Galaxy Unmanned Systems LLC - blimp drones

Peter Lobner, updated 9 January 2023

1. Introduction

Galaxy Unmanned Systems LLC (GUS) is a Fort Worth, TX-based company founded by brothers Tony and Jason White. Galaxy offers a wide range of services related to unmanned aerial systems, including concept, design, manufacturing, certification, testing, payload configuration, subsystem integration, documentation, training and operation. The company has more than 40 years of industry experience with remotely controlled and autonomous systems. Their current unmanned airship products are the non-rigid GC-35 Unmanned Tactical Airship System (UTAS, aka GC-35-G2A) and the GC-75 Large Unmanned Tactical Airship System (LUTAS, aka GC-75-G2A).

The GC-35 (left) and the GC-75 (right). Source: GUS

Galaxy identified the following key operational capabilities of their blimps: vertical takeoff and landing (VTOL), high visibility while in the air, capable of carrying heavy payloads safely and efficiently, and small operational footprint.

The Galaxy blimps can be used for a wide range of commercial, military and civil applications, including aerial broadcasting and advertising, surveillance, utility inspections (i.e., powerlines, pipelines, rail, oil and gas facilities), agriculture and land surveys, air sampling, forestry and wildlife management, search and rescue and scientific research. GUS systems are built to customer specifications and are highly customizable.

Future airship development plans include the GC-80, which is a modest scale-up of their successful GC-75, and an advanced, autonomous, scaleable, hybrid electric blimp design concept known as the GCXX-E4B, which currently is funded under an Air Force contract.

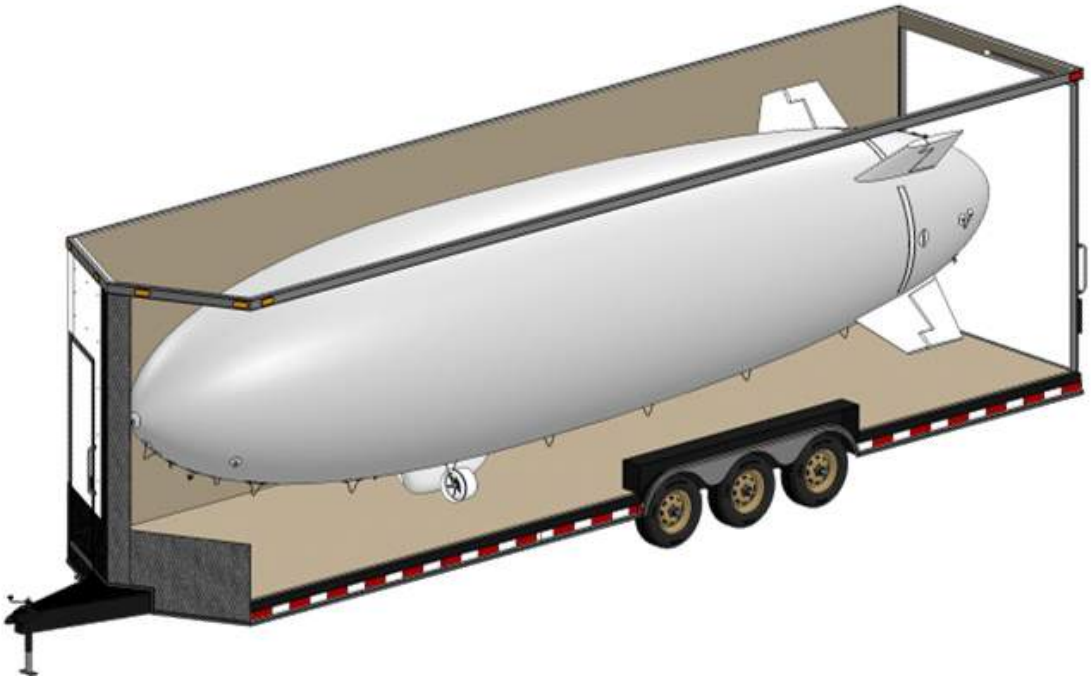
The Galaxy Unmanned Systems website, which addresses their full line of unmanned aerial systems and related products and services, is here: https://galaxyuas.com

Their Facebook page is here: https://www.facebook.com/gusllc/

2. GC-35 UTAS – Galaxy 35ft Unmanned Tactical Airship System

The GC-35 UTAS is a small blimp that is designed to be transported fully assembled in a standard 35-foot, bumper-pull, hitch trailer and be easily deployed by a ground crew of two.

GC-35. Source: GUS



The flight-ready GC-35 is transportable in a trailer.

GC-35 tail and propulsor details. Source, all four images: GUS

GC-35 basic design and performance characteristics

Parameter	GC-35 UTAS
Type	Non-rigid
Lifting gas	Helium
Length	35 ft (10.7 m)
Diameter, maximum	8 ft (2.4 m)
Envelope	Rip-stop coated nylon
Power system options	• Gasoline engine with or without generator • All electric • Solar-electric hybrid
Propulsion system	2 x thrust vectoring ducted fans attached to the gondola
Payload, max	15 lbs (6.8 kg)
Speed	0 (hover) to 30 – 40 mph (26 – 35 knots) max
Altitude	200 – 500 ft (61 – 152 m) typical, 3,000 ft (914 m) max
Range	1 mile (1.6 km) limited by manual radio controls, or more than 25 miles (40 km) when operating as an autonomous system
Endurance	Depends on propulsion; can be 8 hours or more

GC-35, view from below. Source: GUS

3. GC-60 prototype

The GC-60 was a 60-foot (18.3 m) prototype video broadcast platform that made history in February 2008 in Phoenix, AZ, where it became the first unmanned airship to provide aerial video for a live broadcast. The GC-60 was featured as the flying video platform for a National Hot Rod Association (NHRA) Powersports race that was broadcast on ESPN. For this event the GC-60 was flying with a Cineflex broadcast quality gimbaled camera. It demonstrated its ability to deliver reliable video coverage in windy conditions and stay on station in gusts of 30+ knots during the event.

GC-60 prototype, sponsored by GEICO. Source: GUS

GC-60 view of February 2008 NHRA Phoenix event. Source: GUS

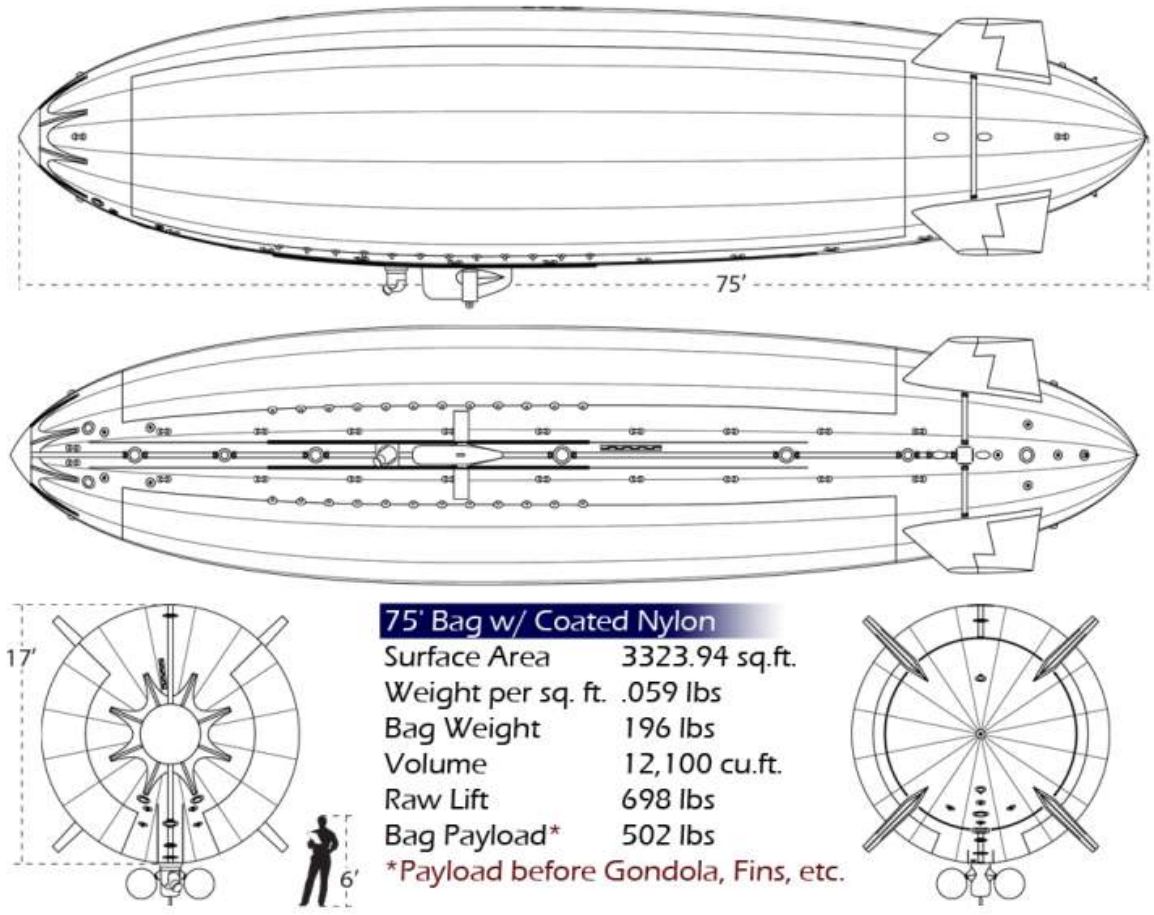
4. GC-75 LUTAS – Galaxy 75ft Large Unmanned Tactical Airship System

The GC-75 LUTAS is the current large airship production model. It is a scaled-up version of the GC-60 prototype.

GC-75 at a mobile mooring mast (above) and in flight (below). Source, both photos: GUS

With its 12,100 ft^3 (343 m^3) coated nylon gas envelope, the 75-foot (23-meter) long GC-75 can carry a 200 lb (91 kg) payload. Like the GC-60, it can fly in 30 mph (26 knots) winds with gusts up to 40 mph (35 knots).

Unlike the GC-35, which can be transported in a flight-ready condition in a trailer, the GC-75 is deflated, packed and moved to its next assignment. GUS has developed a helium recovery system that captures the helium for reuse as the airship is being deflated.



Four-view drawing of the GC-75. The single landing gear under the gondola is not shown. Source: GUS

Cineflex gimbaled camera mount and gondola with thrust-vectoring propellers in the horizontal cruise position. Source: GUS

GC-75 propellers vectored “up” for vertical takeoff. Source: GUS

5. GC-80

The GC-80 is a mature design for a scaled-up GC-75, with a VTOL capability carrying a 300 lb (136 kg) payload, and a maximum speed of 60 mph (52.1 knots, 96.6 kph). As of January 2023, GUS has not yet built a GC-80.

6. Organic Resupply Bus (Orb) & the *Constellation Concept*

In October 2019, GUS was awarded a 12-month, $111K Small Business Innovation Research (SBIR) contract (https://www.sbir.gov/sbirsearch/detail/1929445) for a US Army-sponsored study of "enhancement and augmentation of current aerostat capabilities that provide low-cost, persistent intelligence, surveillance and reconnaissance during high-intensity conflicts." Under this contract, GUS and its partner firms performed a feasibility study for leveraging GUS's commercial unmanned airship designs for military use and demonstrating potential advanced capabilities through the use of commercial products as military prototypes. The deliverables in 2020 included design concepts for Army review for hybrid aerostat/airships that can operate autonomously.

In November 2020, SBIR awarded GUS a 6-month, $150K contract (https://www.sbir.gov/sbirsearch/detail/1942811) for a US Air Force-sponsored STTR (Small Business Technology Transfer) Phase I project to develop design concepts for an "LTA Hybrid Electric 'Orb' for Urban Air Mobility." The term "Orb" is an acronym for "Organic Resupply Bus," which functionally is an unmanned, autonomous, multi-mission, hybrid electric-powered airship. This work was performed under the USAF program known as AFWERX, which has a goal "to develop effective solutions to the challenges facing the service through partnerships with private sector business entities, with particular emphasis being placed on collaboration with technology startups."

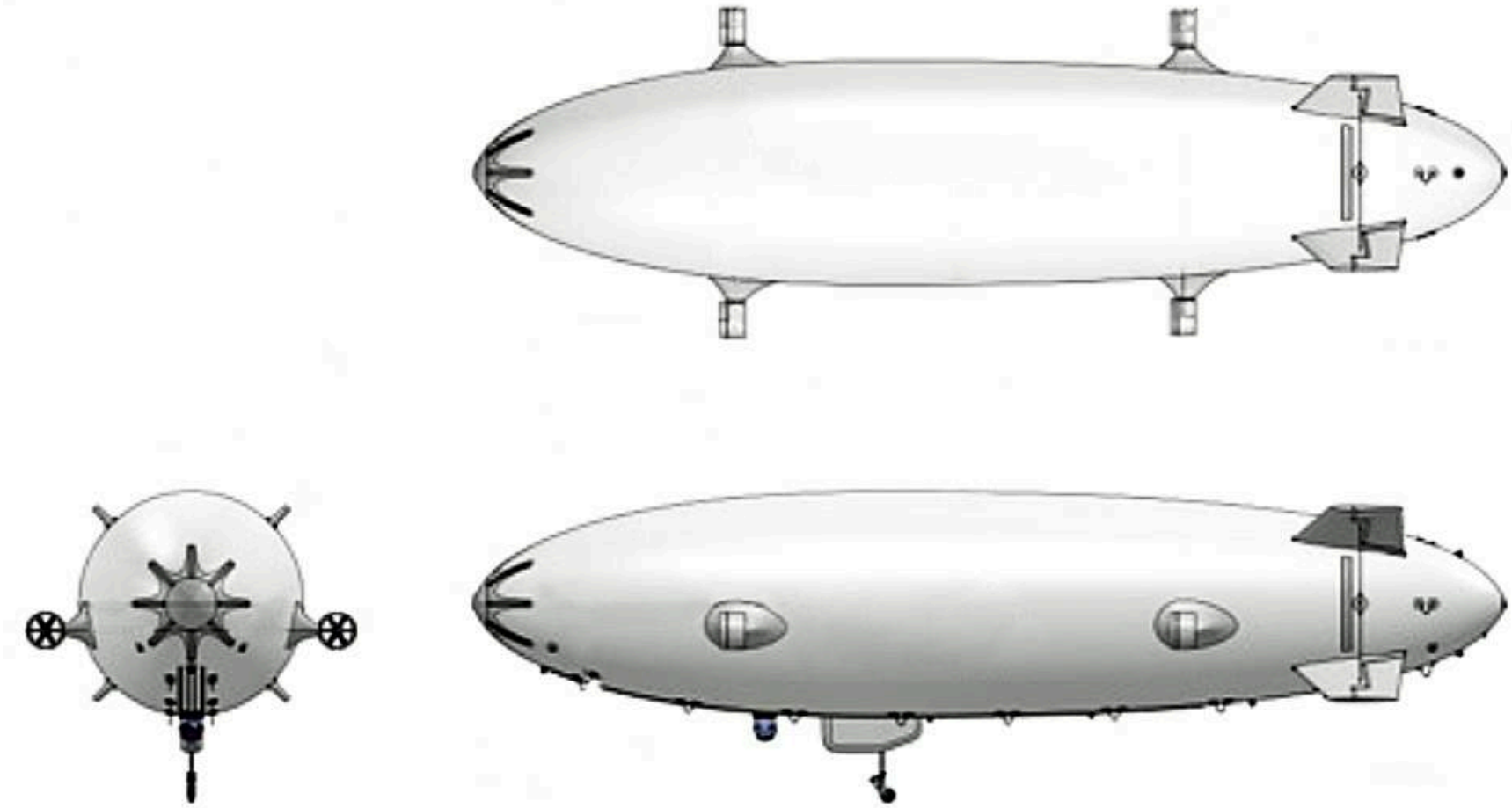
A follow-on SBIR / USAF AFWERX 15-month, $750K contract was awarded to GUS in September 2021 to perform an STTR Phase II project (https://www.sbir.gov/sbirsearch/detail/2166399). The deliverable is expected to be a small flying prototype of a non-rigid

autonomous airship that will be used to validate design and performance characteristics of an LTA hybrid electric Orb airship.

Autonomous, hybrid electric "Orb" GCXX-E4B UAS testbed

The non-rigid GCXX-E4B scalable UAS testbed airship that GUS and its team are developing under AFWERX contract is a customizable, open architecture, autonomous LTA vehicle that is expected to be sized between the GC-35 and GC-75, likely about 50 feet (15.2 m) in length. It will have a new gas envelope that supports four shrouded, electrically-powered, thrust-vectoring propulsors mounted directly to the envelope, which has provisions for a large photovoltaic (PV) solar array its top surface. This Orb concept retains the X-tail configuration of the GC-35 and -75. Payloads are attached to a pair of reinforced rails mounted along the bottom centerline of the envelope, in a manner similar to the GC-35 and -75.

Bow quarter view of a GCXX-E4B scalable UAS testbed showing the shrouded propulsors vectored "up" to generate dynamic lift. Note the rail system along the bottom centerline of the envelope.
Source: GUS / AFWERX, circa 2021

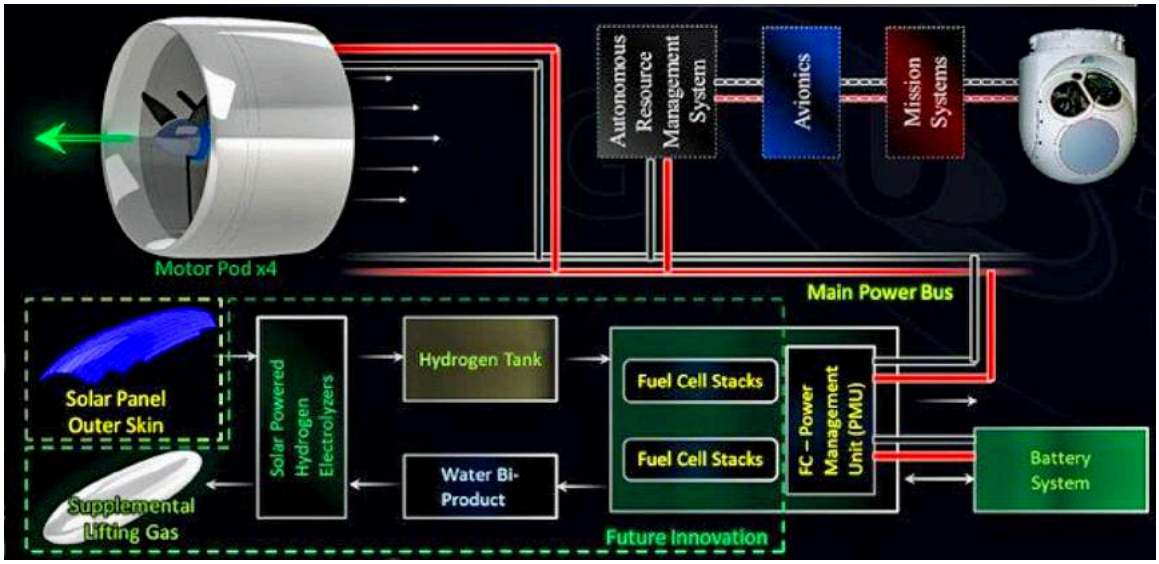


General arrangement of the GCXX-E4B autonomous scalable UAS testbed.
Source: Adapted from GUS, circa 2022

General arrangements of a GCXX-E4B scalable UAS testbed and mobile dock, which is designed for autonomous mooring. Source: GUS, circa 2021-2022

This Orb testbed airship will be too large to be transported fully assembled in a trailer, like the GC-35. Instead, it will be deflated, packed, transported and reinflated onsite, like the GC-75. GUS's helium recovery system could be used to minimize loss of helium during this cycle.

The Orb airship has an open architecture power management system that initially will be battery-powered. The power management system can be expanded by adding one or more supplemental power sources. In the near-term, that could be accomplished with a conventional gas turbine auxiliary power unit (APU). In the longer term, advanced power sources such as a hydrogen fuel cell and a large PV solar array could be installed and tested in flight.



GUS hybrid power system concept schematic diagram. Source: GUS / AFWERX, circa 2021

In the above advanced hybrid power system schematic diagram presented by GUS on its AFWERX project, a regenerative hydrogen fuel cell would be powered by a solar PV system to electrolyze (split) water and produce hydrogen and oxygen gas during daylight hours. The hydrogen gas would be stored for use as a fuel for the fuel cell, or as a supplemental lifting gas. The oxygen generated by the electrolyzer can be vented to the atmosphere. To produce power, the hydrogen fuel cell would draw hydrogen gas from the storage tank and use ambient oxygen from the atmosphere to produce electricity and water. The water is collected and recycled to the electrolyzer to

produce hydrogen again. As shown in the schematic diagram, a Power Management Unit would deliver power from the fuel cell and the battery to meet airship electric power demands and to charge the battery when possible. Such a hybrid power system could enable very long-duration flights (days, weeks).

The Constellation Concept

With its team of industry and university partners, GUS has created the *Constellation Concept,* which it refers to as a platform agnostic system architecture for "a complex ad-hoc mesh network of unmanned systems working collaboratively and autonomously to self-identify / orient / navigate / execute tasking according to a cloud-based collection of actionable objectives." Autonomy applications, also include inflight collision avoidance and docking / mooring.

Basic autonomous operation is implemented through the continuous fusion of data from a variety of sensors on the airship, such as GPS, vision systems / LIDAR, inertial measurement units (IMU), vehicle flight conditions (airspeed, heading, attitude, altitude, etc.), and vehicle system status (propulsion power and thrust vector settings, aerodynamic control surface positions, etc.).

GUS and their team plan to use the GCXX-E4B autonomous, scalable UAS testbed to demonstrate and validate the *Constellation Concept*.

Application of the *Constellation Concept* on an LTA drone carrier

Building on the scalable GCXX-E4B vehicle design and the *Constellation Concept* open architecture, GUS and its team have conceived a scaled-up Orb airship as a drone carrier (a "mothership"), that can deploy in flight a swarm of small, autonomous fixed-wing and/or multi-copter drones. In GUS's mesh network architecture, multiple Orb motherships can operate together on a coordinated mission. The array of small, autonomous drones carried by an Orb mothership can be optimized to meet the particular mission objectives.

Constellation Concept implemented in a multi-tiered macro / micro drone swarming system. Source: GUS / AFWERX, circa 2021

7. For more information

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- “Galaxy Unmanned Systems selected for Army airship SBIR,” sUAS NEWS, 15 October 2019: https://www.suasnews.com/2019/10/galaxy-unmanned-systems-selected-for-army-airship-sbir/
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- Patrick Egan, “AFWERX Gives Greenlight to Build Hybrid LTA ORB Prototype, “ sUAS News, 21 July 2022: https://www.suasnews.com/2022/07/afwerx-gives-greenlight-to-build-hybrid-lta-orb-prototype/

Videos

- “GC-35 Unmanned Tactical Airship System (UTAS)” (5:30 minutes), Galaxy Unmanned Systems LLC, 22 March 2019: https://www.youtube.com/watch?v=KbceK46SOhw
- “GC-75 Flight Characteristics” (2:07 min), Galaxy Unmanned Systems LLC, 30 Mar 2019: https://www.youtube.com/watch?list=TLGGd61U4QHDVxAxMjAyMjAyMQ&v=QokxSBLTvA8&feature=emb_logo

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/