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Allan McArtor
Chairman Airbus North America

When the Wright Brothers were designing their first successful flying machine a century ago, they realized its weight would be critical to being successful in lifting off the ground and taking man into the unknown world of flight. One of the heaviest parts of the plane was the engine. They realized they needed something lighter than cast iron to make the engine block, so they turned to a "new" metal, lighter than cast iron but strong enough to meet their needs. That new metal was aluminum produced by a company in Pennsylvania then known as the Pittsburgh Reduction Company… today's Alcoa.

Just six years later, when the Curtis Aerospace Corp. set a speed record of 47 miles per hour in an international flying competition in Rheims, France, tires from another well-known company, Goodrich, which has since evolved into a major supplier of aerospace systems, made its takeoff smoother.

It's no wonder then, that Airbus is drawing on the expertise of these two great companies, along with that of the premier machine-tool maker, Cincinnati Machine in Ohio, to help build the aircraft of the 21st Century – the 555-seat Airbus A380. The demands of flying machines have changed dramatically over the years since Wilbur and Orville, but one thing has not changed – the parts that go into them must be strong and light, as well as increasingly sophisticated.

While names like Goodrich, Alcoa and Cincinnati Machine may bring to mind images of muscle and power, these days another word should be added when considering their aerospace work – finesse. The machines that make complex metallic and composite parts require highly sophisticated engineering skills, as do the fasteners that tie composites to metallics and join the components of the landing gear that cushion the impact of a huge plane as it touches down on a concrete runway. The list is a long one.

The Airbus relationship with these great companies and their suppliers goes back many years and it was the mutual confidence and respect built up over those years that led to their role in this wonderful new flying machine, the Airbus A380.

T Allan McArtor

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AIRBUS

Experience + Cooperation = **Progress**

The 555-passenger Airbus A380 is the biggest aircraft of its type ever made, which means that it presents unusual demands on the engineers designing each of its systems, especially the plane's landing gear. At the 650-ton maximum take-off weight of an A380 freighter, the old phrase, "where the rubber meets the road," takes on a new meaning altogether.

"This is the largest gear we have ever made in terms of height and weight," said Steve Chalmers, VP & General Manager Airbus, Regional & Business, for Goodrich Corporation.

"Most people don't realize just how much technology is embedded in landing gear; the tolerances have to be within thousandths of an inch. This means some very fine cutting on some incredibly large pieces of steel and titanium. It is the equivalent of making a 14-foot long surgical instrument in terms of precision."

Like all elements of the A380, the initial challenge was to see if a system could be developed that could handle both the physical demands of a plane this size while using technology and materials that could save weight. With a landing gear system that includes two six-wheel gears on the body of the plane and two four-wheel gears on the wings, the Goodrich design team and their Airbus counterparts knew they had a system that could meet the very complicated equations for distributing the impact of loads both on the runway and on the aircraft itself. Each gear is designed to support aircraft mass of approximately 175 tons, or the equivalent of 150 compact cars.

◂ **Six-wheel main body landing gear bogeys for the A380 will stand 18-feet fully extended while four-wheel wing bogeys will stand 16 feet.**

But what about saving weight?

By incorporating high-strength titanium in the gear construction, the result is a system that meets rigorous demands for corrosion protection, fatigue and ease of maintenance while saving thousands of pounds.

Goodrich, based in Charlotte, North Carolina, is applying similar design skills to its development of the A380's systems for evacuation, power generation, ice detection, air data, flight control, cargo loading and lighting, among others.

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▾ **Cincinnati Machine** has led the way in developing the machinery that allows the use of advanced high-strength fibers in an efficient system of aircraft production. Its new Fiber Placement machines, for example, give Airbus the ability to vary the width of material allowing constant thickness on tapered shapes, the ability to utilize localized buildups and cutouts and the ability to steer or change ply angle **"on the fly"** as part of a continuous manufacturing process, among other advantages.

As Goodrich engineers were at work on their challenges, engineers at Alcoa were tackling others. An airplane is made up of millions of parts, parts that must carry enormous loads, stand up under the stress of buffeting winds and be durable. A nut and bolt from the garage doesn't quite do the trick, something the designers at Alcoa Fastener Systems New Product Development Center in Carson, California, understand well. Alcoa will provide about a million fasteners of varying types for each A380, but one of the most challenging to develop was the lockbolt that will tie together composite panels and aluminum cross members inside the huge A380 wing box. The A380's wings are each 119 feet from wing tip to fuselage and are designed to carry almost 41,000 gallons of fuel as well as housing landing gear.

"With its size and performance characteristics, the uniqueness of this aircraft had a great effect on design," says Bill Christopher, Executive Vice President of Pittsburgh, Pennsylvania-based Alcoa, whose products touch almost every part of the A380.

"In addition to meeting operational performance, however, the aircraft has to be affordable. All the operational efficiencies in the world won't mean anything if it costs too much. In addition to addressing the operational and acquisition costs of the A380, we also worked with Airbus to ensure that this new aircraft fits within the airlines' existing maintenance models and infrastructure requirements."

To meet the challenge of the A380 wing box, for example, Alcoa's engineers – working closely with the Airbus design team – developed a new part. The Extended Performance Lockbolt with a titanium collar is both strong enough to handle the wing's great size and compatible with the composite and aluminum materials it has to link.

"The challenge of building any aircraft, and especially one as new and exciting as the A380, is that it is the ultimate test of teamwork," said Noël Forgeard, Airbus Chief Executive Officer.

"No one group of people, no matter how bright they may be, can tap the levels of expertise necessary. That is why Airbus has developed a system where we turn to the top companies in the world for their expertise and then bring them deep into the design process.

I don't think we could have been as innovative as we have been over the years had we done it any other way."

High-tech safety systems from companies like Goodrich will contribute to the unprecendented protections available to all who board the A380 ►

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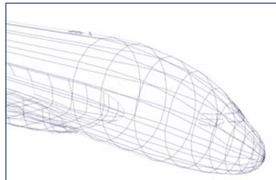

Design, however, is much more than computers and mathematical formulas. It also includes methodical and exhaustive testing to ensure that a part will do what it is intended to do over the many years and thousands of take-offs and landings of an aircraft's life span. Goodrich's test system for its landing gear is an example, combining specially developed software and many different types of tests including endurance, fatigue, and strength testing as well as the drop test.

"The drop test is conducted by putting a complete gear in a tower, putting the weight of the aircraft on top of gear, spinning the tires to the speed that is reached on the runway and finally dropping the gear from various heights at speeds of up to 12 feet per second," said Gerry Kouverianos, VP of Product Support and Engineering at Goodrich. This test allows hundreds of thousands of pieces of data to be captured within two tenths of a second. The majority of the testing of the mammoth gears will be conducted at a new 21,000 square-foot lab, the largest such facility ever constructed by Goodrich.

▴ **The A380's center wing box is the largest composite component in aviation history and for the first time, the rear fuselage section immediately behind the pressure bulkhead is also being produced using composites.**

And while Goodrich is doing its tests, Airbus is doing its own tests to check the impact on runways - an issue of critical importance not only to Airbus and airlines but also to airports where the A380 will operate – at its own specially constructed facility, underscoring how even the seemingly mundane takes on a new dimension with the A380.

Alcoa Fastening System's engineers developed the XPL® Lockbolt Fastening System to tie composite and metallic parts together in the A380 center wing box.

GOODRICH work for the A380 spreads across the US

The Airbus A380 is setting a new standard in aircraft design from its nose to wing-tips to its tail. In addition to the new landing gear, Goodrich, for example, also has developed new concepts in evacuation slide design that allow a full passenger load to exit the aircraft within 90 seconds in the event of an emergency.

Other Goodrich experts, meanwhile, have perfected systems that allow the introduction of much lighter-weight electronics systems in place of heavier hydraulics to power the movement of key aircraft parts. And at Alcoa, the largest forgings ever made for wing skins allow production of parts both lighter in weight and easier to assemble because of fewer parts.

Goodrich on the A380

Primary and Standby Air Data Systems
Primary Automatic Ice Detection System
Primary and Secondary Flight Control Systems
Variable Frequency Electrical Power System
Cargo Mechanical System
Body and Main Wing Landing Gear
Evacuation System
Pylon Aft Fairing and Rear Secondary Structure
Exterior Lighting
Flight Attendant Seating
Cockpit Observer Seating
Engine Components

ALCOA's technologies cover the A380