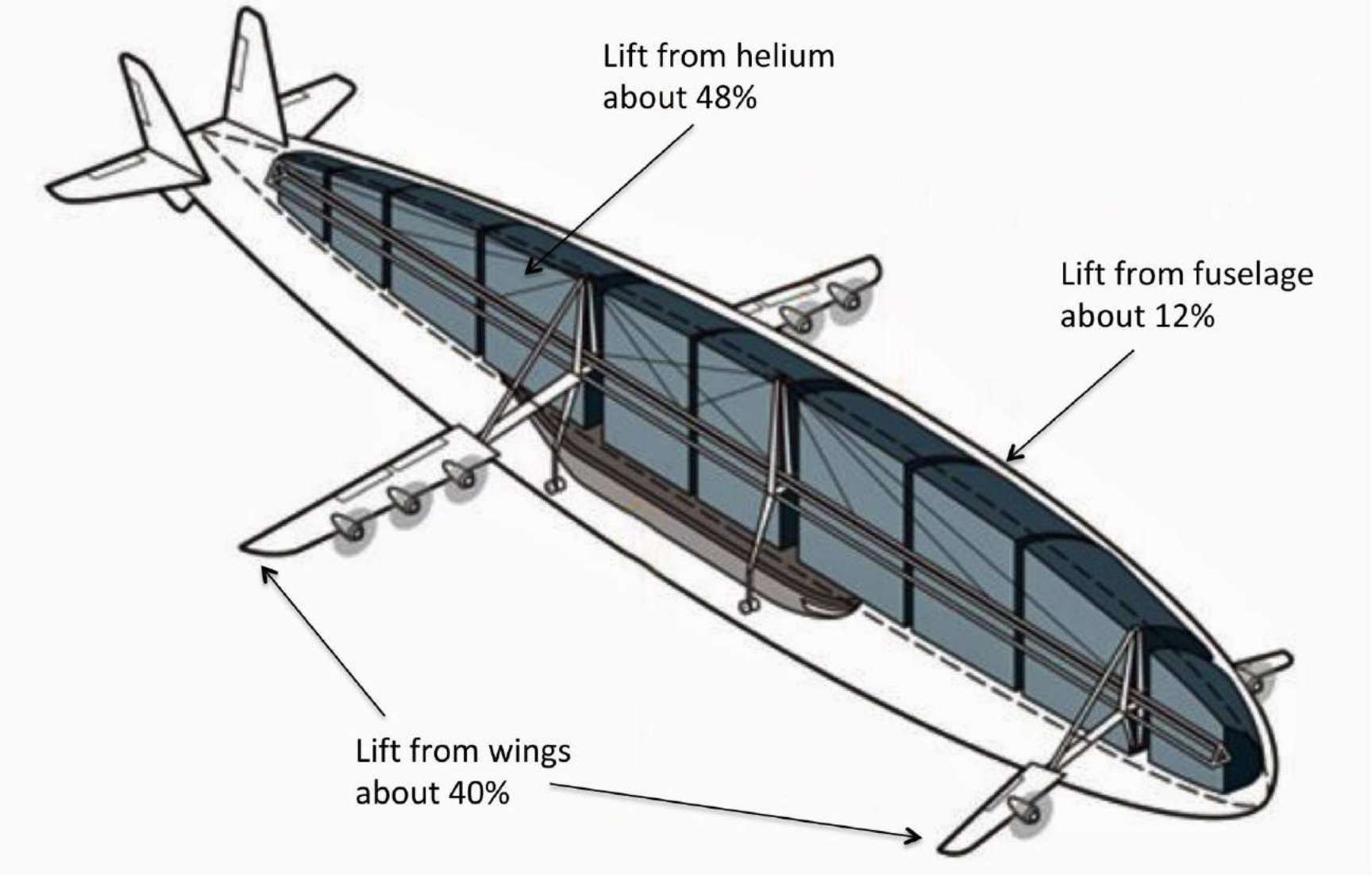
Within the semi-rigid hull (32), insulated lift gas cells (28) contain enough helium to make the Dynalifter semi-buoyant. As shown in patent Figure 4, ambient air chamber (30) fills the remainder of the space within the hull. The lift gas cells are free to expand and contract within air chamber (30) based on changes in altitude and temperature as the airship rises and descends. Ambient atmospheric pressure is maintained inside the hull by venting or supplying air via a chamber valve (48).



The semi-rigid load-carrying structure of a Dynalifter showing three structural towers.
Source: Screenshot from Ohio Airships video "Dynalifter"



Anatomy of the Dynalifter. Source: Ohio Airships



Dynalifter lift distribution. Source: Adapted from Ohio Airships

4. The Dynalifter prototype (DL-100)

Ohio Airships completed their 112 foot (34.1 m) long, 2,200 pound (998 kg) Dynalifter prototype in 2005. This prototype was designed to carry a pilot and one passenger. A series of 8 low-speed and 3 high-speed taxi tests in 2006 demonstrated the hybrid aircraft's structural integrity and general controllability, and verified that takeoff speed was achievable with the existing aircraft configuration. The prototype received an Experimental Airworthiness Certificate from the FAA in July 2006.

Prototype in its hangar. Source: Ohio Airships

Prototype roll-out. Source: Ohio Airships

Prototype roll-out. Source, both photos: Ohio Airships

After being damaged by thunderstorms in 2007, the prototype was rebuilt with newly designed skin and helium cells, and benefitted from a 500 pound (227 kg) weight reduction. The prototype became known as the Dynalifter DL-100, which now serves as a 1/10th scale demonstrator for a full-size Dynalifter commercial transport.

DL-100 in its current trim. Source: Ohio Airships

DL-100 taxi & rotation test, December 2012.
Source: Screenshot from Ohio Airships video

5. Full-scale Dynalifter concepts

These large aircraft can be configured for a variety of roles. Potential applications for Dynalifters include:

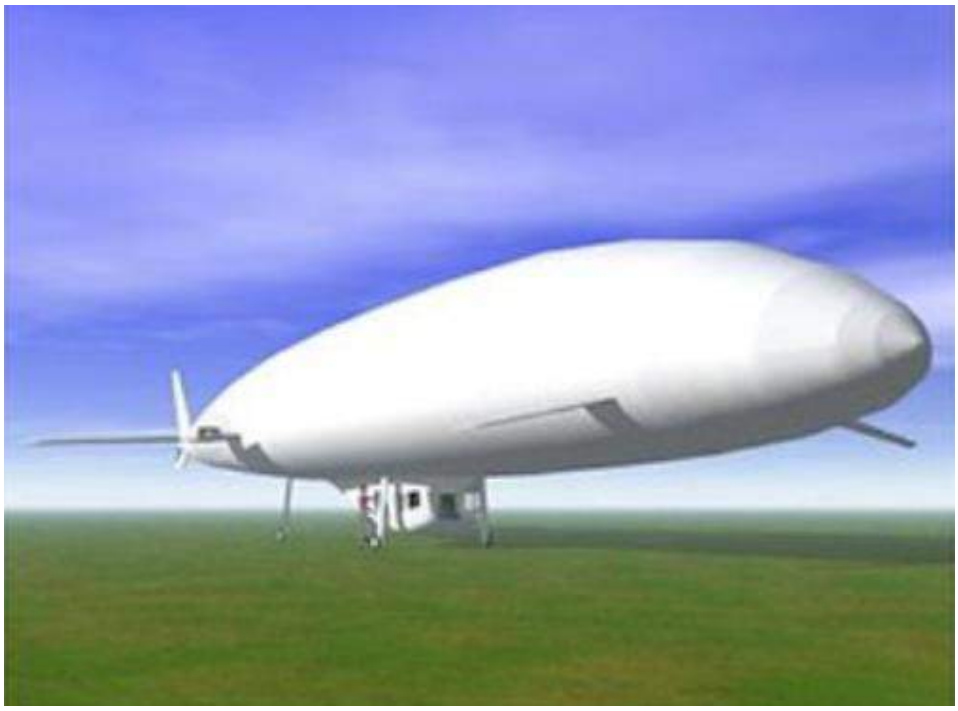
- Civil and military heavy cargo carrier
- Civil and military long-duration patrol
- Luxury passenger transportation
- Forest fire suppression (water bomber)
- Drone delivery vehicle

Ohio Airships refers to the Dynalifters freight capabilities as delivering “roadless trucking” in remote areas and in developing nations with poor transportation infrastructure.

Following is a brief look at several full-scale Dynalifter concepts.

Dynalifter Patroller

This is a relatively small, long-endurance aircraft that generally resembles the design of the DL-100 prototype. This aircraft could be configured for a variety of roles such as police surveillance, search and rescue, pollution enforcement, and airborne surveys.



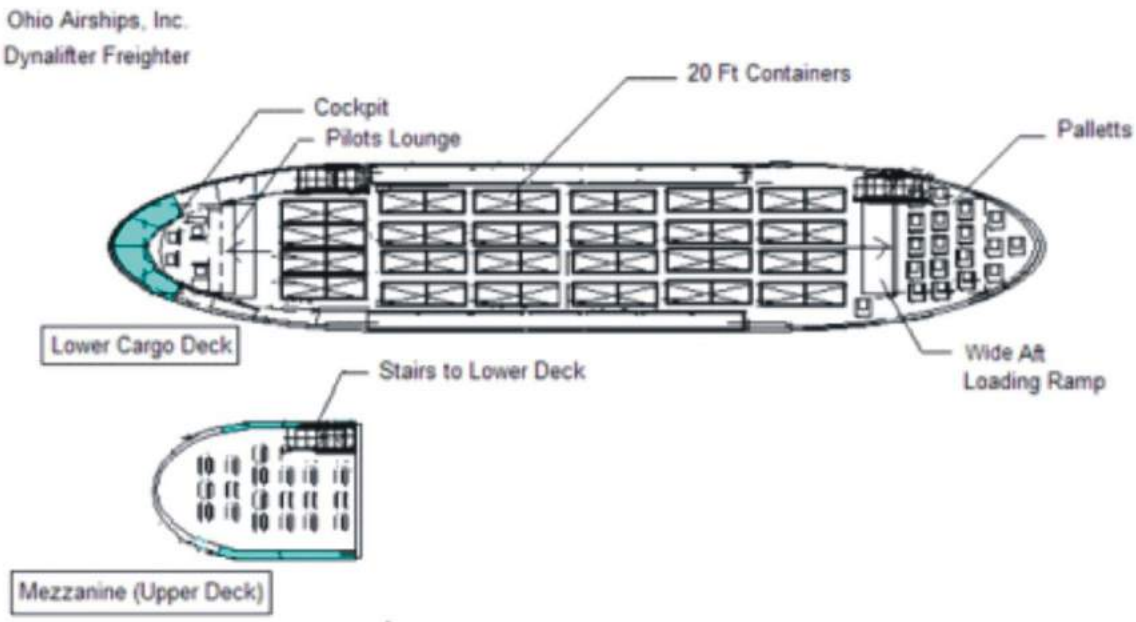
Concept drawings of the Dynalifter Patroller. Source: Ohio Airships

Dynalifter Freighter

The 990 feet (302 meter) Dynalifter Heavy Freighter is capable of carrying about 145 tons (131.5 metric tons) of cargo. Flying at 140 knots, intercontinental delivery times would be comparable to second-day air service, with a transatlantic crossings taking as little as 23 hours.

Concept drawings of the Dynalifter Freighter. Source: Ohio Airships

Concept drawing of the Dynalifter Freighter. Source: Ohio Airships



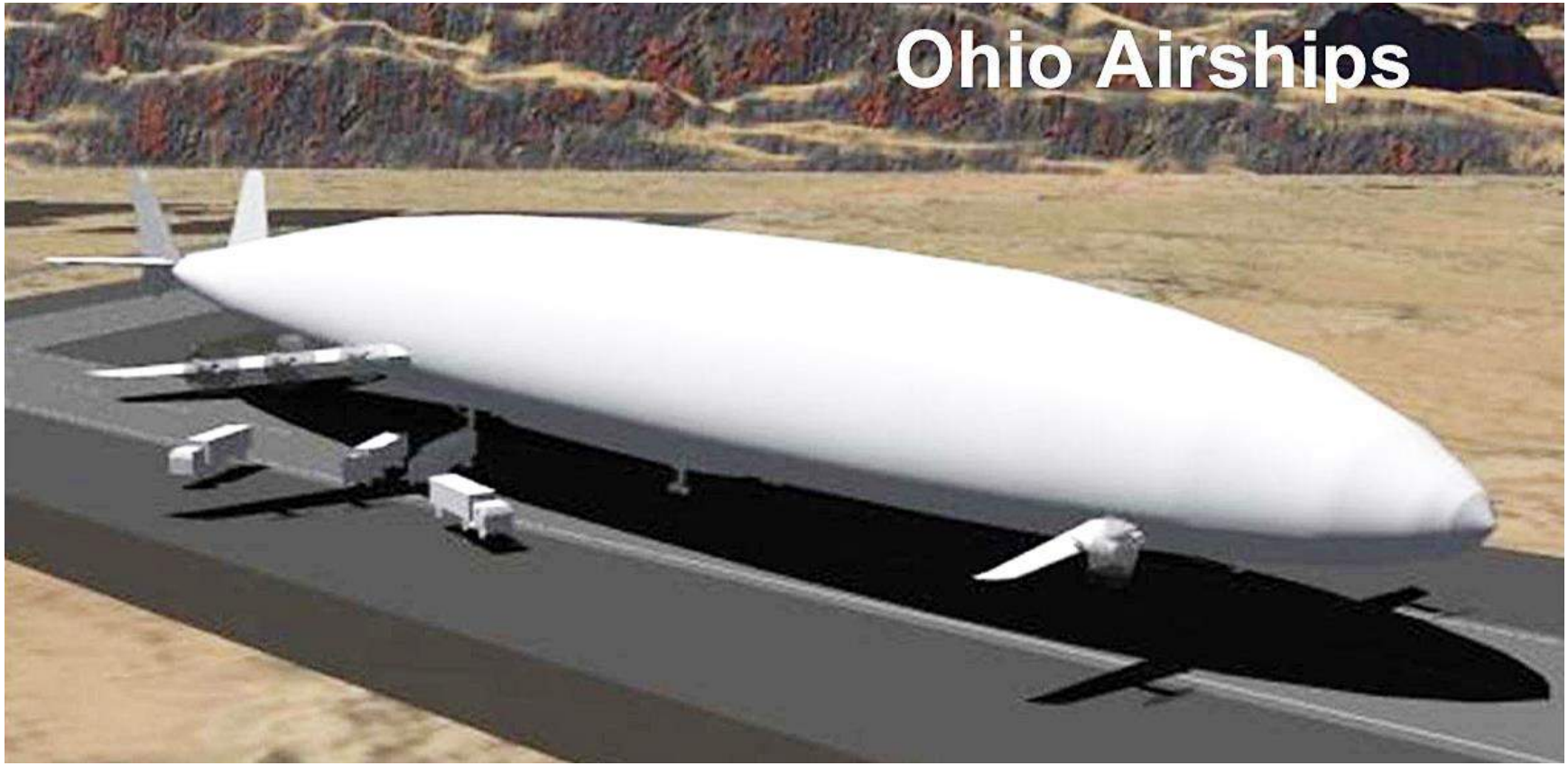
Cargo and passenger configuration in a Dynalifter Freighter. Source: Ohio Airships

The Dynalifter patent US 6,311,925B1 described the use of a detachable cargo container that would be pre-loaded with cargo or mission-specific equipment. Loading the airship would be accomplished by simply moving the airship over the container, lowering it over the container by kneeling the landing gear, and then attaching the container. Using this process, a Dynalifter Freighter could load and unload in less than one hour. The cargo container may contain additional compressed lifting gas that can be used by the airship for additional aerostatic lift when needed to handle heavy cargo. In addition, the container may include fuel and provisions to add ballast to stabilize the aircraft on the ground in heavy wind.

Dynalifter freighter rendered by artist Imatk for the October 2006 cover of Popular Mechanics.
Source, above: https://imatk.cgsociety.org/yw7w/popular-mechanics-ai
Source, left: Popular Mechanics

Relative scale of a 990 foot (302 meter) Dynalifter Freighter and a typical container cargo ship. Source: Airship Blog

Dynalift Freighter "X-ray view" showing the internal structures, including the structural spine and the patented cable-stay structural towers that carry the loads from the front wings, the gondola and cargo bay, and the main wings. Source: adapted from Ohio Airships



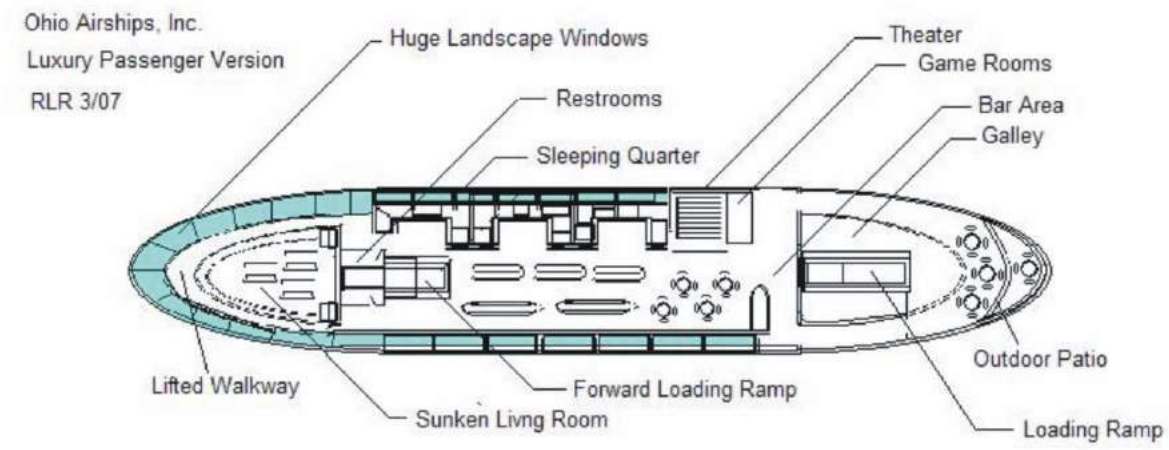
Concept drawing of a Dynalifter Freighter unloading cargo at an airport.
Source: Ohio Airships

Dynalifter Cruiser

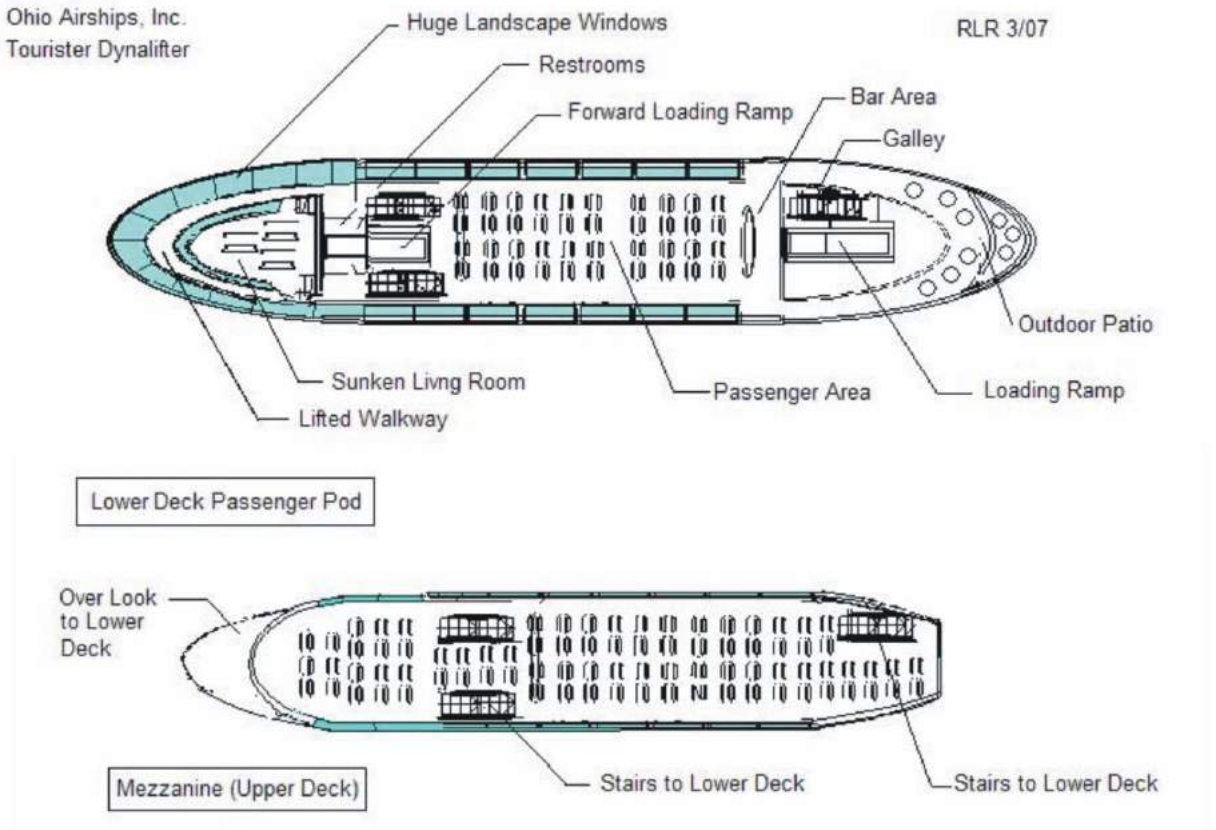
The Dynalifter Cruiser is conceived as "…the most comfortable form of air travel in history. Like a cruise ship in the air, the Dynalifter Cruiser will take you where you're going in luxury." The Cruiser shares the airframe design of the Dynalifter Freighter, but replaces the voluminous cargo hold with a two-level passenger cabin that can be outfitted for luxury cruising or for a higher-density tourist configuration.

Concept drawings for the Dynalifter Cruiser. Source: Ohio Airships

Concept drawing of the Dynalifter Cruiser in flight over Paris.
Source: Ohio Airships



Luxury passenger configuration for a Dynalifter Cruiser. Source: Ohio Airships



Tourist seating configuration in a two-deck passenger cabin on a Dynalifter Cruiser. Source: Ohio Airships

Dynalifter Drone Runner

The Dynalifter Drone Runner is an airborne mothership for short-range package delivery drones. Ohio Airships claims that long-range Dynalifters are ideal because they fly slow enough (about 80 knots) to deploy and retrieve slow-moving package drones. Also, unlike other types of airships, the Dynalifter is rugged enough to operate in all weather conditions. A prototype is in the design phase.

Concept drawing: Drone Runner deploying many small delivery drones. Source: Ohio Airships

Concept drawing: Drone Runner and a small delivery drone at its destination. Source: Ohio Airships

You can watch a short video on the Drone Runner concept here: https://www.youtube.com/watch?v=3EI6OEtcH3o

The basic concept of deploying (and retrieving) small, short-range drones from long-range Dynalifter aircraft seems to align with the goals of the Gremlins project sponsored by DARPA. The current focus of the Gremlins project is on demonstrating the ability to launch and retrieve small drones from a C-130 transport. It seems that a Dynalifter aircraft would be better suited for this task, since it offers a less challenging environment for launching and retrieving small drones (i.e., slower speed, less wake turbulence). You'll find more information on the DARPA Gremlins program at the following link: https://www.darpa.mil/program/gremlins

6. For more information

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