AIRLANDER

A British company is developing the biggest aircraft ever built, the Airlander. Clive Simpson reports

The largest aircraft ever seen is expected to take to the UK skies for the first time at the end of the year. It could soon be setting a new benchmark for heavy-lift transportation and reconnaissance throughout the world.

The Airlander, developed by Cranfield-based Hybrid Air Vehicles (HAV), uses innovative technology to combine the best characteristics of fixed-wing aircraft and helicopters with lighter-than-air technology to create a hyper-efficient aircraft.

It can stay airborne for up to five days at a time and fulfil a wide range of communication, cargo-carrying and survey roles, in both the military and commercial sectors, with a significantly lower carbon footprint than other forms of air transport.

Hybrid air vehicles produce less noise, less pollution, are more environmentally friendly and have longer endurance with a more flexible cargo-carrying capacity over conventional aircraft. They can take off and land vertically and operate from austere environments, including water, desert, ice and fields.

Point-to-Point

Chris Daniels, Head of Partnerships and Communications at HAV, told *AIR International* the new aircraft would likely "revolutionise" the air cargo transportation market. "It will enable for the first time ever a truly point-to-point 50 tonne cargo-carrying capability, with the ability to operate with limited infrastructure and support," he said.

HAV flew the first full-size Airlander (commissioned under the US Army's Long Endurance Multi-intelligence Vehicle project) at Lakehurst, New Jersey, in the United States in August 2012. The giant craft, designated the Airlander 10, is now back in Britain in the only hangar in the country large enough to accommodate it – one of the twin landmark airship 'sheds' that dominate the Bedfordshire countryside at Cardington.

These hangars, built 100 years ago, are where the ill-fated R101 airship was constructed in the 1920s. The R101, twice as long as today's Airlander and which had a dining room and lounge on board, crashed on a flight in France in 1930.

Airlander 10 ground tests and flight trials are planned to start from Cardington later this year after a complete rebuild. It will serve as a prototype for the Airlander 50, a larger heavy-lift version capable of transporting 50 tonnes of freight while burning around a quarter the amount of fuel of an aeroplane doing the same job.

Market

Independent studies have suggested the market for this new type of aircraft to be between 600 and 1,000 units worldwide. Ramping up production to ten a year within five years is projected to lead to the creation of 1,800 jobs in and around Bedfordshire.

The Airlander's ability to transform some aspects of air travel is becoming recognised by HAV's investors. It can stay in the air for days at a time, offers incredible fuel efficiency, minimal noise pollution and does not require a runway.

It offers a revolutionary alternative for emergency aid distribution, heavy cargo lift to or from remote or inaccessible areas and luxury travel - all with low environmental impact.

It looks like a giant airship but has a unique aerodynamic shape that means it can also create lift, just like an aircraft wing.

Bruce Dickinson, the lead singer of heavy metal band Iron Maiden and a high-profile investor in HAV, compared the ship to Gerry Anderson's 'Thunderbird 2', a heavy duty transporter aircraft depicted in the 1960s cult TV series Thunderbirds.

"The airship has always been with us, it's just been waiting for the technology to catch up," he said. "Airlander is 70% greener than a cargo plane and can plonk 50 tonnes anywhere in the world you like.

"I came on board as an investor with £250,000 - it really was a leap of faith. It is only if you are prejudiced and narrow in your vision that this doesn't make any sense. Airlander has a tremendous future and above all it inspires the imagination because once you see it you realise how enormous the opportunities are."

Size and Structure

The new hybrid aircraft is 302ft (92m) long - about 60ft (18.2m) longer than the biggest airliners, the Airbus A380 and Boeing 747-8. It is also almost 30ft (9.1m) longer than the massive Antonov An-225 Myria, which until now was the longest aircraft ever built.

All images Hybrid Air Vehicles

AIRLANDER 10 SPECIFICATIONS

Envelope volume: *1,340,000ft³ (38,000m³)*

Dimensions: *length 302ft (92m), width 143ft (43.5m), height 85ft (26m)*

Endurance: *up to five days manned*

Altitude: *up to 20,000ft (6,100m)*

Speed: *cruise 80kts (148km/h), loiter 20kts (37km/h)*

Total weight: *44,100lb (20,000kg)*

Payload capacity: *up to 22,050lb (10,000kg)*

AIRLANDER 50 SPECIFICATIONS

Envelope volume: *3,640,000ft³ (103,000m³)*

Dimensions: *length 390ft (119m), width 196ft (60m), height 115ft (35m)*

Payload module: *length 98ft (30m), width 18.5ft (5.6m) - height 13ft (4m)*

Endurance: *up to four days manned*

Range: *2,600nm (4,815km)*

Altitude: *up to 10,000ft (6,100m)*

Speed: *cruise 105kts (195km/h), loiter 40kts (74km/h)*

Total weight: *128,100lb (58,100kg)*

Payload capacity: *up to 132,300lb (60,000kg)*

The hull's aerodynamic shape, an elliptical laminated fabric cross-section, allied to a cambered longitudinal shape, provides up to 40% of the vehicle's lift. Internal diaphragms required to support the shape allow for a limited amount of compartmentalisation, further enhancing the fail-safe nature of the vehicle. Multiple ballonets (small auxiliary gasbags) located fore and aft in each of the hulls provide pressure control.

Profiled pneumatic tubes or skids on the underside of the two outer hulls offer multi-surface ground operation, including amphibious capability. The skids are retracted for a clean in-flight profile.

The Airlander 10 is powered by four 350hp (260kW), four-litre V8 direct injection, turbocharged diesel engines. Two are mounted forward on the hull and two on the stern for cruise operation. All four are configured in ducts with blown vanes to allow vectored thrust for take-off and landing, plus ground handling manoeuvres.

A long payload module, located on the centreline, comprises a flight deck with payload compartment at the fore, a mid-body payload beam for externally slung loads, and an aft section for fuel tanks and additional payloads.

Government Backing

This spring the UK Government-backed Technology Strategy Board awarded a £2.5 million grant to HAV as part of a £4 million public and private sector project to develop specific engineering aspects of HAV's novel hybrid air vehicle.

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Secretary of State for Business, Innovation and Skills Vince Cable said: "The growing aerospace sector has the potential to generate thousands of new jobs and billions of pounds to the UK economy in contracts. That is why so much effort is being put in by government and industry to ensure we stay ahead of the competition and build on our strong position as second in the world for aerospace.

"As part of our long-term industrial strategy we are jointly funding £2 billion of research and development into the next generation of quieter, more energy efficient and environmentally friendly planes.

"This includes backing projects like Hybrid Air Vehicles' innovative low carbon aircraft which can keep us at the cutting edge of new technology. Here is a British SME [small and medium enterprise] that has the potential to lead the world in its field."

The Cardington hangars are the spiritual home of the British airship industry and HAV has taken out a lease on Hangar 1, working in close collaboration with Fosbern Hangars, the owner, to ensure the historic and listed building is fit for a modern engineering company.

The £2.5 million government grant will help HAV take a significant step in the journey towards commercial manufacture of the innovative, low-carbon Airlander 50. It will enable the detailed modelling of the aircraft's aerodynamic characteristics and its engines using wind tunnels and the latest computer-aided fluid dynamic simulations. It will also be used to develop a methodology for engineering the largest carbon composite structures used in aviation, the software to control and monitor the hull pressure system (crucial for a helium-filled aircraft) and improve manufacturing and assembly techniques to increase hangar capacity in order to meet expected demand.

Proof of Concept

HAV will have garnered sufficient technical knowledge after completion of these intermediate developments to undertake a series of proof-of-concept flight tests using the current vehicle, and to complete the design of the Airlander 50 cargo aircraft.

During a tour of the Cardington's Hangar 1, complete with its giant vehicle (inflated with air for checkout purposes), Mike Durham, HAV Technical Director, told *AIR International* the Airlander 10 flight model was "good for five to ten-tonne payloads". It would mostly be used for reconnaissance and geo-survey work, whilst the Airlander 50 was "all about freight".

He said: "With the Airlander 10 our goal is to have the prototype vehicle in the air by the end of this year and be selling product round about mid-2016. The first Airlander 50 should fly in 2017 with deliveries to customers from the following year.

"There are no real technology roadblocks to doing bigger vehicles. The Airlander 50 will be 400 feet and if there is market demand there will be a stretched 200 tonne version in around 2022-2024."

US Army

The Airlander 10 was originally developed for the US military at a cost of around $300 million. Cuts in the military's spending to

AIRLANDER KEY FEATURES

The Airlander is designed to be an ultra-safe form of air travel. The vehicle does not stall, lands on any reasonably flat surface and has a take-off and landing speed of around 40kts (74km/h).

It uses a combination of buoyancy (helium gas) and aerodynamics (the shape of the body) to generate lift. The 'hybrid' is in essence an aircraft with some inherent buoyancy, similar to a lifting body (a vehicle in which the body itself produces lift).

The design, says HAV, creates the perfect balance between economic flight (typically associated with airships), operational flexibility (typically associated with helicopters), range and payload.

A key attribute is operational flexibility. In addition to conventional take-off and landing, the vehicle is also capable of vertical take-off and landing. It can, for example, hover like a helicopter while hoisting up to 40% of its designed payload – 20 tons in the case of the Airlander 50.

The range and payload of Airlander far exceeds that of helicopters - most rotary aircraft have an operating range of 150 to 300 nautical miles (277-555km), whereas the Airlander 50 will be able to operate on 2,600nm (4,815km) missions.

The vehicle is also a model of operational efficiency: the heavy lift version requires little or no infrastructure to operate. An innovative landing system called an Air Cushion Landing System enables it to land on almost any reasonably flat surface, including land, water, ice and snow. Suction can also be used to ensure the vehicle remains stationary during loading and off-loading.

This lack of reliance on infrastructure enables Airlander to operate point-to-point, offering major benefits in terms of time, risk reduction, operating costs and the environment.

The company says it will have capability to build five to six vehicles a year from its single hangar and increase production to around a dozen vehicles per annum within five years.

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1 The Airlander 10 is optimised for survey work in both civilian and military applications. **2** Hybrid Air Vehicles sees a large market for the Airlander for heavylift cargo transport. **3** The Airlander 50 is being designed to carry loads as heavy as 50 tonnes from point to point. **4** The Airlander 10 was test flown by the US Army under its Long Endurance Multi-intelligence Vehicle programme in 2012 but the project was cancelled last year.

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help reduce the US budget deficit meant the project was axed in early 2013.

The US Army requirement, in terms of flying conditions, was for the vehicle to be able to take off and land in 35kts (64km/h) of wind from any direction, which is not too different to the conditions commercial aircraft have to meet.

Durham said: "We started negotiations to bring the Airlander 10 back from the States in the spring of last year.

"We then disassembled it over four weeks in the autumn and it came back to the UK in mid-December where it has been air-inflated so we can start the rebuild process. Everything we brought back from the US government has had to be re-inspected for flight and the assembly process will continue through the summer."

Testing

Ground tests and checkout will start in September. The Airlander 10 will then be moved on to a mast on the adjoining airfield for an initial ground test programme.

"After that we will make our second flight ever, which will be the first flight in the UK," Durham added. "It will be a typical first flight event – take off safely, fly round the block once and put down safely. The relatively limited flight envelope will last about 90 minutes, about the same as for the US flight."

The first flight will be restricted to a speed of about 40kts (74km/h) and a height of around 2,000-3,000ft (609-914m) although the vehicle is capable of 80kts (148km/h) and flying at 16,000ft (4,876m).

Durham said: "A five-month test programme should then leave us in a position to start flight demonstrations and trials with potential customers, to show the capability of the vehicle."

This first vehicle comes under Civil Aviation Authority B Permit to Fly regulations as being the best way to get such a prototype vehicle flying. Subsequent versions of the Airlander will be certified through the European Aviation Safety Agency.

"Fundamentally there are a set of CS30T regulations, transport category large airship regulations, prepared for this type of vehicle but there will be some additions to those because of the uniqueness of our vehicle," said Durham.

Materials

The vehicle's external surface is made of high-tech fabric which, size for size, is about the same weight as three pieces of A4 paper, or around 250g/m^2. It is stronger and capable of withstanding about 700lbs (315kg) of load per inch width.

The material itself – comprising different fabrics of varying strengths and standards – was made by Warwick Mills in the USA from specifications developed by HAV.

Durham said: "We specified each one in terms of the material weaves, the laminate [and] the Mylar and Tedlar barriers before it was woven and laminated. We then used another company, ILC Dover, who make spacesuits among other things, to do the detail design, cut the individual pieces of fabric and to weld them together."

The fabric for the Airlander 50 will need to

FUTURE FLYING PLANS

HAV revealed to AIR International it plans to fly Airlander at the 2016 Farnborough International Airshow (FIA) after attending the show in a low-key capacity for the first time this summer. Chris Daniels, head of Partnerships and Communications at HAV, said: "We will be flying at Farnborough 2016 and I cannot imagine we'll be anything other than the star of the show.

"It will be amazing for the Airlander, for the aerospace industry and for the public who see her being put through her paces up close."

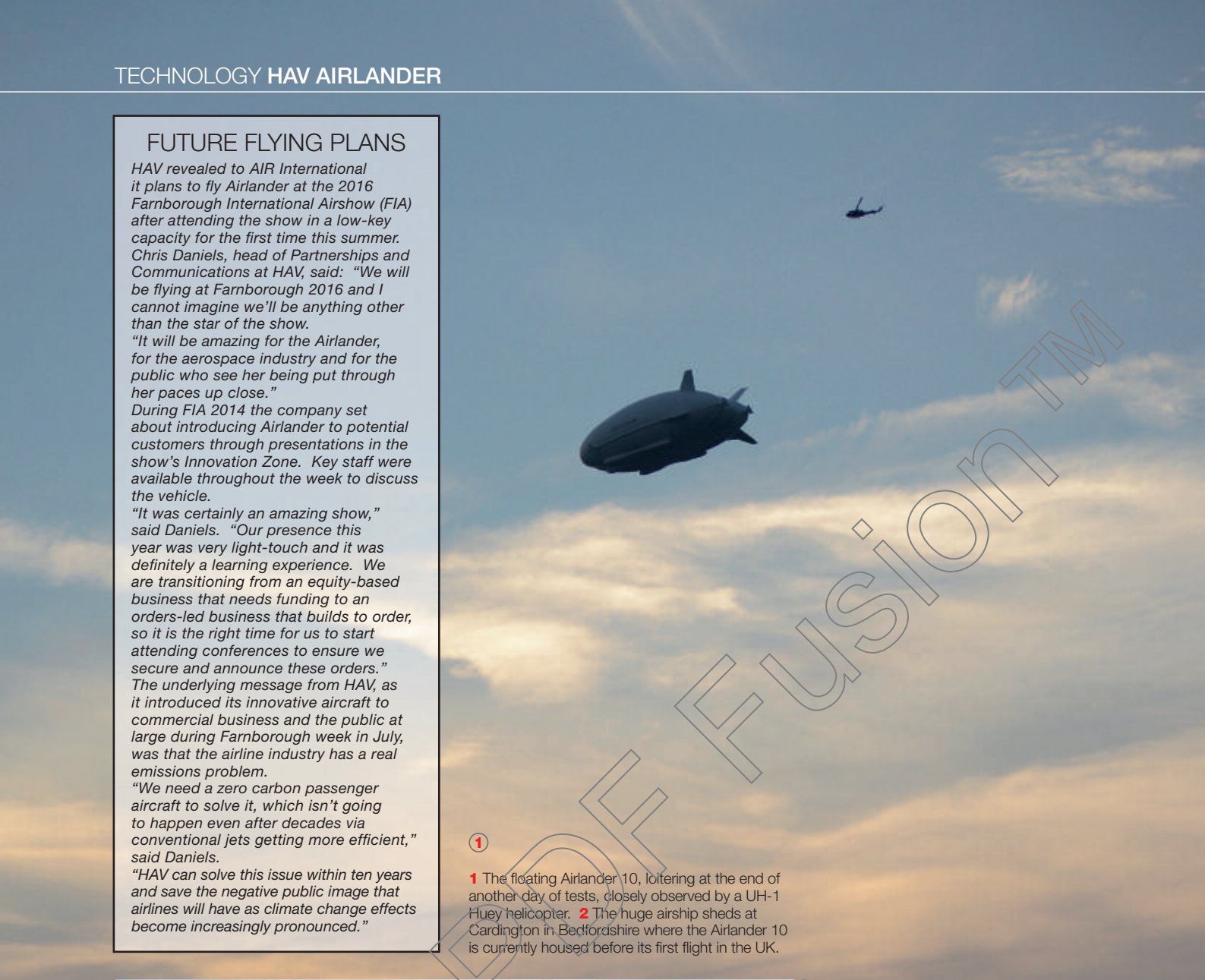
During FIA 2014 the company set about introducing Airlander to potential customers through presentations in the show's Innovation Zone. Key staff were available throughout the week to discuss the vehicle.

"It was certainly an amazing show," said Daniels. "Our presence this year was very light-touch and it was definitely a learning experience. We are transitioning from an equity-based business that needs funding to an orders-led business that builds to order, so it is the right time for us to start attending conferences to ensure we secure and announce these orders."

The underlying message from HAV, as it introduced its innovative aircraft to commercial business and the public at large during Farnborough week in July, was that the airline industry has a real emissions problem.

"We need a zero carbon passenger aircraft to solve it, which isn't going to happen even after decades via conventional jets getting more efficient," said Daniels.

"HAV can solve this issue within ten years and save the negative public image that airlines will have as climate change effects become increasingly pronounced."



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1 The floating Airlander 10, loitering at the end of another day of tests, closely observed by a UH-1 Huey helicopter. **2** The huge airship sheds at Cardington in Bedfordshire where the Airlander 10 is currently housed before its first flight in the UK.

be about 40% stronger so there is still more development work to do.

Ground Handling

The hybrid has a much better ground handling capability than an airship and HAV has been working hard to mitigate ground handling challenges. Only two pieces of ground handling equipment are needed for the Airlander 10: a 'chin mast' and a rear cradle.

The former plugs in underneath the front of the aircraft and allows it to 'weather vane' around the mast so it is always pointing into the wind and can withstand 80kts (148km/h) of ground wind.

The second piece of ground handling equipment is a small scissor lift called the castoring ground cradle, effectively a pair of temporary wheels which go under the back of the vehicle so the skids are not scuffed or damaged when attached to the mast.

There are two main configurations for the Airlander family: communications/surveillance and heavy lift. The former, which has optionally pressurised mission modules, offers up to five consecutive days aloft. The heavy lift option will offer a variety of configurations including 20, 50 and, ultimately, 200+ tonne payloads.

The project has already captured the imagination of aviation enthusiasts. HAV has set up an Airlander Club and is offering a competition, via its website (www.airlander.co.uk), to win two VIP tickets on the first passenger flight.