Airspeed Airships – remotely-piloted blimps

Peter Lobner, 4 November 2023

1. Introduction

Nigel Wells founded Airspeed Airships in the UK in the early 1980s. A decade later, he provided the following report on the status of Airspeed Airships and several of the small, unmanned blimps his firm had produced in his 1995 AIAA paper, "Practical Application of Remotely Piloted Airship."

> "My experience in RPAs began in 1981 with an electric powered design measuring 4 m (13 ft) in length. Experiments continued over the years with a total of 12 types being flown. To begin with, these airships were barely able to lift their own weight into the sky and were designed specifically for pleasure flying. It gradually occurred to me that their unique qualities could be used commercially. Most of the early experimental flights took place at a farm in Speldhurst, Kent (southeast of London), between 1981 and 1989."

In 2004, Arnold Nayler reported on worldwide airship activities and provided the following updated on Airspeed Airships:

> "The company have built some 60 remotely-piloted airships (RPAs) for aerial photography, advertising and scientific research by universities and government agencies since 1985. They are currently operating in Brazil, France, Germany, Switzerland, UK and the USA. The latest was supplied to (NASA Jet Propulsion Lab).
>
> Recent developments include improvements to the range, autonomous flight control, new radio and TV links, a gyro-stabilized system for the control surfaces and experiments with cycloidal propellers."

This article provides overviews of several of Airspeed Airships small unmanned blimps and a larger R101 rigid airship flying model.

2. AS-260

Nigel Wells described the AS-260 as follows:

> "During the late 1980s, a brand new design look to the air. The Airspeed **AS-260** was, at 6.1 m (20 ft), much larger than anything built before and the first to employ many of the features of the present airships. The AS-260 was powered by two model aircraft engines which could be vectored through 120° and was fitted with X-type control surfaces. This was the first ship to carry a 35mm camera and advertising banners. It was used extensively for photography and commercial advertising during this period before being sold in 1990."

3. AS-200

Nigel Wells described the AS-200 as follows:

> "Subsequently, in 1992, all activities moved to Pembury in Kent where the first microwave TV system was flown aboard the **AS-200** airship, which also made a number of pioneering flights carrying an 8mm video camera. The AS-200 was built by Martin Hill and differed from previous designs in respect of its inverted Y-type control surfaces. The television system was supplied by David O'Brien of the Link & Detector Co. and represented a major leap forward in the project's capabilities."

General design parameters of the AS-200

Parameter	**Airspeed Airships AS-200**
Type	Conventional, non-rigid
Length	6.25 m (20.5 ft)
Diameter	1.52 m (5 ft)
Fineness ratio	4.11
Volume, total	7.48 m^3 (264 ft^3)
Envelope	Welded mylar
Aerodynamic controls	**Standard AS-200**: Inverted Y-configured tail planes **LSC-IBISC**: Cruciform-configured tail planes
Payload	1.58 kg (3.5 lb)
Propulsion	2 x petrol engines driving contra-rotating propellers

Source: S. Bennaceur, Laboratoire IBISC, CNRS, France (2007)

In the mid-2000s, a French team from the Laboratoire IBISC, CNRS, and the Laboratoire d'Ingénieurie Mathématique, Ecole Polytechnique de Tunisie collaborated on study of autonomous flight control systems for flexible blimps and the importance of factoring that flexibility into the control algorithms. Their goal was to develop a model to enable an easy implementation of control and stabilization algorithms for flexible airships. Their analytical results were validated against flight test data collected from an AS-200 blimp belonging to the University of Evry, located south of Paris.

LSC-IBISC's airship was an Airspeed AS-200.
Source: S. Bennaceur, Laboratoire IBISC, CNRS, France (2007)

Source: A.B. Moutinho, Dissertation (2007)

The project team reported (Bennaceur, et al., 2007) that precise modeling of the dynamic behavior of the airship was necessary, taking into account the effects of the flexibility of the airship and its interaction with the dynamic airstream.

4. AS-300

Nigel Wells described the AS-300 as follows:

> "Following this (the AS-200), the forerunner of the present standard design took to the skies for its maiden flight at the Northampton Balloon Festival. The **AS-300** was a 7 m (23 ft) long, 11.3 m^3 (400 ft^3) design, which incorporated just about every design innovation that I could build into her. The object was always to improve stability and control in bad weather and simplify ground management. This airship was used to demonstrate the concept to both the MOD (Ministry of Defense) and CAA (Civil Aviation Authority)"

In the 1990s and early 2000s, Roy P. Gibbens (Gibbens & Associates, Meridian, Mississippi) conducted extensive tests on the use of cycloidal propellers as a means to improve the controllability of airships. One of his test platforms was a 7-m (23-foot) long, remotely controlled, blimp manufactured by Airspeed Airships, likely an AS-300. That airship was modified by removing the two original conventional thrust-vectoring propellers and installing two horizontally-mounted cycloidal propellers cantilevered transversely from the gondola. Flight tests in the UK in 2001 demonstrated that the airship was fully controllable with the two cycloidal propellers.

Airspeed Airships blimp, likely an AS-300, adapted for testing cycloidal propellers. Source: Roy P Gibbens (2011)

Following the successful UK test flights, the airship was then shipped to the U.S. for further modifications and flight tests at Gibbens' facility in Mississippi. Gibbens reported on these tests:

> "The upper tail fins/rudders were removed and the lower controls were locked in place, acting only as directional fins. The controls were adjusted to allow the propellers to be 'cross controlled' and make the airship turn without the use of the rudders. The airship made turns with only two propellers on the gondola. Quicker turns could have been made with an additional propeller mounted on the aft end of the airship."

Indoor flight test of Gibbens' Airspeed blimp adapted for cycloidal propeller testing. Note that the upper tail fins have been removed. Source: Roy P. Gibbens (photo 2001)

More details on Roy P. Gibbens cycloidal propeller blimp tests are in a separate article.

5. AS-400

Nigel Wells described the AS-400 as follows:

> "The operational base then moved to Paddock Wood and it was here that tests were carried out to finalize installation of camera and TV equipment using the **AS-400** airship."

6. AS-500 (Karma)

The most notable application of the AS-500 was as the original version (V1) of the Karma autonomous airship, which was selected and flew in support of a project initiated in 2001 by LAAS (Laboratory for Analysis and Architecture of Systems), located in Toulouse, France. LAAS is a research unit CNRS, the French National Center for Scientific Research, within the Department of Information and Engineering Sciences and Technologies.

Karma V1 on its first radio-controlled flight, with stern thruster installed
Source: LAAS (July 2002)

The objective of the French Karma project was to demonstrate an airship with the ability to execute planned trajectories on the basis of its sensors, and in the long term, on the basis of the perception of ground elements. The Karma project initially focused on defining blimp trajectory control laws and on environment modeling issues using low altitude imagery.

LAAS modified their AS-500 by replacing the original petrol engines with electric motors and the adding of a small electric motor-driven stern thruster. In addition, onboard equipment was added to support autonomous flight, including black & white stereovision, blimp state sensors (differential GPS, pitch, roll, wind and battery sensors), on-board computer, and autonomous actuator controls with manual override.

General design parameters of the AS-500 (Karma V1)

Parameter	**Airspeed Airships AS-500**	**Karma V1**
Type	Conventional, non-rigid	
Length	7.8 m (25.6 ft)	
Diameter	1.8 m (5.9 ft)	
Fineness ratio	4.25	
Volume, total	15 m^3 (530 ft^3)	
Envelope	• Welded mylar construction • Radio-controlled emergency helium release valve on top of the envelope	
Ballonet	Fed by air captured from the propeller slipstream	
Aerodynamic controls	X-configured tail planes	
Payload	• 3.5 kg (7.7 lb) static • 5.0 kg (11 lb) dynamic (blimp typically flies 1.5 – 2.0 kg overweight)	• 1.5 kg (3.3 lb) static • reduced due to batteries • 2.8 kg (6.2 lb) dynamic (1.3 kg overweight)
Propulsion	2 x 7.5 cm^3 (0.46 in^3) petrol engines, each driving a thrust vectoring (100º range) propeller transversely mounted to the gondola	2 x electric motors, each driving a thrust vectoring (100º range) propeller transversely mounted to the gondola
Speed, max	45 kph (28 mph)	< 45 kph (<28 mph)
Stern thruster	None	1 x stern thruster added for yaw control while hovering, but later removed
Wind speed, operational	25 kph (15.5 mph) with petrol engines	10 kph (6 mph) with electric motors
Endurance	40 min on 1.0 kg (2.2 lb) of fuel	12 to 15 minutes on batteries

Source: Lacroix, et al. (2002)

The LAAS research team developed a global control strategy that integrated a path planner, a path follower and elementary controllers. This model was validated against experimental results of cruise flight stabilization obtained with the Karma V1 blimp.

Karma V1 ready for fifth flight, with stern thruster removed.

Karma V1 on its fifth flight with cameras and Ethernet antennas.
Source, both photos: LAAS (August 2002)

A second version of the Karma blimp, known as V2.0, was developed and first flew in 2003. With a transparent gas envelope and a minimalist gondola, about all that was left of the original AS-500 blimp were the X-configured tail fins, still with the original AS-500 markings.

More information is in a separate article on the Karma project.

7. AS-800

Airspeed Airships AS-800-series blimps were used from the late 1990s through the mid-2010s in two notable applications: Project AURORA and the National Aeronautics and Space Administration's (NASA) / Jet Propulsion Laboratory (JPL) prototype aerobot testbed program.

AURORA

Project AURORA (an acronym for Autonomous Unmanned Remote mOnitoring Robotic Airship) was a collaborative project involving the following participants:

- Information Technology Institute (DRVC/CenPRA), Campinas, Brazil
- Instituto Superior Técnico (IST), Lisbon, Portugal
- INRIA (National Institute for Research in Digital Science and Technology), ICARE project (Instrumentation, Control and Architecture of Advanced Robots), Paris, France

The AURORA project was initiated in 1997 to develop sensing, control, navigation, and inference technologies required for semi-autonomous operation of robotic airships for aerial inspection.

AURORA originally was conceived as a three-phase project with progressively more capable airships.

Parameter	AURORA I	AURORA II	AURORA III
Mission duration	1 – 2 h	8 h	>24 h
Typical distance	1 – 10 km (0.6 to 6.2 mi)	10 – 50 km (6.2 to 31 mi)	>100 km (>62 mi)
Typical payload	10 kg (22 lb)	50 kg (110 lb)	>100 kg (>220 lb)

Source: Alberto Elfes, et al. (1998)

The AURORA I platform was a 9 m (29.5 ft) **AS-800** blimp manufactured in the UK by Airspeed Airships. Like the smaller Karma AS-500, the AURORA I blimp was fitted with on-board equipment needed to support semi-autonomous flight and the aerial inspection mission.

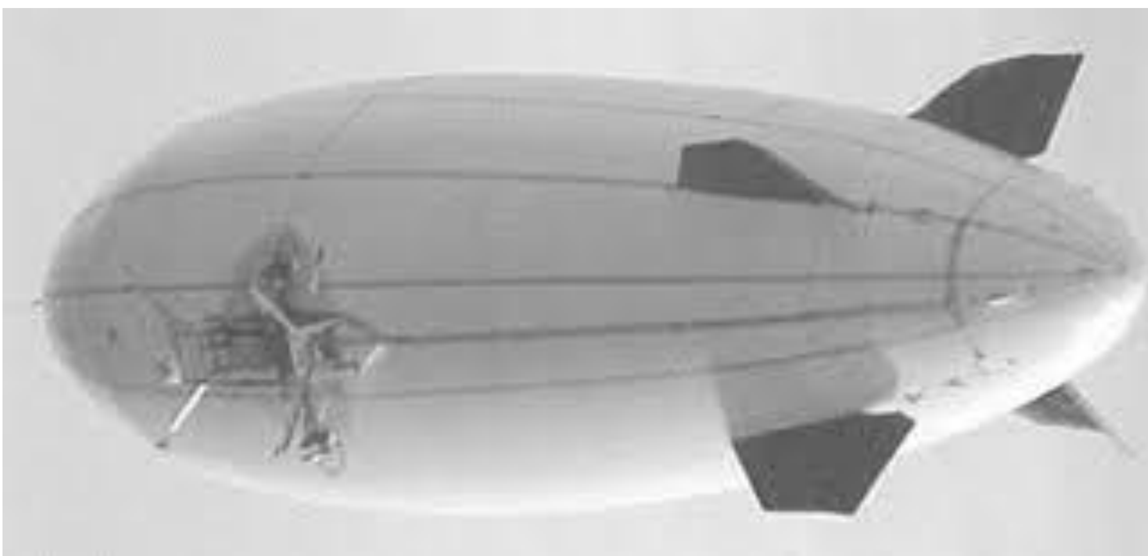
AURORA I airship is a modified AS-800. Source: Josué Ramos, et al. (2001)

General design parameters of the AS-800 (AURORA I)

Parameter	**Airspeed Airships AS-800 (AURORA I)**
Type	Conventional, non-rigid
Length	9.0 m (29.5 ft)
Diameter	2.25 m (7.4 ft)
Fineness ratio	4.0
Volume, total	30 m^3 (1,059 ft^3)
Ballonet	Fed by air captured from the propeller slipstream
Aerodynamic controls	• X-configured tail planes, ±25 degrees deflection. • Controls become ineffective at low speed, below 4 m/s (14.4 kph, 9 mph)
Payload	10 kg (22 lb)
Propulsion	• 2 x thrust vectoring (-30 to +90 degrees) two-stroke petrol engines transversely mounted on the gondola, each driving a shrouded propeller • Can operate collectively or differentially • At low speed, control actuation is accomplished by vector thrusting and, as needed, differential control.

Source: Josué Ramos , et al., et al. (2001)


AURORA I airship in flight. Source: SS Bueno, et al. (2002)


AURORA I in flight. Source: Josué Ramos (2003)

The project team developed a full non-linear 6 degrees-of-freedom dynamic mathematical model of the AURORA blimp for use in control system development. In 2001, AURORA I accomplished one of the first successful autonomous flights by an airship through a set of pre-defined points.

After a decade of autonomous controls research with the evolved AURORA I airship, a multi-national team led by Alexandra Moutinho reported in 2016 on their development of a control approach whereby an autonomous control system can cover the complete aerodynamic range encountered by an airship, from hover to cruise flight, and handle the abrupt dynamics transitions between the two flight regions and the different use of actuators necessary within each region. Their 2016 paper presents a non-linear gain-scheduling airship control design methodology encompassing both aerodynamic and hover flight and offering the following attributes:

- Valid over the entire flight envelope, enabling the execution of complete missions
- Simultaneously controls lateral and longitudinal motions
- Robust to wind disturbances (constant wind & gusts)
- Takes into account actuation limitations
- Easy to tune and to implement

The performance of the proposed control solution was tested in a simulation environment where the airship non-linear dynamic model was based on the actual characteristics and performance of the evolved AURORA I blimp.

The original Airspeed Airships AS-800 AURORA I blimp was replaced in about 2006 by an evolutionary design with a longer, fatter gas envelope.

After almost two decades of research and development for autonomous airship controls the project ended in 2016 with the completion of the original AURORA I phase. The later phases were not funded.

More information is in a separate article on the AURORA project.

NASA / JPL AS-800B prototype aerobot testbed

In the early 2000s, the National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory (JPL) began developing the core autonomy technologies required for "aerobot" (robot airship) exploration of solar system bodies that have an atmosphere. While the primary target of exploration was Saturn's largest moon, Titan, the core aerobot autonomy technologies being developed also were directly applicable for Venus or terrestrial aerobots.

The JPL prototype aerobot testbed platform was an 11 m (36.1 ft) unmanned **AS-800B** blimp manufactured in the UK by the firm Airspeed Airships. The AS-800B was outfitted with avionics and navigation systems necessary to for conducting remotely-piloted and autonomous flights and for communications with a ground station.

JPL's AS-800B aerobot. Source: JPL (Oct 2006)

Autonomous flight of the JPL aerobot, conducted at the El Mirage dry lake in the Mojave desert. Source, both photos: JPL (Oct 2006)

Initial field tests of the JPL aerobot testbed were conducted at the Southern California Logistics Airport in Victorville, CA. The initial flights were remotely-piloted to allow extensive testing of the onboard avionics and data acquisition systems.

Extensive field tests of the JPL aerobot testbed and the autonomous flight control system were conducted at the El Mirage dry lake site in the Mojave desert, and robust waypoint navigation was demonstrated.

General design parameters of the AS-800B

Parameter	**Airspeed Airships AS-800B**
Type	Conventional, non-rigid
Length	11.0 m (36.1 ft)
Diameter	2.5 m (8.4 ft)
Fineness ratio	4.3
Volume, total	34 m^3 (1,201 ft^3)
Ballonet	Fed by air captured from the propeller slipstream
Aerodynamic controls	X-configured tail planes, ±25 degrees deflection
Payload	• 12 kg (26.5 lb) static • 16 kg (35.3 lb) dynamic (blimp typically flies overweight) • The avionics and communication systems are installed in the gondola.
Propulsion	2 x 23 cm^3 (1.4 in^3) displacement petrol engines rated @ 2.3 kW (3 hp), each driving a thrust vectoring (0 to +90 degrees) shrouded propeller mounted to the gondola.
Speed, max	13 m/s (25 knots)
Altitude, max	500 m (1,640 ft)
Endurance, average	60 min

Source: A. Elfes, et al. (2005)

More information is in a separate article on the NASA / JPL AS-800B aerobot.

8. R101 flying model, circa 2000

Nigel Wells built 120:1 scale flying model of the 236.8-m (777-ft) long R101 rigid airship designed by Barnes Wallis and built by Vickers in the 1920s. This 13.7-m (45-ft) long model airship was built for Airship Heritage Trust (AHT) for use in advertising and promotions. In addition, Wells also constructed a scale replica of the Cardington mooring mast.

R101 model under construction at Airspeed Airships, showing rigid hull framework. Source, both photos: AHT

R101 model under construction showing rigid hull framework.

R101 model (L) in the hangar alongside an Airspeed drone airship (R). Source, both photos: AHT

AHT reported: “Two flights were made on 5th February 2000, both of about 20 minutes in duration. On these flights the ship only flew with just two of the four electric motors working, and was slightly over equilibrium. With all batteries on board she is 4 lb heavy….Control in pitch and yaw is excellent and the passenger gangway in the bow opens to drop a 30 ft line which makes landing very easy….. Windspeed flown in so far: 10 -12 knots.”

R101 model in flight. Source:
Screenshot from Trevor Munk video (2000)

9. Epilogue

Airspeed Airships is no longer in business. After nearly two decades of producing small, remotely-controlled blimps, Nigel Wells' firm appears to have gone out of business by the early 2000s. However, several of his small blimps, notably AURORA and Karma, have made significant contributions toward the development of autonomous flight control systems for Earth-bound airships, and the NASA/JPL aerobot has made similar contributions toward the future exploration by "airships" of planetary bodies with atmospheres.

10. For more information

General Airspeed Airships

- Nigel Wells, "Practical Operation of the Remotely Piloted Airship," AIAA-95-1634-CP, Airspeed Airships paper presented at the AIAA 11th Lighter-than-Air Systems Technology Conference, 15 to 18 May 1995, Clearwater Beach, FL, U.S.A., May 1995: https://arc.aiaa.org/doi/abs/10.2514/6.1995-1634
- Nigel Wells, "Practical Application of Remotely Piloted Airship," Airspeed Airships paper, AIAA-95-1634-CP, 1995
- Arnold Nayler, "Airships Today – 2004," Airship Association Ltd., 2004: https://www.aerall.org/docs-colloque2004/intervention_Arnold-NAYLER.pdf

AS-200

- S. Bennaceur, et al., "An Efficient Modeling of Flexible Blimps: Eulerian Approach," paper presented at the ASME 2007 International Design Engineering technical Conference, IDET/CEI 2007, Las Vegas, NV, September 2007: https://www.researchgate.net/publication/27611176_Modelisation_d%27un_dirigeable_flexible_-_Modele_Eulerien

AS-300

- Roy P. Gibbens, "AirLighter," 2011: https://lynceans.org/wp-content/uploads/2023/10/AirLighter_RPG_2011.pdf

AS-500, Karma V1

- "Karma, the Blimp," LAAS, February 2002: https://homepages.laas.fr/simon/eden/robots/blimp.php
- Karma photo gallery, LAAS: https://homepages.laas.fr/simon/eden/gallery/karma.php
- Simon Lacroix, et al., "The autonomous blimp project of LAAS/CNRS Current status and research challenges," LAAS/CRNS paper, 2002:

https://homepages.laas.fr/simon/publis/LACROIX-ISER-2002.pdf
- Emmanuel Hygounenc, et al., “The Autonomous Blimp Project of LAAS-CNRS: Achievements in Flight Control and Terrain Mapping,” LAAS/CNRS paper, 2003: http://www.comets-uavs.org/papers/HYGOUNENC-IJRR-2003.pdf

AS-800, AURORA I

- Alberto Elfes, et al., “Project AURORA: Development of an Autonomous Unmanned Remote Monitoring Robotic Airship,” J. Brazil Comp. Soc. 4 (3), April 1998: https://www.scielo.br/j/jbcos/a/Fbhsrb73QCb3FqzK3Rdyv4s/#
- Josué Jr. G. Ramos , et al., “Autonomous Flight Experiment With Robotic Unmanned Airship,” paper presented at the 2001 IEEE International Conference on Robotics & Automation, Seoul, South Korea, 21 – 26 May 2001: https://www.researchgate.net/publication/224072222_Autonomous_Flight_Experiment_with_a_Robotic_Unmanned_Airship
- S.S. Bueno, et al., “Project AURORA: Towards an Autonomous Robotic Airship,” ResearchGate, January 2002: https://www.researchgate.net/publication/228518304_Project_AURORA_Towards_an_autonomous_robotic_airship

AS-800B, NASA prototype aerobot testbed

- “The JPL Aerobot,” Jet Propulsion Laboratory: https://www-robotics.jpl.nasa.gov/how-we-do-it/systems/the-jpl-aerobot/
- A. Elfes, et al., “Autonomous Flight Control for a Planetary Exploration Aerobot,” Jet Propulsion Laboratory & University of California, 2005: https://www.researchgate.net/publication/228409685_Autonomous_Flight_Control_for_a_Planetary_Exploration_Aerobot

R101 model

- “R101 Flying Model,” Airship Heritage Trust (AHT): https://www.airshipsonline.com/airships/r101d/index.html

- Video, “Model R101 d airship test flight,” (0:30 min), posted by Trevor Monk, 22 May 2010: https://www.youtube.com/watch?v=TK804m-_56w&t=5s

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/
  - Roy P. Gibbens – cycloidal propeller test platform
  - Karma – autonomous blimp
  - AURORA – autonomous blimp
  - NASA / JPL - aerobot
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/