LONG-TERM CHALLENGES FOR AIR TRANSPORT AT THE HORIZON 2030

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CONTEXT AND MOTIVATIONS

Since the advent of commercial air transport, overall air traffic in the world has shown continuous growth. Even the worldwide impact of such conflicts as the Gulf War of 1991 and the events of 11 September 2001 have depressed air traffic growth for several months only. As a result, future air traffic growth tends to be accepted as a certainty, especially inside the air transport industry.

However, a number of signs are appearing in Europe such as airport congestion and capacity limitations, volatility of oil prices, concerns for the global climate, environmental legislation, etc that raise questions about future continuing growth. Is air transport reaching maturity in Europe? When and how will air transport experience traffic stabilization? Which are the main drivers behind the evolution of air traffic? What are the risks and how can sustainability of air transport be reinforced? From that which is perceptible today, which influences will prove critical in the future?

These questions were raised in EUROCONTROL, the European Organisation for the Safety of Air Navigation, which regularly produces short-, medium- and long-term forecast of air traffic volumes for Europe in terms of number of aircraft movements. In addition, two major ECAC-EUROCONTROL studies on Air Transport future evolution at a 20 years horizon, namely “Constraints to Growth” in 2001 and “Challenges to Growth” in 2004 (CG04, ref 1), have for several years provided a foundation for Long-term strategic planning in Air Traffic Management (ATM). The 2001 and 2004 studies became the cornerstones for all the European ATM planned activity afterwards; i.e. a baseline on which implementation programs were build in EUROCONTROL and now in SESAR.

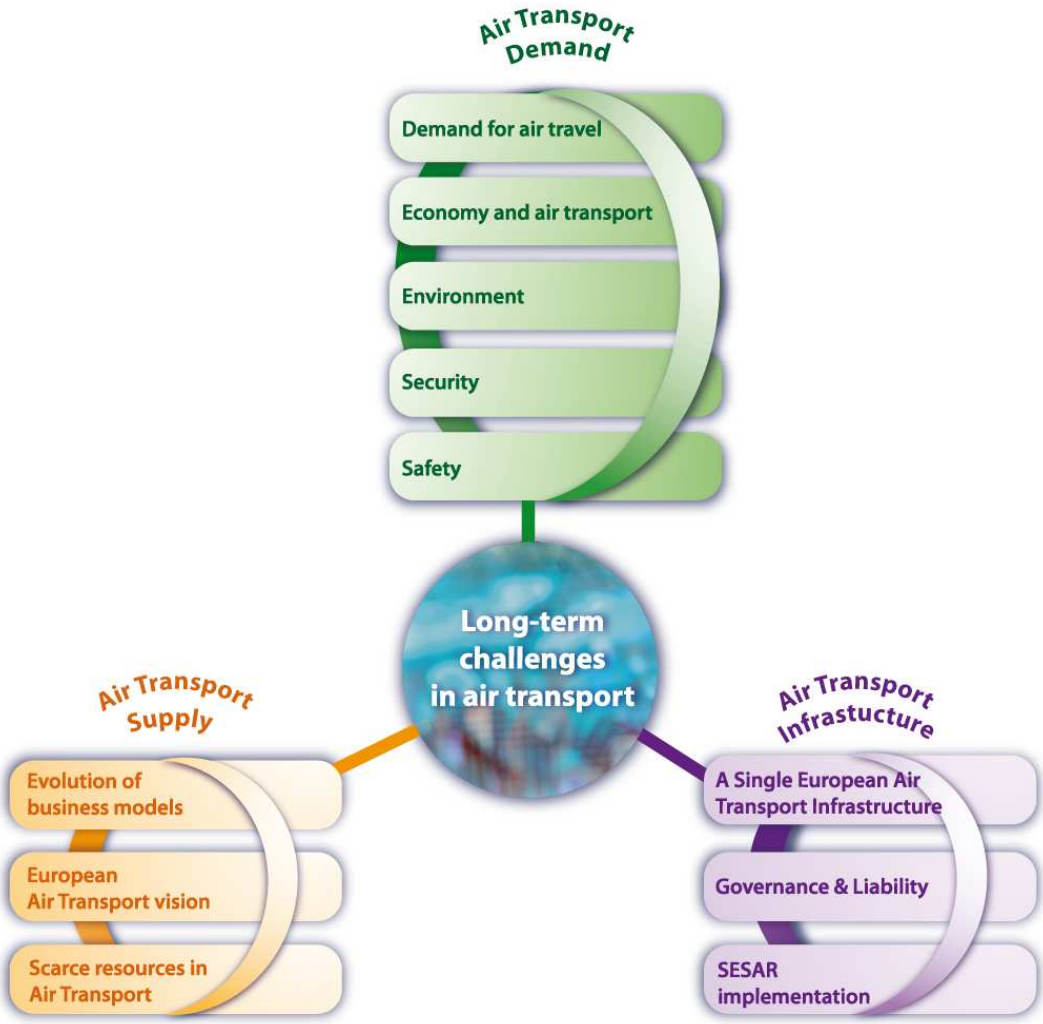
For the 2008 “Challenges-of-Growth” study (CG08, ref 2), basis for all the work done on air transport infrastructure now, a qualitative survey motivated by the above questions was conducted (ref 3), in complement to the quantitative studies involved in the main CG08 study. Exploring expert views about the socio-economic challenges of air transport and ATM, looking at passengers rather than aircraft movements, its purpose was to provide a vision of what the evolution of Air Transport will be over the next 20 years and to explore possible factors that cannot be quantified but that still may have an impact on air transport at the

horizon 2030. The findings reinforce the challenges identified in the main CG08 study report, while providing a wider perspective on decisions affecting future air transport evolution.

THE SURVEY

The present survey aimed at collecting views across the air transport industry about the long-term challenges in air transport to 2030. Over 40 high level leading experts from the EC, the European Environment Agency, IATA, ACI Europe, ASD, Air Traffic Alliance, Airbus, CANSO, IFATCA, experts from airlines, ANSPs and Research Establishments, and EUROCONTROL were interviewed in 2007-2008 on their views about the challenges in Air Transport by 2030. The interviews were anonymous and conducted in a non-directive manner so as not to influence the expert views. The interviews were recorded, analysed and processed into a qualitative survey report (ref 3).

The views expressed by the experts fall into three broad categories related to air transport: demand, supply, and infrastructure, broken down in sub-categories as follows.



The report provides a 'snapshot' of leading opinions about air transport long-term evolution drivers as perceived in 2008, and do not purport to represent the views of EUROCONTROL or of all the interviewees.

RESULTS IN A NUTSHELL AND FOCUS OF THE PAPER

Most of the views reflected a single, remarkable vision: although air transport growth faces serious challenges, a stable trend of growth is perceived for the long-term, even if the political and economic climate may affect its rate. The current crisis, happened after the survey, will have profoundly affected traffic growth expected to recover by 2011, but will not affect the long-term trend. The main driver behind air traffic growth will remain the overall demand for air travel, which will continue to increase regardless of any changes taking place in the future.

The detailed analysis of the views expressed in the survey (ref 3) reveals 16 main challenges to growth, presented in the next section. Then, in the following sections, a focus is proposed on drivers of evolution in air transport on the demand side and on the supply side, as expressed during the survey, still valid because they address the long-term.The intention is to provide insight into the likely evolution of business models in air transport, in view of the evolution of socio-economic factors. Finally, the paper opens on other initiatives and studies undertaken in the sector in parallel with the survey with the aim to deepen understanding of factors influencing air traffic evolution.

THE 16 MAIN CHALLENGES

An understanding of the following 16 main challenges expressed in the body of opinion in the Survey (ref 3) is vital for planning the future of air transport.

The main challenges to growth of air traffic are socio-political and economic on the demand side: fuel and ticket prices, public environmental awareness, and possible restrictions on the use of fossil fuel. Views on challenges of growth included considerations on the evolution of business models in air transport supply for airlines, military and new airspace users, airports and the manufacturing industry. The following sections of this paper address those challenges in more depth.

A category of challenges not detailed in this paper is the number of considerations devoted to the modernization of air transport ATM infrastructure through SESAR, the Single European Sky ATM Research progamme. SESAR is a pan-European project financed by the European Commission, EUROCONTROL and the Industry to define and develop a new ATM system to be deployed in phases from 2013 onwards. The expert views highlight the necessity of modernizing air transport infrastructure through SESAR. The successful implementation of SESAR requires: workable solutions for meeting European regulation; dealing with liability and sovereignty issues in an industrial sector concerned with the safety and security of citizens; and solving the implicit financing challenge of a large transport

infrastructure serving multiple stakeholders. The air transport system must pursue ATM network defragmentation; and, because of the increasing scarcity of its resources (e.g., slots, frequencies), should move towards a network congestion management approach. The new ATM concepts will change the role of human operators in the system, requiring more research, effort and innovative solutions during the transition phase to address safety and standardization issues.

1. Fuel and ticket prices

Fuel price increase, including any alternative to oil, is a long-term trend that will profoundly restructure the air transport market, but oil prices will not be a "show-stopper". Ticket price is probably at the bottom of its curve.

2. Environment

Environmental awareness will dramatically modify Society in the longer term. The image of Air transport in the public mind has been tarnished by its perceived impact on the environment. The main levy to reduce aviation emissions will be to reduce travel demand through taxes and/or individual emissions quotas.

3. Restrictions using fossil fuel

Political or financial restrictions on the use of fossil fuels will likely come into force, but Society will need alternative fuels and technologies. In aeronautics, the product has a 30 to 50 year lifespan, so 2020 is no longer the horizon to view. IATA challenges the industry to build a zero emission aircraft on the 2050 horizon.

4. Security issues

Dramatic events have a detrimental effect on the growth of air transport. Security checks add an additional burden on travelling. Security issues for R&D include crisis management, filtering (with solutions such as “the trusted passenger”) and attack-prevention through airport and aircraft protection technologies.

5. Planning and understanding future travel needs

The air transport world makes forecasts and predictions, but fails to understand the influencing factors. An in-depth understanding of these factors would help refine projections so as to improve orientation.

6. Sovereignty and civil-military cooperation

National borders are limiting seamless operations in European air transport. The Single European Sky initiative aims to modernize European ATM. However, the EC has no competency over military matters. The population is not ready to delegate sovereignty to Europe. There are no votes to be won by giving up the airspace. Politicians need a crisis before they can take difficult decisions about the sovereignty aspects raised in SES by the Functional Airspace Blocks (FABs).

7. Liability issues

In 2020-2025, multiple bilateral State agreements to address sovereignty in FABs will probably be replaced by a General Agreement. Delegation of airspace involves human responsibility and legal liability issues. In the very long-term, States will probably have freed themselves from their safety liability (Article 28 of the Chicago Convention).

8. EC “market led” economic regulation model

The EC’s model of regulation is “market-led standardization” and relies on the companies involved. This model is imposed on ATM, where safety is much more critical than in other sectors. Applying economic efficiency rules to safety does not work. Regulated economies need strong States, i.e., competent, with legal and technical powers, and able to resist powerful companies and lobbies. ATM requires a strong regulator with strong technical expertise, which defines the vision and guidelines and “creates” the market by standardization and certification.

9. Financing the air transport system infrastructure

On the airspace users’ side, the costs of the infrastructure investment (including SESAR) needs to be shared between the users with equity (e.g., the payers should be the beneficiaries). The military will incur enormous costs to achieve compliance with SESAR. Airlines will have to equip their fleet to fly in the SESAR airspace. Even for ANSPs and States, the legacy systems will be very expensive to upgrade.

10. Network de-fragmentation

Europe is full of vested interests, and fragmentation is difficult to overcome. For instance, ANSPs are small businesses that want to survive. They are supported by the drive for autonomy and sovereignty, which will exist as long as Europe does not have an integrated defence - probably in 2030-2040 timeframe. In a European landscape, on the basis of common standards and system architecture, it is important to know who is in charge of regulation, specification, system construction, and certification - and, of course, who is in charge of operations and operators.

11. Scarcity management

Air transport is moving from unlimited resources (runway, airspace, fuel, emissions, time, etc.) to scarcity. The issues will no longer be to increase capacity to cope with demand, but more so to manage scarce resources. Airports, runways, TMA, and the frequency spectrum will be scarce resources for air transport.

12. Changing role of the human operators in the 2050 ATM system

The three-fold increase in traffic in the very long-term (2050) will require more automation. The role of human beings in the system is being questioned. The operating roles will be subject to radical change. This will trigger resistance aimed at maintaining the status quo, using safety as a pretext.

13. Safety of complex ATM systems (safety culture, legal risks, system of systems)

Safety is a pre-requisite for air transport. Society is increasingly less tolerant of risk. In the context of modernization of the ATM system based on human-centred automation, where the role of human beings is being redefined, maintaining safety levels implies a number of challenges (risk of criminalization of professionals, resistance to economic pressure, and the difficulty of assuring safety for an automated system of systems).

14. Lack of competent resources in the transition phase

Change will be slower than expected. There are significant cultural and operational maturity differences within Europe. Where maturity is low, basic problems will have to be solved before significant advancement in the human performance, safety, and security areas becomes possible. In particular, there are not enough human resources in the EU available for the SES implementation in the transition phase (day-to-day operations, R&D, training, certification, regulation).

15. Standardization issues

In the USA, organizations for standardization are stronger than in the European scattered model. This can favour US manufacturers. If European aviation standardization goals are for Europe only, they are not suitable. Several worldwide successes for EU aerospace standards show that there is room for voluntary action and international cooperation. However, current standardization processes and financing may not be effective enough to cover future needs.

16. Innovation in ATM

ATM has a very slow innovation rate (15 years as compared with 3-7 years on the flight deck). Apart from the obvious problem of ageing technology, this means also that available technology on the flight deck cannot be exploited by the ground infrastructure. Certification is a slow process and must be accelerated. Some experts are disappointed with the rate of development in the SESAR Definition Phase (not ambitious enough). SESAR has adopted the trajectory-based concept without exploring other concepts. For instance, separation remains based on sectors. The challenge is to satisfy the objectives of economic, operational and environmental efficiency.

A FOCUS ON SOCIO-ECONOMICS OF DEMAND

This chapter is constituted with a selection of the expert views on air transport demand, in particular the most challenging drivers of possible breakthrough from the past growth trends.

1. Demand for Air Travel

An increasing demand for air travel is the first challenge to the future of air transport. The instinct to explore new horizons is probably written in the human genes. The willingness to travel is an outcome of people's curiosity, which some refer to as "the hunter instinct of man", and others as "L'homme nomade" [Attali J., L'Homme nomade, éd. Fayard, 2003]. Over the ages, the average time spent travelling has not changed. Humans simply travel farther with technological developments.

Demand for air transport is heavily influenced by the economy and the demographic evolution. According to the UN Demography Report 2008, the world population is going to increase to 9 to 10 Billion people by 2050. Air traffic demand for passenger and freight, even if this is undesirable from an ecological perspective, is likely to continue to increase.

Some experts believe that worldwide economic and social uncertainties, associated with various factors, such as environmental concerns, infrastructure, perceived inconvenience of flying, imply that predictions for passenger growth are flawed. However, evidence indicates that overall demand does not reduce, but instead adapts and spreads. Constraints influence demand, which in turn influences supply. If air traffic growth is constrained (e.g. by capacity limits or regulation and/or by price increases), then demand changes and supply adapts and restructures.

Leisure Travel

The development of competition between airlines, which followed air transport deregulation, coupled with more efficient and less costly aircraft technologies, has brought air transport democratisation. Tourism is an important contributor to air transport growth –and vice versa-. About 69% of air journeys made by Europeans are leisure trips. Demand for leisure-driven air transport will probably continue to grow.

Determining how leisure air travel demand will evolve in the future requires understanding how passengers make their decisions to travel and how behaviours and needs will evolve. A recent study of the characteristics of air travel demand in 2025 has a likely increase in the level of air travel demand for:

- the purpose of Visiting Friends and Relatives (VFR)
- retired people;
- as a way to escape from the very fast rhythm imposed by society

In addition, it foresees that:

- demand for individualised travel would increase;
- only higher air fares or regulation measures limiting supply levels will lead people to reduce their air travel demand.How to improve long-term demand analysis methods in general?

Professional Mobility

Professional mobility, second to tourism and leading to migration flows, remains an important driver of air transport demand. Moreover, professional mobility is supported by the EU as a channel for developing the future European economic model.

A view not shared by all is that business travel might decrease as an outcome of the development and accessibility of communications technology (Video-conferencing, tele-working).

- Air travel might increasingly be used by senior management and high-level sales executives only, on a point-to-point basis, from less constrained airports, resulting in the development of the business model for Business Aviation in Europe.
- However, video-conferencing is not yet viewed as a serious alternative to travel: people still usually prefer to travel with the experience of human interaction.
- In addition, some people might opt for a remote residential location for enhanced living conditions, while travelling to various workplaces several times per week.

Finally, emerging economies attract business activities, which act as a catalyst for more transport and travel movements until levels of wealth begin to reach towards those in developed nations. In the future, there is likely to be very strong growth along these lines, comparable with the doubling of air traffic every 20 years as observed in the West, in Asia (especially China), Russia, and Latin America. These emerging economies seeking access to the same travel modes and behaviours as the developed countries, may lead to significant growth in demand.

Freight

Over the long-term, maritime and air transport continue to experience growth markets for freight, although this represents a small share of European traffic compared with passenger transport. Both raise environmental issues that must be addressed. Air transport allows for just-in-time delivery. The share of freight is therefore growing in air transport. Lufthansa has built a huge freight hub in Central Asia, linking South East Asia, South Asia and Europe.

Freight has a huge potential for increased traffic, which will add stress to the system. Freight has not been looked at sufficiently.

2. Economy and Air Transport

A 6% growth in global air transport demand has actually been the standard for the last 60 years. Air transport growth over the long-term has exhibited a stable trend, even through economic stagnation and recession. Although economic forces have exerted a negative impact on demand in special circumstances (for instance, the 1970s oil crisis), traffic is seen, historically, to return after negative periods. Forecast air traffic growth is the highest for any mode of transport.

Air transport is seen by many in the industrial and the political arena as being of special importance for the European and global economy. Economic and transport growth, in particular air transport, are generally seen as inter-linked. Macro-economic factors affecting air transport evolution are global GDP, fuel price, and ticket price.

European aviation in the global economy

One of the main challenges for European air transport is the global economy. Although there are short-term fluctuations, China and India will face major growth. These nations will become such big players in the global economy that Europe might fall behind in 10 to 15 years with regard to air transport. Already, the 2008 Olympic Games triggered an interest in China for Central Flow Management (CFM).

Compared with Europe, emerging economies are less constrained, for example, with regard to airport expansion. In some remote nations around the globe, aviation is vital to the economy. Roads and high-speed trains are absent from these places. Air transport therefore becomes the sole connectivity, and consequently governments invest heavily in facilitating aviation. The aviation of emerging economies is therefore in competition with EU aviation.

For some experts, this is a serious problem for Europe's economic competitiveness in the world, reinforced by the attitude of European governments who do not act to promote air transport. Rather, air transport in Europe is one between other modes of mass transport, perceived as a luxury more than a necessity, with good alternatives. However, air transport is one of the central arteries of the global economy through the transport of goods and citizens. Artificially constrained by political decisions, this would damage the EU's economy, which could initiate a vicious cycle of recession.

Fuel price

Over the long-term, the biggest concern for the air transport industry is the cost of fuel, either oil or alternative fuel. Profitability, reduced costs and return on investment are the key factors that govern organisations like Airbus, Boeing, and the airlines. For the financial well-being of a commercial air transport operator, fuel cost is the greatest issue, as this represents the

main part of its operating costs. This depends on fuel price and fuel burnt. Ever since its beginning, air transport has been fuelled by oil derivatives.

Aviation technological improvements to reduce oil consumption bring less and less benefits. Furthermore, no complete technology breakthrough is expected within the next 20 years. After 2050, other solutions should appear, in the experts' opinion, at a price likely to be higher than oil. Nonetheless, the search for alternative fuel will probably affect other modes of transport before air transport.

Demand and availability of oil will be important factors for air transport evolution as these drive fuel prices. The oil price will increase, as in the long-term oil demand is likely to increase faster than supply. Oil price is not yet driven by scarcity. Global oil reserves for the next 80 years are probably greater than the estimations, and oil availability does not mean actual physical limitations for air transport. After all, air transport accounts for 3% of global fuel consumption, and even if doubled would still only represent 6%.

Fuel price is not going to be a "show-stopper" for air transport, even if its volatility makes business planning extremely difficult. Without additional political intervention, a higher fuel price will only reduce air traffic growth. Air transport is probably the only consumer that could afford fuel even at USD 500 per barrel. At such fuel price, air transport would become a luxury product again. Demand for air transport would be affected, particularly for low-cost leisure travel, less so for long-haul business where ground transport competition is low.

Ticket price

Today, the cost of air travel may well be at its lowest ever. Competition between airlines is driving ticket prices down, which, in turn, sustain air transport growth. The ATM community is creating an increasingly efficient system. Airlines are becoming far more efficient in the way they operate their businesses; and they have significantly reduced overhead costs.

However, fuel price and tax increases may well drive prices up again. In Europe, the political signs are that air travel is considered too cheap; this could potentially have a strong negative impact on demand. We are probably at the bottom of the curve of disposable air ticket prices, without knowing where they will be 20 years from now.

Nevertheless, in the long term, ticket price increases might still allow for growth in demand. A quick economic analysis shows that, even with pessimistic hypotheses, demand will still grow by 2.5% in developped economies in the period 2005-2025.

Sustainability

How can sustainability be achieved in the future? Concerns are voiced over the lack of consideration for sustainable growth in air transport, when capacity is seen as the major objective. Whatever the oil price, industry is still building more and more aircraft, which will be in use for the next 20 to 30 years. Also, something seems to be wrong when considering how low travel prices are today.

The air transport industry is perceived as complacent: it seems to understand "sustainability" only in terms of improving environmental performance of flights, whilst continuing to develop aviation both for short-haul - often in competition with other transport modes - and for long-haul, and counting on the Emissions Trading Scheme (ETS) to compensate for its emissions. For many, this represents a failure to take appropriate transitory measures and assume social responsibility.

3. Environment

More and more people are becoming aware of the impact of human activities on the environment. Environmental issues will shape future societies, far beyond small measures such as the Kyoto Protocol and the Rio conference. For some experts, the CO2 problem is a "joke" that will be solved within 50 years. By 2030, the real problem for humankind will probably be the difficulty of feeding a global population of 9 billion human beings. There is a need to be more serious about the environment if we are to achieve the sustainability of our societies.

Some experts consider that there is no understanding of the impact air transport has on the environment, and how climate change may affect demand and traffic flows. Environmental issues will have a constraining impact on air transport if these issues are to be tackled to provide high mobility with increasing demand for travel. In the future, they will probably bring stronger regulation of air transport, such as a cap on fossil fuel usage or limitations on the free use of airspace. This will add to the issue of capacity. Green aircraft will appear by 2040-50. However, green engines are still a challenge as today no other energy source (apart from nuclear) can replace oil. Environmental issues will modify the supply industry. Certain business models will not be sustainable, and only the biggest carriers will survive. Almost no new airports will be built.

The environment is probably the biggest challenge to air transport in the long term. There are many aspects to this challenge, but political attention is driven by societal concerns about climate change, and focuses therefore on emissions. At the level of airports, noise issues are also attracting close attention. Environmental impacts of aviation raise the question of social equity: those who benefit are not those who suffer. Finding an acceptable balance in this regard is one of the challenges of sustainable air transport. The environment shapes air transport, but does not block it. This is essentially a socio-political challenge.

Emissions reduction, a political target

The environment is a growing public concern that might dictate limits, but these depend on political, behavioural, and societal changes and will manifest itself economically, and in terms of changes in values and consumer behaviour. The implications for both are not yet clear.

Air transport is unlikely to significantly reduce its emissions by 2030 in absolute terms. The amount of emissions from air transport will grow if demand is to be satisfied. The rate of

increase in emissions is the square of the increase in speed (and aircraft are fast). Therefore, emissions cannot be reduced by 30% of what they are today to accommodate three times the current traffic in the long term.

Some experts think that CO2 emissions must be limited as far as possible, otherwise growth cannot be accommodated. In addition to the technological improvements on the aircraft side (ACARE), which will not counterbalance the increased production of CO2 (because of traffic growth), the Emissions Trading Scheme provides a good solution to compensate for the CO2 produced. In any case, the contribution of aviation to global CO2 emissions is relatively small.

Other experts consider that there is a need to get the priorities right. The most important issue is the climate change and the reduction of emissions. A combined solution is needed between the best possible technology and reasonable taxes on emissions to achieve a general reduction of emissions.

Shaping the industry with respect of the balance between transport needs and environmental action is a challenge not only for air transport actors but for society as a whole. If society wants to have a dynamic air transport system with the capacity for growth, but without being able to reduce emissions, society will have to reduce emissions in other areas. Emissions-trading is a way of accomplishing this balance.

In the US, the perception is that growth in air transport will come from point-to-point flights with smaller aircraft, thereby increasing the overall quantity of emissions. However, there won't be regulations in the US to cut emissions.

In Europe, there will be a strong political drive, not only to stabilise, but to reduce overall emissions. Since 1995, the EU has stabilised its total CO2 emissions (and even reduced them by 3%). But, at the same time, transport growth was 25% and air transport growth was 90%. Cars can still do much better. In air transport, engine technology has achieved a great deal. Aircraft weight can still be reduced, but there is a limit.

If European politicians decide to curb transport as a way to reduce emissions, the public reaction might be a trade-off in favour of cars against aircraft. This would be supported by the concept of quotas such as the “Individual Carbon Footprint”. People would have to choose between several ways to use their emissions entitlement. This idea of a quota per inhabitant is considered as probably the biggest danger for air transport. There is a comfort zone in being able to finger-point air transport as the main cause of excessive CO2 emissions than to look into private car emissions. Every transport sector will have to play its part in being environmentally responsible. But air transport is the fastest growing sector, and this raises concerns. There are diverse sources of information in circulation about the air transport industry. An informed debate in society (and within the industry) about the real impact of aviation on the environment and society is therefore very difficult, although usefull in light of the very bad image of aviation.

Noise versus emissions

Historically, noise has been the main concern at the level of airports. Airports have been involved in environmental management for a long time with water and waste processes. Traffic movement caps were, and often still are, a part of noise reduction programmes. However, emissions are becoming more prevalent. In addition to the debate on global emissions, local emissions can prevent, restrict, or even stop infrastructure development. Much better air quality at airports will be a future requirement. Hence, long taxi routes and long waiting times for take-off or taxi clearance will become unacceptable. Airports are now working to become carbon neutral. The definition of this concept is not yet clear. Apart from the airport itself, this may come to include activities in commercial areas (shops, restaurants, etc.), landing and take-off of aircraft, and the local traffic around the airport site.

However, the combination of all noise, local emissions and global emissions constraints will make it difficult for airports to optimise operations. For 15% of European airports, environmental issues are limiting factors. As traffic increases, so do the environmental constraints. There is a continuous debate about the possibility of pertinent annoyance indicators between the aviation industry and airport neighbours. Current initiatives are exploring the potential for co-formulation of such indicators. In the future, there is an expectation that societal resistance to pollution from air transport should become more constructive (i.e. working with, and not against, the air transport industry). Compensatory measures will probably become more widespread.

When building aircraft, environmental issues -emissions and noise- are always of concern. However, the two factors have different impacts. Gaseous emissions, such as CO2, are both local and global. These are cumulative and must be reduced. Noise, on the contrary, is a local issue, but the public is becoming more and more aware of noise. Over the years, the noise signature of aircraft has been greatly reduced. The problem for engine design is to balance the reduction of emissions and noise, as they can conflict with each other. The reduction of noise can affect the economics of operating the aircraft. Political considerations should not be so short-sighted as to forsake long-term global issues for short-term local ones. In the trade-off between noise and emissions reduction, most experts agree that the preference should be given to emissions reduction.

Economic regulation

Emissions reduction will only come through rising prices and taxes - or quotas and the related trading schemes. An increase in the cost of travel should lead to a decrease in emissions.

Regulatory solutions concerning air transport supply include the participation of aviation in the Emissions Trading Scheme (ETS). As a result, the air transport sector ends up with a quota system, and the large impact on the cost of air travel will be passed from airlines by charges to passengers. The participation of the aviation industry in the ETS is rather well accepted in the industry. The ETS is seen as a good economic measure to compensate for emissions.

However, the ETS receives some criticism. It is sometimes viewed as a “right to pollute” more than a solution for environmental issues. If not expensive enough, the trading scheme will not be an incentive to invest. Otherwise, it would affect ticket prices and demand.

Reducing demand to cut emissions is possible via political measures. For instance, the EU is thinking of developing a taxation system that would render short-distance air transport trips very unattractive where an alternative to air transport exists. There is also the idea of individual quota to simply apply eco-taxes, e.g., on tickets, resulting in higher ticket prices.

These measures raise a number of questions:

- what would be the impact of a price increase on ticket sales?
- what would be the impact on airlines charging emission taxes on passengers (environmental strategies, economic health, transport market, etc.)?
- what would be the impact on the European market? Would there be delocalisation of business? How would economic growth be affected?

4. Summary

There is a strong potential for growth in demand for air travel, driven by demography and economy, as air transport growth is linked to the economic development. However, air transport depends on fuel availability and prices that will drive its price and affect future demand. In addition, growing environmental awareness will lead to stronger limitations to air transport growth driven by political and technological trade-offs between noise and emissions, local and global, short-term and long-term environmental impacts, and ultimately society mobility needs.

A FOCUS ON THE EVOLUTION OF BUSINESS MODELS

This chapter is constituted with a selection of the expert views on air transport supply, chosen to bring a perspective on possible evolution drivers in the supply

1. Competition in European short-haul transport

Long-haul air transport is not subject to competition with other modes of transport. Air transport is the only sensible way to cross long distances.

For short-haul, competition in Europe takes place between aircraft and trains rather than between aircraft and cars as in the USA. Between European capitals separated by small distances, High Speed Train (HST) (TGV, ICE, etc.) is more convenient, particularly when considering the hassle caused by security gates at airports. In addition, HST brings passengers close to city centres. Travelling time is comparable but comfort is better. HST will spread throughout Europe, rendering some of the airborne short-haul connections superfluous. The Eastern European countries have a strong “rail culture”, but whether this

same trend will be seen in certain emerging nations is unclear. For some nations, air transport is still easier to develop because there is less need for surface infrastructure.

The goal of transport policy in Europe is not to promote aviation as such, but to deliver the transport infrastructure to serve the needs of citizens at the level of quality required - be this by train, aircraft, or whatever means of transport is available. Inter-modal transport will become a necessity. Under environmental pressure, airlines could start to position themselves as multimodal transport operators, especially if they can benefit from subsidised infrastructure.

2. Future Airlines

Airlines have a business model for optimisation and efficiency. That is why airlines chase every kg of fuel, especially at high prices, and cut back on administration costs by e-ticketing and using electronically supported cargo systems. With internet and e-technology, passengers want to do everything by themselves (register, book tickets, choose, etc.). The battle of tomorrow is innovation for the customer.

Future aircraft for airline operations

There will be no major technological breakthrough in the types of aircraft operating in 2020. For long-haul for example, the planes will be A380 and B777, A350 and B787. Airbus variants with 1000 passengers will be in operation. In addition, for short-haul, there will be the A320 and B737 replacements.

The A380 and the B777 are part of the logic of substantial flows between large airfields supported by the hub system. The A350 and the B787 were conceived with the development logic of the long-haul point-to-point system as an alternative to the hub system. This is based on the idea that 13 Chinese capitals will constitute marketplaces of more than 10 million inhabitants. These capitals are bound to deal directly with European capitals independently of one another.

Flying further and faster with a quick turn-around time is a factor that contributes to efficient aircraft operation. There are two factors to consider when designing and building aircraft: size and speed. For the construction of large aircraft, like the A380, a good case for the economic justification is needed. Contrary to the Hub and Spoke concept, the concept of point-to-point, such as Lyon to Salt Lake City, emphasises speed and distance. The large market between hubs, e.g, Paris and New York, emphasises size and distance. The two modes of operation will probably co-exist.

Airlines business development might not be based on frequency anymore, but on a strategy of "productive" growth using larger aircraft. In addition, new small aircraft, with no legacy, might be the ‘vehicles’ to bring new technology into the system.

Future airlines business models

The concentration of legacy airlines will continue. This will reduce competition, which is often detrimental to the environment and to the economic performance of the operators: several departures at the same time for the same destination, small modules, and high frequencies, more fuel usage, and more space utilised. The air transport model evolves toward a trust of three worldwide alliances between three European and three American poles: American Airlines alongside British Airways, United Airlines alongside Lufthansa, and Delta North West alongside Air France. At the moment, intra-American flows, intra-European flows, and European-American flows represent 54% of worldwide flows. Airlines from other parts of the world will probably enter some of these three alliances.

In parallel, low-fare carriers stimulate demand at regional airports by offering the lowest possible prices with or without subsidies. This model works mainly for short-haul point-to-point operations from regional airports. But regional airport ATC services are cross-subsidised by ATC revenues from hub airports. From that perspective, governments permit legacy airlines to subsidise their own competitors at regional airports. This is probably not economically sustainable. Small regional airlines will have increasing difficulty in remaining profitable with the increase in fuel cost and other charges. If true costs are charged, regional aviation may be unsuccessful in Europe in the long-term.

Today, business models are starting to converge. All airlines will be forced to diversify what they offer. This can be seen through the mechanism of prices. Low-fare carriers will become middle-fare carriers. In order to grow, they will have to operate on the fringes of legacy airlines by developing long-haul business. Majors, on the other hand, will have to reduce their fares through cost reduction. Transatlantic flights will change airline operations. Within 20 years, new companies will emerge on long-haul business where low-fare carriers can be 20% to 25% less expensive than majors.

The customers' frame of reference for prices has changed. The image of luxury is likely to remain for long-haul flights only. But short-distance transport, increasingly considered as a "commodity", should only be "low-fare". This is a stable trend reinforced by the increasing gap between rich and poor in the world. Until now, most travellers belonged to middle-class and senior people in the developed economies. But the worldwide middle-class is not homogeneous and is becoming poorer. Air transport might become too expensive for both the lower- and middle-class.

At the same time, wealthier people will be able to afford business aircraft benefiting from the latest technological progress and offering more flexibility and comfort using secondary airports; e.g., at present Falcon enjoys a backlog of orders until 2012.

Business aviation could be the main driver for future aviation, whereas mass air transport might become a public service again. In this context, airlines will suffer the most.

3. Military users

Military operations in European airspace are mainly for training operations and the transit of fleet to training zones. European airspace is fragmented and every State has its own area for air-defence training.
Traditionally, military aircraft have used protected reserved areas. With the growth of civil traffic, however, European airspace is increasingly shared between civil and military; e.g., through the Flexible Use of Airspace (FUA) concept. The objective for the future air transport system is to organise the optimum sharing of airspace between civil and military users. This objective raises a number of institutional and financial challenges for the air transport infrastructure and ATM in the context of pan-European projects such as SESAR.
Military aviation will have fewer aircraft to fly, since military budgets are being cut across Europe. For instance, in the last 10 years France has reduced its fleet from 600 combat aircraft to 340, and will continue: 300 in 2015 and 200 by 2020. Training operations will require less airspace but for longer periods of time. These requirements will have to be adaptive to future air combat rules and practices. Military training has to be adapted to any new type of military threat.
In the future, the military might evolve toward adopting an airline-like business model. They will become much more cost-aware, financially constrained, and will start becoming more flexible and innovative to reduce costs. Provided that Europe continues developing in a peaceful manner, the impact of military operations on capacity may reduce. As an example, the British Royal Air Force conducts part of its flight training in Canada.

4. Small and unmanned aircraft: Consequences for ATM and air transport

In the years to come, an additional challenge will be the integration of new aircraft into the system. Smaller and smaller aircraft holding between 30 and 40 passengers risk overloading the market. This is because of the reduced price of aircraft and the emergence of Very Light Jets (VLJ). These may be used for air taxi purposes (flexibility) or to link big cities to remote locations (connectivity). VLJ might also be used as an alternative to airlines by wealthy people looking for maximum flexibility and to avoid airport check-in procedures. Business aviation increased dramatically after 9/11 because of security concerns and the extremely long queues at baggage check-ins at airports. In the USA, 25% of IFR traffic is VLJ. In Europe, this is only 10%, but VLJ growth is twice that of conventional aircraft. VLJ may have a negative impact on aviation safety if pilot qualifications are “watered down” to allow more people to buy them, resulting in less trained people having access to the pilot seat.

Also, Unmanned Aircraft Systems (UAS) may take a potentially high market share, with a wide range of applications such as delivery, search and rescue, communications and so on.
UAS may be operated from very small airfields. UAS might be used for communication purposes, blocking parts of airspace for long timespans. A problem arises with their integration within non-segregated airspace and the transition between different kinds of airspace calling for particular airspace design and operational procedures. UAS size and performance introduce safety issues: how to ensure separation (self mode versus mixed mode) with other traffic, either small or very large vehicles, with huge differences in speed

and reactivity. This will call for new safety rules to be developed. Air equipment and ground station certification raise a particular concern for the degraded mode of operations. In addition, there is the security issue, to avoid UAS being transformed into a flying bomb, voluntarily or not.

With regard to VLJ, everything will depend on the volume of operations. If limited in number, the ATM system will be able to accommodate them. If high in number, they will add flights to the system; this will alter the drafting of air traffic flows and routes, representing a serious strategic planning challenge, which is fundamental to today's ATM system, but even more so for SESAR - thus increasing the need for stronger regulation. Indeed, for the SESAR concept of operations, traffic must be planned and anticipated. Integration of a high number of VLJ would not be easily bearable.

However, the overall effect of small aircraft on air transport is probably overestimated. These will not be used like airliners from 6 a.m. to 11 p.m. Therefore, they should not represent a real constraint on the system. They could easily be absorbed by adapting the technical system. This point of view is not shared by all experts, though.
VLJ and UAS will eventually add to the environmental problem. But as long as society remains money driven, owners will be able to pay for their share of rights to emit. Moreover, they could very well bring about new technological improvements in aviation in this regard. Prevention of accidents between UAS (sense-and-avoid rules) and manned vehicles (see-and-avoid rules) could also push automation forward (a paradigm shift).

5. Future Airports

Competition between airports

Airports must be efficient in dealing with all their stakeholders, especially with airlines and passengers. There is a lot of competition between airports as a result of differing growth rates serving different kinds of customers. Airports compete for these different customers. They, especially the large ones, are trying to achieve a good passenger mix, instead of the specific passengers of 10 to 15 years ago. Big airports are also trying to attract low-fare passengers.

Small airports usually depend on one carrier, whereas larger airports (hubs) serve many, usually in one alliance. Airports are looking for the right mix of traffic, i.e., not necessarily based on one carrier. The large hubs are even looking into operating more than one alliance to make better use of their capacity. Although hubs have only a small percentage of local traffic as part of their traffic mix, this is comparable in absolute terms to local traffic at small airports.

Financing airports

The airport sector is changing fast. Originally, airports supported one carrier and had public financing only. Now, they are very much diversified with a wide customer base and complex financing schemes. Financing of airports is not 100% public anymore, nor is it fully privatised. Airports are increasingly managed as companies with a private business approach -by reducing costs to increase performance- rather than as public services, despite remaining exceptions. However, the opening of airport management companies' capital will bring a change in mentality.

In addition to their operational revenues, airports have other revenue streams to finance their operations, such as:

- Commercial revenues (e.g., shops) account for a substantial proportion of airport income (between 40% and 70%). Airports operations are subsidised by commercial revenues to keep passenger costs low. Airlines prefer the subsidy method. This is seen in Spain where charges are 70% less than the EU average.
- In some countries, such as Scandinavia, Greece and Portugal, strong public networks (groups of airports owned by one organisation) have successful airports subsidising smaller ones.
- Airports could also fragment more with a change of ownership. Many UK airports are already owned by bus companies, for instance.
- Another form of revenue is real estate management with airport cities. These will have facilities such as hotels, conference centres, leisure facilities, but no permanent residence.

There are a lot of traffic movement caps imposed on airports, which restricts efficiency. The no-growth option already exists at some airports. This is a challenge in Europe as this limits investment for infrastructure development.

Airport market evolution

Hubs are in demand. The EUROCONTROL Challenges-To-Growth 2004 study reported that 85% of air traffic was passing through only 130 airports. The macro-economic trend of 6% growth in demand for worldwide air transport over the next years is a concern, because this implies that the majority of the large European hubs will be saturated by 2015. The London airport system could be the portrait of what Europe will look like in 20 years.

In the future, with the 2008 Open Skies Agreement, long-haul demand will grow at the expense of short-haul. It is envisaged that the low-fare model will be used for point-to-point intercontinental flights. At London Heathrow, this means slot substitution, and not growth. Increasingly, a shortage of EU runway capacity will encourage the substitution of slots from short-haul to long-haul. Passenger numbers will increase but not the number of aircraft movements (higher load factors, and bigger aircraft).

Even if large airports become saturated, traffic will spread to non-saturated regional airports. If airlines want to expand, they will go wherever there is available room, unless economic

and environmental regulations limit such development (e.g., when there are capacity limitations that are too strict from the beginning). The business model will change by using secondary airports and by establishing point-to-point connections. If demand keeps growing up to 2030, airports will become accustomed to the limitations and other solutions will be found. Moving capacity to smaller airports will increase the distance for passengers connecting between regional and international flights, and passengers want minimum connection time. But reduced transit time compensates longer distances, and the general public is happier with small airports, which are much easier to use than the major hubs.

The restructuring of air transport supply will lead to the specialization of airports into a hierarchy between hubs and regional airports, and airports being connected by rail instead of competing with each other. The advantages will be lower costs, more punctual movements, etc. It is questionable whether, within 20 years, the hubs will still be as important as today or whether there will be more long-haul point-to-point traffic.

6. Summary

The air transport supply is in transformation. Airports increasingly compete for airlines and for passengers. However, with future traffic growth, the network of airports will evolve towards hubs saturation, leading to more use of smaller airports, to a hierarchisation of airports possibly linked by ground transport (co-modality) and to a possible shift of slots towards long haul. Airlines business models will continue their evolution towards low-cost service, even on long-haul, and towards a few world-wide alliances. However, depending on the evolution of the economy affecting the low- and middle-class wealthiness, there is a risk that mass air transport becomes less successful. In parallel, small and unmanned aircraft and business aviation operating point-to-point from less constrained airports will increase, bringing new technological improvements and challenges to the air transport system.

CONCLUSIONS

The survey (ref 3) aimed to raise some fundamental questions, inclusive of issues with a broad socio-political focus, in the debate on the future growth of aviation. The findings reinforce the challenges identified in the main CG08 report, while providing a wider perspective on decisions (passengers, economic actors and policy-makers) affecting future air transport evolution.

Although the views reflect the perception of an overall positive trend, there is also recognition of the significant degree of uncertainty inherent in future traffic growth. The survey indicates that although air transport faces serious challenges, a stable trend of growth in demand is perceived for the long-term, even if the political and economic climate may affect its rate. It identified the main challenges to be fuel and ticket prices, public environmental awareness, and eventual restrictions on the use of fossil fuel. The focus given in this paper highlights the very different futures that might arise in air transport in terms of type and numbers of passengers, number of movements, business models of air transport service operators,

airports network configuration, types of aircraft, resulting from the relative strength of the factors influencing demand and supply.

The main CG08 report (ref 2) expects growth to continue; the number of flights in 2030 is expected to be nearly the double of 2007, with a long-term trend of 3% instead of the 4% over the last 50 years. The "most likely" scenario predicts demand of flights per year exceeding what the airports can deal with. By 2030, 19 airports will be operating at full capacity for 8 hours or more a day and about half of every day's flights will pass through one of these airports. Congestion will be a routine feature of traffic and Europe will need to maintain an agile air transport system, able to respond quickly to changes in demand and to congestion consequences.

There is a need for more research into the scale and nature of air transport evolution to refine projections of demand. Planning with in mind an understanding of these factors is vital for the future of air transport. A number of other initiatives aiming to explore the future of air transport for Europe and in the wider context of European transport have taken place in the last two years in the industry, at the European Commission, in ACARE –the Advisory Council for Air transport and Aeronautical Research in Europe-. In Eurocontrol, further studies address in more depth the issue of congestion in the airports network as forecasted in CG08, as well as the possible consequences of the Peak Oil for air traffic growth. These studies are conducted to improve and refine the forecast models necessary to plan for, and better adapt, the ATM system of the future.

BIBLIOGRAPHY AND LINKS

1. EUROCONTROL *Challenges to Growth 2004 Report (CG04)* :

   http://www.eurocontrol.int/eatm/gallery/content/public/library/CTG04_report.pdf

2. EUROCONTROL *Challenges of Growth 2008 Report* (*CG08),* 2008:

   http://www.eurocontrol.int/statfor/gallery/content/public/documents/Challenges%20of%20Growth%2008%20Summary%20Report%20v1.pdf

3. Pilon N. and Brom L., *Challenges in Air Transport 2030: Survey of Experts' Views (2007-2008),* Report n° 09/07/15-20, EUROCONTROL CND Experimental Centre, 2009:

   http://www.eurocontrol.int/eec/public/standard_page/DOC_Other_2009_003.html

4. Young D., Pilon N. and Brom L., *Challenges ahead for European Air Traffic* in "*Computational Models, Software Engineering, and Advanced Technologies in Air Transportation: Next Generation Applications*", IGI Global, October 2009