Advanced Technologies Group (ATG) – SkyCat & SkyKitten

Peter Lobner, Updated 24 August 2021

1. Introduction

The UK firm Airship Industries, led by Jeffery R (Roger) Munk, manufactured conventional airships from 1970 to 1990 and was based at Cardington, Bedford, which is a site historically associated with British airship production. Airship Industries went into receivership in 1990 while teamed with Westinghouse on the Sentinel airborne early warning (AEW) airship project. Westinghouse regrouped, hired the former AI team members, and formed a new entity, Westinghouse Airships Inc., to execute the balance of the Sentinel contract and complete the Sentinel 1000 airship. After the Sentinel airship program was cancelled in late 1995, Roger Munk and former AI team members left Westinghouse and formed Airship Technologies Services Ltd.

Jane's All the World's Aircraft reported that the UK firm Airship Technologies Services Ltd. "was created in February 1996 to revive activities of the former Airship Industries company……..ATG (Advanced Technologies Group) is the trading name, from June 2000, of Airship Technologies Services Ltd…"

ATG became well known primarily for two advanced airship projects:

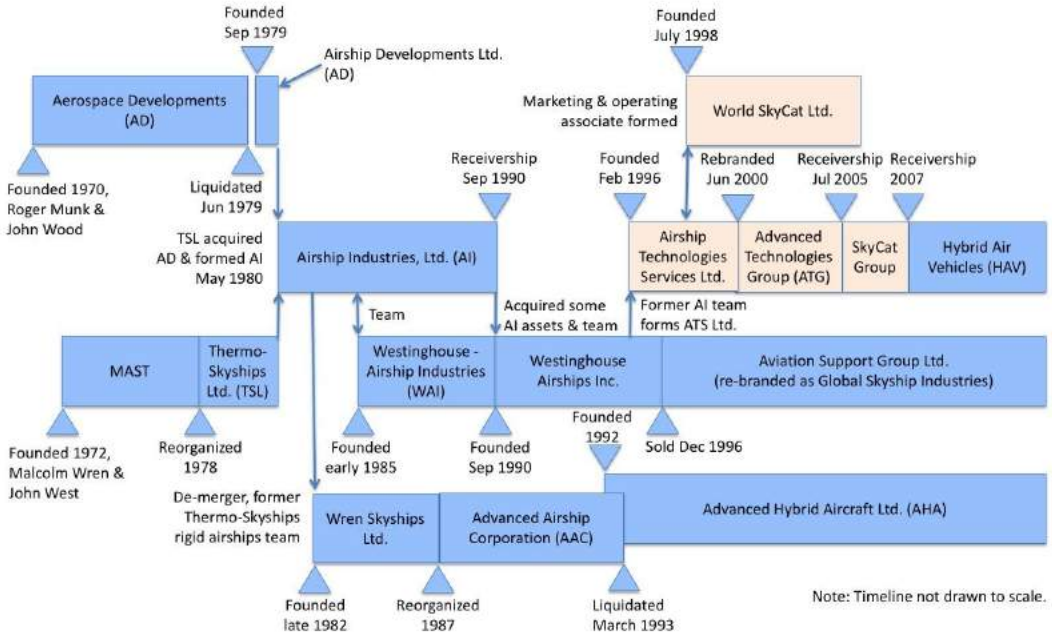
- A family of hybrid, heavy lift airships known as the Sky Catamaran, or "SkyCat" for short, started in about 1999.
- A stratospheric High Altitude Platform (HAP) named "StratSat," for delivering communications and surveillance services from geo-stationary positions in the stratosphere, started in 2001.

These projects led to the development and flight testing of sub-scale prototypes and advanced designs for full-scale airships. ATG also offered a range of nonrigid airships and built one AT-10 blimp. They also developed the design for the Condor optionally-manned high altitude surveillance airship, which was derived from the SkyCat.

World SkyCat Ltd. was created in July 1999 as the marketing and operating associate for the SkyCat range of hybrid airships and was intended to be the launch customer for the first SkyCat hybrid airship. In spite of promising business prospects for the SkyCat on the US military HULA and WALRUS heavy cargo airship programs, ATG and World SkyCat failed to generate the financial commitments needed for SkyCat production. ATG also failed to capitalize on their first StratSat business opportunity in Malaysia. As a consequence, ATG went into administration in 2005 and the StratSat business was discontinued.

ATG's hybrid airship and blimp businesses were acquired by SkyCat Group in 2006, which lasted only a year before going into receivership in 2007. Roger Munk founded Hybrid Air Vehicles (HAV) and acquired the assets of SkyCat Group later in 2007.

That was quite a complex web of intrigue. Here is a timeline chart that may help you make more sense of it.



Roadmap to airship firms managed or strongly influenced by M.W. Wren and Roger Munk, highlighting ATG and its immediate predecessor and successor firms,

This article addresses ATG's SkyCat family of manned hybrid airships and the remote-controlled SkyKitten sub-scale hybrid airship technology demonstrator. The StratSat stratospheric airship, the AT-10 blimp, and the Condor optionally-manned surveillance airship are subjects of separate articles. The continuing story of hybrid airship development by Hybrid Air Vehicles Ltd. (HAV) also is the subject of separate articles.

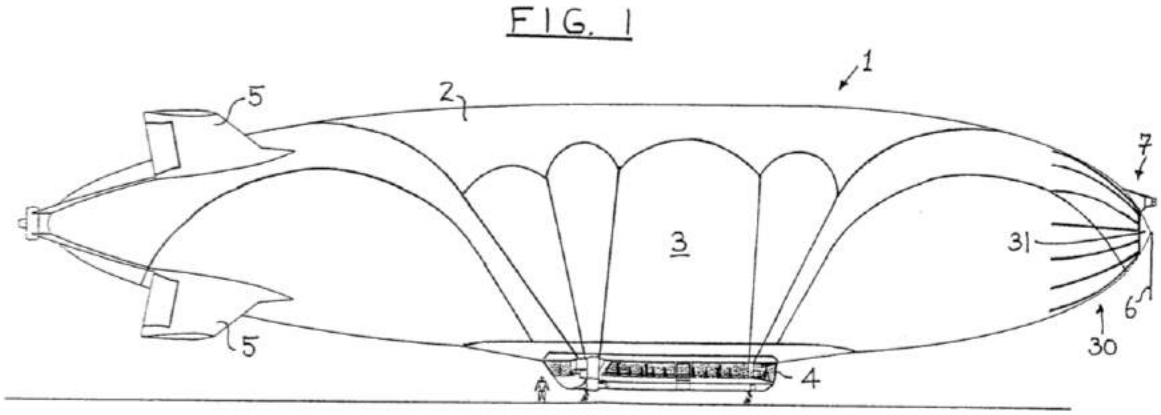
2. ATG hybrid airship patents

The head of ATG, Roger Munk, also was the inventor of the hybrid airship designs developed by ATG in their SkyKitten sub-scale technology demonstrator and the SkyCat full-scale airship. The basic design is described in detail in a family of related international, UK, US, Canadian, Japanese, Australian and Russian patents. ATG patents addressing the following hybrid airship design features are addressed in this section:

- Bow-mounted lateral thruster
- General arrangement and features of a hybrid airship
- Dual-mode air cushion landing system

Patent WO2000047468A1, "Airship bow thruster apparatus"

This patent was filed 8 February 2000 and published 17 August 2000. You can read this patent here:
https://patents.google.com/patent/WO2000047468A1/en



The patent abstract describes the purpose of the novel bow thruster (item 7 in the above diagram) as follows:

- "It is an aim of the present invention to provide airship bow thruster apparatus for applying control forces at the extreme nose of an airship for use when the airship is operating below the threshold of effectiveness of its normal aerodynamics controls, e.g. during landing and takeoff and particularly during mooring."
- "A further aim of the present invention is to eliminate the need for large ground handling parties hitherto essential in mooring and unmooring airships."
- "A still further aim of the present invention is to improve the low airspeed maneuverability of an airship allowing, for example, markedly increased hover accuracy."

WO01/94172 A1, "Hybrid Air Vehicle"

Roger Munk's earliest hybrid airship patent filing appears to be this international patent application, which was filed 1 June 2001 and published 13 December 2001. You can read this patent here: https://patents.google.com/patent/WO2001094172A1/en

This patent describes a hybrid airship with the basic configuration of ATG's later SkyKitten and SkyCat.

> "This invention relates to a hybrid air vehicle (HAV) and in particular to an air vehicle which combines characteristics of an airplane, a lighter-than-air airship and a hovercraft."
>
> "A hybrid air vehicle (1) having a gas-filled contoured flattened hull (2) including a pair of longitudinally extending side lobes (3,4) defining, on the underside of the hull, a longitudinally extending central recess (9), a payload module (10) received in the central recess (9) and air cushion landing gear units (11,12) on the underside of said side lobes (3,4) of the hull. The landing gear units (11,12) are spaced apart on either side of the payload module (10)."

The basic configuration of this hybrid airship is shown in patent Fig. 1.

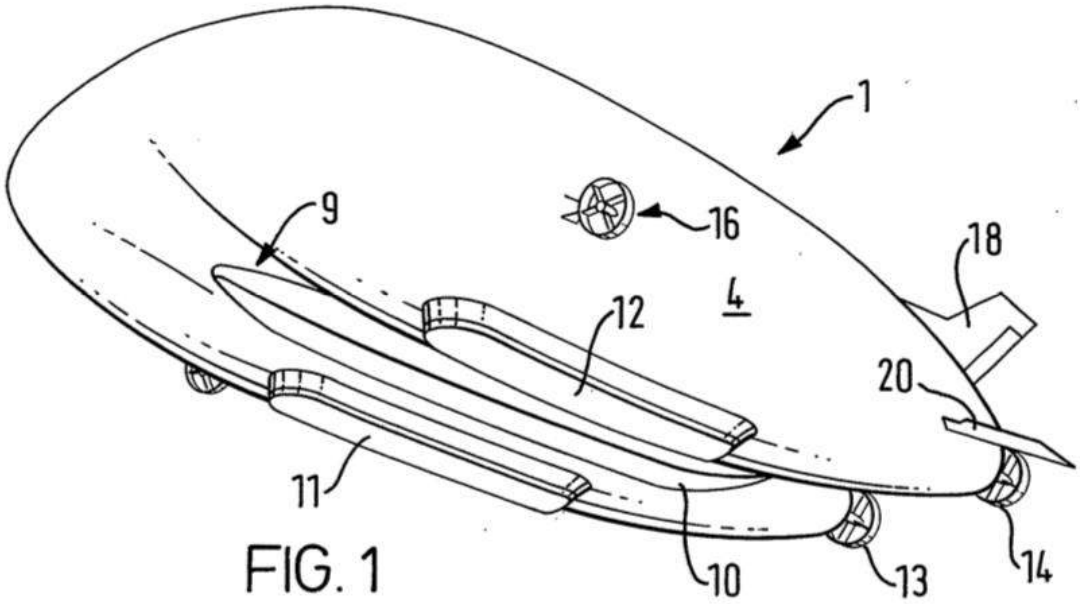


FIG. 1

Oblique view showing the underside of the hybrid airship.

The ATG air cushion landing gear described in patent WO01/94172 A1 implements two different principles:

- Lift: This allows a semi-buoyant airship to move along the ground on a cushion of high-pressure air.
- Suction: A semi-vacuum holds an airship on the ground.

The lift feature enables the heavier-than-air hybrid airship to operate like a hovercraft and taxi without assistance and takeoff or land on prepared surfaces (i.e., runways), many unprepared surfaces (grass, dirt, sand) with minor obstacles and even water.

The suction feature enables the heavier-than-air hybrid airship to improve its stability when stopped on the ground and reduces the need for tethers after landing, for example, in windy conditions. The suction feature also enables rapid load exchanges (cargo loading or unloading) without having to continuously manage a ballast exchange during a transition between unloading and loading. However, the airship needs to be properly ballasted by the end of the load exchange, before suction is discontinued.

UK patent GB2382808A, “Lighter-than-air aircraft with air cushion landing gear”

This patent was filed 5 December 2001 and published 11 June 2003. It provides details on ATG’s design concept for a hybrid airship that closely resembles the SkyCat. You can read this patent here: https://patents.google.com/patent/GB2382808A/en

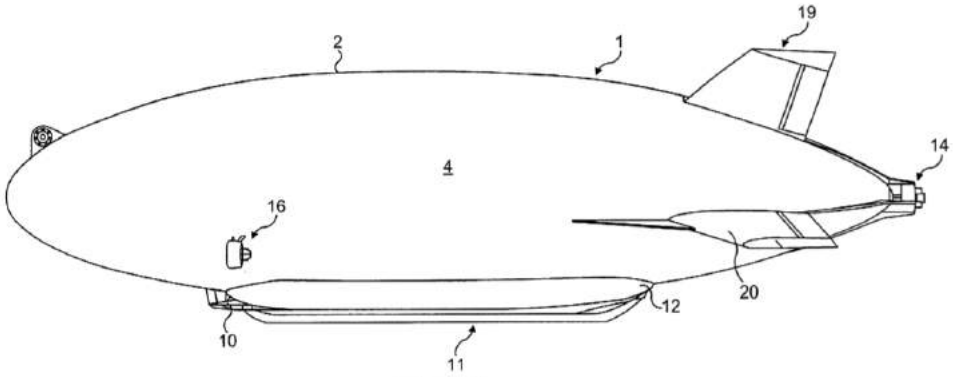


FIG. 3

Side elevation view showing the locations of the thrust vectoring stern propulsors (14) and flank propulsors (16). Note that the fixed bow lateral propulsor (raised protrusion on the nose) is not numbered.

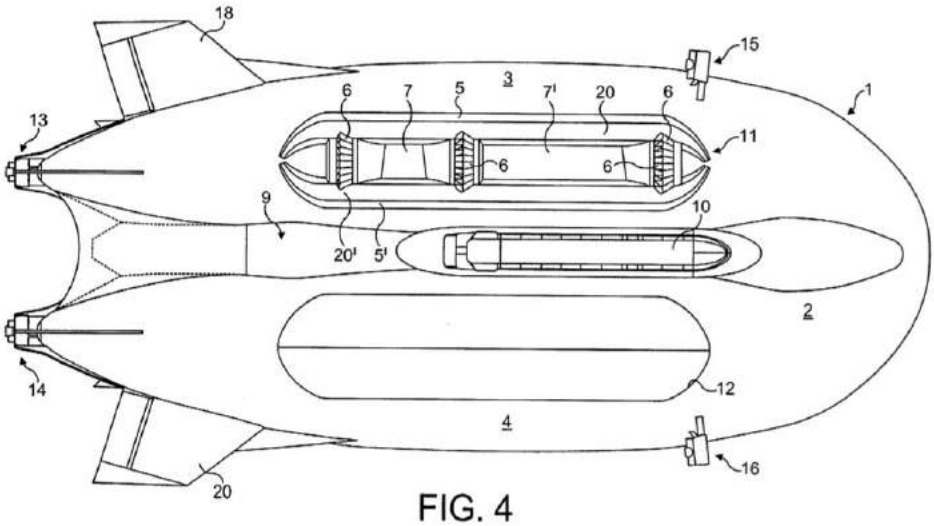


FIG. 4

View of the underside of the hybrid airship showing the locations of the air cushion landing gear units (11 is shown open, 12, is shown closed), the central payload module (10), and the thrust vectoring propulsors (13 to 16). Note that the fixed bow lateral propulsor is on the top of the airship.

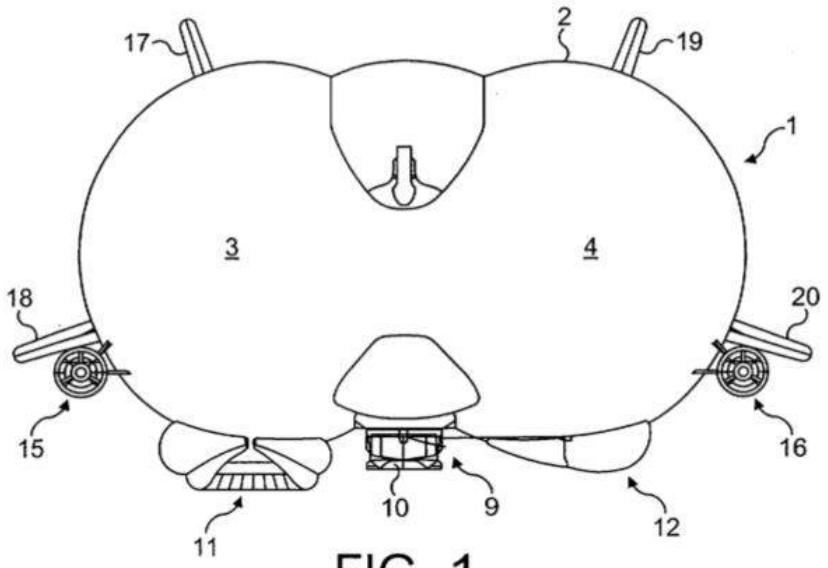


FIG. 1

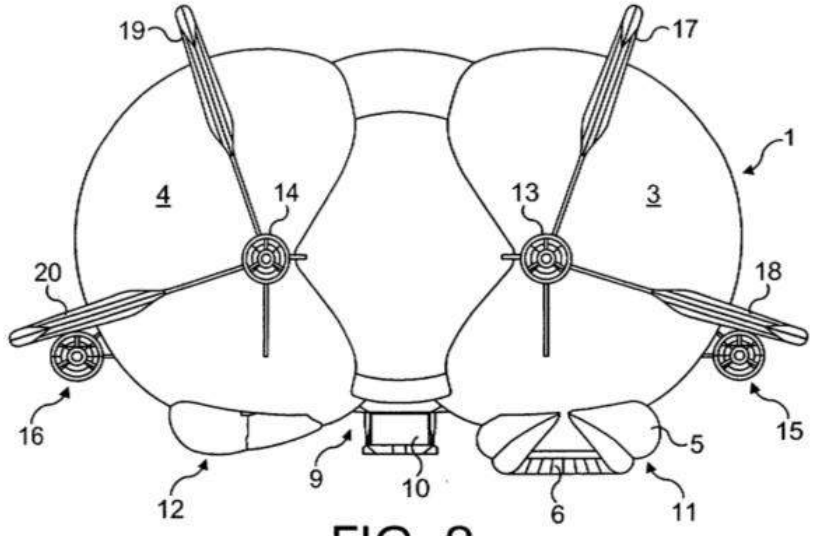


FIG. 2

Bow (Fig. 1) and stern (Fig. 2) views of the hybrid airship. Note the placement of the payload module (10) in the central recess (9) under the gas envelope and between the air cushion landing gear units (11 is shown open, 12, is shown closed)

3. The HULA and WALRUS military heavy lift airship programs

J-4 "SkyCat-1000 Engineering Study" (2001 – 2004)

Before HULA and WALRUS, the Joint Chiefs of Staff (J-4 Mobility Division) began an investigation into the military utility of hybrid airships in 2001 and funded the "SkyCat-1000 Engineering Study." The J-4 study participants included the Naval Air Systems Command's (NAVAIR's) Advanced Development Program Office (ADPO) – Airship Concepts, and Army's Office of the Deputy Assistant Secretary for Research & Technology.

The J-4 "SkyCat-1000 Engineering Study" examined a notional 1,000-ton payload ATG SkyCat hybrid airship from a technical perspective as well as operationally in intra- and inter-theater airlift scenarios. In 2003, author Charles Newbegin reported:

> "The Engineering study looked at a half-a-dozen military modifications to ease loading and off-loading; width, height, and weight of vehicles; and the inclusion of passenger carrying modules. The final modification selected (referred to as Mil-C…) included ramps for RO/RO (Roll-On/Roll-Off) operations, Variable Mezzanine Decks (VMD) to adjust for height of cargo, and a Wider Payload Module (WPM) to accommodate dual rows of the widest pieces of equipment in the Army inventory. Using the Mil-C payload module, the modeling scenario determined 17 SkyCat-1000 airships could deliver one SBCT (Stryker Brigade Combat Team, consisting of 14,600 tons of equipment and 3,000+ soldiers) from Fort Lewis (Tacoma, WA) to Korea within 89 hours – meeting the deployment objective set by the Army for one BCT (Brigade Combat Team)."

The above deployment could be accomplished without requiring access to airport facilities at the destination. The delivery point could be in the field, close to the actual point of need. ATG's baseline SkyCat-1000 cargo module floor was designed to handle 200 lb/ft^2 loads. For the Army roles being considered, higher main deck floor strength was required. For example, the majority of the main deck would need to be strengthened to handle 300 lb/ft^2 loads, and part of

the main deck would need to strengthened to handle 500 lb/ft^2 loads, sufficient to carry the M1A2 tank.

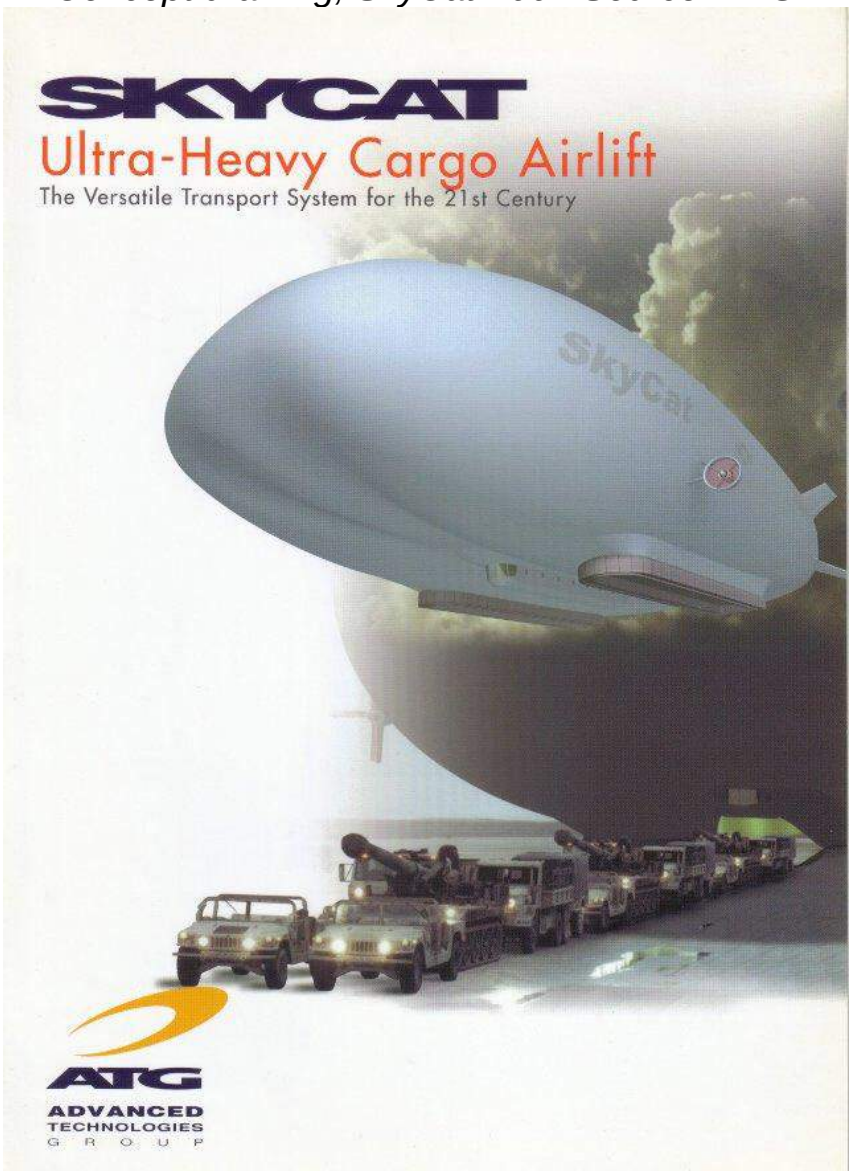
HULA and WALRUS (2002 – 2006)

NAVAIR's ADPO – Airship Concepts managed the Navy's HULA program from mid-2002 through mid-2003, when responsibility for the HULA program was transferred to the Defense Advanced Research Projects Agency (DARPA), where it became known Project WALRUS.

ATG proposed a range of hybrid airships including the SkyCat-20, SkyCat-200 and the massive SkyCat-1000, for the emerging US military airship market. Their main competitors in this market were Lockheed Martin, Aeros and Millennium Airship, Inc.

Rendering of an ATG SkyCat-200 hybrid airship on a flight line with C-5 cargo aircraft. Source: ATG / HAV.

Concept drawing, SkyCat-200. Source: ATG



ATG brochure cover. Source: ATG

In mid-2005, ATG lost out to Lockheed Martin and Aeros in the Project WALRUS Phase I competition to build a technology demonstrator airship. Project WALRUS was terminated in mid-2006, after completion of Phase I and funding for following years was deleted from DARPA's budget.

Continuing Navy interest (after 2006)

After the termination of WALRUS, the Navy's interest in lighter-than-air craft, including heavy lift hybrid airships, continued under the auspices of NAVAIR's ADPO - Airship Concepts. Details of ATG's SkyCat and similar heavy lift hybrid airships continued to be studied, for example, for resupply at sea and force insertion missions as part of the Navy's SeaPower 21 initiative. None of these studies resulted in a Navy order for a hybrid airship from ATG or other manufacturer.

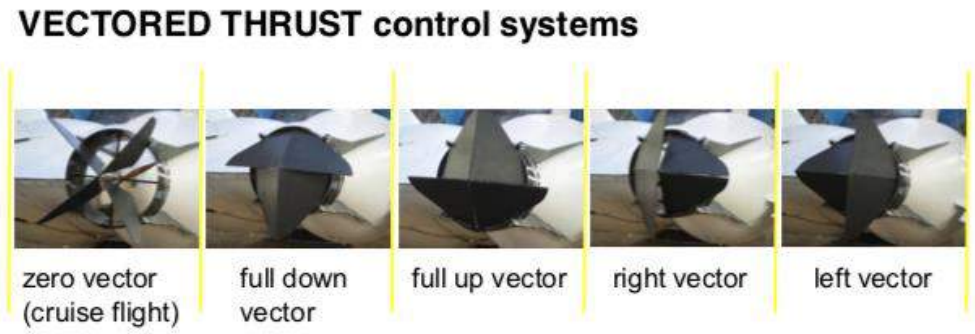
4. Patent lawsuit

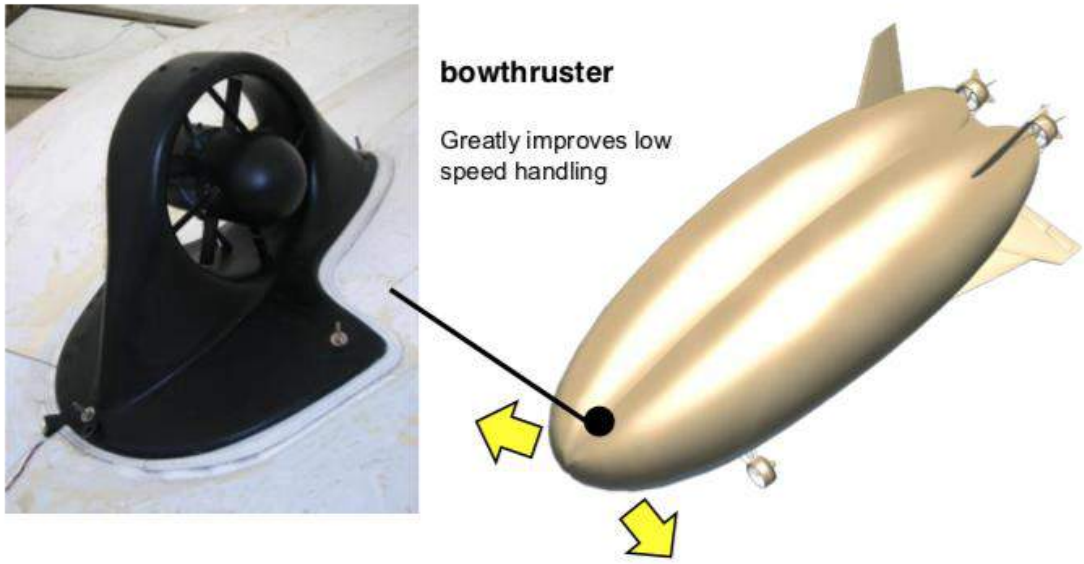
On 18 March 2007, a civil litigation, "Lockheed Martin Corporation v. Jeffery Munk et al." was filed claiming patent infringement by Jeffrey Munk, Skycat Ltd., and ATG related to their US patents US6880783 and US7040572. The Lockheed Martin P-791 was striking similar to ATG's SkyKitten technology demonstrator airship and the full-size SkyCat hybrid airship. These hybrid airships use many of the same design concepts, and, at the time, there were some who believed that the two programs were related. The lawsuit was terminated on 16 September 2008 with no declaratory judgment against the defendants.

5. Basic characteristics of the SkyCat hybrid airships

As a hybrid airship, the semi-buoyant SkyCat is heavier-than-air and generates only part of its lift from helium aerostatic lift, nominally 60 – 80%. The balance of the lift is generated by vectored-thrust propulsors and by aerodynamic lift from the shaped gas envelope, which acts as a lifting body when the airship has forward speed.

The control system coordinates the thrust vectors generated by the bow thruster (left/right), pivoting flank propulsors (up/down), and four triangular-shaped variable vanes in the slipstream of each stern propulsor (up/down/left/right).





Source: HAV (2009)

The SkyCat was designed for normal short takeoff and landing (STOL) operations with a full load, which requires forward speed to generate aerodynamic lift during takeoff and during the landing approach. With a light load and propulsive lift, a SkyCat was designed to hover and make a vertical takeoff and landing (VTOL).

To become airborne, the SkyCat activates its air cushion landing system (ACLS), which lifts the airship off the ground on a cushion of

air and enables the propulsion system to taxi the airship and make a short takeoff run. To land the airship, the SkyCat makes a short landing approach and uses the ACLS to cushion the landing and taxi to a parking spot without the need for typical airship ground support staff and infrastructure. The ACLS allows the SkyCat to operate on almost any type of surface, including flat or uneven land, grass, swamp, snow or on water, giving the vehicle a fully amphibious capability.

The SkyCat's ACLS is a dual mode system that can be realigned to draw a suction on the ground and immediately stabilize the airship after it has come to a stop. The ACLS can hold down a light (positively buoyant) airship during a load exchange and it can stabilize the airship in windy conditions.

6. World SkyCat Ltd.

Formed in July 1999 as the marketing and operating associate of ATG for the SkyCat range, World SkyCat Ltd. offered 12 variants of the SkyCat family of hybrid airships. Thanks to the Internet Archive, the World SkyCat marketing brochure, circa 2004, is still available online at the following link: https://web.archive.org/web/20170814175059/http://www.worldskycat.com/images/SkyCat.pdf

7. The SkyKitten technology demonstrator

The 12.2 meter (40 foot) long SkyKitten was a one-sixth scale, remotely controlled model of a planned SkyCat hybrid, heavy-lift airship design. It was propelled by two fixed propulsors with thrust vectoring paddles at the stern, powered by mini-diesel engines. Control was provided by two flank-mounted vectoring propulsors driven by small electric motors powered from a battery.

SkyKitten first flew on 23 June 2000 at Cardington Airfield. It demonstrated stable flight, full VTOL / STOL capability, the ability to takeoff and land on water, and the ability to use its ACLS in suction mode for added stability on the ground.

Heavier-than-air SkyKitten carried out of the hanger at Cardington. Source: The Airships at Cardington, UK

Above: SkyKitten flying overhead showing the air cushion landing system, the central payload pod, and the placement of the four thrust vectoring propulsors. Source: The Airships at Cardington, UK

SkyKitten sits in the temporary "lake" at Cardington
Source: The Airships at Cardington, UK

SkyKitten above the temporary "lake" at Cardington

Source: The Airships at Cardington, UK

8. The SkyCat-15

The general configuration of the planned production SkyCat airships was similar to the sub-scale SkyKitten and the hybrid airships represented in the ATG patents. The first production model originally was intended to be the SkyCat-15, which was designed with a gas envelope volume of 24,500 m^3 (865,000 ft^3) and a payload capacity of 15 metric tons (16.5 tons) over a range of 3,700 km (2,300 miles).

Author Edwin Mowforth reported that ATG was building the SkyCat 15 at Cardington in late 2000 but apparently abandoned this project for the larger SkyCat-20.

9. The SkyCat-20 and -220

The SkyCat-20 and the much larger SkyCat-220 hybrid airships shared the same general arrangement and were designed for normal short takeoff and landing (STOL) operations at full load. Both of these models incorporated the following significant features:

- Proportionally more powerful vectored thrusters enable SkyCat to operate between 8% light and 40% heavy, thereby greatly increasing its payload capacity while eliminating the need for taking on ballast when discharging some loads.
- With the more powerful vectored thrusters, SkyCat also could hover and operate in VTOL mode with a reduced load.
- The addition of a bow thruster provided lateral thrust to precisely point the bow and improve maneuverability at low speed and in hover.

The SkyCat's laminated fabric envelope contains the helium lifting gas and separate air volumes (ballonets) that are used to adjust internal pressure, buoyancy, and pitch and roll trim. The envelope is pressure stabilized and there is no rigid structure inside the envelope. The rigid payload module is attached under the envelope, along the airship's centerline. Catenary curtains inside the envelope support the weight of the payload module and distribute that load via internal diaphragms into the upper surfaces of the envelope. The diaphragms compartmentalize the internal volume of the envelope.

Basic design parameters of the SkyCat-20 and -220 are summarized in the following table from the World SkyCat marketing brochure.

Overall dimensions:	SkyCat-20	SkyCat-220
Length:	81.0m	185.0m
Height:	24.1m	47.0m
Width:	41.0m	77.3m
Payload module:		
Length:	25.5m	64.0m
Height	2.6m	4.8m
Width:	3.5m	7.8m
Payload:		
Standard STOL mode:	20.0 tons	220.0 tons
Hover/VTOL mode:	14.5 tons	160.0 tons
Range:		
Max payload, at cruise:	2,400 n.miles	3,225 n. miles
Speed:		
Cruise:	75 kts	80 kts
Sprint:	85 kts	95 kts

Source: World SkyCat

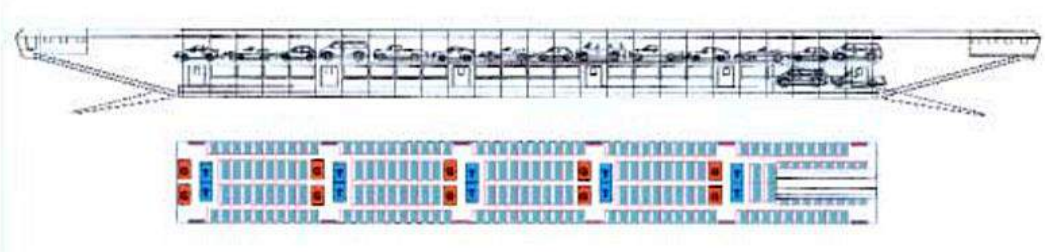
Maximum operating altitude was 2,745 m (9,000 feet).

The SkyCat-20 is powered by four ATG A-Tech 600 direct injection diesel engines rated at 599 shp (447 kW). The SkyCat-200 is powered by four 8,040 shp (5,996 kW) turboshaft engines. The engines and propellers are installed in ducts with two engines on the forward hull and two engines on the rear hull. Movable vanes in the ducts can deflect the propeller slipstream to provide vectored thrust for takeoff and landing and for maneuvering on the ground.

The two pilot stations are fitted with conventional stick controls linked via a two-channel “fly-by-light” flight control system to the powered control actuators. The airship has a 28V DC electric power system and a low pressure pneumatic system that powers the flight control actuators. The pneumatic system provides very low susceptibility to lightning strike.

SkyCat 4-view drawings (above) and isometric drawing (below). Source, both graphics: https://www.aerospace-technology.com/projects/skycat/

Concept drawing, SkyCat configured as an aerial water tanker to fight forest fires. A water scoop enables the tanker to take water on directly from a nearby body of water. Source: World SkyCat



Concept drawing, SkyCat-220 ferry making a water landing carrying up to 420 passengers and 42 vehicles on two decks with Ro-Ro vehicle loading. Source: World SkyCat

Two views of a SkyCat cabin mock-up configured for a military mission. Source: The Airships at Cardington, UK

10. The SkyCat-1000

The SkyCat-1000 was the largest in ATG's range of hybrid airships. Principal data for this airship are listed in the following table.

Envelope Volume:	2,000,000 cu.m	(70.6 m cu.ft)	Payload:	1,000 tonnes	
Overall Dimensions:	Length: 307 m	(1,007 ft)	Range:	4,000 nms	
	Width: 136 m	(446 ft)			
	Height: 77 m	(253 ft)	Altitude:	9,000 ft	
Payload Deck Space:	Length: 80.8 m	(265 ft)	Speed:	Cruise	100 KTAS
	Width: 12.2 m	(40 ft)		Maximum	110 KTAS
	Height: 8.0 m	(26 ft)			

Source: ATG SkyCat-1000 brochure

Propulsion was to be provided by six 15,000 shp / 12,000 shp continuous (11,185 kW / 8,948 kW continuous) turboshaft engines driving four ducted propulsors with moveable vanes in their exhaust slipstream for thrust vector control.

- Two engines within each stern duct drive a common propulsor.
- One engine within each forward (flank) duct drives a single propulsor.
- Primary propulsion is provided by the stern propulsors. The forward (flank) propulsors are used primarily for ground handling, takeoff and landing.

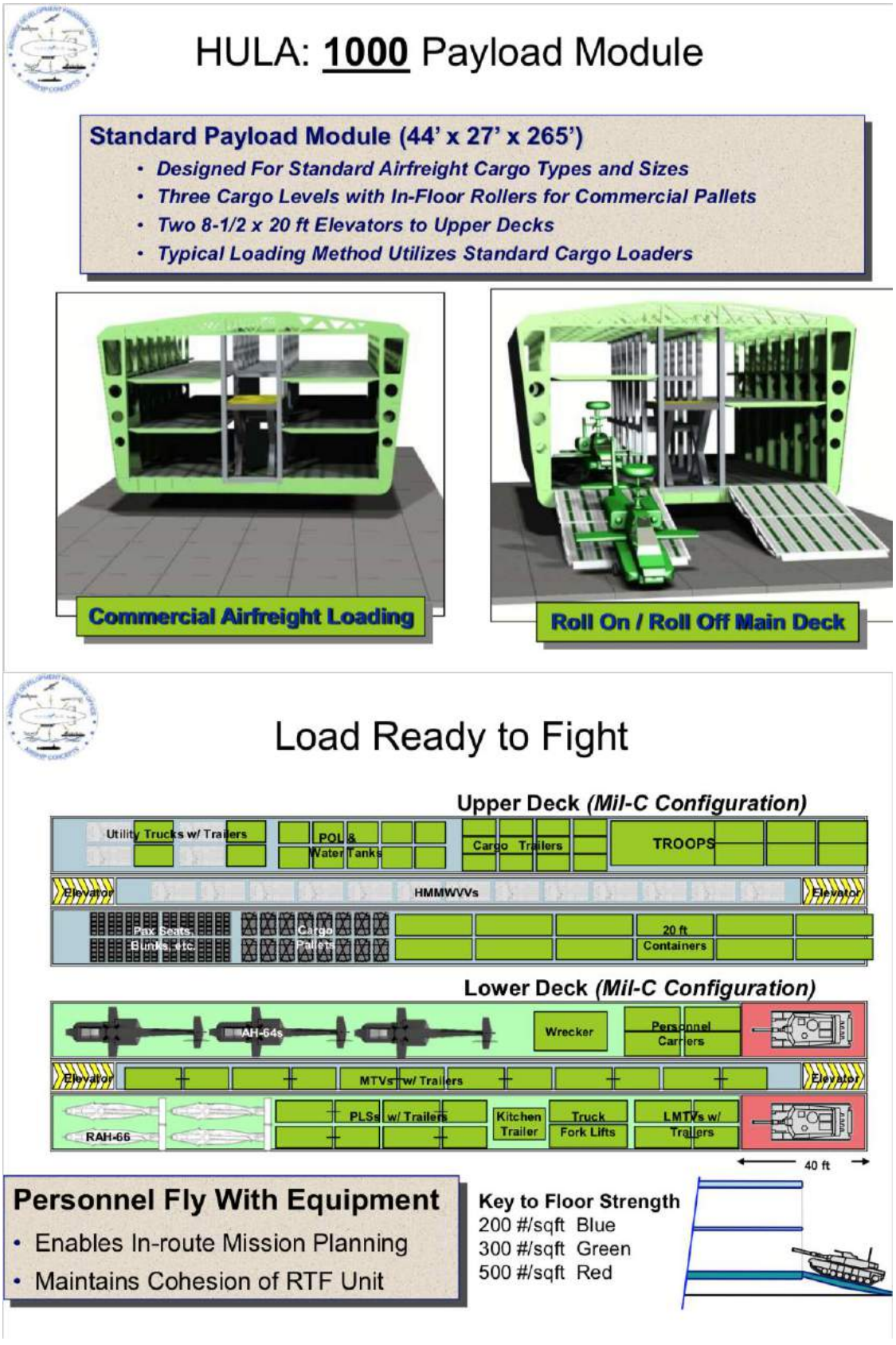
In flight, the hull generates aerodynamic lift and provides up to 40% of total lift. This allows the airship to take off and land heavy, using propulsive lift during the takeoff and landing segments.

The rigid payload module is suspended under the giant gas envelope by means of catenary curtains inside the envelope, which distribute that load via internal diaphragms into the upper surfaces of the envelope. The baseline SkyCat-1000 was designed to carry 1,000 metric tons (1,100 tons) of cargo in the large rectangular payload module, with roll-on access to the main (lower) cargo deck and elevator access to one or two mezzanine decks above the main cargo deck. The floors of the payload module were designed to handle 200 lb/ft^2 loads.

As noted previously, an evaluation of the SkyCat-1000 in connection with Project WALRUS recommended changes to ATG's baseline design to better accommodate heavy military equipment.

- Most of the lower deck floor would be rated for 300 lb/ft^2
- Part of the lower deck floor would be rated for 500 lb/ft^2 to accommodate the US Army's M1A2 tank.
- The height of the variable mezzanine decks could be adjusted. Their floors would be rated for 200 lb/ft^2
- Fore and aft ramps enabled roll-on / roll-off (Ro-Ro) cargo handling from the lower deck.

If ATG had gotten the financial support it needed to proceed with the SkyCat-1000, Roger Munk estimated that development to first flight would have taken four years.

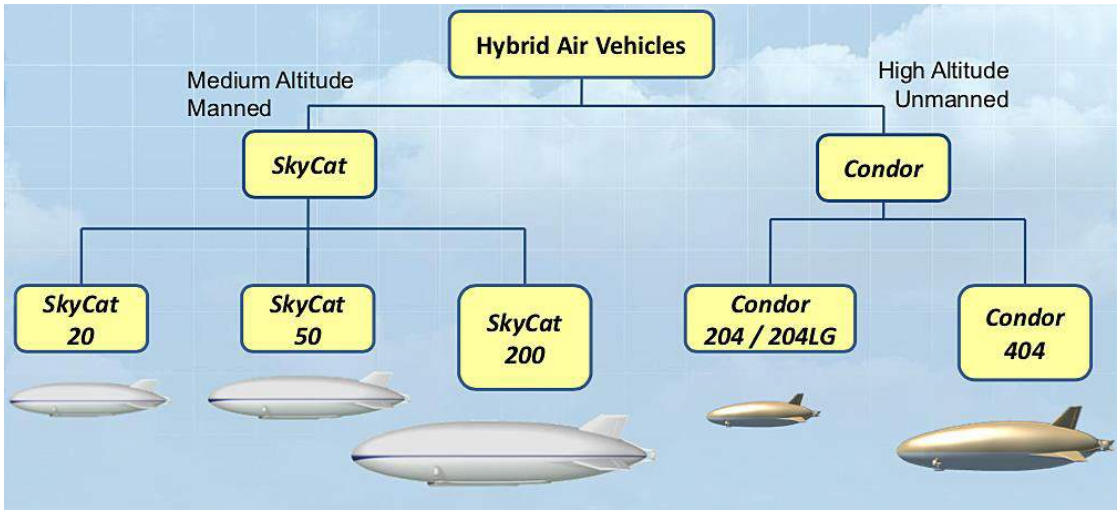


Source, both graphics: NAVAIR ADPO presentation (2 Sep 2009)

11. Requiem for ATG

As described previously, ATG went into administration in 2005 and their hybrid airship and blimp businesses were acquired by SkyCat Group in 2006, which lasted only a year before going into receivership in 2007. The resilient Roger Munk founded Hybrid Air Vehicles (HAV) in 2007 and, in the process, acquired the rights to ATG's hybrid airship and blimp technologies dating back to about 1999.

The family of ATG hybrid airship designs acquired by HAV in 2007 included those shown in the following chart, as well as the sub-scale SkyKitten technology demonstrator, the largest hybrid airship design, the SkyCat 1000, and the AT-10 blimp.



Source: HAV, adapted from Gordon Taylor presentation (Oct 2009)

The HAV website is here:
https://www.hybridairvehicles.com/about-us

Roger Munk died in February 2010, four months before the team of HAV and Northrop Grumman won a $517 million US Army contract to develop and operationally demonstrate an optionally-manned hybrid airship known as the Long Endurance Multi-Intelligence Vehicle (LEMV), based on ATG's Condor design. The HAV-304 LEMV later became the HAV Airlander 10 prototype, which flew in 2016 and 2017 to support the development of HAV's Airlander line of commercial hybrid airships.

12. For more information

- Grahame Wilson, “The Airships at Cardington, UK,” http://members.ozemail.com.au/~p0gwil/AIRSHIPS-CARDINGTON/AIRSHIPS-Introduction.htm
- Charles Newbegin, “Modern Airships: A Possible Solution for Rapid Force Projection of Army Forces,” School of Advanced Military Studies, United States Army Command and General Staff College Fort Leavenworth, Kansas, 2003: https://apps.dtic.mil/dtic/tr/fulltext/u2/a416208.pdf
- Edwin Mowforth, “An Introduction to the Airship,” 3rd edition, ISBN 0-9528578-6-2, The Airship Association, 2007
- Gordon Taylor, “Hybrid Air Vehicles – Now and the Future,” Presentation to The Society of Naval Architects and Marine Engineers – Arctic Section, 4 March 2009: https://higherlogicdownload.s3.amazonaws.com/SNAME/3383113f-3070-4ddd-acd4-504418eb35a9/UploadedImages/Files/2009/March%2009_Taylor_Presentation.pdf
- S. Huett, “Hybrid Aircraft Envisioned Military Relevance,” NAVAIR Advanced Development Program Office – Airship Concepts, 2 September 2009: https://www.offiziere.ch/wp-content/uploads/8-Huett-Navy-Airship-Perspective.pdf
- Gordon Taylor, “A Green Solution to Canada’s Transport Challenge,” HAV, presented at Airships to the Arctic V” Symposium, Calgary, Canada, October 2009: https://isopolar.com/wp-content/uploads/2013/03/Gordon-Taylor-presentation-Hybrid-Airships-A-Green-Solution-to-Canadas-Transport-Challenge.pdf

ATG hybrid airship patents

- US6880783B2, “Hybrid air vehicle having air cushion landing gear,” filed 18 June 2002, published 19 April 2005: https://patents.google.com/patent/US6880783B2/en?oq=6880783
- US20030001044A1, “Hybrid Air Vehicle,” filed 18 June 2002, published 2 Jan 2003:

https://patents.google.com/patent/US20030001044A1/en?oq=20030001044

- US7040572B2, “Lighter-than-air aircraft with air cushion landing gear means,” filed 5 December 2002, granted 9 May 2006: https://patents.google.com/patent/US7040572B2/en?oq=US7040572B2
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- Navy YEZ-2A (Sentinel 1000 & 5000)
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- ATG / HAV - Condor high-altitude surveillance airship
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- Hybrid Air Vehicles (HAV) / Northrop Grumman HAV-3 and HAV-304 (LEMV)
- Hybrid Air Vehicles (HAV) - Airlander 10 & 50 airships