

## Long-range air transport market

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### Abstract

The main objective of PARE Project is to support the implementation of ACARE 23 Goals. In Year 1 PARE Report, each PARE Objective relates to a relevant Recommendation for Aeronautics in Horizon Europe. Five of the PARE Objectives refer to the Long-range air transportation markets.

The methodology of research consists in the establishing of a list of main studies, research on aircraft market based on literature review, a selective and comparative analysis on the achievement linked to Flightpath 2050 objectives, a presentation of main international achievement and furthermore the recommendations to improve the European aircraft offers for the next period.

The research was focused on 5 directions: large aircraft market, regional aircraft market, business jet market, helicopter market European Union leadership and military UAVs.

Regarding the large aircraft market, the related PARE Objective is to promote a level playing field on this market. The objective aims to build defences against a tendency of World Trade Organisation (WTO) disputations to ignore the fact that European success in the airline market is based on the merits of engineering, quality and efficient operations and not on unfair subsidies. If not properly contained, the long running processes at WTO might become a permanent nuisance. The Report is recommending as solution the development of a strong legal, commercial and technical basis prepared, if necessary, to deal with litigation at the WTO and, preferably, renew the large aircraft agreement between the EU and the USA.

Concerning the recent evolutions in regional aircraft market, the Year 1 Report stresses that this market, both jet and turboprop, has an attractive potential for the EU players, mainly A 220 and ATR. However, they face a fierce competition from traditional rivals Canada and Brazil, as well as from newcomers from Japan, Russia and China. The PARE Objective in this field consists in “Strengthen the position of the EU in the regional aircraft market” and we generate the recommendation to support the development of European regional aircraft in a world market with an increasing number of competitors and, additionally, to consider synergistic tie-ups between large and regional aircraft suppliers.

EU is participating rather timidly in the volatile business jet market. After the analysis undertaken, we can say that only the competitive position of Dassault in large cabin business jets is notable. Its main rivals, Bombardier and Gulfstream, diversified their offer with military applications which considerably improve their business cases parameters. A similar approach by Avanti, however, did not prevent the bankruptcy of the manufacturer. In answering to PARE Objective “Strengthen the position of the EU in the business jet market”, the Report is recommending a stronger support of the development of European business jets and their expanded use as sensor / surveillance / control platforms.

An other major PARE Objective is to maintain or to enhance the current helicopter market EU leadership. Some threats to this position might come from the very ambitious US’s Future Vertical Lift programme to design helicopters or tiltrotors with: twice the range; 50% higher speed; over twice the hover payload under demanding hot and high conditions, using engines with double power but similar fuel consumption, size and weight. After the PARE analysis, we recommend that EU spends all efforts and all necessary resources to ensure that its industry keeps at least abreast of developments in high-power high-speed helicopters and tiltrotor aircraft with enhanced hot-and-high lift capabilities. The aim here is to safeguard against potential surprise breakthroughs that could change Europe’s leading market position.

Finally, another priority objective identified by PARE is eliminating the embarrassing EU handicap in industrial development of military UAVs. This field seemed neglected and some un-coordinated efforts, for example in Medium Altitude Long Endurance UAVs, have not been completed. The consequence is the procurement by some EU countries of non-EU equipment. PARE is recommending leveraging the technological capabilities demonstrated in several prototype drones into a coherent European Programme covering all levels, to satisfy internal needs and compete on the world market.

The result of analysis undertaken, and the recommendations proposed in the project will be updated and developed in the second- and third-year reports.

## 1. Introduction

PARE Project [1] is aimed to point to the directions of aeronautical development in Europe in line with the strategy defined in the Agenda established by the Advisory Council for Aviation research and Innovation in Europe (ACARE). 35 PARE Objectives are connected with relevant Recommendations for Aeronautics in Horizon Europe. Five of the PARE Objectives refer to the large aircraft market, regional aircraft market, business jet market, helicopter market and military UAVs.

The methodology of research consisted in evaluating a large amount of data extracted from a thorough literature review, a selective and comparative analysis on the achievement linked to Flightpath 2050 objectives, a presentation of main international achievement and furthermore the recommendations to improve the European aircraft offers for the next period.

The research was focused on 5 directions: large aircraft market, regional aircraft market, business jet market, helicopter market European Union leadership and military UAVs.

## 2. Large aircraft market

### 2.1 The Current Status of the Airbus-Boeing Competition

The long-range airliner market is dominated by the Airbus-Boeing duopoly that arose at the end of a long competitive period in which Airbus steadily gained ground starting from a newcomer status. The prize of this competition is the dominant position on a market in continuous growth. A total backlog of 14816 aircraft [2] is currently distributed mainly between the “Two Big” (Fig. 1.).

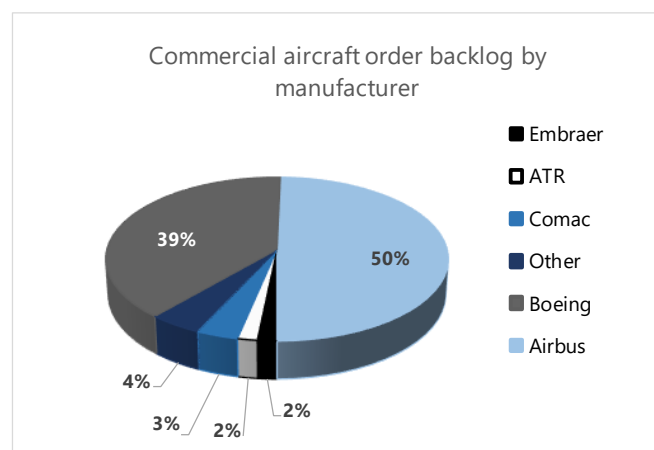


Figure 1: Commercial aircraft order backlog by manufacturer (Source: Flight Fleet Analyzer via [2])

The reasons for this duopoly are multiple:

- Airbus and Boeing absorb a greater share of the industry. In 2018, Airbus acquired Bombardier’s C Series with a new line of 110/130-seat jets, provisionally known as the A220-200 and A220-300. Boeing is creating a joint venture with Embraer covering Embraer’s E-Jet series, spanning 75-120 seats.
- Extremely high entry barriers.
- Extreme concentration at the top of the market in terms of major revenue-producers.

The continuing Boeing-Airbus rivalry has taken place during decades, since Boeing began, in the late 80s and early 90s, to take seriously the challenge of the small outsider just established in 1970. The only notable competitor at that

moment for Boeing on the commercial airliner market was McDonnell Douglas (MDD), producer of both narrow bodies and wide bodies. But MDD was strongly affected by recession in early 90s and was to be merged into Boeing in 1997. So, instead of Boeing becoming a monopoly on that market, it was irritated by the appearance of the unexpected European competition. Some analysts even consider that the Airbus presence on the market accelerated the decline of MDD and its absorption by Boeing [3]. For a better understanding of the circumstances of the duopoly development, a short review of the conditions in the industry is useful.

The significant achievements in aerospace industry (and here the airliners production is relevant) are based on three ingredients:

1. Strong financials: it is well beyond the possibilities of a normal size company to spend the multi-billion dollar necessary to develop a new type of airliner. Producing such machines is an act of large-scale economics, so it needs to be supported more or less explicitly by governments. This happens mainly because the private capital is reluctant to approach very large investment with a rather long recovery horizon (they prefer early repayment profiles) [3]. The capital markets are also less inclined to take the risk of failed projects and assume its painful consequences.
2. Powerful science and engineering resources: resources that need to be based on an existing wide base of STEM (Science, Technology, Engineering, Mathematics) education output, on a systematic experience accumulated in any of the contributing fields, as well as on a good capability of invention and innovation.
3. Efficient industrial organisation: developing a product means also a proper industrialisation. Reaching appropriate production volumes at competitive costs and quality levels to satisfy the market demand is probably the most difficult task. It requires a rather rich experience, a strong discipline, a quality approach well implemented, a science of managing a large supply chain. Every such component of the industrial system is to be built and maintained using a careful design and proof process.

The absence of any single one of these three ingredients in the minimum necessary amount is spoiling any chance of contemplating the entrance on this market. This means that high entry barriers prevents outsiders to threaten the incumbents' positions.

After the end of WW2, the complete package of the three ingredients listed above was present (at the THEN necessary levels) in a small and select group of countries: UK, US, France, USSR, Netherland. During the ensuing decade they developed airliners based on the acquired expertise in large bombers or military transports, but able to incorporate new revolutionary technologies as the turbine propulsion. But, in time, probably starting in mid 50s, larger projects (B 707 and DC8 jets and Tu 114 turboprop) began to require huge sums which hardly could be available to smaller players compared to US and USSR. UK tried to stay in competition with Vickers VC10 but soon abandoned, limiting the effort to smaller sized BAC111 [4]. France also kept a modest ambition with Caravelle while Netherland (with German contribution) launched Fokker family. Besides UK, France and Netherland, other European countries like Italy, Spain, Germany enjoyed valuable engineering and industrial resources (ingredients 2 and 3 above) but, obviously, lacked the finance potential necessary to grand aviation projects.

One decade later, in mid 60s, Europe began to resent the advance US and USSR were gradually acquiring in aeronautical industry. The European leaders understood that, as an aggregate, Europe had plenty of engineering brains and industrial expertise, so the lack of individual national financing potential was the only obstacle to proceed to large projects. The solution was an alliance of European nations to establish an entity able to compete on the large aircraft market. Appropriately recorded as "Groupement d'Interet Economique" (GIE), Airbus consortium was set up in December 1970 by France (Aerospatiale), Germany (MBB and VFW Fokker), UK (British Aerospace), Spain (CASA) and Netherland (Fokker VFW). Financing was provided by loans from French, German, Dutch and Spanish governments, from a consortium of French and German banks and from private BAe funds [4]. At that time the partners had already started work for the first twin-engine wide-body airliner, A300, featuring some new technologies like composite structure elements. Entering service in 1974, it proved to be a success, competing in the so called "wide-bodies war" against the three contemporary US machines, B757, DC-10 and L-1011.

Currently, the market shares in the single-aisle narrow body and twin-aisle wide body market are different, showing an approximate balance: Airbus is leading the former and Boeing the latter. Both Airbus and Boeing are in the healthy situation of having the largest order books in history and face challenges in achieving higher production rates. The future investments might be directed towards evolutionary developments of existing aircraft or in totally new designs that will require years of maturation to incorporate new technologies. When the new designs come perhaps 10 or more years away, they may still be the ultimate evolutions of the tube-and-wing configuration rather than the more radical concepts (like flying wings or joined wings) that may require an intermediate stage of large-scale demonstrators.

Today's competition in the single-aisle segment is represented by Boeing's 737 and Airbus's A320 families. Some consultants estimate that the segment "generates a vast majority of the profits" for each of the airframes; for example, a B737 produces a 30% profit compared to 20% for a B777 [5]. Narrow body airliners represent also the bulk of the historic volumes delivered (around 10478 for Boeing until December 2018 and 10926 for Airbus until May 2019) and of the existing orders (4611 for Boeing and 5795 for Airbus, at May 2019), according to the data provided by manufacturers [6], [7], [8], [9]. This balance might be slightly upset by an eventual reputational damage for the Max series due to recent unhappy events.

Meanwhile, the market for large wide-body aircraft is split between Boeing and Airbus, with around 60-40% of the market respectively, depending on the year. In the mid-2000s, rising oil costs caused airlines to look towards newer and more fuel efficient aircraft. Two such examples are the Boeing 787 Dreamliner and Airbus A350 XWB, both featuring a largely (more than 50%) composite structure and modernised, low consumption, powerplants and also less noisy. A total backlog of 1041 wide-bodies aircraft for Airbus and 1188 for Boeing was recorded at the end of 2018. This market duopoly means that Boeing and Airbus are constantly fighting to gain an advantage over the other in terms of aircraft sales. Before a new contender (CRJ929) [10] would come with a tempting offer, this situation will persist many years from now.

Regarding aircraft production, both Airbus and Boeing have adopted a strategy of globalization by implanting component factories and general aircraft fitting on all continents. Airbus, for example, has a general assembly at Mobile (Alabama) in the USA as well as in China. 130 nationalities and 4 generations are represented by Airbus people and Boeing has regional executives in offices worldwide to extend the company's global reach and local market focus. Boeing is present in countries or regions around the globe, overseeing 18 regional offices in key global markets. Boeing has 11 research and development centers around the world.

## 2.2 Mutual Accusations of Illegal State Subsidies

The high stakes have been generating fierce conflicts: while Boeing has continually accused Europe over launch aid in form of credits to Airbus, Airbus has claimed that Boeing receives illegal masked subsidies from the US Government when it granted permission of free use of results of military projects in their civilian programmes.

A 1992 bilateral EU-US agreement regarding the trade in large civil aircraft (TLCA) which banned support from governments in production financing and allowed up to 33 % of the development programme cost to be met through government loans which are to be fully repaid within 17 years with interest and royalties. US (Boeing) claimed the agreement have been violated by Airbus when using RLI (reimbursable launch investment) from governments. While denying any wrongdoing, Airbus demonstrates that the money had been paid back with interest, plus indefinite royalties if the aircraft is a commercial success, a system fully compliant with the agreement and the rules established by WTO. Mutually, Airbus claims that some forms of subsidy are definitely the military contracts awarded to Boeing by the U.S. government, as well as the technology development performed by NASA also providing support to Boeing. A third form of subsidy, received in its recent products such as the 787, Boeing comes from local and state governments such as Washington, Kansas, and Illinois.

In 2005 each party filed complaints against the other at WTO, escalating the tensions between them through what was to be considered the world's largest trade dispute. By filing WTO trade disputes against one another, the US and EU in turn withdrew from the TLCA. An interim WTO investigation report into the claims made by both sides was made in September 2009 and subsequent rulings from 2010 until present established that both parties had had indeed some illegal subsidies. The most recent ruling, in May 2018, seems to somehow favour Boeing's position, but WTO has yet to rule on state tax breaks for the American company. However, EU denies any lack of compliance and both parties claimed victory in their press releases.

The acrimony continues with more energy, Boeing and Airbus each claiming multi-billion penalties for the harm caused by the rival.

US and EU are threatening each other with retaliatory tariffs imposed on the products. As of April, this year, US warned that it was preparing a list of tariffs on \$11bn-worth of EU goods, including aircraft and helicopters. Meanwhile, Brussels is drawing up its own catalogue of American products that it will levy penalties on if Washington goes ahead with its threat. However, nothing will be decided until the WTO sets the level of damages this summer. A huge amount of resources is spent continuously in this trade war.

And so, the situation seems to extend perpetually the game of the subsidy.

## 2.3 PARE Recommendation in Large Aircraft Topic

A priority objective identified in PARE is to promote a level playing field in the large aircraft market. The objective aims to build defences against a tendency of World Trade Organisation (WTO) disputations to ignore the fact that European success in the airline market is based on the merits of engineering, quality and efficient operations and not on unfair subsidies. If not properly contained, the long running processes at WTO might become a permanent nuisance. The Report is recommending as solution the development of a strong legal, commercial and technical basis prepared, if necessary, to deal with litigation at the WTO and, preferably, renew the large aircraft agreement between the EU and the USA.

## 2.4 European low-cost market catalyst of Airbus – Boeing competition on single aisle aircrafts

An important vector in the development of single-aisle aircraft production, especially of families Airbus 320 and Boeing 737 is the high deployment of LCCs market. LCC has been the fastest growing market segment, to the detriment of Traditional Scheduled. From 2007 to 2016, low-cost flights grew by 61% (from 5,200 flights per day to 8,400 flights) whereas traditional scheduled flights were down 10% (from 16,300 flights per day to 14,700 flights). This includes some direct transfer of flights to low-cost subsidiaries. At times, LCC was also the only sector growing in periods of economic and political uncertainty [23].

In terms of low-cost seats, the biggest markets in Europe are Spain (82.2 million seats in 2018), UK (75.21 million) and Germany (55.68 million) [11] (fig 2).

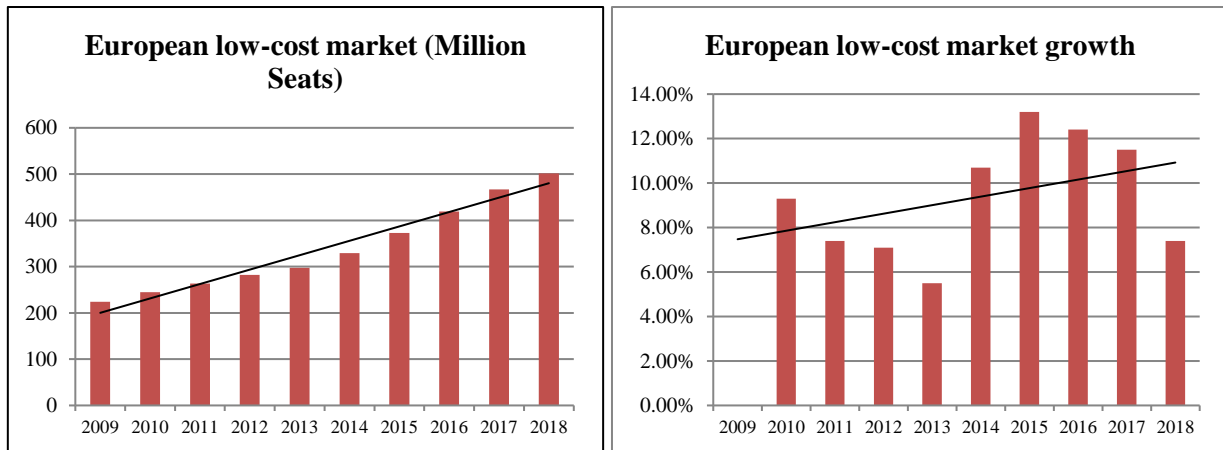


Figure 2: European low-cost market regarding number of seats and market growth (2009-2018) [11]

As known, in most cases, LCC fleet consists of new aircraft from Boeing 737/Airbus A320 family. Regarding the aircraft market segment, LCC prefer aircraft configurations with more seats (an average of 150 seats). So, the low-cost fleet strategy was carefully developed in order to get important discounts for their orders. However, LCC are starting to offer long-haul flights using new versions of families Airbus 320 or Boeing 737.

The competition between traditional and low-cost carriers has an impact on aircraft manufacturers, reflected in a high demand on the range of middle market aircrafts, with a dominant command for B737 and A320 [12]. Deliveries have grown for both Airbus and Boeing commercial orders and are supposed to maintain this trend; the two manufacturers are estimated to deliver 86% of the aircrafts worldwide by 2037.

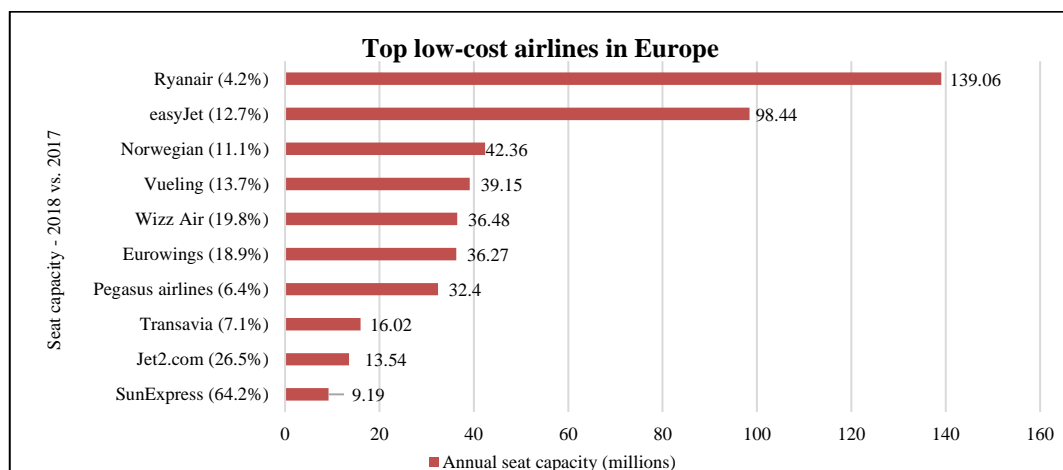


Figure 3: Top low-cost carriers in Europe [11]

The low-cost carriers (fig.3) are sharing the market for aircraft types in a balanced way and are increasing their already high monthly production in order to respond to the demands of LCCs. Analysing the fleets of the main LCCs, we can constate that: Ryanair currently operates a fleet of 400 Boeing 737-800 series with an average age of theirs planes of 5.5 years. Easy Jet reported a fleet of 315 aircraft comprising of 132 Airbus A319, 168 Airbus A320, 13 Airbus A320neo and 2 Airbus A321neo. We can see that the main competition on LCCs market is also a competition Airbus – Boeing especially on narrow body aircrafts.

The LCC fleet expansion still considers narrow-body jets, and by 2029, 13,800 737 MAX and A320neo aircraft will be delivered, representing over 2/3 of the global fleet [21]. In this concern, both manufacturers are reporting a growth in narrow-body deliveries, with an annual rate of 4.9 %, the number of such aircrafts will top 25,700 by 2029, 9800 more than in 2019 [21].

### 3. Regional aircraft market

#### 3.1 The current market for regionals

The main market for regional aircraft is represented by REGIONAL CARRIERS, i.e. carriers with an average range around 500 km or fleet without narrow-body and wide-body aircraft (turboprops and / or regional jets only). Their operators act as feeder for long distance air travel at major hubs, besides serving also shorter routes. It is also an important market for Europe, much more accessible to other entrants than the Airbus-Boeing duopoly of giants. It appears that the large corporate structure of Airbus and Boeing is well suited to the design and production of long range single and twin aisle jet liners, but not cost-effective at the one-tenth smaller scale of regional aircraft best left to smaller industry groups.

The regional airliners market appears to develop steadily. According to the data provided by European Regions Airlines Association (ERAA) [13] the total deployed capacity of the intra-European market operated by its members is continuously increasing and reached around 7.5 million seats and 94 000 movements. The average stage length is 504km and the average flight duration 1hr14min. ERAA carriers operated 911 unique routes, their focus being shorter, thinner routes. The vast majority, 82% of the routes throughout the year was placed between 300 and 650 km, compared with 500 to 1500 km for LCCs. ERAA carriers have a market share in Europe of approximately 16 % of flights and 9% of seats. The industry transports 45 millions passengers each year on 960,000 flights. In US an average 22% of the total seating capacity is aboard regional aircraft and it continues to climb.

To keep the load factor at higher levels (i.e. to increase efficiency), smaller aircraft are preferred. As reported by US' RAA (Regional Airlines Associations) in 2018 [14], the average seating capacity of a U.S. regional aircraft was 62 seats. However, a growth tendency is observed for this figure, it used to be 51 just 10 years ago (a 22% increase). In Europe, the current value is around 73, raised from 58 in 2007. The explanation for this tendency is in the increase of the share in the total of larger machines, as the old small capacity types are retired. However, the average value of the number of seats in the fleet is still much lower than those corresponding to LCCs.

#### 3.2 Regional Jets

Small turbofan aircraft with 50-120 seats are competing on this market now and in near future. One can call such a rather crowded market as more competitive, at least compared to the one for larger planes. Embraer is a market leader with its E170 / E190 family, its position being at this moment threatened seriously only by A-220 (ex Bombardier C-Series) family. The other regional jets from Bombardier, the mature CRJ family was rather neglected for some times and there are some indications of the intention of selling the programme in 2019. However, other potential competitors on the regional jet market, like Comac ARJ21 (currently in certification process), Sukhoi Superjet 100 (already holding a Western Type Certificate) and probably Mitsubishi MRJ 90, will certainly create a regional turbofan market distortion for Embraer and Airbus. Other (more remote) risk might come from the Turkish Do 328Jet, a product labelled TR Jet, or (less probable, due to the potential lack of financing) from upgraded variants of Antonov AN-148.

#### 3.3 Regional Turbo-props

The ATR42/72 family is the survivor of the European offer of regional airliners, following the demise of Dornier, rundown of British Aerospace models, end of SAAB 340 and 2000 and production and concentration of CASA on military transports. The revival of the ATR42/72 is due to the superior economics of turboprops over jets, with modest compromise on flight time due to lower speed on short routes. ATR claims to have covered 75% of the 90-115 units strong yearly demand in the recent times [15]. The Italian side of ATR believes in an extension to the 100-seat, a view apparently not shared by the French side. Some speculate Airbus could fear that a hypothetical ATR100 would compete

with A-220 and, less importantly to the already modest selling A319. The other contenders in the regional turboprop market are considerably less competitive. Since Dash 8 Q400 (ex-Bombardier, now Viking since November 2018) is not yet prepared to face the competition of ATR, it would need an upgrade and a production line apt to adapt to higher output. Iliushin Il-114, expected to be revived soon is an unknown, probably in need of modern technology, while other currently used types have serious handicaps, so ATR is in strong control of the market. A hybrid electric variant is contemplated by the company.

### 3.4 PARE Recommendation in Regional Aircraft Topic

Concerning the recent evolutions in this market, the Year 1 Report stresses that this market, both jet and turboprop, has an attractive potential for the EU players, mainly A 220 and ATR. However, they face a fierce competition from traditional rivals Canada and Brazil, as well as from newcomers from Japan, Russia and China. The PARE Objective in this field consists in “Strengthen the position of the EU in the regional aircraft market” and we generate the recommendation to support the development of European regional aircraft in a world market with an increasing number of competitors and, additionally, to consider synergistic tie-ups between large and regional aircraft suppliers.

## 4. Business Jet market

### 4.1 Business Jet market segments

According to General Aviation Manufacturers Association (GAMA), [16] three classes of business jets are identified by specific performances and price levels:

- a. Light jets – for example Cirrus SF50, Cessna Citation series lower end or Pilatus PC-24;
- b. Midsized jets –Bombardier Challenger, Cessna Latitude, Embraer Legacy etc class;
- c. Large business jets – Gulfstream, Bombardier and Falcon families.

Light jets and the lower end of midsized are facing competition from turboprops and even from piston engine models. But from a business aviation world market worth nearly \$20bn yearly, only about 10% buys non-jets.

### 4.2 Business Jet market segments

Both the number of units sold by the manufacturers each year and the money spent by customers for procuring business jets have shown strong volatility during the last decades. Any recent recession hit this industry that suffered much more than other aerospace sectors. After the record of over 1300 aircraft produced in 2008, the volumes halved in subsequent years to fluctuate later just above those numbers [16].

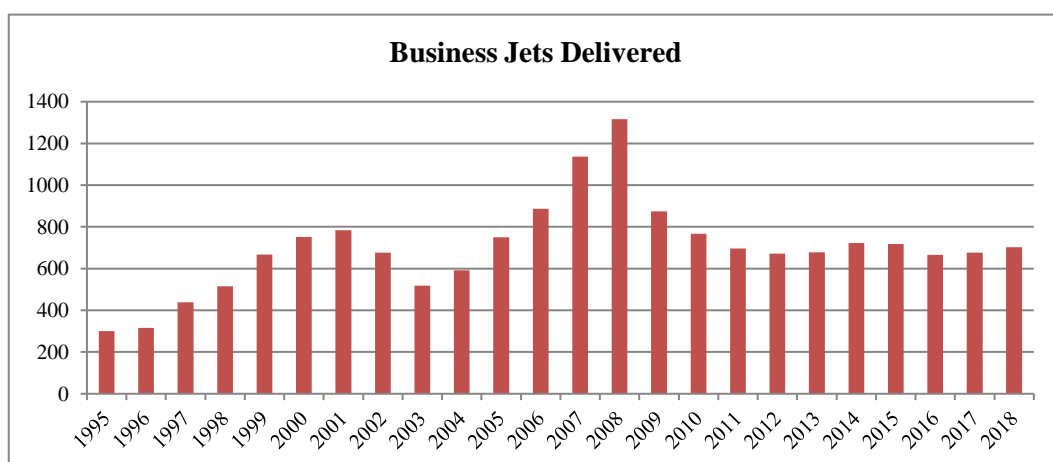


Figure 4: Business Jets delivered (1995-2018)

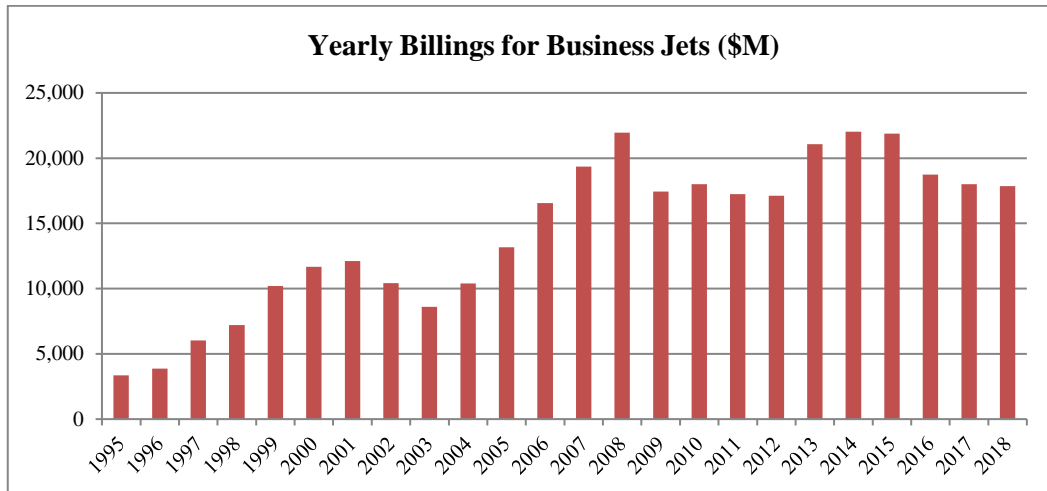


Figure 5: Yearly Billings for business jets (\$M)

After several years of decline, the business jet market seems to show small signs of recovery: a total of 703 units were delivered in 2018 compared to 677 in 2017. However, behaviour of each market segment was different. Light class, very crowded as ever, did show a rather encouraging increase of 16%, explained by analysts by the resurgent US market in connection with economic growth [17]. Midsize class sales were nearly level, explained maybe by the current transition between generations.

On the contrary, the Large class is still suffering from the blows of the previous recession, with volumes decreased by 7%. This is probably the effect of soft demand in traditional markets like Middle East and China [18]. The only manufacturer who recorded an increase in deliveries in 2018 was Gulfstream, 121 units compared to 120 in 2017.

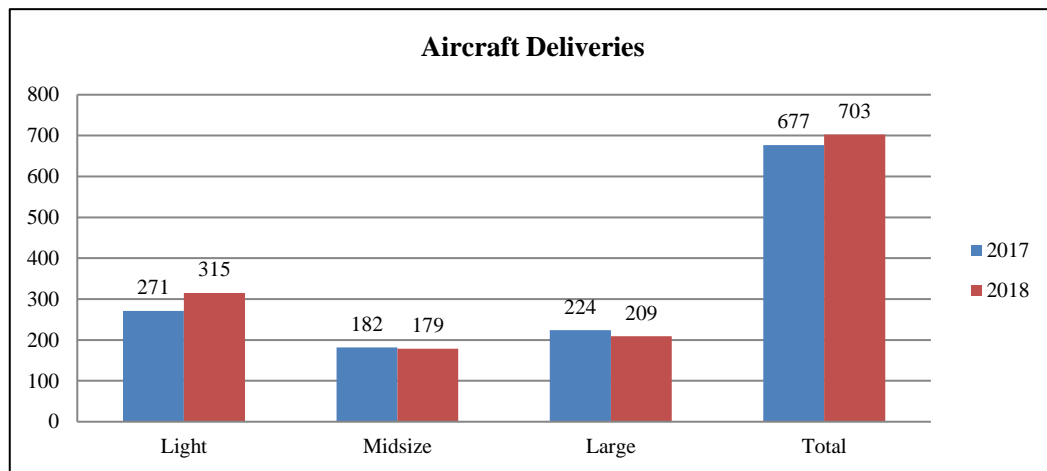


Figure 6: Business jets deliveries (2017-2018)

Europe is far from leading in this market. Of the total number of business jets delivered worldwide in 2018 (703 units) and billed at \$17.8bn, only 60 were manufactured in Europe, billed for a total of just over \$3bn. Dassault shipped just 41 Falcons (down from 49 in 2017 or 95 in 2010).

### 4.3 PARE Recommendations on Business Jet Topic

EU is participating rather timidly in the volatile business jet market. After the analysis undertaken, we can say that only the competitive position of Dassault in large cabin business jets is notable. Its main rivals, Bombardier and Gulfstream, diversified their offer with military applications which considerably improve their business cases parameters. A similar approach by Avanti, however, did not prevent the bankruptcy of the manufacturer. In answering to PARE Objective “Strengthen the position of the EU in the business jet market”, the Report is recommending a stronger support of the development of European business jets and their expanded use as sensor / surveillance / control platforms.



## 5. Helicopter market

### 5.1 The helicopter market volatility

The helicopter market position is one of Europe's major successes, with Airbus helicopters a world leader and Agusta-Westland another successful player on this market [16]. They are competing against Boeing-Vertol, Bell and Sikorsky (Lockheed-Martin) from the U.S. as well as against Mil and Kamov from Russia. The helicopter market has some stable elements like search-and-rescue, emergency medical evacuation and law and order protection. Other elements are more volatile and vulnerable to large fluctuations. During previous decades, the helicopter market expanded due to:

- The wars in Iraq and Afghanistan leading to high demand for rotorcraft due to the lack of local infrastructure to support rapid mobility on the ground and the risks with the proliferation of roadside bombs;
- The high oil prices fostering the offshore oil prospecting and exploration supported by medium and heavy helicopters.

The decline in military operations in Middle East and the reduction in oil exploration due to the lower oil prices, caused a reduction of both the military and civil helicopter markets, that are slowly recovering.

Faced with reducing order books, the American helicopter industry is pressing the US government mostly through the armed forces to end decades of stagnation in helicopter technology, as the focus was on the production of existing types and derivatives. The aim is to supplement mature production programmes with contracts to develop new models that can then be produced as replacements for the existing vast fleets, even if on a reduced scale of less than one-on-one. The expectations of increased performance are focusing on:

- Greater hot-and-high capabilities, overcoming the existing performance degradation of current models in those conditions, by using more powerful propulsion and rotor systems;
- The larger power can also result in increased speed, payload and range and shorter reaction time.

Although these developments are driven by the military, the results in improved performance will be transferred to the civil market sooner rather than later.

### 5.2 Tendencies for the Future of Helicopter Market Demand

Some threats to Europe's market leader position might come from the very ambitious US's Future Vertical Lift programme to design helicopters or tiltrotors with: twice the range; 50% higher speed; over twice the hover payload under demanding hot and high conditions, using engines with double power but similar fuel consumption, size and weight [19]. The programme is justified by the need to counter threats from near peer adversaries in Europe and elsewhere: hence it is relevant to the defence of Europe. The FVL contenders are the V-280 Valor tiltrotor from Bell and SB-1 Defiant dual rotor plus pusher-propeller helicopter from Boeing and Sikorsky; Europe has analogues in the Augusta-Bell AB609 and Airbus X3, as well as competitive turboshaft engines from Safran and Rolls-Royce. It is already demonstrated that the tiltrotor configuration is providing the highest top speed (Defiant reached 518 km/hr in 2018), however its manoeuvring capabilities are inferior to rotorwing machines.

Although it is a military programme, it could have civil spinoffs: (i) double-range for off-shore oil industry; (ii) higher speed for medical emergencies and executive transport; (iii) greater payload for rescue and transport missions. All this could challenge the current position of Europe with over 50% of the world helicopter market share. The strong U.S. investment in greater hot-and-high and high-speed capabilities must be matched if Europe wants to maintain long term market share.

Russia is also funding the development of an advanced high-speed helicopter. The Central Aerohydrodynamic Institute (TsAGI) has confirmed on 27 November 2018 that Kamov Design Bureau started work to create a flying laboratory on the basis of the Ka-52 helicopter. The concept feature a 'delta' fixed-wing, co-axial rotor system, a side-by-side cockpit, and pusher engines in the rear similar to what is used on the Sikorsky S-97 Raider and SB-1 Defiant. The co-axial rotor system will be driven by twin engines. It is expected that new technologies will provide more speed (probably about 400 km/hr) and range and better fuel efficiency.

Europe must match the U.S. and Russian efforts if it wants to keep its leading position in the world helicopter market. Safran Helicopters is introducing a new family of turboshaft engines to compete with the advances made in two military U.S. programs. The Airbus X-3 [20] (Table 1) has gained the world helicopter speed record 472 km/hr, in 2013) showing that Europe does not lack the technology or ingenuity. Airbus Helicopters has recently unveiled the aerodynamic configuration of the high speed demonstrator it is developing as part of the Clean Sky 2 a European Union project seeking ways to reduce aviation's impact on the environment. Codenamed Racer, for Rapid and Cost-Effective Rotorcraft, this demonstrator will incorporate a host of innovative features and will be optimised for a cruise speed of more than 400 km/h. It will aim at achieving the best trade-off between speed, cost-efficiency, sustainability and mission performance. Final assembly of the demonstrator is expected to start in 2019, for a 2020 first flight.

The RACER is the flagship concept aircraft for Clean Sky 2. Under the Clean Sky aviation banner, more than 600 entities in 27 countries are working together to develop “environmentally benign” aircraft tech, with the goal of reducing fuel consumption and carbon dioxide emissions by 50 percent, nitrous oxide emissions by 80 percent and external noise by 50 percent, compared to 2000 levels.

Table 1: Competition for future high-performance helicopters and convertibles

Helicopters	Maximum speed	Maximum altitude	Cruise speed	Service ceiling	Rate of climb	Tip speed	Autorotation
<b>Eurocopter X3</b>	472 km/h (293 mph/255 kn)	10.000 ft (3,048 m)	407 km/h (253 mph; 220 kn)	3.810 m (12.500 ft)	28 m/s (5.500 ft/min)	0.91 Mach	2.800 f.p.m.
<b>SB-1 DEFIANT</b>	475 km/h (295 mph/256 kn)	6.000 ft	463 km/h (250 ktas)	3.000 m)			

However, the massive resources being put into high-speed helicopters and convertibles in the U.S. leave no room for complacency: the advances there must be matched on this side of the Atlantic in a competitive or cooperative but coordinated program.

### 5.3 PARE Recommendations on Helicopter Market Topic

Another major PARE Objective is to maintain or to enhance the current helicopter market EU leadership. After the PARE analysis, we recommend that EU spends all efforts and all necessary resources to ensure that its industry keeps at least abreast of developments in high-power high-speed helicopters and tiltrotor aircraft with enhanced hot-and-high lift capabilities. The aim here is to safeguard against potential surprise breakthroughs that could change Europe’s market leading position. There is a need for a program with a minimum investment to ensure that Europe does not fall behind. It is not necessary to match the massive US funding of FVL. The result of FVL could be as expensive as the Bell V-22 Osprey with small effect on the market; or it could like the RAH-66 Comanche lead to no significant production after years and billions of investments. The aim here is to safeguard against potential surprise breakthroughs that could change the European leading market position without making large speculative investments.

## 6. Military UAV

### 6.1 Current UAV market demand

Under the general term of Unmanned Air Vehicles (UAVs) a very wide spectrum of equipment addresses a multitude of applications. For the scope of this paragraph, the discussion will cover only the large Unmanned Combat Aerial Vehicles (UCAVs).

In this sector, Europe is far from being competitive. An example not to be followed is the case of its UCAV projects. In Europe there is no shortage of technology, as proved in the UK-only Taranis program, the German Talarion, the Italian Hammerhead and the multi-national Neuron led by Dassault. However, none of those has reached production. The projects are at an early stage with no guarantee that leadership and nationalism issues have been resolved. The recent official abandon by France’s and UK of a 2010 UCAV joint programme with no pertinent explanation is a sad example. Consequently, Europe is buying Global Hawks, Reapers and Predators from the U.S. and Herons and others from Israel. The in-development US programmes using Artificial Intelligence (AI) like Loyal Wingman and Skyborg have no EU equivalent at present.

Other countries had progressed in this field, ahead of Europe. The reluctance of the United States to export armed drones has allowed China to take a leading position as the supplier of such systems in Asia and the Middle East. The efforts made by the Chinese to develop a wide range of almost state-of-the-art drones and the willingness to export them at unbeatable prices creates a market advantage that will be difficult to challenge. India is working hard to develop UCAVs, Turkish Aerospace is also a player on this market with their Anka product.

It is essential to have either one common or several competitive programs that go beyond studies and prototypes into production

A priority objective identified by PARE is eliminating the embarrassing EU handicap in industrial development of military UAVs. This field seemed neglected and some un-coordinated efforts have not been completed. The consequence is the procurement by some EU countries of non-EU equipment.

A supplementary incentive to focus on this field is the modern application of military Medium Altitude Long Endurance (MALE) UAVs as civil maritime patrol systems. Recently a contract worth about 60m Euros was signed by European Maritime Safety Agency to use Elbit Hermes 900 UAVs, produced in Israel. Europe needs such long-range patrol activities to survey environment, e.g. oil spills, or to monitor refugees traffic. It is a pity that a EU source is not yet available.

## 6.2 PARE recommendations on UAV market topic

Since the necessary expertise, industrial basis and financing sources definitely exist, the European industry should provide an European alternative to the UCAVs currently used in Europe, with potential to also enter the world market. PARE is recommending leveraging the technological capabilities demonstrated in several prototype drones into a coherent European Programme covering all levels, to satisfy internal needs and compete on the world market.

Europe has the technology to develop all classes of UAVs that are increasingly relevant to a wide range of defence and civil missions, so the issue is one of coordination in the allocation of resources.

There must be an end to the European dependence on foreign UAVs, and a move to enter the international market, since there is the technology.

## 7. Conclusion

EU needs a comprehensive strategy in the development and production in all branches of the aviation. While the Large Transport Aircraft, the Regional Aircraft and the Helicopter EU industries must concentrate to defend their world markets leaderships, in other fields like UCAV they have to fight an up-hill battle in which the competition already advanced in acquiring valuable experience.

The important deployment of the LCCs in terms of new routes and more flight frequencies has generated and will continue to generate important demand on single-aisle aircraft. By then, the low-cost market is counting on 50% of all seats until 2027. Already, the European LCC market assumed 45% of the capacity share in Europe. Since LCC rely on extremely efficient in new aircrafts, corroborating this with the high demand for air travel, the result is high orders for commercial aircrafts single aisle, which will support the competition between the two main competitors: Airbus and Boeing. Single-aisle aircraft will be reflected in 65% of the deliveries, representing 49% of the delivery value, targeting the 150-seat size configurations, while the twin-aisle sector will have few slots available in the next 5 years— the popular B787 and A350 will reach their planned production rates in 2019 [21].

The dynamics of the aviation markets are rather accelerated. In the last 8 months, since the publication of PARE Year 1 Report, some important events happened in aviation world: the announcement of the end of Airbus 380 production in 2021 and the two catastrophes of Boeing 737 Max. They might produce unexpected consequences in the course of the aircraft market with possible important changes in the current forecasts. Already, some airlines have modified their orders in terms of fleet mix and more reconfiguration is expected in the near future. The EU industry should be prepared to adapt efficiently to the new conditions and to consolidate its positions in all the specific markets discussed above.

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