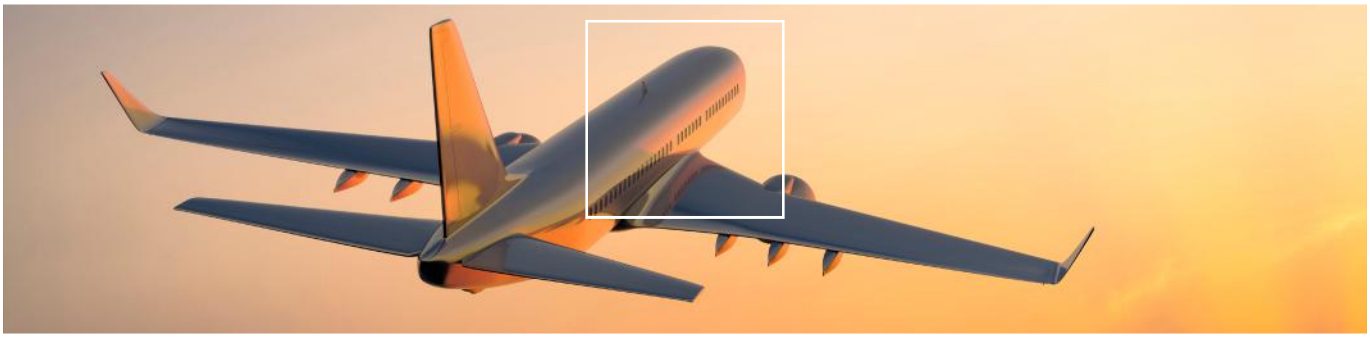
Arthur D Little

Viewpoint

What's next for aerospace composites?

Perspective on current trends in the aerospace composite components market



When the Boeing 787 Dreamliner and Airbus A350 XWB were developed almost a decade ago, they promised a new level of profitability for airlines and huge growth potential for the composites industry. Now that the early struggles are over, composite planes are taking to the skies. Today, the airspace composite components (ACC) market represents the largest demand for composites, even though supply chain struggles are still shaking the industry. Manufacturers are looking for the next growth area, and they may have found it: engines and interiors. Arthur D. Little has investigated current trends and challenges within the global ACC market.

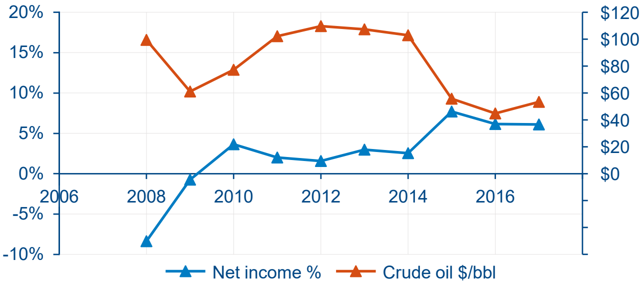
Profitability story for airlines through composites

The airline industry has long been known for generating a low combined net income margin, at around 2–3 percent. When Boeing introduced the 787 Dreamliner at the beginning of the 21st century, it sold the idea of a profitable airline. The key selling proposition of this new composite long-range, wide-body aircraft was a lightweight structure that was made of more than 50 percent composites and offered 20 percent fuel savings over the 767. The second composite plane, Airbus A350 XWB, followed not long after, with a similar level of composite content and promises.

As observed from the chart below, profitability of airlines is strongly correlated with fuel costs, and OEMs bet the success of their composite planes on it. Ultimately, composite planes were a success and proved that going forward, the aerospace sector would be a key demand industry for lightweight materials.

Global airline profitability vs. oil prices

Average profitability of publicly listed airline companies with revenues over $100m



Source: Arthur D. Little

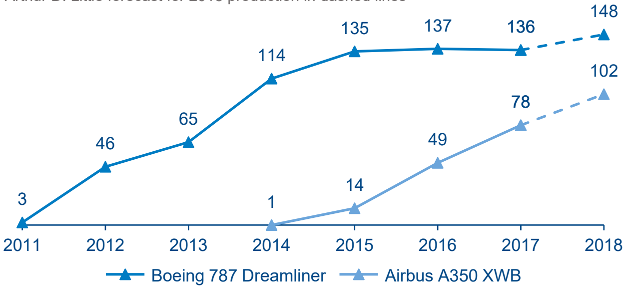
Aerospace, the most developed composites market

The aerospace market's main differentiators from other composite component markets such as automotive are its maturity (composites have been used on aircraft since the 1960s), and resilience (due to steady demand, long-lasting programs and challenging qualification processes that secure the market share of well-established suppliers).

Aerospace programs last more than 20 years once developed. For example, the 737 was first developed in 1967, and the 10,000th unit was rolled out of its Renton, Washington factory in March 2018. Securing a part in any program can provide a demand security for composite part makers that allows them to invest in their production capabilities.

Deliveries of Boeing 787 Dreamliner and Airbus A350 XWB

Arthur D. Little forecast for 2018 production in dashed lines



Source: Arthur D. Little

Another key consideration for the maturity of the market is the long, expensive and challenging qualification processes conducted by OEMs, industry organizations and accreditation agencies. These processes last several years, and both raw material suppliers and component manufacturers need to pass them to be able to sell their products. These processes also drive the cost of aerospace composite materials up to six times their industrial equivalents.

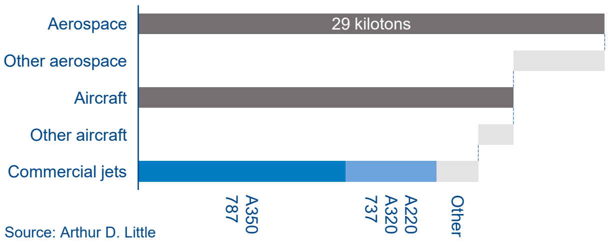
A sizable market with steady inherent growth

Today, the aerospace sector is the single-largest source of demand for composite component manufacturers. According to Arthur D. Little's market study, it makes up close to 60 percent of global carbon fiber demand by value. Aerospace is also a steadily growing market, with an expected 7 percent CAGR over the next five years. Within the aerospace market, demand for composites for aircraft components is four times larger than for the rest of the segments combined: rotorcraft, spacecraft and defense (missiles and unmanned aerial vehicles). Commercial jets are the key driver of this demand, and make up 90 percent of composite components in the aircraft segment.

As of 2018, the A350 and 787 make up the vast majority of the composites demand in commercial jet airframe systems, with A320 and 737 programs following at a much smaller scale. Access to these programs is crucial for any composite component manufacturer to achieve critical size.

Commercial jet composite components market share breakdown

Composite components in commercial jet airframe systems by volume in 2018



Source: Arthur D. Little

ACC market growth appears strongly dependent on production ramp-up of major programs

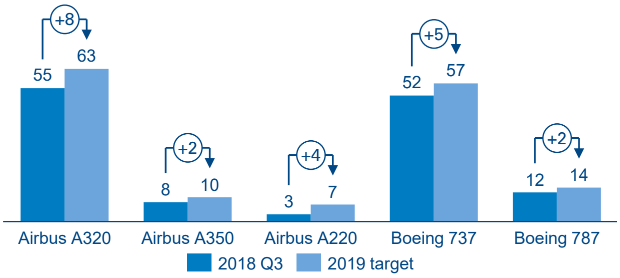
Two main drivers of ACC market growth are composite content in aircraft and aircraft production, both of which are increasing.

Average composite content in new aircraft airframes is estimated to have increased from 7 percent of total empty weight in 2010 to 13 percent in 2018. This ratio has almost doubled since composite commercial jets were introduced, but Arthur D. Little expects no new commercial composite planes to enter the market in the next five years. However, legacy programs with fewer composite components are also ramping-up, therefore this ratio is expected to increase only slightly in the next five years.

Airbus and Boeing are both eager to increase the production rates of their composite planes (which are far below production rates of their cash cows: the A320 and 737). Airbus is still ramping up the production of the A350 to reach its target of 10 per month. Resolving some quality issues in aircraft interiors will get Airbus to its target in 2019. Boeing also announced in 3Q 2018 that it planned to increase its 787 production rate from 12 to 14 per month in 2019.

Planned increase in the production rates of leading programs

Aircraft production per month



Source: Arthur D. Little

Supply chain issues push towards insourcing

During the development of the 787 Dreamliner, Boeing handed off 80 percent of component development and manufacturing responsibility to its suppliers. Its aim was to make use of the supplier's expertise and spread the development costs. This led to a global supply chain made up of players from 26 different countries, most notably the US, Canada, the UK, Germany, France, the Netherlands, Sweden and Japan.

Outsourcing initially led to decreased production costs for Boeing; however, the reliability of the supply chain plummeted. Boeing faced huge issues at every step of development. Early models of the plane had to be built several times. The carbon fiber frame turned out too weak to support the wings, so it had to be reinforced. Even after it was completed, problems emerged during tests. The first plane was eventually delivered three years later than initially planned.

Supplier issues keep haunting Airbus and Boeing. In September 2018, there were 60 737s piled up in front of Boeing's Renton facility due to missing engines. 787s were stacking up in front of its North Charleston, South Carolina site around the same time due to missing seats and engines. Airbus A220 and A350 programs were also hit due to reliability issues regarding interior parts from Zodiac Aerospace. At one time, 10 A350s were parked in front of the Toulouse, France site waiting for lavatories.

Boeing has suffered from its accelerated effort to outsource in the past decade; therefore, it is turning away from further outsourcing in its upcoming programs. For example, Boeing's new 777X will have new composite wings similar to those of the 787. The 787's wings are made in Japan by Mitsubishi. However, the 777X's wings will be manufactured in Boeing's new $1b wing factory in Everett, Washington.

GE is insourcing strategic composite parts

Aeroengine manufacturer GE Aviation is also increasing insourcing. However, its motives are different from those of Boeing. GE announced a new direction in mid-2018, to focus on its aviation, power and renewable energy business units. The company is gradually divesting other business units such as transportation, oil & gas, and healthcare. As a result, GE's portfolio will be simplified and the balance sheet will be stronger.

GE's new strategy is to focus on turbines, and as part of this, it is focusing on strategic investments that will benefit all three focus areas and give the company a competitive edge. One strong example is the insourcing of composite components manufacturing, and in the case of ceramic matrix composites (CMCs), the vertical integration of the entire value chain.

Composite usage in aeroengines has been increasing with every new generation of turbofan engines. For example, GE Aviation has been developing composites for a long time. Recently, its GEnx, LEAP (CFM) and GE9X engines have made extensive use of composites. Historically, composites have been more commonly used in the cold sections of engines; however, manufacturers have also started using composites in the hot sections. For example, GE manufactures high-pressure compressor turbine shrouds out of CMCs. Rolls Royce has also started testing composite fan blades and CMC turbine shrouds for its next-generation engines.

In 2012, GE formed a joint venture with Safran and Nippon Carbon, called NGS Advanced Fibers, to produce ceramic fiber and matrix and turn it into CMC tape that could be used to manufacture CMC components in its facility in Asheville, North Carolina. This facility manufactures turbine shrouds that are installed in GE's latest-generation engines. The company also licensed this CMC technology from NGS and invested $200m into two factories in Alabama. One manufactures SiC fiber and other makes SiC tape to be sold to GE, Safran and the US Department of Defense. GE has integrated the CMC value chain, and believes efficiencies created through the increased use of CMCs will define the future of aeroengines.

Vertical integration leads to increased margins

ACC value chain is dominated by large, integrated suppliers on one end and oligopolistic OEMs on the other. Component manufacturers are smaller and numerous, and recently, many of them were acquired by players from either side of the value chain.

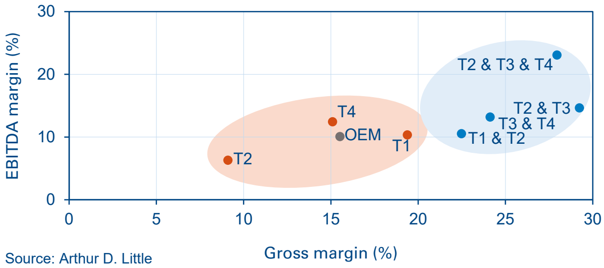
Suppliers in the market are large players such as Toray, Hexcel and Solvay, which produce fiber and resin. They are often both horizontally and vertically integrated. In recent years, they also conducted inorganic moves to integrate towards intermediates. Examples include Teijin's acquisition of Toho Tenax, Hexcel's acquisition of Structil and Toray's acquisition of TenCate. This is appealing for several reasons: access to additional profit pools, developing the demand for the supplier's product, and becoming a one-stop shop for component manufacturers.

Suppliers are also integrating towards the component manufacturing business. Component manufacturers are small and numerous because capital requirements to start manufacturing components are not too high. Examples of this type of move are the acquisition of Harris Aero by Albany Engineered Composites and the automotive component manufacturers acquired by Toray and Mitsubishi Chemical. Another example of an integration move from a supplier is Aerospace Composites Malaysia, the joint venture between Hexcel and Boeing.

Tier 4: Raw materials	Tier 3: Intermediates	Tier 2: Components	Tier 1: Systems	OEMs

Profitability comparison of composites players along the value chain

Selection of 30 companies with profitable operations (% of sales)



Source: Arthur D. Little

Component manufacturers are more often sought out by large and consolidated system manufacturers, and even OEMs. There are numerous examples, including Safran's acquisition of Zodiac, GKN's acquisition of Fokker, AVIC's acquisition of FACC, and SAAB's acquisition of Applied Composites. Most common reason for system manufacturers to vertically integrate is to have wider control over their supply chains.

Private equity firms also see an opportunity in acquiring smaller component manufacturers and merging them to create sizable players. Examples include Applied Composites, owned by AE Industrial Partners; AIM Aerospace, owned by Liberty Hall Capital; and Unitech Aerospace, owned by Acorn and Edgewater.

These all demonstrate the attractiveness of the ACC market. However, there should be no new composite airframe in the next five years. Where will the growth come from?

Where is the growth for aerospace composites?

According to aircraft experts, composite components in the airframe are close to reaching a glass ceiling, with the current levels of around 50 percent of the airframe by weight. Production of airframes will ramp-up; however, no new composite airframe is expected in the next five years. Therefore, composites will look for growth in propulsion systems and aircraft interiors.

Latest-generation engines prove that the turbofan engine is the next natural growth area for composite components. Currently, in the most generous cases, composites make up around 35 percent of the empty weight of these engines.

Carbon composite components were traditionally used in the cold sections, and use cases have developed inwards towards the hot sections. Nacelles were the first group of components to be switched to carbon composites, followed by fan blades.

On the other hand, CMCs have proved capable of performing extremely well in the hot sections of the engine. CMC parts can operate without burning at the combustion temperature of aircraft engines, which is 1,500°C. Metals, which are traditionally used in these parts, start to melt at 1,300°C. Reducing the cooling requirement of the engine allows the air to be directed inside the engine to increase efficiency. Additionally, these CMC parts weigh one-third of a similar-purpose metal component.

In the GE9X engine, the combustor, shrouds, blades and nozzles are made out of CMCs. This engine will be used in the Boeing 777X, and it is 10 percent more efficient than the GE90 engine used in the 777. According to GE, two percent increase in fuel efficiency is directly attributable to CMC components.

Aircraft interiors can provide another good opportunity for composite component manufacturers. According to aircraft maintenance experts, operators replace seats every four or five years on average, and entire aircraft interiors every eight or nine years. Glass-fiber composite components are already used in some parts such as side walls, overhead bins, galleys and seat enclosure. However, stronger materials are required to replace the aluminum used in the seat structures due to safety regulations.

Currently, black metal replacements have started to be used, such as carbon-fiber replacements of the aluminum seat plates. However, for composites to obtain a significant market share in the seat structure, design of these seats needs to be reconsidered. Some innovative players, such as Zodiac and Hexcel, are cooperating to develop composite seat designs.

Conclusion

Aerospace composite components currently are and will remain an attractive market, thanks to the reliable underlying demand created by composite planes, A350 and 787. New growth opportunities for composite materials are developing, especially in the hot sections of turbofan engines and in aircraft interiors, such as the seat structure.

Composite component manufacturers should invest in being a reliable part of the supply chain they are in, and continue to innovate. Innovative players will create new composite materials and designs that ensure the growth of the aerospace composite components market.

Vertical consolidation, OEM (re)insourcing, and private equity appetite all have the power to transform the value chain structure moving forward; however, players will need to decide the best moves to ensure that they stay ahead in the innovation race and capture the growth opportunities.

Contacts

Austria
taga.karim@adlittle.com

Belgium
baes.kurt@adlittle.com

China
pell.russell@adlittle.com

Czech Republic
brabec.dean@adlittle.com

France
knab.delphine@adlittle.com

Germany
schmitz.klaus@adlittle.com

India
srinivasan.srini@adlittle.com

Italy
agresti.giancarlo@adlittle.com

Japan
suzuki.hiroto@adlittle.com

Korea
lee.kevin@adlittle.com

Latin America
guzman.rodolfo@adlittle.com

Middle East
kuruvilla.thomas@adlittle.com

The Netherlands
eikelenboom.martijn@adlittle.com

Norway
thurmann-moe.lars@adlittle.com

Russia
ovanesov.alexander@adlittle.com

Singapore
ito.yuma@adlittle.com

Spain
colon.cristobal@adlittle.com

Sweden
brundin.niklas@adlittle.com

Switzerland
schlosser.andreas@adlittle.com

Turkey
baban.coskun@adlittle.com

UK
eagar.richard@adlittle.com

USA
beaumont.mitch@adlittle.com

Authors

Delphine Knab, Samih Coskun Baban, Dr. Andreas Schlosser, Dr. Philipp Seidel, Can Lök, Thomas Knoblinger

Arthur D. Little

Arthur D. Little has been at the forefront of innovation since 1886. We are an acknowledged thought leader in linking strategy, innovation and transformation in technology-intensive and converging industries. We navigate our clients through changing business ecosystems to uncover new growth opportunities. We enable our clients to build innovation capabilities and transform their organizations.

Our consultants have strong practical industry experience combined with excellent knowledge of key trends and dynamics. ADL is present in the most important business centers around the world. We are proud to serve most of the Fortune 1000 companies, in addition to other leading firms and public sector organizations.

For further information please visit **www.adlittle.com** or **www.adl.com**.

www.adl.com/AeroComp