

# AS AIRCRAFT EVOLVE

# SO DO WHEELS AND BRAKES



Antavia image.

**James Careless**

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hen people marvel at modern aircraft, they tend to focus on major technological advances like carbon fiber

airframes/wings and fuel-sipping turbojet engines. But progress is also occurring in less obvious but equally important areas of today's flying machines — namely wheels and brakes.

## A Long List of Improvements

The Wright Flyer (the earliest successful powered aircraft) had neither wheels or

brakes. It landed on skids, and the pilot just hoped for the best.

Wheels for takeoff and landing emerged a few years later. They soon became standard equipment on World War I biplanes and beyond, growing in size and weight-bearing capability over time.

So did brakes. They evolved from the small brake shoes used on bicycles to larger, more robust drum brakes, and then disk brakes.

The power to activate these brakes originally came from hand-levered control cables. But this approach was only

adequate for small aircraft, which is why hydraulic braking systems using pressurized fluid and master cylinders came into being. (Some aircraft also use pneumatic braking systems.)

In the 21st century, "one of the latest developments in brake actuation has been the electric brake," said Alex Lara, director of Wheels & Brakes Service at AAR Corp. "Recently electric brakes have been introduced in the B787. Electric brakes are powered by the aircraft's electric system and this force is transferred to the heat sink through electromechanical actuators.



This new design considerably reduces the possibility of hydraulic fluid leakage and facilitates brake installation and maintenance.”

Like most MROs, AAR offers Cost per Landing, All-Inclusive Flat Rate repair and overhaul, and tire management programs. The company also provides spare wheel and brake inventory for its customers, so they don't have to invest in spares themselves.

“The arrival of electrical brakes on recent aircraft is probably the main new trend in this area,” said Ismaël Fadili, sales

and marketing director at France's Antavia AMETEK MRO.

“When it comes to wheels, the technology has been rather the same in recent years.” Antavia has two different shops for wheels and brakes located in France, and about 30 people dedicated to these products.

The basic concept underlying aircraft



*Ismaël Fadili  
Sales and Marketing Director,  
Antavia*

wheels and their brakes — robust rolling surfaces that support safe takeoffs and landings — has not

changed. But the structure of this technology is evolving, said Phil Randell, CEO of UK wheel/brake specialist firm World Aero. World Aero is a privately owned, independent aircraft wheel and brake MRO based close to London Gatwick



*Phil Randell  
CEO, World Aero*



World Aero's Randell says a key trend his company is seeing is the weight reduction of wheel and brake components. New materials and stronger wheel structures ensure that they are still robust in service, he adds. World Aero image.

Airport. Frequently supported aircraft types range in size from Learjet 45 to Boeing 747-8, with a constantly varied list of wheels and brakes being processed at any one time.

"As with most other components that make up aircraft, a key trend we are seeing at World Aero is the weight reduction of wheel and brake components," Randell said. "Whereas wheels used to be really heavy and almost indestructible, they often now look like something you'd expect to see on a race car! Everything is being pared down so we are seeing ever leaner, more delicate-looking equipment

on aircraft. Of course, new materials and stronger wheel structures ensure that they are still robust in service."

But every technological advance comes with some form of tradeoff. In the case of modern aircraft wheels and brakes, making them lighter means that they may have shorter lifespans compared with the heavy items of the past. "The efficiencies and fuel savings delivered by lighter-weight wheels and brakes tend to outweigh the additional costs of potentially higher rejection rates at overhaul," said Randell.

Offering better performance than older technologies, modern carbon brakes and

radial tires are also becoming common on everything from small commuter planes to long-haul aircraft.

"There are also ongoing retrofit programs for types such as the 737NG to replace steel brakes with carbon equipment, a process that requires the replacement of the main wheels too," Randell told *Aviation Maintenance* magazine. "The cost of the new components is high and the resale value of the old equipment is negligible. Still vendors are offering huge incentives for aircraft operators to refit their equipment, such as free wheels and brakes for an entire fleet."

Again, every improvement comes with a price. In this case, the repair cost of carbon brakes is considerably higher than steel types, which could be a deal-breaker for many cash-strapped aircraft operators. On the other hand, the operational lifespan of a carbon brake is "often three times that of a steel brake," said Randell. This much-longer lifespan translates into significant time and money savings on brake changes, plus reducing "the logistics of routing units to and from overhaul, spares holding levels, and administration," he said. An added bonus: Carbon brakes weigh less than steel brakes, so carrying them aloft reduces fuel burn and saves even more money for operators.

A final technological advance in this category is the use of boltless wheels. A boltless wheel relies on a lockring device that marries the wheel flange to the wheel base. This change allows the boltless wheel to have fewer parts and less weight than its conventional bolted counterpart.

According to World Aero's Randell, boltless wheels have made serious inroads into corporate aircraft, but not their larger cousins. "The only aircraft type of note to have done so recently is the huge Hercules C-130 transport aircraft," he said. To be specific, the U.S. Air Force upgraded its entire C-130 fleet to boltless wheels and carbon brakes in 2013.

## Trends in Wheel and Brake Service

In response to advances in aircraft wheel and brake technology, the specialist MROs that service them are making changes to their operating procedures. However, "many of our practices have remained the same over the years as there has been no major disruption in this technology," said Fadili. "This is why we are focused on how to be more productive using the automation of tasks such as wheel scans and automatic blasting machines."



One challenge the wheels and brakes sector has been experiencing is the talent shortage. Just as we discuss in the story on the helicopter mechanic shortage (see page 26), this deficit in human resources is being felt in all MRO sectors, including wheels and brakes. Looking for ways to encourage new technicians to enter the sector is crucial and needs to happen immediately, many say. Antavia image.



Wheels and brakes MROs, like all businesses in the pandemic era, have been learning to handle supply chain issues around the world and many have experienced logistical delays across the board. World Aero image.

This is also the case at FerroCrtalic, a Slovenian firm with 55 years' experience in removing paint for aircraft wheels (among other things, paint removal is required to allow wheels to be inspected for cracks

and other signs of wear).

"The process for cleaning modern painted wheels is the same for older models," said

Aljaz Molek, FerroCrtalic's sales manager

for special equipment. Nevertheless, FerroCrtalic has stayed abreast of the times when it comes to paint removal methods. Instead of using chemical processes, the company says it is providing the most advanced "plastic air blasting" method to remove paint using small plastic particles, thus eliminating the toxic substances associated with the chemical processes. And reusing the plastic is much more environmentally friendly. On top of that, the company also provides high-pressure waterjet paint removal, which is basically removal of paint using pure water at high pressure. The water can be recycled and used numerous times.

"As well, we are now deploying 'laser cleaning,'" Molek said. In this process, a laser beam is pulsed at a target using a high frequency (50 kHz to 1500 kHz). The short pulses create just enough energy within the wheel's surface for rust and paint to evaporate into plasma and burn off.

"Being new, laser cleaning is quite an expensive technology," said Molek. "But its price will come down over time,



The MRO sector for wheels and brakes is very established and key components are straightforward, says World Aero's Randell. Strength, reliability and ultimately safety have always been at the core of wheel and brake repair, so it's more about refining and honing practices, rather than big step-changes. World Aero image.

allowing more aircraft operators to take advantage of it."

World Aero is also focused on improving its wheel and brake maintenance processes. Echoing Fadili, Randell observed that "the MRO sector for wheels and brakes is very established and the key components are actually quite straightforward, so we don't tend to see a lot of new practices and innovation. Strength, reliability and ultimately safety have always been at the core of what we do, so it's more about refining and honing practices, rather than big step-changes."

Also like Antavia, World Aero is "continually streamlining processes to achieve better efficiencies and faster turnaround times," he said. "We will do whatever is needed to meet customer deadlines, often at little to no notice. It's this flexible, premium level service that keeps our customers loyal and sets us apart from our competitors."

One area where wheel and brake MROs are seeing change is in their customers' management of this maintenance process. "More and more airlines are steering away from maintenance and concentrating on

flying," Lara said. "As a result, airlines are looking for a one-stop shop when it comes to their wheels and brakes. They are seeking companies that can manage all the repairs and logistics associated with these components, including tires."

### COVID's Impact

Two years of the pandemic have had a significant effect on the wheel and brake industry, going right back to early 2020 when the world went sideways. But the impact on business has varied from sector to sector.

"As far as the commercial and regional sectors are concerned, Antavia has seen a volume decrease in line with the percentage of aircraft flying," said Fadili. "For the military and business jet sectors — with the exception of the first two-three months of the pandemic — activity has remained at a pre-COVID level."

"AAR did see a drop in commercial business, but at the same time we witnessed an increase in the cargo sector," Lara said. "Some customers have been deferring major repairs, due to the advantage of having excess spares,

as a result of their partially parked fleet. More recently, due to supply chain issues around the world, we have experienced logistical delays across the board. OEMs have increased their lead times on orders from 30 days to 60 and even 90 days. Freight forwarders have also reduced their services and increased or have added surcharges."

Decreases in customer business and supply chain challenges have affected the cash flow of MROs across the aviation industry. Uncertain as to when COVID-19 will finally recede and allow the volume of aircraft usage to return to pre-pandemic levels, these MROs are husbanding their financial resources carefully, and keeping expansion plans on the back burner.

A case in point: "As with many other organizations, many of World Aero's business development plans have been placed on hold during the pandemic," said Randell. "Our focus has very much been about protecting our team, supporting our customers and weathering the storm. Flexibility, preparation and the right skill set are the crucial factors we've been focusing on to ensure World Aero is

in the best position to react accordingly to our customers' needs as we move forward."

"Some of our customers have not been able to weather the pandemic," said FerroCrtalic's Molek. "But we are getting the feeling that business is starting to pick up, and that the aviation industry's future is looking better for all of us."

## Looking Ahead

Whether or not COVID-19 is in the rearview mirror, the wheel and brake industry is looking ahead to the future and making plans to profit from it.

At Antavia AMETEK MRO, they see "staying the course" as their best business strategy.

"As there are no major new aircraft programs scheduled for the next few years, there are no major new technologies arising," Fadili said. "Nevertheless, we could see some improvements in line with addressing environmental concerns, such as new painting or surface treatments."

FerroCrtalic is pursuing a similar approach. "We have been working during COVID to be prepared when the industry picks up," said Molek. "We want to be ready to ramp up with what we have when this happens."

AAR and World Aero are taking a longer view of the future and what's coming.

"The wheel and brake industry will continue to grow as orders for new aircraft increase: Airlines are retiring their older wide-body aircraft and replacing them with newer more efficient narrow bodies," AAR's Lara predicted. "Electric brake technology will continue to be the trend, along with the introduction of lighter and stronger materials. Additionally, carbon will become more efficient and reliable as OEMs compete and continue to improve their products. On the wheel side, besides lighter and stronger materials, I believe the two-piece lock ring design wheels will continue to evolve and become the next generation of aircraft wheels. This design eliminates the need for tie bolts, thus reducing cost and maintenance."

World Aero's Randell agreed with Lara's upbeat assessment. He also expects to see "an increased focus on IT to streamline the processing of units through workshops, utilizing barcodes, scanners and other technologies."

But there is a cloud on the wheel and brake industry horizon: "A challenge that is going to increase further for the



Shown here, A320 brakes at World Aero. World Aero image.

whole of the MRO sector is a lack of new talent entering the market," said Randell. "We are seeing fewer young people interested in joining the industry, which in turn will lead to a skills shortage as the established, older workforce retires," he explained. "At World Aero we work hard to promote opportunities, career progression and on-the-job training to attract the next generation of engineers. But it's still not easy to find candidates of the right caliber, a problem that has been made even harder by COVID. This is a real worry for the sector — and something we all need to be addressing now."

The bottom line: The aviation wheel and brake industry is evolving to keep up with new technologies, while maintaining tried-and-true processes that work as well in this century as they did in the last one. **AVM**