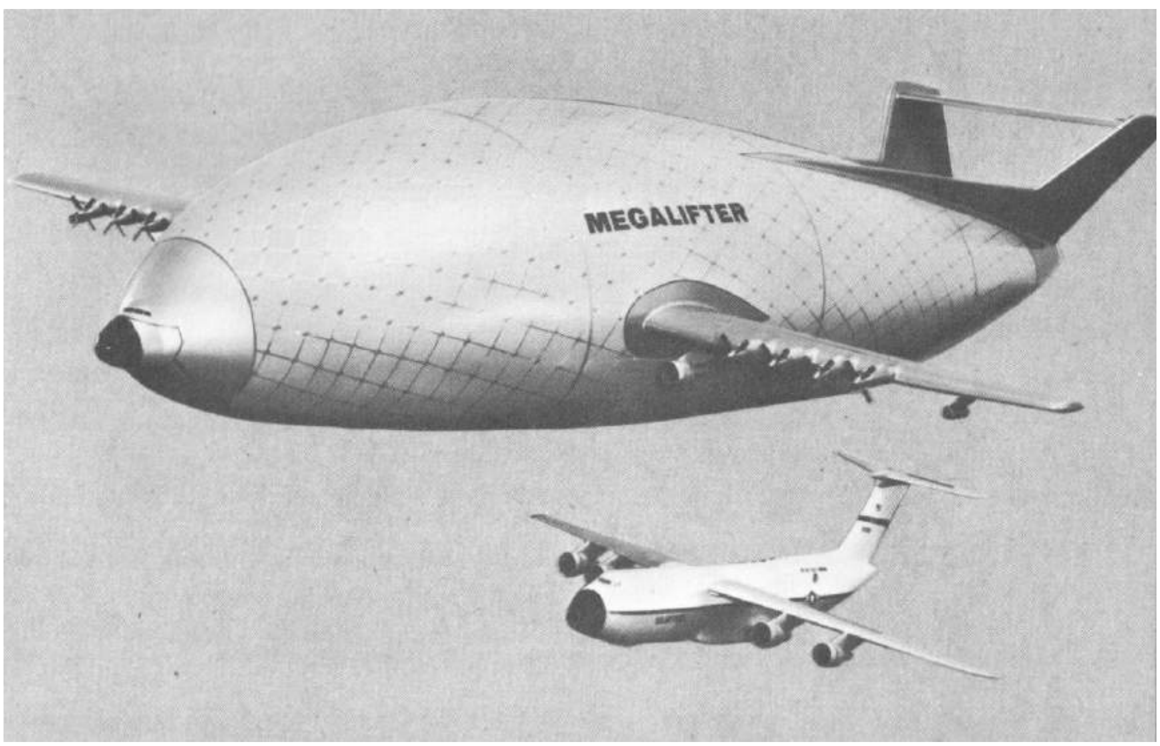
Magalifter - semi-buoyant hybrid aircraft

Peter Lobner, Updated 24 August 2021

1. Introduction

The concept for a semi-buoyant, heavy-lift, hybrid cargo airship / aircraft seems to have originated in the mid-1950s with Goodyear Aircraft Corp. and their non-rigid Dynamic Lift Airship. The concept of a very large semi-buoyant hybrid aircraft was advanced further in the mid-1960s by Aereon Corporation with their semi-rigid, delta-wing lifting body Dynairship.

In 1972, Frank M. Clark, one of the founders of Magalifter Co., launched the development of the semi-buoyant hybrid Megalifter aircraft. The main advantages claimed for this giant hybrid aircraft design included greater stability, larger payloads, lower cost and shorter takeoff distances than conventional heavy transport aircraft.



Scale comparison: Original turboprop + turbofan powered Megalifter concept and an Air Force C-5 Galaxy heavy cargo plane.
Source: Airships for the Future (1976)

By 1974, the Megalifter was proposed to the National Aeronautics and Space Administration (NASA) Ames Research Center in response to their call for ideas for using lighter-than-air vehicles to meet future large cargo transportation needs. However, no significant NASA funding was provided for Megalifter development.

With financial support from Howard Hughes (or Summa Corporation), work on the Megalifter continued until Hughes' death in 1976. A Megalifter was never built.

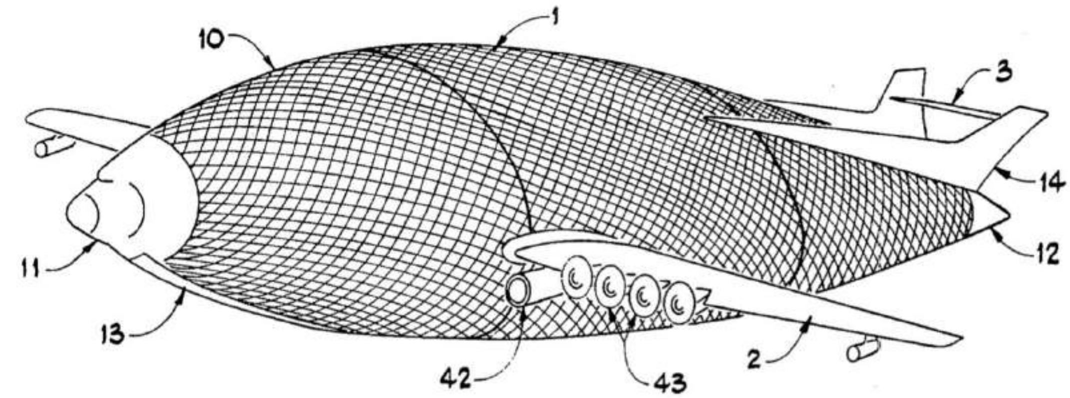
2. The Megalifter patent

Inventors Frank Clark and George Christner filed a patent application for the Megalifter on 3 April 1975. Patent US4052025A, "Semi-Buoyant Aircraft," was granted on 4 October 1977. This patent provides the following summary description of the craft:

> "A semi-buoyant lift-augmented aircraft …… which includes a fuselage having an airfoil shape and a high lift wing to provide appreciable lift in an airstream. The fuselage includes a rigid external framework, preferably consisting of a geodesic type web helically wound around the longitudinal axis, and one or more buoyant cells within the rigid external framework pressurized to exert force on the framework and provide substantial structural reinforcement. A longitudinal channel for cargo is provided within the fuselage, the resulting hollow keel structure serving to further reinforce the aircraft. Preferably, the buoyant cell is of a fixed volume, thereby providing increased reinforcement to the framework as the aircraft rises to operating altitudes and stresses."

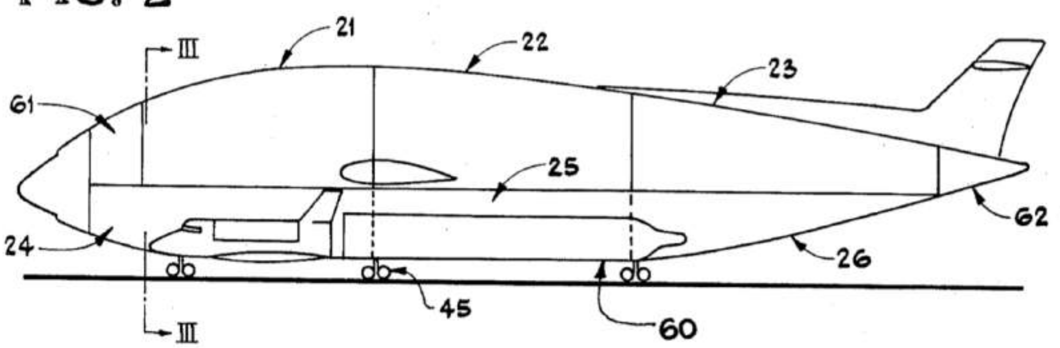
> "As a result of this novel configuration, in motion the combination of the buoyancy of the fuselage, its airfoil shape, and the lift imparted by the wings is sufficient to maintain the aircraft airborne, while the pressurized buoyant cells provide augmented reinforcement to maintain the structural integrity of the aircraft in the turbulent regime of flight."

FIG. 1



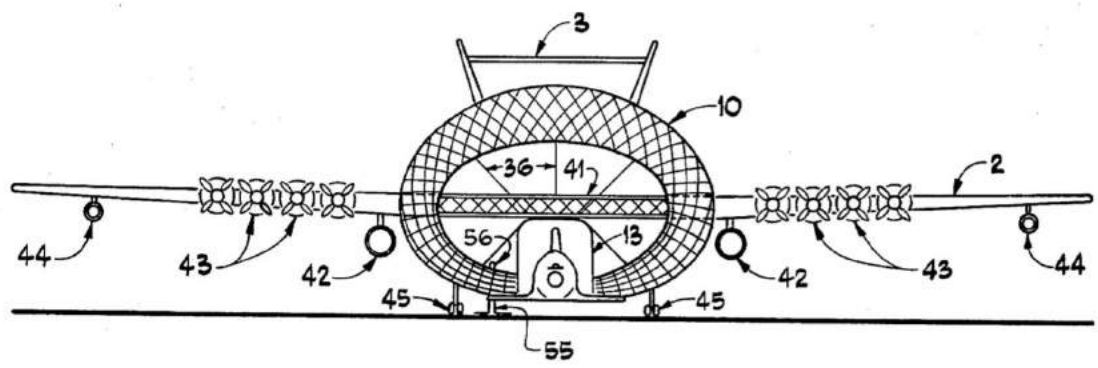
In patent Figure 1, the rigid, helical exoskeleton (10) extends from the surplus C-5A flight deck (11) to the tail fairing (12). The exoskeleton is held in tension by the lift gas cells within the fuselage, which are pressurized to about 0.5 psi at sea level. The exoskeleton holds the lift gas cells at constant volume. At an operating altitude of 18,000 feet (5,486 m) the internal pressure in the lift gas cells will be about 5.0 psi. The lift gas cells are made of a lightweight triaxial weave fabric developed by ILC Industries, Inc.

FIG. 2



The aerodynamic profile of the aircraft is evident in patent Figure 2. There are lift gas cells in the upper fuselage (21, 22 & 23) and corresponding cells in the lower fuselage, on either side of the longitudinal channel (the cargo bay). These lift gas cells are attached to the geodesic exoskeleton. The kneeling and swiveling landing gear (45) from a C-5A is shown extended.

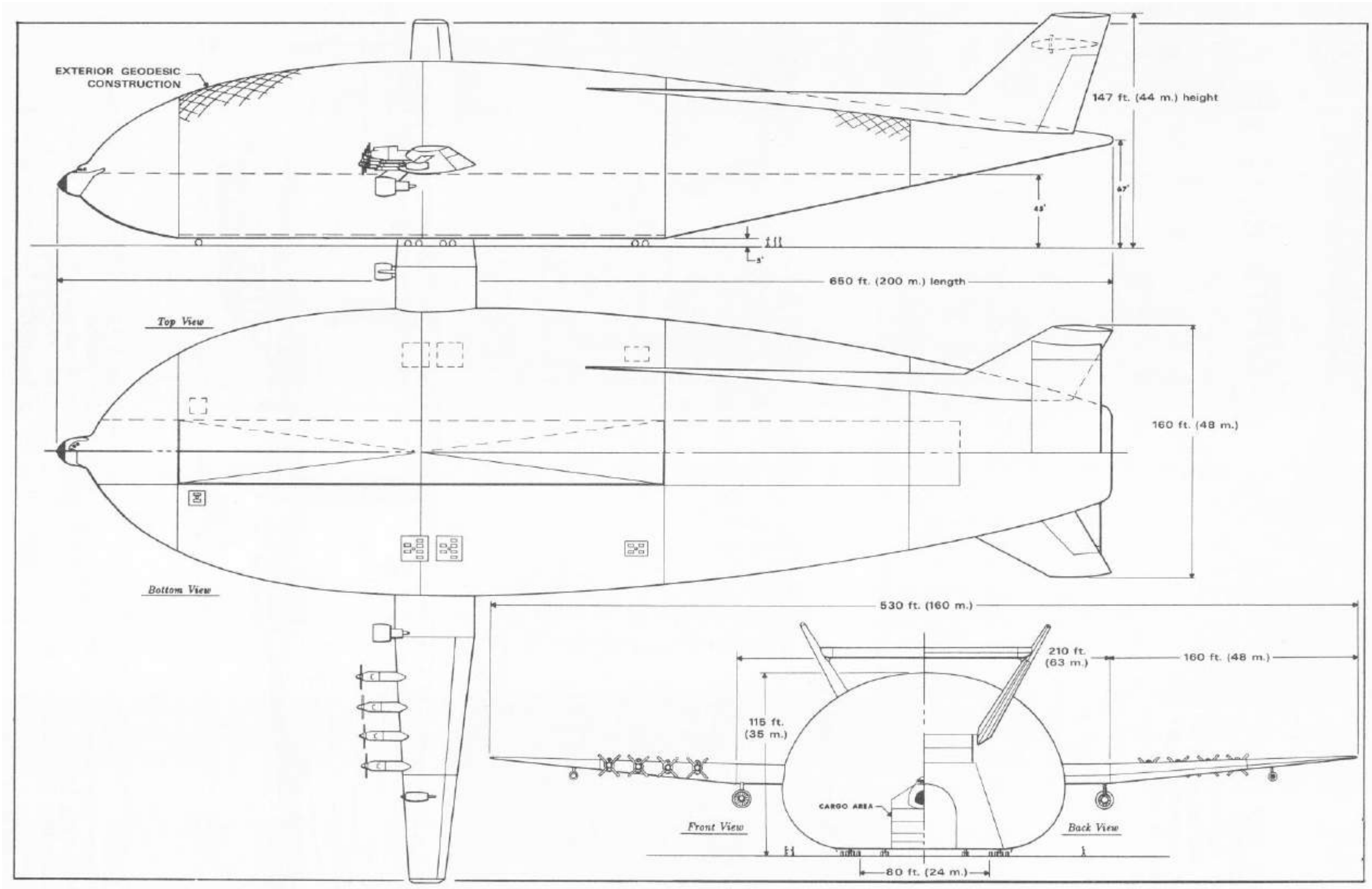
FIG. 3



In patent Figure 3, the central longitudinal channel (13, the cargo bay) is attached to the transverse wing box (41) and also is supported by internal cables or cross-ties (36) that transfer some of the weight of the channel to the exoskeleton and assist in maintaining the shape of the fuselage. The propulsion shown in Figure 3 is comprised of eight turboprop engines (43) and two large turbofan engines (42) and is intended to achieve a flight speed of about 200 mph (322 kph). In addition, two thrust vectoring jet engines (44) near the wing tips assist conventional aerodynamic controls in providing yaw and roll control, for example, during severe turbulence or following loss of a main engine.

Patent Figure 3 shows a hydraulic pin mooring station (55) on the field that is designed to engage a socket on the aircraft (56) near the aircraft's center of gravity. When engaged, this feature is intended to anchor the aircraft in higher crosswind conditions. With the swiveling landing gear, the Megalifter could rotate freely on its mooring pin and point into the wind.

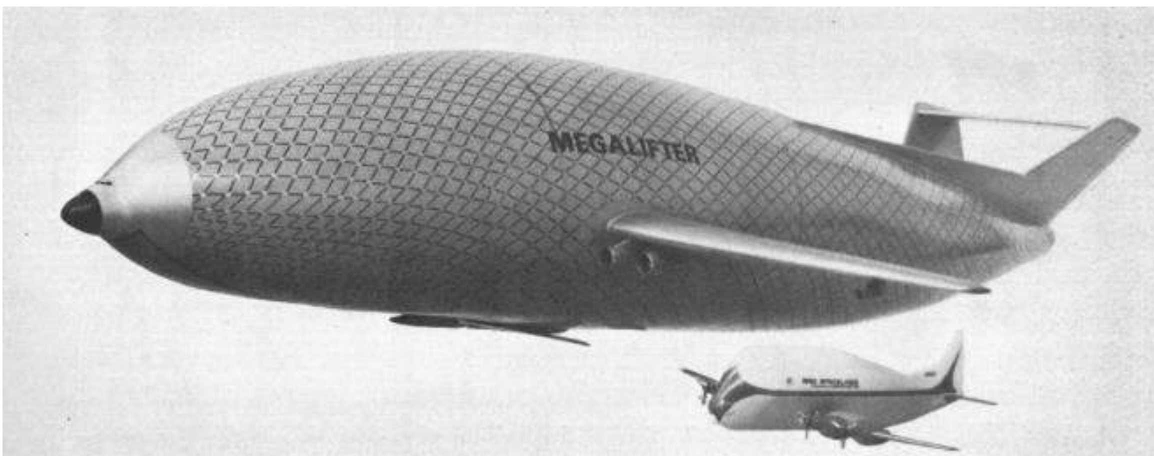
More design details are described in Patent US4052025A, which you can read here:
https://patents.google.com/patent/US4052025A/en?oq=us4052025



3-view turboprop + turbofan-powered Megalifter. Source: Airships for the Future (1976)

3. Description

This giant Megalifter would have been 650 ft (198 m) long, with a maximum fuselage width of 115 ft (35 m) and a wingspan of 530 ft (115 m). In comparison, the Aerospacelines Super Guppy is 141 ft (43 m) long, with a maximum fuselage width of 26 ft (7.92 m) and a wingspan of 156 ft (47.5 m). The Megalifter wings are aluminum versions of the large wooden wings originally designed for the HK-1 flying boat built by Hughes-Kaiser, which was re-designated H-4 when Henry Kaiser withdrew from the project in 1944. The H-4 Hercules was commonly known as the Hughes Spruce Goose.

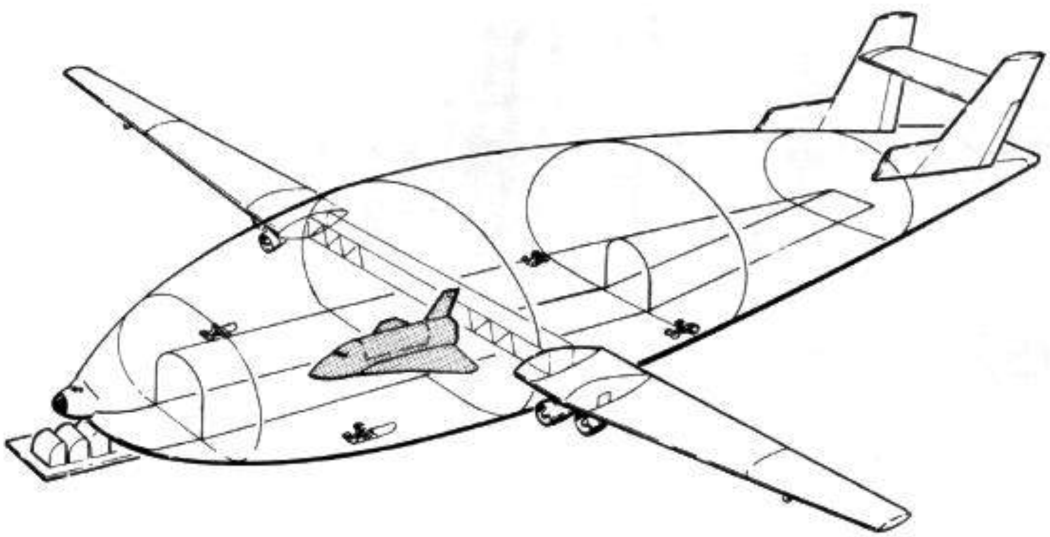


Scale comparison: All-turbofan Megalifter and the Aerospacelines Super Guppy oversized cargo carrier. Source: AW&ST magazine 29 July 1974

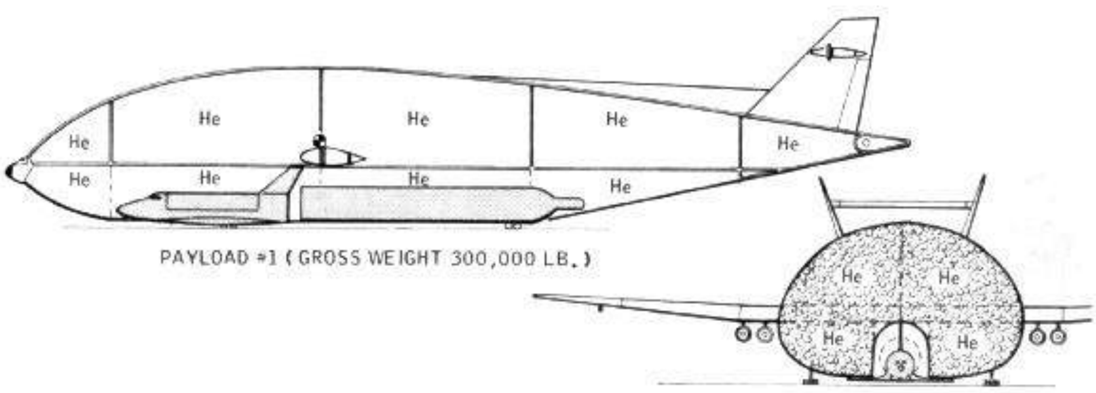
This conceptual design of the Megalifter evolved from the turboprop plus turbofan propulsion system shown in patent US4052025A to an all-jet configuration with four large General Electric TF-39-GE-1 turbofan engines with a thrust of 41,000 pounds (18,600 kg) each, replacing eight turboprop engines. Both designs have the thrust vectoring jet engines near the wing tips to assist in yaw and roll control.

The shape of the Megalifter's rotund, lifting body fuselage was defined by the rigid "exoskeleton" comprised of geodesic-shaped, small-diameter, tubular structural members. The outer layer of each structural member and joint fairing was Teflon or other low friction material.

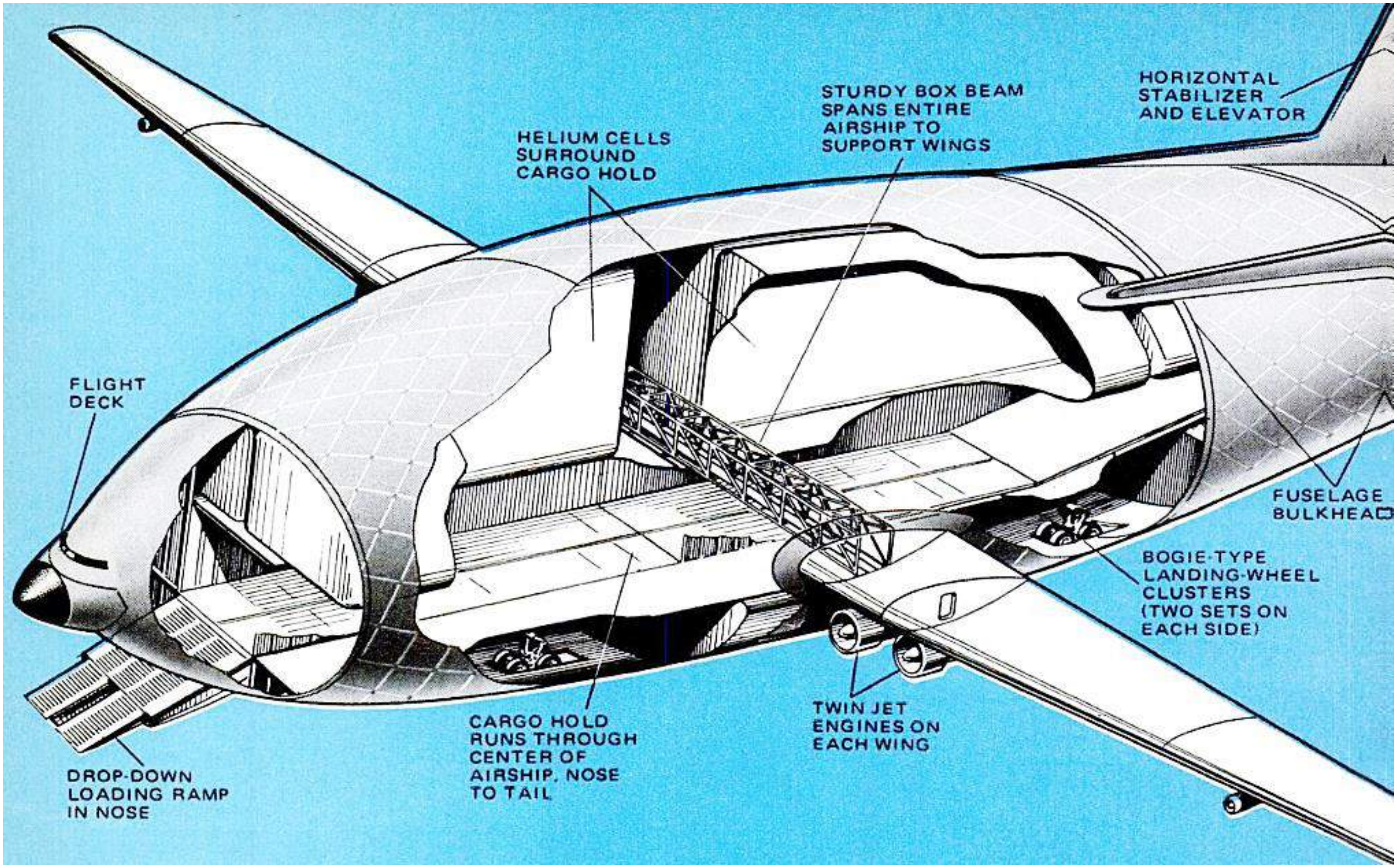
Within the exoskeleton, the helium lift cells were positioned around the 300 x 40 x 40 foot (91.4 x 12.2 x 12.2 meter) cargo compartment, which was designed as the structural spine of the aircraft. The cargo compartment runs from the flight deck to the tail structure and is structurally integrated with the transverse wing box and the tail structure to establish a rigid frame. The floor of the cargo compartment consists of removable pallets that can be individually or collectively loaded on the ground, moved into position under the aircraft, and then winched up into the aircraft and secured in place.



General arrangement of the Megalifter aircraft showing the transverse wing box, which is attached to the top of the cargo bay.
Source AW&ST magazine 29 July 1974



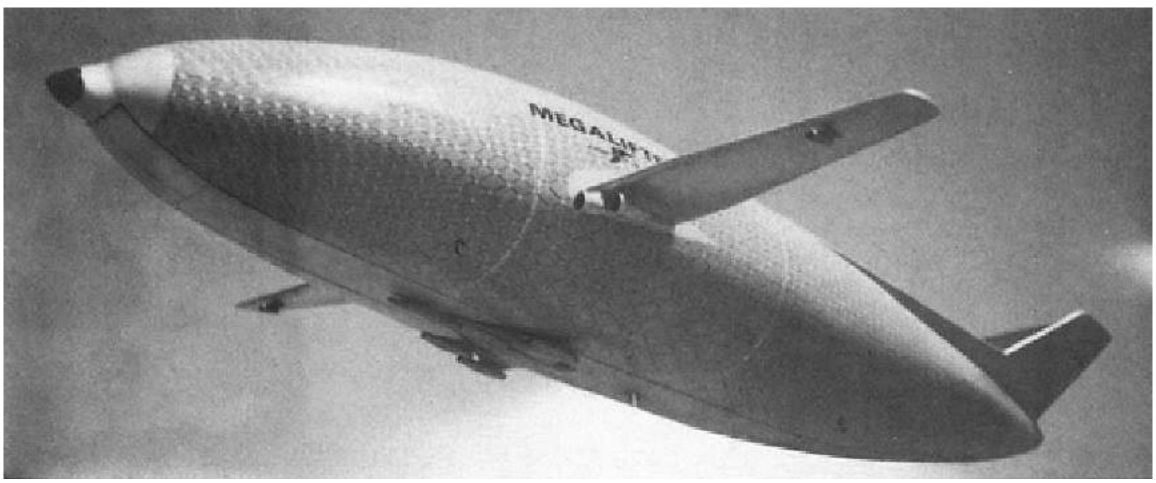
Arrangement of the lift gas cells installed around the cargo bay, which is shown loaded with a Space Shuttle and its large external tank.
Source AW&ST magazine 29 July 1974



Megalifter cross-section. Source: Popular Mechanics (July 1977)

The empty gross weight of the Megalifter without any buoyancy was expected to be 725,000 pounds (328,854 kg). A buoyancy sufficient to offset 478,000 pounds (216,817 kg) was desired (about 65% of empty gross weight). The semi-buoyant aircraft would have had an equivalent weight of 247,000 pounds (112,037 kg) when the gas envelope was filled with 7,000,000 ft^3 (198,218 m^3) of helium. This is almost the same gas volume as the LZ-129 Hindenburg (which used hydrogen lift gas).

The Megalifter's maximum payload was expected to be about 400,000 pounds (181,437 kg / 181 metric tons). In comparison, the Hindenburg could carry a "useful load" of 22,046 pounds (10,000 kg).



Concept drawing, Megalifter in flight, carrying a semi-submerged Convair B-58 bomber. Source AW&ST magazine 29 July 1974

4. Advanced Megalifter concepts

Intercontinental ballistic missile (ICBM) carrier

In March 1975, Aviation Week & Space Technology magazine reported that Boeing Aerospace Co. was investigated the possibility of adapting the Megalifter as an airborne launcher for the MX advanced ICBM.

> "Configured as an airborne MX missile launcher, the Megalifter would carry four 40-in diameter, 70,000-lb. class missiles in a semi-upright position – canted at about 40 degrees. The

> missiles would be carried in special shock absorbing harnesses and would be launched by dropping them through the floor and igniting the booster stages."

This approach eliminates the need to pitch the aircraft up and use a drogue parachute to extract a horizontally stored missile, as was done in an air-launch demonstration with a Minuteman ICBM and a Lockheed C-5 cargo aircraft.

> "Boeing is interested in a relatively large fleet of the MX carrier vehicles that could be used on long-endurance airborne alert. In this capacity, the Megalifter would have an endurance of 100 hours, cruise speed of 76 mph, and dash capability of 225 mph."

Two types of powerplants were considered: four 50,000 lb. thrust-class turbofans or eight 4,900 eshp-class turboprops (like in the original design of the Megalifter). The turboprop version would have had better slow cruise performance for long-endurance missions.

The Air Force never developed an air-launch ICBM capability.

VTOL Megalifter

The basic Megalifter was a short takeoff and landing (STOL) hybrid aircraft that takes off at about 70 mph (112.6 kph) through the combination of aerostatic lift from helium (about 65%) and aerodynamic lift from its lifting body fuselage and large wing and tail surfaces. The small wingtip vectored thrust jet engines are used for yaw and roll control.

With large vectored thrust engines in place of the main turbofan engines, the Megalifter could generate significant propulsive lift, perhaps enough to perform a vertical takeoff and landing (VTOL) in a lightly loaded conditions.

Hydrogen-fueled Megalifter

The Megalifter was considered suitable for use as a flying testbed for the NASA Langley Research Center's program to study the feasibility of using hydrogen as an aircraft fuel. However, this opportunity never developed.

5. For more information

- Donald Fink, "Hybrid Heavy-Lift Vehicle Under Study," Aviation Week & Space Technology (AW&ST) magazine, pp. 49 – 51, 29 July 1974
- "Heavy Lift Platform for ICBM Studied," Aviation Week & Space Technology (AW&ST) magazine, p. 12, 3 March 1975
- William J. White, "Airships for the Future," pp. 132 - 134, Sterling Publishing Co., Inc., New York, IBSN 0-8069-0090-3, 1976
- Bill Allen, "Big Boom in Gas Bags," Popular Mechanics, July 1977, page 65: https://books.google.com/books?id=tOIDAAAAMBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
- "Hughes' Megalifter aka Clark Megalifter," Secret Projects, 2007: https://www.secretprojects.co.uk/threads/hughes-megalifter-aka-clark-megalifter.2759/