COMPOSITES
DAWN OF A NEW ERA

COMPOSITES HAVE MADE THEIR WAY INTO THE AEROSPACE INDUSTRY IN A BIG WAY IN RECENT DECADES. AS TECHNOLOGICAL ADVANCES EXPAND THEIR REACH, AIRCRAFT MANUFACTURERS CONTINUE TO SEEK OUT CUTTING-EDGE MATERIALS TO PRODUCE MORE EFFICIENT FLYING MACHINES. WILL COMPOSITES CONTINUE ITS RISE UNABATED AND WHAT ARE THE IMPLICATIONS FOR AFTERMARKET PLAYERS?

The concept of composites has existed for several millennia. As early as 3,000 B.C., ancient Egyptians mixed straw with mud in order to create stronger bricks that don't crack with shrinkage in the arid climate. Cartonnage from papyrus were also used to make mummy cases. This ancient approach remains relevant in the manufacturing of tubular shells with composites today. Instead of paper, complex materials such as fibre-reinforced polymers, ceramic matrix composites and metal matrix composites are used to manufacture both structures and components in defence, wind, and automotive industries.

DEVELOPMENT OF COMPOSITES IN AEROSPACE

Historically, the defence and space sectors were the first to accept the application of composites. In the late 1970s and early 1980s, the National Aeronautics and Space Administration (NASA) challenged large-transport manufacturers to use graphite material to redesign existing aircraft components. As part of this, Boeing developed graphite and epoxy horizontal stabilizers for its 737, which were put into commercial service in 1984. This led to increased confidence in, and acceptance of, composites for primary aircraft structure.

As fuel costs continued to increase and hit US$140 a barrel in mid-2008, commercial flying came under sustained pressure to improve performance. The advantages offered by composites – weight reduction, mechanical strength and thermal chemical stability – increased its appeal for application into commercial air transport. Aerospace manufacturers began to move away from using honeycomb composite structures — which are lightweight but prone to having strength-reducing voids within the material — to solid, three-dimensional composites structures. These were made using new production processes which increase tension, compression, impact and shear strength while making structures as much as 50 percent lighter than titanium or aluminium alloys. The industry widely adopted carbon fibre reinforced plastics (CFRPs) as its composite material of choice for airframe structures, engine nacelles and fan casings, floorboards and interior parts.

TOP:
The A350XWB boasts more than 50 percent composites with composites now spaning entire wing structures, fuselage and airframes.

Since 2005, civil aircraft have dramatically increased their composite content. The Boeing 777, which was first introduced in 1994, comprised 12 percent composites by weight. In comparison, the Boeing 787 Dreamliner is approximately 50 percent (by weight) composites. Airbus has also steadily increased its usage of composites over the years. While the A380 had about 25 percent composites content, the A350XWB boasts more than 50 percent of composites. The application of composites in aircraft now spans entire wing structures, fuselage and also airframes.

> **"A RECENT STUDY PROJECTED THAT THE GLOBAL AEROSPACE COMPOSITES MARKET WILL REACH US$32.35 BILLION BY 2021."**

A recent study by Research and Markets projected that the global aerospace composites market will

reach US$32.35 billion by 2021, at a compounded annual growth rate of 8.95 percent from 2016 to 2021. The carbon fibre segment is anticipated to lead the aerospace composite market in 2021 with a share of around 50 percent, followed by glass fibre and aramid fibre.

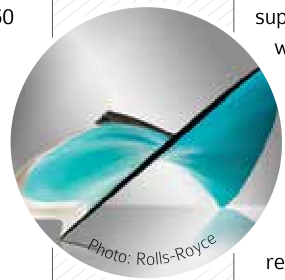
GROWTH AND INVESTMENTS IN COMPOSITE BUSINESSES

As new materials and manufacturing processes are developed, the use of composite materials in prototyping, component, engine and airframe manufacturing looks to be a new norm. Materials such as S-glass and carbon-reinforced thermosets and thermoplastics are set to grow in a diverse suite of interior applications. Aircraft manufacturers and OEMs are also demonstrating their commitment to the Research and Technology of composites, pumping in resources to develop new technologies and competencies in advanced materials and its application.

In October 2016, Hexcel Corporation, one of the largest producers of carbon fibre and manufacturers of advanced composites aircraft structures, announced the amendment of two key contracts to supply advanced composites to Airbus Group, generating total sales of US$15 billion. The contract includes the supply of materials for the A350XWB secondary structures and the A350 family up to year 2030. Hexcel also celebrated the opening of a new US$10 million Innovation Centre in Duxford, UK in May 2016, to house the company's research into resin systems and adhesives. Interest in advanced composites for aerospace and the contracts it had won made Hexcel one of the most notable companies on Wall Street in 2016.

Rolls-Royce also recently announced its US$30 million expansion into a new 5,760 square metre facility in Southern California that will be dedicated to research and development of ceramic matrix composite (CMC) materials and processes for use in next generation aircraft engine components. In May 2013 Rolls-Royce acquired Hyper-Therm High-Temperature Composites, and announced its plans to grow and invest in a 'CMC technology hub' in Cypress, California. "The development of lighter, stronger, composite fibre components is just part of our commitment to continuously improve the performance of our products by focusing on lowering fuel consumption, emissions and noise. The team here in Cypress will be dedicated to seeing the commercial application of these technologies that will soon be adopted into advanced manufacturing production methods for gas turbine components," said Rolls-Royce President and CEO of North America, Marion Blakey.

BELOW: **Meggit Aircraft Braking Systems.**



ABOVE: **Rolls-Royce plans to grow and invest in a 'CMC technology hub'.**

BELOW: **S-Glass, Carbon Composite Fibre Patch.**

UK-based Meggitt group, too, has made great investments into composites. Meggitt Aircraft Braking Systems recently expanded its carbon brake manufacturing capacity in Danville, Kentucky with three new production furnaces and related support machines. The expansion was intended to meet current and future demand, including components for the Canadian Bombardier C-Series aircraft and Gulfstream 650 business jet. Meggitt Polymers & Composites (MPC) also recently relocated and expanded its facility in San Diego, coinciding with the ramp-up of the F-35 combat fighter aircraft programme for which Meggitt manufactures engine components and other structures. The larger facility includes capacity for expansion into the high-growth market of composite components for commercial aircraft. Meggitt's focus into advancing its composites capability is also evident with its acquisition of Cobham PLC and the composites components arm of EDAC at the end of 2015.

PROJECTING THE TREND FOR COMPOSITES IN AEROSPACE

Though it has seen strong growth and interest in the recent decades, the trajectory for advanced composites in the next decade and the longer term is less certain.

While aircraft manufacturers are keen to improve aircraft performance, cost remains a factor in the reality of a gloomy business environment. Investments made in technologies must be realised within a short amortization period. This will be difficult for composites due to required modifications in work flow, jigs, tools and new manufacturing processes. The projected weakening of the global economy and relative low fuel costs is also expected to dampen demand for new generation aircraft as airlines rebalance their portfolios toward aircraft currently in operation. In short, the cost to develop and implement new composites technologies on upcoming aircraft will have to be much lower than what was demonstrated with recent models for it to take flight.

Growth driven demand by LCCs and regional airlines for narrow body aircraft also does not look to contribute positively to the composites market. Reservations about the practicality of composites for narrow-body primary fuselage structures persist, which might limit composites to wing and tail assemblies. Another challenge in narrow-body aircraft is the high manufacturing rates, which is estimated at 40 to 60 per month, as opposed to 10 to 15 for twin-aisle aircraft. Suppliers like Hexcel must be able to respond with adequate production capacity – increasing the lay-down rate and significantly reducing time required for the cure cycle – in order to deliver a dependable supply chain.

TOP: Rolls-Royce announced its expasion into research and development of ceramic matrix composite materials in next generation aircraft engine components.

BELOW: The Boeing 787 Dreamliner is approximately 50 percent (by weight) composites.

The increased application of composites in aerospace has also brought concern and changes in the Maintenance, Repair and Overhaul (MRO) industry. Now that new generation aircraft have come into service, a very steep learning curve is expected of the MRO industry so adept and practised at working with metal. Yet, an unsettling amount of ambiguity remains regarding the behaviour of airplane composite structures, damage tolerance and the nuances of advanced material repair. These issues are compounded by lack of standardisation regarding certification, repair techniques, and knowledge gaps in vital areas of inspection and non-destructive testing.

Recognising the essentiality of education and training, Boeing Flight Services in Singapore has launched a composites workshop, readying operators and repair facilities as composites become more widely accepted in the aerospace industry. Originally opened to cater to the demand of 787 composite training, it is the only such workshop in the Asia-Pacific region for the Boeing Co., with two others located in Miami. The training entails teaching Boeing operators and repair facilities how to perform repairs according to Boeing Structural Repair Manual procedures. Since opening its new campus in February last year, Boeing has trained nearly 300 students from 14 customers.

Aerospace training institutes such as the Air Transport Training College and tertiary institutions such as Temasek Polytechnic and ITE College Central have also begun offering practical training courses in advanced composites maintenance and repair. As part of the Skills Future framework, such courses would allow airframe mechanics, experienced structural technicians and maintenance personnel to upgrade their skills and perform inspection, evaluate damage, and apply repair techniques to restore damages to composite structure components.

As resources continue to be being pumped into R&T for advanced composites and manufacturers integrate new materials into next generation aircraft, the landscape of the aviation industry is set to change. To stay ahead of the curve, the aerospace community must work to quickly acquire the technical information needed to perform the repairs on a large scale. This will involve not only investments in new equipment and new technologies but entirely new training regimes. Most importantly is the readiness to assent to a new mindset and the agility to offer flexible service to fulfil the increasing demand of its airline customers.