Building Behemoths

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When Thomas Brandt took over the helm as CEO of the Germany-based manufacturer of the Zeppelin NT airships, he made it his business to visit each airship player in the world. From small companies based in China to his Russian customers, Brandt finally made it to the United States to meet with his prime goal, Goodyear Tire & Rubber Company.

Founded in 1898, Goodyear is the airship industry elite with over 80 years in the business that has led to the production of more than 300 airships — it's been rumored that the company has even dabbled in the tire business from time to time. During his meeting with Goodyear, Brandt exchanged pleasantries and business cards, but no dotted line was signed.

According to Brandt, he achieved his objective with the mere seed that was planted. It took Goodyear two years to pick up the phone and discuss adding the Zepplin NT airships to its fleet, and in May 2011, Zeppelin Luftschinfftechnik landed its largest contract in company history. Goodyear ordered three new Zeppelin NT model LZ N07-101s (NT-101) for a staggering $20.6 million each.

The Zeppelin NT is the only type-certified airship with a rigid framework made out of aluminum longerons, thin strips of carbon fiber to which the skin of the aircraft is fastened, carbon fiber cross beams, and Kevlar cables that brace the internal structure.

The Zeppelins' three engines and gondola are mounted directly on the rigid internal structure to ensure that the NT offers a high level of safety and performance. With a length of 75 m and an envelope volume of 8,450 m3, the Zeppelin is the largest airship in the world today.

The envelope consists of three layers. The outer layer is Tedlar, a material that is resistant to ultraviolet radiation and typically used in demanding surface protection applications. The second layer is a polyester fabric that holds the helium loads, while a layer of polyurethane rounds out the envelope.

More Power

The airship is powered by three independent engines, two lateral and one rear engine, each with 200 hp and a swiveling propeller. The three engines combine to produce a maximum speed of 78 miles per hour with a typical cruising speed that tops out at 40 mph. The engines are mounted high above the gondola, so passengers only experience a low noise level. The positioning also accounts for the airship's high maneuverability.

Unlike anything in the industry, the airship's two lateral vectored thrust engines can be rotated 120º and combined with variable pitch propellers to give the pilot the ability to stop, hover, land, and climb vertically, much like the action of a helicopter. Bringing up the rear of the ship are two propellers that work off of one engine. One propeller provides lateral thrust, similar to a helicopter tail rotor, while the other propeller provides added hover capabilities.

In 1993, Zeppelin launched onto the airship scene with new technology that was safer to fly, and less expensive. The idea was to give the control of the airship back to the pilot. Airships normally operate at a low air speed, and with the old design, they were no longer controllable aerodynamically. The airships had to be landed into a ground crew that would essentially catch the descending ship. Takeoff operations provided similar hassles as the ground crew had to assist the pilot in a launching procedure similar to casting a boat or ship from shore.

Because Zeppelin wanted to give the piloting back to the pilot, the company installed the thrust vector control system that, with the use of the three engines, gave the pilot full control of the airship even at zero airspeed. Pilots now have full control over pitch and yaw, and they can also control their nautical (forward) speed with the thrusters.

The thrust engines are controlled with one of two joysticks that are mounted on either side of the cockpit, providing precise control of the propulsion system and the flight controls on the tail fins.

The new concept first flew in 1997, but then came the long process of type certification. A type certificate is awarded by aviation regulating bodies to aerospace manufacturers after it has been established that the particular design of a civil aircraft, engine, or propeller has fulfilled the regulating bodies' current prevailing airworthiness. Zeppelin achieved the type certificate in 2001, and has since built three airships that are current flying in the U.S., Germany, and the third is on its way back home after a stint wowing Japanese passengers.

According to Juergen Fecher, the head of the flight testing and flight physics department, three airships in a decade is a fair output. Fecher says that it is possible to put out an airship every year, but the typical lead time is 18 months. The first of the Goodyear fleet will fly in 2013 and feature an improved design.

A Lot of Small Items

Goodyear will assemble the airships in the U.S. with the help of Zeppelin. The NT-101 design may have been influenced in part by its partners overseas, but Fecher stresses that the airship is strictly the German company's design.

The new blimps will feature higher payloads, which will allow the addition of two passenger seats (bringing the maximum seating to 15), and an improved electrical power system that will power a day/night LED system for advertising on the side of the airships. The team will also work to increase the ship's range.

"The design improvements are a lot of small items," says Fecher. "We have improved some items so that the airship could also be used as a scientific platform, but this is something that you see more in Europe, not so much in the U.S. Goodyear will basically use the airships for advertising, therefore the LED system is more important."

The LED system is a massive display that stretches 1,300 m2 on one side of the airship and consists of thousands of color LEDs. A computer on the flight deck programs the movies, still pictures, or basic letters that are then displayed on the huge billboard.

Currently, the LEDs are so bright that the sign can be read in color and remain visible in the daylight.

Fecher and his team increased the payload by roughly 400 pounds, bringing the maximum gondola capacity to two tons, depending on the flight conditions. Fecher increased the payload by reducing the weight of the existing pod and by optimizing the envelope to get a bit more volume out of the airship.

"The total payload is a difficult number to tell, because the static lift that the airship provides depends on the altitude, the outside temperature, etc." Fecher notes.

Zeppelin was able to double the NT-101's range relatively easily by installing auxiliary fuel tanks into the gondola. With this modification, the airship has about 44 hours of endurance and extends its maximum range to 1,200 nautical miles.

"When I look back, the challenge was to design such a complex system. Airship experience is nothing that is hugely available in the world, there are not many manufacturers," adds Fecher. "We have a lot of innovative items in our airship like the fly-by-wire and the thrust vector control system. To get all of these working safely, and get the ship through certification were the biggest challenges."

The fly-by-wire system consists of the aforementioned joysticks in the cockpit and the electronic connections linking the pilot's control station with the rudders and engines. According to Fecher, it's a less complex, but similar system to those found on new Boeing and Airbus airplanes.

Testing & Quality Control

The certification process is laborious to say the least. With a significant portion of design work behind them, Zeppelin's team of 20 engineers is currently working to have every component checked, installed, inspected, and type-certified.

"I wish I could say that we have our napkins and we draw airplanes all day long, but that is not the case," Fecher says of the daily life of a design engineer. "Most of the day, we're making reports. Everything that we do here has to go through an intense review process. Every report has to be checked and proofed because it is normally part of the certification process."

Fecher's team uses a great deal of analysis software, from finite element analysis (FEA) and computational fluid dynamics (CFD)down to simple Microsoft Excel spreadsheets. His team uses FEA software to create the loads that occur during airship maneuvers and wind gusts. The load data set is converted to the finite element model and then calculated for stresses and fatigue.

The airship's shelf life is dependent on its care, but typically the first thing to go is the envelope, according to Fecher. The envelope has a minimum life of ten years, and the airship is designed for 25,000 flight hours, which roughly works out to 20 years.

Fecher relies on the simulation software to prove his calculations. The flight simulation then has to be validated through flight tests.

Among the other seats in the shop was Solidworks as Fecher's team's CAD software of choice.

“Working in the aerospace business is interesting for every engineer, especially when you get into the lighter than air or airship world,” Fecher says. “This is really a world where you do things that are not very common. If you want to invent things and procedures, and try new things, the airship world is the right place to be — that is, if you don’t care to go to outer space, which is still not possible with airships.”

According to Zeppelin’s CEO, it’s possible that airships will play a larger role in the transportation industry. If fuel prices go up sharply, and ecological requirements put more of a burden on airplanes in terms of fuel efficiency, some strategists have envisioned that airships will have a much bigger role in the next 20 to 30 years. Book your flights now, the view of the world is breathtaking from 1,000 feet, or so I hear.