

CHALLENGES FOR EUROPEAN AEROSPACE SUPPLIERS



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INTRODUCTION

Airlines around the world are ordering new planes and demanding new technology. As a result, the global aerospace industry is growing and aerospace suppliers must become more innovative and flexible to keep up.

The industry faces three main challenges in the next decade, according to a study conducted by Oliver Wyman of the European aerospace industry. Suppliers must:

- Design and develop more complex parts and systems, with higher technology content, shorter lead times, and at a competitive cost
- Extend their supply chain footprint to emerging markets
- Upgrade production capabilities and share more financial and operational risks with original equipment manufacturers

These challenges will have a direct impact on supply chain management, which thus must become more robust and agile.

They also come at a time when the industry must deal with a number of exogenous issues. Market demand is growing continuously for both original equipment and spare parts, while airlines are asking for increasing diversity in aircraft models. The industry faces new competition from emerging countries, OEMs are creating an international supply base, and regulators are writing stronger environmental and noise rules for aircraft.

Oliver Wyman interviewed 40 European senior aerospace executives at original equipment manufacturers and Tier 1 and Tier 2 suppliers. This study highlights major trends we uncovered and how aerospace suppliers can react to generate profitable and long-term sustainable growth.

MANAGING GROWTH AND NEW CHALLENGES

Nine out of ten executives interviewed for this study are optimistic or very optimistic about market evolution and demand growth in the commercial aerospace sector. That's no surprise.

During the past 10 years, demand for commercial aircraft has been gradually expanding, due to continuous global growth in demand for passenger and cargo transport, particularly by air. The BRIC countries, Brazil, Russia, India, and China, are seeing huge demand for planes as a result of increasing population and wealth, and transport in the Middle East is also growing, as the region aims to become a hub for air transport. Aircraft manufacturer forecasts suggest that global demand for new aircraft in the next 20 years will reach around 36,800 units, which is 20 percent more than during the 1993 to 2013 period. Only around 14,700 of the new aircraft will replace existing planes; the rest will be needed for traffic growth.

Current large commercial aircraft programs are meeting this demand. For example, by December 2014, orders for the Airbus A320neo had neared 2,700. Existing programs at Airbus and Boeing are expected to last until 2030, ensuring strong market demand and a high throughput rate for the supply chain. For example, the production rate for the A320 and the Boeing 737 reached 40 aircraft a month in 2013 (Exhibit 1).

As Airbus and Boeing deliver current models, the development of new aircraft is expected to slow down. Enhancements like those developed for the 737NG or A320neo will be

rolled out to other aircraft to improve costs and reduce environmental impacts with less development complexity than would be the case for new model designs.

New programs are now largely coming from niche competitors, such as Bombardier, Embraer, and Mitsubishi, and new entrants, such as Sukhoi Irkut and COMAC. These programs offer a different value proposition to supply chain partners, with higher-value content and lower-volume contracts.

As these programs grow, new challenges will emerge for the supply chain. Suppliers will need time to develop new concepts, recruit and retain engineers and production staff, ensure production quality and meet delivery deadlines, and define the appropriate manufacturing organizations and supply chains to satisfy aftermarket demand.

Other external factors also will impact the supply chain as demand grows. First, OEMs tend to extend their footprint only to chase new growth opportunities, to rebalance euro and dollar exposure, or to comply with offset requirements. In these cases, manufacturers may require suppliers to stay close and to adapt their own supplier network to new geographies. Second, environmental regulations and rising fuel prices have pushed OEMs and suppliers to develop lighter and less costly products. Third, facing major project delays and greater pressure from their clients, OEMs are seeking to share financial risks with their suppliers. This means that suppliers must develop robust in-house legal capabilities to deal with OEMs.

Finally, OEMs increasingly try to cut costs by rationalizing their supplier base. This puts strong pressure on suppliers to remain competitive so that they are not ejected.

EUROPEAN AEROSPACE SUPPLIERS' CHALLENGES

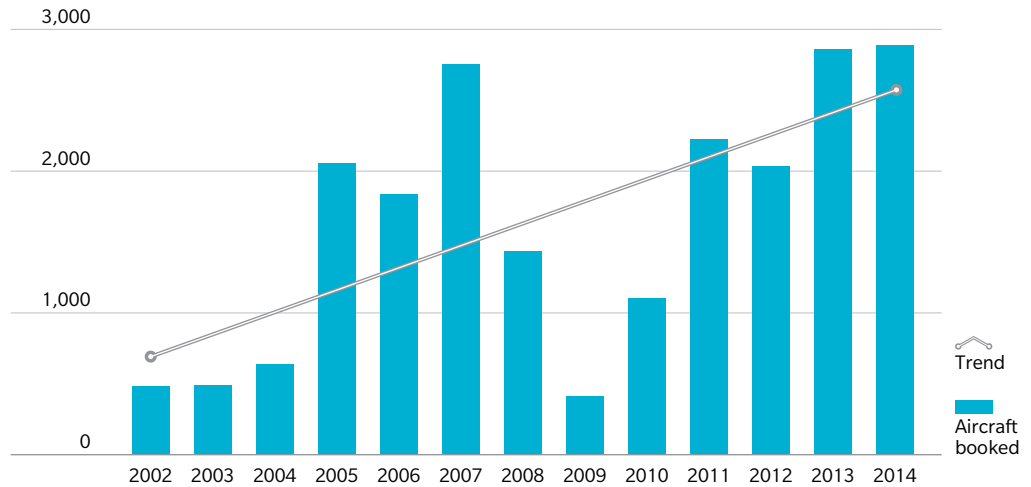
To thrive in this new environment, aerospace suppliers will face three main

challenges over the next decade. They must develop robust and agile supply chains, while extending the footprint of their manufacturing and engineering so as to be part of a more global supply chain. Suppliers must in addition take on more innovation and technology development work for the OEMs.

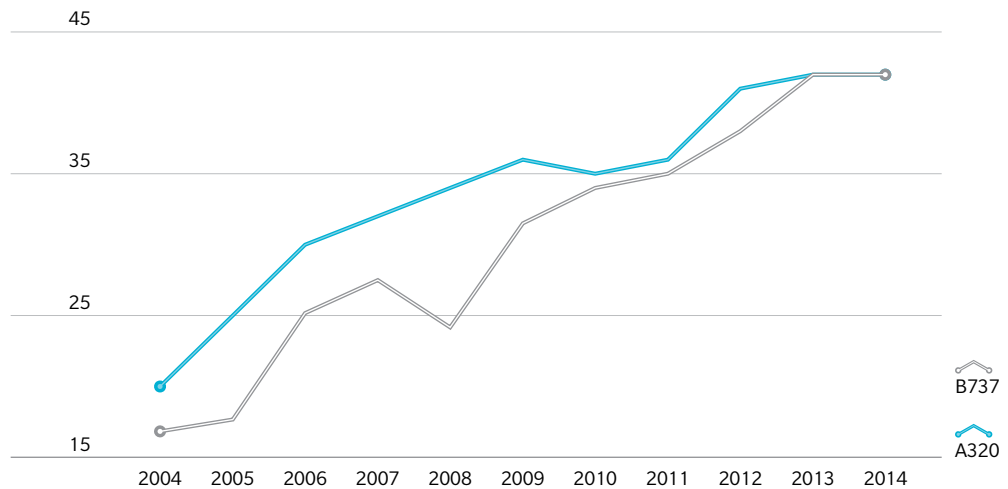
As a chief executive of a Tier 1 supplier put it: "Supply chain in aeronautics is all about choosing the right partners."

Exhibit 1: Aircraft demand and production rate increase

AIRBUS AND BOEING NET ORDER
NUMBER OF AIRCRAFT BOOKED



A320 AND B737 MONTHLY PRODUCTION RATES
AIRCRAFT/MONTHS



Source Airbus and Boeing annual reviews; Oliver Wyman analysis

DEVELOPING A ROBUST AND AGILE SUPPLY CHAIN

Airlines' growing orders are pushing Airbus and Boeing to refocus their activities on assembling, and to outsource the development of entire systems that they used to handle internally. This means that OEMs must accelerate and reinforce their purchasing processes and supply chain management and rebalance their risk profiles. This heavily impacts the entire supply chain. OEMs' specifications have become more complex, with stricter quality requirements and intellectual property transfer clauses. Furthermore, R&D and tools are no longer systematically funded by OEMs, and contracts include clauses that fix prices in dollars for the next 10 to 15 years.

In this context, smaller suppliers may not be able to catch up with legal and contractual requirements and heavier capital spending, meaning that consolidation may be a necessity for many.

For example, Airbus counted just 90 suppliers for its A350 model in 2012, compared with around 200 Tier 1 suppliers for its A380 in 2007 (Exhibit 2).

OEMs reinforce this trend by pushing the larger suppliers to rationalize their own supply bases, aiming to cut the number of suppliers by as much as 50 percent. This is especially rampant in sub-industries where fragmentation is still high, such as aero-structure components. Public authorities support such consolidation, either through existing financing bodies (such as the FSI or CIRI in France) or by creating dedicated funds to support consolidation (for example, France's Aerofund 1, 2, and 3). The consolidation of the industry is visible in many areas, such as the aircraft fastening market, which counted 14 players 15 years ago in France, compared with only three today.

Exhibit 2: Number of suppliers for different product models

OEM	PRODUCT MODEL	NUMBER OF TIER 1 SUPPLIERS	
Airbus	A380	200	
	A350	90	
OEM	PRODUCT MODEL	NUMBER OF SUPPLIERS	NUMBER OF RISK SHARING SUPPLIERS
Embraer	EMB 145	350	4
	EMB 170/190	38	16
TIER 1	PRODUCT MODEL	NUMBER OF SUPPLIERS	
Rolls-Royce	Trent 500	250	
	Trent 900	140	
	Trent 1000	75	

Source Aerospace Global Report 2011 IMAP; Usine Nouvelle; Oliver Wyman analysis

In addition to consolidation, suppliers must also rethink their supply chains to compensate for OEM weakness in planning and spare parts management. These challenges deeply impact the relationship between industry players, as each must integrate more complex activities. Tier 1 suppliers are now being entrusted with complete modules and systems by OEMs and are expected to manage more complexity. Suppliers are also becoming more involved in R&D and innovation. This means that they must grow outside of their core business, extend their engineering capacities, manage relationships with new suppliers, and recruit employees with the right skills to develop whole modules. The supplier-OEM relationship is shifting from *build-to-print* to *build-to-specs*. Risk-sharing schemes are also expanding, with Tier 1 suppliers taking on a higher percentage of risk.

An illustration of this trend is Stelia (formerly Aerolia). The company was created when Airbus outsourced its nose fuselage parts manufacturing in 2009. It is now a super Tier 1 supplier, managing entire work packages and its own value chain. Another example is Spirit Aero, created in 2005 when Boeing Commercial Airplanes sold its Wichita, Kansas division (fuselage and cockpit) to an investment firm.

Tier 2 and Tier 3 suppliers must also evolve and work with the larger Tier 1 suppliers to perform most manufacturing tasks. As Tier 1 suppliers cannot pass along risks (such as penalties) to smaller and more fragile suppliers, such risks will tend to increase quality, cost, and delivery requirements. Tier 2 and Tier 3 suppliers must then scramble to accelerate performance, on-time delivery, and service levels. They do bear substantial risk of failure, and one failing supplier can impact the whole program and generate important financial consequences for the OEM.

CASE STUDY 1 MODULARIZATION AND WORK PACKAGE OUTSOURCING



The trend in recent years has been for OEMs to outsource larger work packages to Tier 1 suppliers. Both Boeing and Airbus are streamlining their supply chains to refocus their role as system-integrating aircraft architects. **For instance, Airbus has cut in half the number of systems and equipment work packages from the A320 to the A350.**

For suppliers, the first step has been to switch to a kitting phase so as to have enough time to develop the right internal capacity. This was the case for a small French supplier (~€30 million in revenue in 2012), a specialist in structural parts. The company took on significant investment and risk to play this new role, including creating a dedicated new engineering department in 2010 to complement its manufacturing activities.

Suppliers may attempt then to switch from focusing on kitting to covering a conception phase as well. There are two limits to the modularization trend, however:

- OEMs are still eager to personalize modules and are not willing to give up design control.
- A rift could emerge among Tier 1 suppliers, as some will be unable to follow the trend and successfully adapt.

WHAT SHOULD OEMS AND SUPPLIERS DO?

OEMs should help Tier 1, Tier 2, and Tier 3 suppliers deploy manufacturing excellence initiatives to support the ramp-up in production and to reduce direct and indirect costs via lean initiatives. These initiatives aim to smooth production flows through more automation, limiting workforce variations.

OEMs should also help Tier 1 suppliers integrate their new responsibilities as “Super Tier 1,” especially for the transcription of specifications and the management of interfaces with new suppliers.

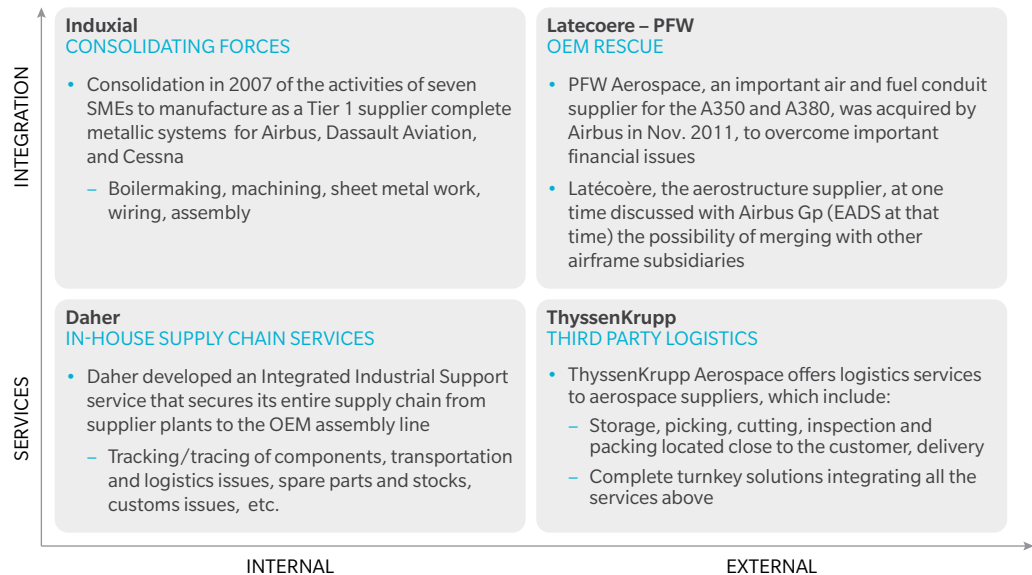
In addition, OEMs should reinforce their supply chain risk management capabilities and operational management of the supplier base. This is necessary to improve their selection of supply partners (based

on operational and financial performance analysis and supply chain robustness) and to help suppliers mature and survive in crisis situations.

Suppliers that have implemented these kinds of initiatives have reached new levels of on-time delivery, nearing 96 to 97 percent. Now, the challenge is for them to maintain this level while increasing volume as demand grows for original equipment and aftersales markets.

“Securing the supply chain is top priority,” said Airbus Chief Executive Officer Fabrice Brégier in February 2013, referring to the recent increase in production rates and the necessity to deliver projects on time. He spoke at a time when many Tier 2 and Tier 3 had failed to anticipate the need to invest in their production capacity, exposing the whole supply chain to major risks.

Exhibit 3: Companies usually follow one of four patterns to secure their supply chains



DEVELOPING THE FOOTPRINT

EXTENDING THE FOOTPRINT TO NEW GEOGRAPHIES

In recent years, OEMs have expanded their footprint to new countries. Airbus Tianjin's final assembly line began operations in 2008, and as of May 2013, the Chinese operation had produced 126 A320 family aircraft. Airbus is planning a US A320 final assembly facility by 2015 in Mobile, Alabama. And Bombardier had planned to extend manufacturing operations by opening two Q400 final assembly lines, one in Russia and one in China. Recent events in the Ukraine put the project with Rostec in Russia on hold, but the Chinese project is still under discussion. In addition, OEMs in emerging countries are becoming more active, with Russia's Sukhoi, China's COMAC, and Brazil's Embraer introducing more small commercial aircraft.

To remain close to manufacturing operations, Tier 1 suppliers have also expanded their operations to the same countries as OEMs. For example, Asia has become an important region, especially for Tier 1 suppliers such as Safran, Thales, and Zodiac (Exhibit 4). Mexico is becoming a low-cost manufacturing center for North American suppliers, with more than \$5 billion in exports through more than 270 aerospace companies operating there. European suppliers are also settling in

Mexico, attracted by the North American market. In 2008, for instance, Daher opened a plant in Mexico in order to penetrate the Boeing market, instead of opening the plant in Asia.

Three key challenges have surfaced with this extension of the aerospace footprint to emerging geographies. First, local governments in emerging markets are imposing offset requirements, pushing OEMs and Tier 1 suppliers to rely on a local supply chain. Second, many suppliers doubt that OEMs' demand in emerging countries will justify the investment. Finally, aerospace companies face more technical and quality issues when extending to emerging geographies: Initial scrap rates are higher due to poor preparation for moving operations and there are risks of technical inconsistencies linked to an increased number of "layers" of suppliers (e.g., batteries on the B787).

MANAGING THE FOOTPRINT EXTENSION

To avoid cash drains or quality issues, most aerospace suppliers have kept product development in their home countries for now, and have outsourced manufacturing capacities only in emerging geographies.

Comprehensive local training has become mandatory. Training programs should

resemble as closely as possible suppliers' training programs at home. A few companies even send trainers from their home countries to teach the first group of local employees. Some companies also bring in employees from their home countries to help launch operations in remote facilities, so as to help with knowledge and culture transfer. It's also crucial to closely monitor outsourced activities. Western engineers sometimes monitor the launch of the first production sets to implement and ensure quality requirements.

Some suppliers prefer to bypass the challenges of setting up operations in faraway countries, and opt to add production facilities in countries closer to home. Some European suppliers favor adding lower-cost production in North Africa rather than in Asia, as rising wages, productivity differences, and volatility of transportation costs make Asia less attractive. As an illustration, the number of employees in the aerospace supply chain in Morocco rose from around 4,000 in 2004 to more than 9,000 in 2012.

Exhibit 4: Main European aerospace investments in China over the past 20 years



Source Catalyst Global Aerospace Sector 2012, Safran reports, Airbus reports, Usine Nouvelle

BOOSTING INNOVATION

The aerospace industry is constantly looking to adopt innovative ways to reduce aircraft weight and cost, and to meet environmental regulations. Yet, most suppliers find it challenging to improve their innovation performance and capacity, including in composite materials and aircraft electrification.

DEVELOPMENT OF COMPOSITE MATERIALS

The advantages of composites have been well understood for decades, but low energy costs blocked their introduction. The rise in jet fuel prices however pushed aircraft manufacturers to improve aircraft efficiency

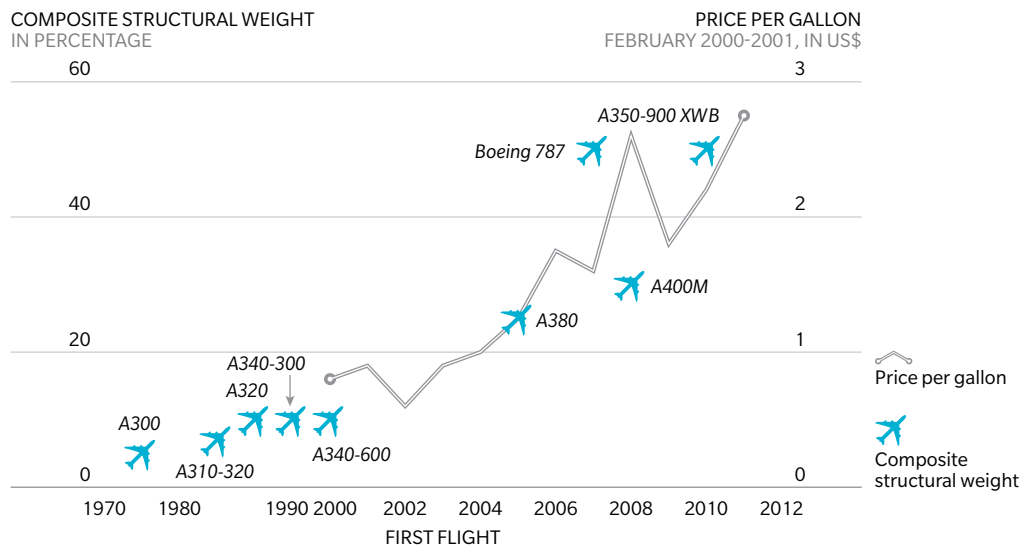
and to increase the use of composites in new twin-aisle aircraft.

OEMs now estimate every 1 kilogram of weight reduction translates into \$1,000 in cost savings for short to mid-range flights.

The introduction of composite materials in aircraft has been an ongoing trend, stimulated by several factors, including material price, fuel price, and innovation in carbon's properties (such as resistance to fatigue and corrosion).

Composite materials are being developed for all sections of the aircraft. The most common target within the industry is to achieve 50 percent composite composition

Exhibit 5: Aircraft composite usage compared to jet fuel price



Source Oliver Wyman analysis

and 20 percent weight reduction by 2020. Recent programs have demonstrated huge progress with the A350 XWB's structure at 53 percent composite and the B787 at 50 percent. Thanks to this new generation of twin-aisle jets, composite demand is expected to triple over the next 20 years.

To ensure a presence in this market, most aerospace suppliers are heavily investing in R&D and have been acquiring capacities from external companies. For instance, UTC Aerospace Systems acquired composite company CTG in 2012 to develop a composite transmission shaft.

Still, the return on investment for composite components has not yet been proven. The material is significantly more expensive to produce than aluminum. For example, thermoset composite materials cost about 15 times and thermoplastics cost around 75 times what it costs to produce the equivalent in machined aluminum. Development and tooling costs are higher as well, while the difference in the total cost of ownership for aircraft operators is not as significant.

The supply chain for composite materials remains too long. There are presently six to seven suppliers from the chain's start to the OEM. Furthermore, there are too many steps for this supply chain to be reactive and flexible, and each link in the supply chain adds its own mark-up, boosting total cost (see Case Study 2).

The technology is not yet mature and there are still problems that can cause maintenance issues, such as lightning

strikes and soundproofing. Reliability and repairability is yet to be proven on a large scale with composites, which are making their debut in civilian aircraft structural parts on the Boeing 787.

Moreover, the recycling of composite components is still an issue, as no solution is foreseen for now, especially for the thermoset composites which are used in aerospace.

The challenge for the next 15 to 20 years will be to improve composite material profitability by reducing related costs and integrating the value chain to boost flexibility.

TOWARD 100 PERCENT ELECTRIC AIRCRAFT

Electrification of aircraft systems is the second innovation challenge. Replacing hydraulic and pneumatic power will reduce power consumption and noise pollution. Above all, electrification reduces system weight, thus cutting fuel consumption.

New aircraft programs are integrating an increasing number of electrical systems. On the A380 for instance, thrust reversers and backup flight control actuators have been developed with electrical power. On the Boeing 787, brakes, engine start-up, and cabin pressurization are now electrical. The Airbus A380 uses 0.8 megawatts of electricity, while the Boeing 787 uses 1.5 megawatts.

The next stage will be the electrification of systems to pressurize, heat, and cool aircraft cabins and to power water pumps.

CASE STUDY 2 AEROSPACE COMPOSITE TRENDS

Due to aerospace specificities (large parts, high performance, detailed certification processes, and supply security requirements), OEMs favor major, partially integrated suppliers, and long-term contracts of 20 years or more. OEMs facilitated the consolidation and emergence of Hexcel Corp., Cytec Industries Inc., and Toray Industries Inc. as integrated suppliers controlling 90 percent of the market for aero pre-impregnated (pre-preg) composite fibers reinforced with resin. Pre-preg producers are capturing most of the value thanks to complex formulations that remain trade secrets. Parts manufacturers are limited to a lower-value assembly and risk sharing role with OEMs.

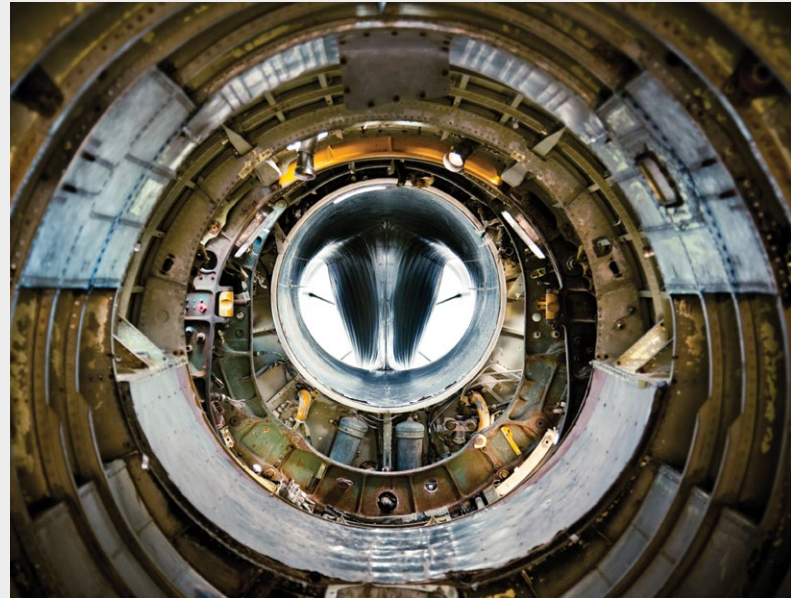
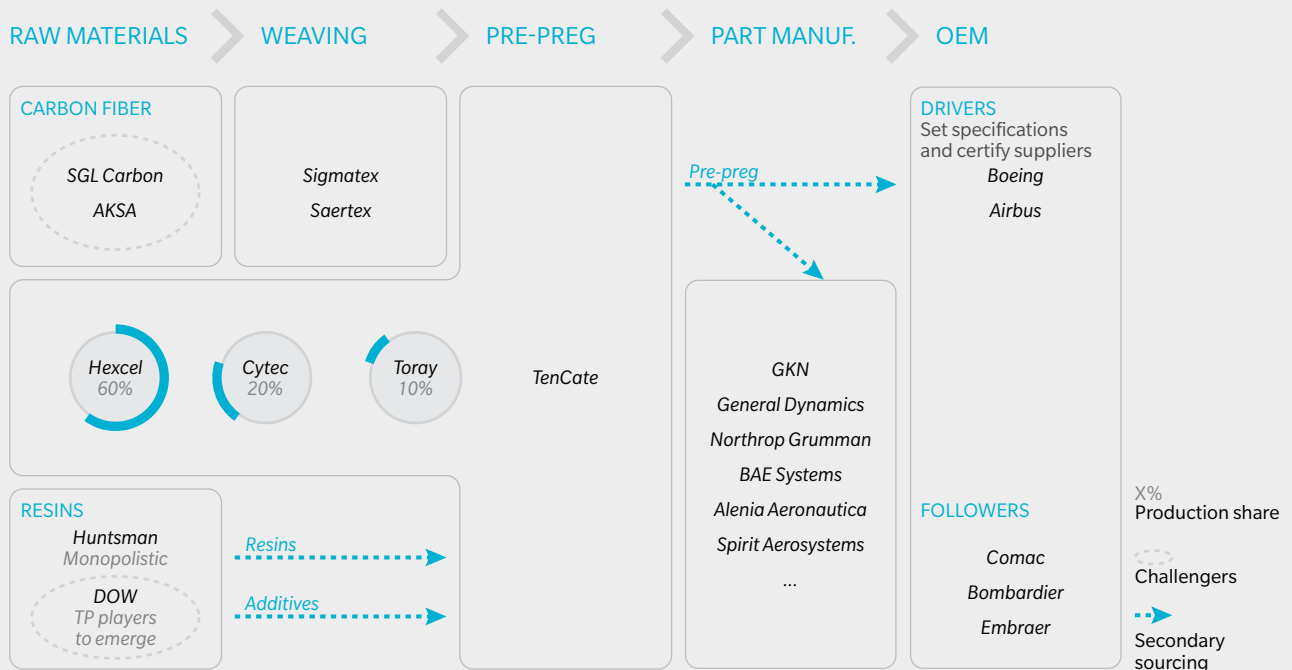


Exhibit 6: Composite industry value chain

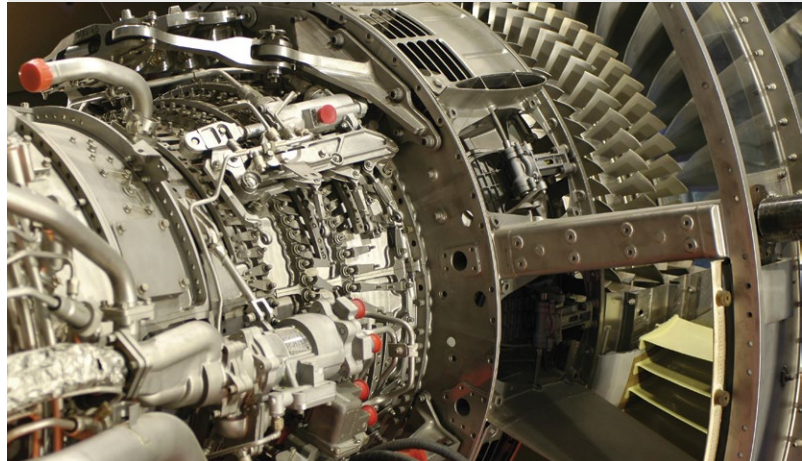


Another objective is electrifying how planes move on the ground. Most aircraft currently taxi their way around airports using thrust from their engines, consuming much fuel along the way. Alternative taxiing solutions are being developed today, either on-board the aircraft or ground-based (non-flyable), applying power to the nose wheel or to main wheels, and addressing power sources (APU or fuel cells). Airlines stand to save up to four percent of total block fuel consumption, and will make gains in maintenance (brakes, engines, etc.), with total savings estimated to reach \$200,000 per narrow body aircraft annually.

The next electrification frontier will be propulsion systems. During critical flight phases, alternative energy could help reduce fuel consumption and thus operating costs. In 2013, Airbus Group, Siemens, and Diamond Aircraft entered into a long-term research partnership to introduce hybrid drive systems.

We expect the quest for 100 percent electric aircraft will continue for OEMs, but unlike the evolutionary approach adopted on the A350 and B787, the next stage will require a complete redesign of aircraft systems. Suppliers are thus positioning themselves to design complete electrical systems, including power generation and distribution systems. For instance, Safran has had responsibility for the electrical systems on the Embraer KC390 since 2012.

CASE STUDY 3 BOOSTING INNOVATION CAPACITIES OF SMALL COMPANIES



Safran began operating its Composite Center in 2013 in Itteville, France, following a €50 million investment. It combines research, engineering, and prototype manufacturing facilities, all dedicated to composites. The objectives of the center are threefold:

- Continuing work on innovative composite technologies, such as 3-D weaving
- Exploring new research paths, including higher temperature-resistant resins, by collaborating with academia, research labs, specialized start-ups, etc.
- Facilitating the circulation of these technologies across all Safran companies

The center is located next to the Safran Herakles plant, which specializes in the manufacturing of thermoset composites, in order to have idea generation and product manufacturing capabilities close to one another.

Projects are led in cooperation with:

- Snecma: Open rotor engine blades, engine parts, and accessory support for the LEAP engine
- Techspace Aero: Low-pressure compressor casings
- Sagem: Housings
- Hispano Suiza: Transmission shafts

IMPROVING INNOVATION AND DEVELOPMENT PERFORMANCE

To meet OEM expectations in line with these innovative trends, suppliers will need to develop their ability to innovate and may need to make fundamental changes to the way they work. Suppliers can introduce open innovation initiatives with start-ups and companies from other industries to help generate innovative concepts and improve their portfolio management process (see Case Study 3).

They can create a design authority, composed of senior experts, to monitor the engineering team's progress and guide the group toward quality, cost, and delivery requirements. The design authority would be able to implement a design freeze when necessary.

Suppliers also can monitor engineering progress by tightening the management of maturity gates during the project development process.

Another option is to employ a functional architecture approach. As systems are more and more interlinked, a comprehensive functional architecture approach can be an effective way to manage interfaces between systems.

Suppliers can increase testing relevance by continuing to reduce physical tests and favoring upfront digital simulation instead. 3-D printed prototypes also can help reduce development time.

Finally, as the production pace quickens, suppliers can adapt their organizations by rebalancing staff, swiftly moving capacity from development to production ramp-up as needed.

CONCLUSIONS

The aerospace industry's supply chain is facing new challenges. To ensure survival, suppliers need to take significant measures to:

- Manage growth and cope with accelerating production ramp-up, while integrating new technologies such as composites, electrification, and new generation engines
- Ensure supply chain agility and robustness, as OEMs are now outsourcing complete modules
- Manage footprint extension to new geographies, following both the development of emerging countries' OEMs and initiatives from traditional OEMs to reduce costs by relocating a portion of their activities
- Boost innovation capacities to support OEMs in their efforts to reduce fuel consumption by 50 percent in the mid-term

In addition to these challenges, another emerging issue will require industry players' attention: the chase for talent and resources. Companies' capacity to attract, retain, and develop talent, both in their traditional geographies and in new targeted areas, will indeed be crucial to their continued success.

ABOUT OLIVER WYMAN

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Oliver Wyman has built up experience serving leading clients throughout the civil and military aerospace value chain, covering a wide array of topics such as R&D performance, industrial footprint strategy, manufacturing excellence projects and project turnaround.

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