Towards building an efficient air transport system in Africa

Adil A. Dafa'Alla* and Elmouiz S. Hussein

Airbus, UK
E-mail: Adil.Dafaalla@airbus.com
E-mail: Elmouiz.Hussein@airbus.com
*Corresponding author

Abstract: It is predicted that the air transport market for passenger and freight aircraft will grow by about 5% annually over the next 20 years. With this unprecedented expansion, there would be a huge pressure on airport capacity and control systems technology would be stretched as never before. If the developing world generally and Africa in particular want to play an equal and integrated part in the international economy, they have to rise to this challenge, which should also be seen as an opportunity to catch up with the rest of the developed world. However, this can only be achieved via heavy investment in technology transfer, the training of personnel as well as securing the right environment for sustainable development that allows local talent to flourish and contribute towards building an efficient air transport system. This, in turn, requires achieving political stability, creating a true investment-attractive climate both in legislative and implementation terms, building infrastructure and training personnel to improve skills and nurture innovation. This paper describes the requirements for an efficient air transport system, discusses the likely challenges and opportunities ahead and makes recommendations for building such a system in Africa.

1 Introduction

In today's global market it is increasingly hard to achieve sustainable development without highly sophisticated infrastructure that supports development plans, links local and international suppliers and customers by an efficient, reliable cost-effective means of communication. Having an integrated efficient transport system is a key part of this infrastructure and, for all practical purposes, a good measure for sustainable development in any country. This integrated system should include land, sea and air transport. To put this in context, take the example that, despite the actual flying time between London Heathrow and Paris Charl DeGoule is about 30 min, the current average journey between central London and central Paris is 7 h. This is about 2 h longer than in 1929 (Ogilvie, 2008).

It is predicted that the air transport market for passenger and freight aircraft will grow by about 5% annually over the next 20 years (Airbus, 2008). Indeed, the USA's Federal Aviation Administration (FAA, 2004) is projecting a growth of 120 million additional international air passengers and tripling of cargo by the year 2015. These need to clear customs and security, their luggage to be processes, cared for while waiting for their flights and assured of smooth and safe journey to their destination with little or no air congestion while emergency procedures should be in place to meet any eventuality. With this expansion, there would be a huge pressure on airport capacity and control systems technology would be stretched as never before. This brings to mind special concerns regarding environmental as well as health, safety and security issues. It should also be noted that this expansion would not be limited geographically as the market is growing more and more global. Indeed, the forecast for domestic sub-Saharan African and domestic South African passenger traffic stands well above the world average at 5.4% and 6.5% respectively. Middle East-South Africa traffic is also expected to grow by a staggering 9.5% annually. The freight traffic is also above the world average, with the routes linking the emerging Chinese and Indian's fast growing economies to their customer bases in Africa and South America topping the list. The freight growth between China and Africa and South America is expected to increase annually by an average of 7.3% and 8.6% respectively. The corresponding figures for India are 6.2% and 6.9% respectively. Indeed, even the freight and passenger traffic between Africa and South America is expected to increase annually by 6.1% and 7.1% respectively (Airbus, 2008).

This unprecedented growth will bring challenges as well as opportunities to the developing world generally and to Africa in particular. While environmental issues are currently being addressed at international level through agreeing global targets and defining new tough standards to minimise environmental damage (*e.g.*, Kyoto Protocol on environment (UN, 1997)), a lot more needs to be done locally to ensure strict adherence to international standards for health and safety of air transport systems as well as ensuring efficient integration with the global network. The fact that, despite the current relatively low volume of air traffic, Africa accounts for 10% of the world's air traffic accidents (Airbus, 2008) shows that Africa is not doing well in this respect.

The safety of the aircraft itself is primarily the responsibility of the manufacturer and it is guaranteed through a rigorous airworthiness certification process, during which the aircraft had to pass a clearly defined international standard required by the certification bodies. However, the airline operators have a direct responsibility of religiously following the maintenance and repair manuals and instructions that are defined by the manufacturer and represent an important part of handing over the aircraft to the operator. Any departure from these rules and guides makes the airline operator directly liable for any breach of safety rules. Airlines also have to operate in accordance with the regulations laid down by local and international airworthiness authorities.

The local civil aviation authority, on the other hand, oversees airport operations and, as such, fully responsible for ensuring that aircraft are airworthy before leaving the airport under its locality and that the airport itself complies with all relevant health and safety requirements. Hence, separation between operators and civil aviation authority management structures is key to proper implementation of regulations. This is important as the regulated cannot logically be part of the regulator's organisation and structure.

Therefore, an efficient safe air transportation system is a shared and equal responsibility of manufacturers, operators and authorities alike. This paper is concerned with defining the elements for an efficient air transport system globally and the requirements for building such one in the developing countries with special emphasis on Africa. It provides an overview of the current and an outlook for future global systems, with recommendations for improvements in developing countries in order to adequately cope with and, hence, harvest the economic fruits of the likely expansion of air traffic to, from as well as over their skies. The potential for Africa, as a representative of the developing world, to play its fair share in the globally expanding air traffic network is also discussed.

2 The potential for Africa

Spanning 30 million square miles, the African continent accounts for 20% of the world's total land area, equivalent to the combined surface area of China, Europe and the USA. Such a vast expanse makes interconnecting travel within Africa by road and rail prohibitive. Therefore, expanding the air transport network appears to be the quickest and simplest way forward in linking the countries, their people and trade both within this massive region and with the rest of the world.

Additionally, African economic performance has been robust in recent years. This is expected to continue at a rate of 5% annual growth in real Gross Domestic Product (GDP) over the next 20 years, which is impressive when compared with the world's average growth of 3.2%. As a result, the Republic of South Africa has emerged as an important regional power and is becoming a major international hub destination. Countries, such as Kenya, Tanzania and Namibia, have also enjoyed booming echo-tourism and trade activities. However, there is little evidence that other parts of Africa have enjoyed similar fortune. Nevertheless, according to the World Tourism Organisation, with a 10% increase, Africa had the highest growth in 2006 in tourism worldwide, with inbound tourism having grown 30% between 2003 and 2006 (Airbus, 2008). This economic boom can obviously help improving the infrastructure and expanding existing air transport network.

Greater liberalisation and emergence of a low-cost sector will also drive a strong increase in Africa's passenger traffic. Airbus forecasts that revenue passenger kilometres will grow well above the world average, at 5.8% per annum over the next 20 years, with more significant growth of 6.6% over the next ten years. However, the intra-regional demand in Africa has remained largely untapped so far. In 2006, the African intra-regional market represented just 19% of the entire African market, compared to 31% for Latin America, 32% for Europe, 40% for China and 53% for North America (Airbus, 2008). This is largely due to delays in fully implementing the new African Transport Policy, which was endorsed by the African heads of states in 2000 with the Yamoussoukro Decision. The objective of this policy is to liberalise the air transport market in Africa by focussing on gradual elimination of all non-physical barriers and to lift restrictions linked to fifth freedom traffic rights, air carrier capacity, and the frequency of passenger and cargo flight operations. Full implementation of the policy is expected to boost the potentially large and currently untapped trans-boarder markets within Africa. It will also facilitate the implementation of the African civil aviation authority similar to the European Aviation Safety Authority (EASA), as will be recommended later in Section 5. If Africa achieves liberalisation, intra-regional traffic has the potential to grow at an impressive 8.0% per year. International markets are also expected to grow strongly. Traffic to North and Latin America will increase by 8.0% and 6.2% respectively, while traffic to Asia-Pacific will rise by a remarkable 8.3% per year over the next decade (Airbus, 2008).

Table 1 Passenger and freight traffic forecast for African submarkets

Passenger traffic forecast		*Freight traffic forecast*	
Submarket	*AAGR*% 2007–2026*	*Submarket*	*AAGR*% 2007–2026*
Africa Sub-Sahara – Asia	5.6	Africa – Africa	4.6
Africa Sub-Sahara – Australia/New Zealand	5.4	Africa – Asia	4.0
Africa Sub-Sahara – Indian Subcontinent	7.2	Africa – Central America	6.4
Africa Sub-Sahara – Middle East	8.3	Africa – CIS	4.2
Africa Sub-Sahara – North Africa	9.7	Africa – Europe	5.7
Africa Sub-Sahara – China	8.0	Africa – Indian Subcontinent	4.3
Africa Sub-Sahara – Russia	3.2	Africa – Japan	1.4
Africa Sub-Sahara – South Africa	8.3	Africa – Middle East	5.2
Africa Sub-Sahara – South America	5.5	Africa – North America	5.2
Africa Sub-Sahara – USA	5.3	Africa – Pacific	4.0
Africa Sub-Sahara – Western Europe	4.5	Africa – China	6.5
Asia – South Africa	6.4	Africa – South America	5.5
Australia/New Zealand – South Africa	6.1	Asia – Africa	4.6
Canada – North Africa	6.6	Central America – Africa	6.4
Domestic North Africa	5.9	CIS – Africa	2.9
Domestic South Africa	6.5	Europe – Africa	4.7
Indian Subcontinent – North Africa	5.1	Indian Subcontinent – Africa	6.2
Indian Subcontinent – South Africa	7.5	Japan – Africa	5.2
Intra-Africa Sub-Sahara	5.6	Middle East – Africa	4.9
Intra-North Africa	5.3	North America – Africa	6.5
Japan – North Africa	5.5	Pacific – Africa	4.5
Middle East – South Africa	9.5	China – Africa	7.3
North Africa – South Africa	8.3	South America – Africa	6.1
China – South Africa	7.7		
World	4.9	World	5.8

Note: AAGR = Average Annual Growth Rate.

Source: Adapted from Airbus (2008)

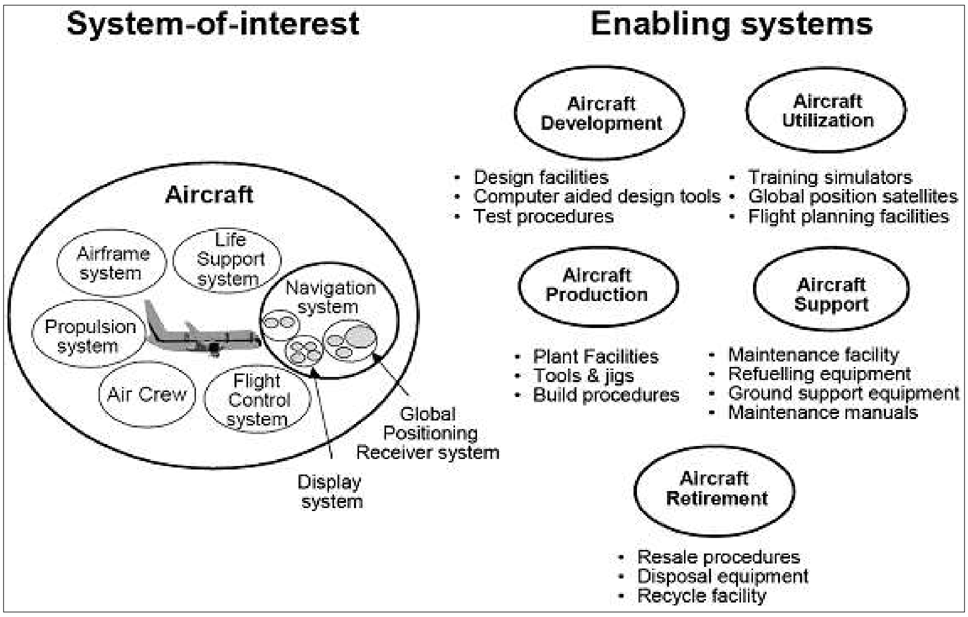
Table 1 summarises Airbus's forecast for the African submarkets over the next two decades. The table clearly shows that the growth forecast for African submarkets is well above the world's average of 4.9% for passenger air traffic and close to the world average of 5.8% for freight air traffic. These are obviously healthy indicators for Africa. In fact, the ability of Africa to attract much of the expansion in air traffic is not surprising owing to its central geographical location between America, Europe and Asia combined with growing regional economy and flourishing trade and tourism. Note that Dubai has jumped from the 28th hub city in the world by the number of international Available Seat Kilometres (ASKs) offered to the region in 1997 to the 10th place in 2007 (Airbus, 2008). This is because of its central geographical location and the development of world-class infrastructure facilitated by a vision that brought commercial focus resulting in vastly expanding commerce and tourism industry. Now, Africa shares the central geographical location with Dubai and, indeed, the echo-tourism industry, though generally less developed, has a much longer history in Africa than Dubai owing to Africa's rich history and diverse wild life and culture. Destinations such as Egypt and Kenya had been known as tourists' attractions for very long time. The Republic of South Africa, on the other hand, is another example of recent commercial focus that resulted in it becoming a regional power. This proves that African think-tanks are quite capable of drawing a vision that supports sustainable development without damaging the environment or depleting future generations' resources.

Therefore, the potential for Africa is there and Africa had to be ready and prepare for this huge expansion right from now in order for it to reap the economic fruits that come with it.

3 The air transport system

An integrated air transport system must include an aircraft system as well as any other enabling systems as main ingredients and has to respond to society's need, which is the prime driver for generating interest in the market in the first place. In fact, an ideal air transport system should address society's, as well as market's, needs even at the early phase of its conception. This is because, in an air transport system that closely matches to the needs of customers and citizens, the cost and efficiency of each of its elements must be the most competitive, particularly in the current global economic downturn.

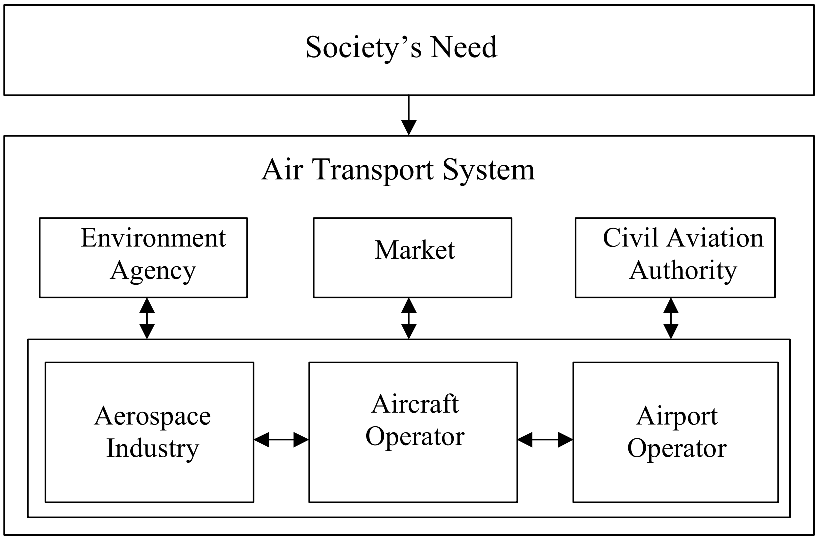
Figure 1 Possible elements and interfaces of an idealised air transport system



Source: Reproduced from ISO Standards (2008)

The aircraft itself is central to the air transportation. However, to make a system, it needs complimentary air crew, navigation and air control systems in addition to life time support. It also requires enabling system that looks after the aircraft from concept through to retirement. ISO 15288 requires an idealised air transport system of interest to consist of a main aircraft system and auxiliary enabling system as shown in Figure 1, which is reproduced from (ISO Standards, 2008). For this system to work a number of component providers need to be engaged. Figure 2 defines these providers and explains the interfaces between them. While the market is there to provide the required funding, the industry produces the required components that the operators would put together to provide the service. The society's need, in this case, would be safeguarded independently by the civil aviation and environment agencies.

Figure 2 Main component providers for the air transport system



However, the key features that define the success of the air transport system must include the following:

- Integration with other transport systems. The air transport should be viewed as complementary part of an overall transport system that is there to provide maximum convenience for its users. Business as well as leisure travellers would view their journey from A to B as one whole and would like the transition from one transport system to the other to be simple and seamless.
- Well-maintained reliable aircraft in order to minimise any delays due to breakdown of components or system failures.
- Good airport infrastructure and services to ensure fluent and comfortable movement of passengers and cargo from the time of arrival to the airport until their departure times. This includes minimising waiting times, an effective security system without limiting mobility of civil liberties as well as effective procedures in place to deal with any emergency situation.

- Responsive flexible air traffic system that readily responds to shifts in demand from all users and capable of delivering the required capacity and efficiency. The system should also give maximum situational awareness on demand to support pilots and other service providers.
- Comprehensive proactive safety management approach to ensure the safety of the travelling public and cargo through sound risk management strategy supported by state-of-the-art data analysis capability to identify related safety issues comprehensively.
- Implementation of advanced weather technology capability to enable operators to mitigate and reduce the negative impact of adverse weather conditions as essential part of the overall safety management strategy.
- Reduce any environmental damage and give enough protection to the environment that allows sustained aviation growth. This includes impact on both people health and climate change.

It is highly recommended that any new system to be developed should at least encompass these key features, be intrinsically expandable to meet future demands as well as readily integrating into the global international air transport system. Indeed, the USA is currently developing a visionary 'NextGen' air transportation system for the USA that meets the future demand and leading the way towards shaping this future. The proposed system assumes, not only the technical integration of the systems and their ability to communicate and share information freely worldwide, but also the harmonisation of equipment and operations globally by developing and employing uniform standards, procedures, and air and space transportation policies worldwide, enhancing safety and efficiency on a global scale (US Department of Transportation, 2004). Although such a vision poses a lot of challenges, it also opens new opportunities for the main system providers, represented by the aerospace industry as well as aircraft and airport operators, as will be discussed below.

4 Challenges and opportunities

The demand for air transportation is increasingly outpacing current airports ability to provide capacity and, hence, creating a lot of strain on existing services and infrastructure. Additionally, a US study estimates there may be as many as 5000 microjets employed by on-demand air taxi services by 2010 and 13 500 by 2022 so microjets alone could represent 40% of daily operations by 2025 (Rolls Royce Forecast, 2004). New vehicle types, such as Unmanned Aerial Vehicles (UAV), would push this percentage even higher.

This opens new challenges for the aviation industry in general and, indeed, also brings with it new opportunities. Big research and technology programmes are now well underway, both in Europe as well as the USA. The US department of Transportation has launched, together with the FAA, an integrated national plan in 2004 for the next generation air transportation system to meet future air transportation safety, security, mobility, efficiency and capacity needs. Likewise, resources were allocated in Europe to implement the ACARE 2020 vision, which shapes the European stakeholders' vision to meet the challenges for the aerospace industry up to the year 2020. Major manufacturers, such as Boeing, Airbus and Bombardier, have just finished restructuring programmes, reorganising their companies, widening their supply base and positioning themselves to respond to these challenges in a timely manner. Additionally, in order to penetrate the market and reduce the cost, these major aircraft manufacturers have elected to embrace a system integration mode of development and production by bringing in risk-sharing partners. These risk-sharing partners must receive infusions of tacit scientific and technical knowledge from parent companies (Pritchard and MacPherson, 2007). These technology transfers are pre-requisite for the systems integration strategy to be effective, quality guaranteed and product integrity protected. This, in turn, contributed to the globalisation of the aerospace industry.

Indeed, globalisation of the aerospace industry is now becoming the norm with over 400 suppliers of aircraft components across the world. Airbus, for example, has recently opened a Final Assembly Line (FAL) of its Single Aisle A320 model in China, Boeing outsourced close to 90% of the parts of its new 787 model and Bombardier has invested $200 million into Mexican manufacturing facilities that will produce wiring assemblies and major structural components (Pritchard an MacPherson, 2007). Furthermore, Iran has increased its aerospace industrial capacity quite significantly over the last two decades, the United Arab Emirates has now started an aircraft's airframe industry in Abu Dhabi, whereas Morocco has just revealed plans for establishing aircraft components industry in the country.

Consequently, in the wake of this expansion and globalisation of the aerospace industry, new opportunities were created worldwide in technology transfer, research, development, design and production lines in the whole aviation sector; industry and operations alike.

4.1 Aerospace industry

In order for the aerospace industry to respond to the society's needs, the next generation aircraft may acquire new shapes and sizes by 2020 to improve the technical efficiency of the air transport system and to raise their safety and environmental performance (European Commission, 2001). Flying wings could offer more efficient and quieter solutions, airships may finally establish themselves as a cheap alternative for carrying freight, and convenience flying could be a reality with tilting wings that allow vertical take-off and landings. The super-liners able to carry over 1000 passengers may need new airport systems to handle them, folding wings to avoid occupying too much airport space, and enlarged and sophisticated entrances and exits that can handle the required fluency at terminals as well as proper evacuation in emergency situations. Moreover, the future is also likely to see more competitive aircraft designs with different configurations than the classic cylindrical fuselage with engines hanging from low wings in response to society's need for more affordable, safer, cleaner and quieter air transport. Blended wing body configuration is one example in hand.

In the meantime, thanks to technology advances, today's aircraft will continue to be improved in design, production, manufacturing, maintenance and operating and traffic management. Second-generation composite materials and use of hybrid laminar flow over the entire aircraft could make significant contributions to reducing aircraft weight and air drag, thereby reducing fuel consumption. The digital revolution will also have vital impacts on flight systems, where much greater integration will bring top line operation, minimal fuel consumption and dramatic improvements in safety standards. Integrated electronic systems will greatly improve reliability, remove causes of unscheduled maintenance and allow the opening of 'the office and home in the sky'. Big strides in safety will be possible through human factors research and intelligent monitoring and control systems that will anticipate problems and take preventative actions even before the pilot is aware anything is going wrong. The crew's confidence that the best possible decisions are consistently made will be assured by electronic systems (European Commission, 2001).

Indeed, the application of emerging technologies had already transformed aircraft design and production over the last few decades. For example, the regular use of Computer Aided Design by all major aircraft manufacturers to help the integrated design of the structure, the systems and the engines right from the first phases of conception has permitted huge reductions in production and manufacturing time and costs. Airbus had, for example, managed to shave off over two years of the traditional development cycle time of its A350 model. This, together with the use of new generation of lighter materials which are corrosion resistant, tolerant of damage and repairable as often as necessary, lower operating and maintenance costs and better overall management of the aircraft and its use, has been instrumental for cheaper air travel.

In reality, literally thousands of systems work together within a modern aircraft. The airframe itself, the engines, the navigation systems on the flight deck are a few examples of the 'high tech' ones, but seat, galley and many other technologies play their part. In today's competitive market, manufacturers need to keep pace with all of them in order to gain advantage in the marketplace. Additionally, there is also relentless demand on the industry in general to reduce emissions (NO_x and CO_2) and burn less fuel and these are goals the aerospace industry will continually strive for. Cleaner and alternative fuels – hydrogen, for example, if its production costs can be lowered – may be able to help in reducing harmful emissions. Indeed, NASA, Pratt & Whitney, Airbus and Boeing are all conducting, either independently or collaboratively with partners, various research programmes in this field. To this end, Boeing, jointly with other partners, is embarking in evaluating the system level benefits of future fuel cell Auxiliary Power Unit (APU) for their concept of a 'More Electric Airplane' (MEA). It is claimed that substantial fuel savings and emissions reductions on future aircraft should be realised as this technology matures within the next ten years to the point of commercialisation (Daggett *et al.*, 2003). Likewise, Airbus has recently successfully tested a new fuel cell system developed jointly with Michelin that uses hydrogen and Oxygen to generate electricity without producing harmful emissions during an A320 aircraft flight (ONE, 2008a). More significantly, Airbus, in a joint venture with Shell and Rolls Royce, has also successfully tested an A380 flight powered by an 'alternative' liquid biofuel derived from gas (GTL) and produced from renewable biomass sources that do not compete with existing food, land and water resources. The analysis of the 3-hour flight test data showed that the use of the 40% blend of GTL to kerosene had no adverse impact on the engine, aircraft systems or materials and that it behaved like conventional kerosene (ONE, 2008b). Seeing the impressive potential of GTL, Shell is currently building, in partnership with Qatar, the first large-scale factory of GTL in the world. Additionally, more efficient engines are achievable that will not only burn less fuel but will also further reduce damaging emissions to a fraction of their current levels. But to bring them within reach, temperatures and pressures in the heart of the engine need to be raised still further and ways to achieve peak efficiency throughout the whole flight are needed.

4.2 Airport operations

To meet the projected future demand in air transport, developed airport infrastructure is needed and a responsive air traffic system is required in order for airspace and airport operations to serve present and future aircraft while maintaining positive community relationships by providing a range of facilities that balance transportation needs with environmental standards for noise, air quality (NO_x) and impact on climate (NO_x and CO_2). Indeed, landing and departure capacity at busy airports will increase through greater use of parallel runways, relaxation of single runway occupancy restrictions and improved wake vortex sensing and prediction systems. These systems and procedures should be integrated with other approach, landing and departure systems to ensure that capacity demands are met.

A modern air traffic system should allow more creative sharing of airspace capacity for civil, commercial and, probably, military users through timely access to operational information. Technology can provide opportunities for an entirely new approach to air navigation that utilises modern communication techniques, advanced computers, precision plotting through GPS and modern computer-based decision assistance programmes and, hence, open up the sky to a much greater and more efficient utilisation of airspace. It also holds great promise for improved aviation security. This would be greatly enhanced by global harmonisation of equipage and operations by developing and employing uniform standards, procedures and air and space transport policies worldwide, enhancing safety, security and efficiency on a global scale as well as addressing key cost drivers such as maintenance and training.

Furthermore, reducing the weather impact on air travel through a system-wide capability for enhancing weather observation and forecasting integrated with strategic flow management support tools used by air system operators will substantially improve airspace capacity and efficiency while enhancing safety. Technologies, that provide clear three-dimensional pictures of terrain, obstacles, runways and taxiways to the air crew, should be developed to ensure that capacity will not be reduced due to adverse weather conditions and other system disruptions.

Additionally, flight safety and security is an important element of airport operations, which is becoming increasingly high on the agenda of both the public and aircraft operators alike. Although the annual number of fatal accidents had actually dropped significantly from the peak of over 40 in 1972 to around 5 in 2004 (ICAO, 2004) despite the huge increase of the number of flying air vehicles, the recent security breaches must have exasperated a perception of increased risk with flying among the public. This perceived risk could lead to a lack of public confidence and, hence, a significant set back to the future of the air transport system. It will also cause a 'push-back' effect in the social acceptance of emerging aviation technologies as well as subsequent emerging new aviation market (Salmon and Motevalli, 2008). Hence, airport operators, civil aviation authorities, aircraft operators, aerospace industry and relevant government agencies should jointly implement a more comprehensive safety and security approach with the objective of preventing accidents and incidents before they happen. In this approach, the regulatory authority needs to assume a more comprehensive role from testing, inspecting, certifying systems to independent approval and periodic auditing of the safety management programmes and, hence, dedicate more resources to address safety and security issues before they become safety or security problems. However, international cooperation in safety and security management is vital in achieving this.

4.3 Aircraft operations

The expansion in the air transport sector over the last two decades or so has attracted more investors. The emergence of low cost carriers, such as Ryanair, XL and Easyjet, was particularly notable. However, the recent rises in fuel cost, combined with the increasingly demanding environmental requirements and general slow-down of economy have changed the rules of the game and made it difficult for many small players to survive. Indeed, while smaller players, such as XL, have simply collapsed, the bigger ones, such as KLM, Air France and Lufthansa, found it essential to merge and join forces in order to weather the storm. Others, such as Swissair, Alitalia and Sabena, are facing severe cash flow problems. In fact, 'merger mania' prompted by high fuel cost and slowing global economies has caught both sides of the Atlantic forcing, for example, US Airways to integrate with America West (Enders, 2008). Also, to meet the expected requirements on noise and emissions, many aging aircraft have to simply be withdrawn from service altogether within the next decade or two. Others might require expensive upgrade, adding to the overall cost to aircraft operators. And, of course, new aircraft, that meets these requirements, would be needed to meet the huge expansion in demand for air transport. This puts extra financial pressure on aircraft operators.

Additionally, future aircraft will sense, control, communicate and navigate with increasing level of autonomy (US Department of Transportation, 2004). These new vehicle capabilities will, in turn, allow for the development of new concepts in air traffic management. Ultimately, air traffic management facilities will be able to take advantage of aircraft and ground system automation, resulting in facility consolidation and virtual facilities. Clearly, beneficial use of new technologies should be supported with all necessary decisions on procedures, roles and assumptions about the operating environment and efficiency, which, in turn, will allow for responsive air traffic management system in a dynamically changing environment. Hence, significant improvement in air traffic management systems could be realised through a combination of employing advanced information management technology, enhanced sensor and detection capabilities, upgraded aircraft performance capabilities and more accurate and tailored weather forecast. Global procedures for operating and spacing aircraft, based on the capability of an individual aircraft and the flight crew's operational performance, would lead to common operations worldwide.

The cost of these new aircraft is also on the rise. Hence, operators need to come up with new inventive business plans to restructure their organisations and increase efficiency. Furthermore, they may need to become more involved with aircraft manufacturers and airport operators in research programmes as well as becoming risk sharing partners or launch customers, which can benefit them in the long run as it will give them a direct say in the way new generation aircraft are developed. In other words, aircraft operators cannot work in isolation. They have to act as an integral member of the aviation family that work collaboratively to satisfy the society's need for affordable, efficient, clean and more customer-friendly air transportation system.

5 Recommendations for efficient air transport system

5.1 General recommendations for the developing world

Air travel will not develop in vacuum. As stated in European Commission (2001), its size, shape and success will be determined by the society as a whole. Hence, aviation sector must satisfy constantly rising demands for lower travel costs, better service quality, the very highest safety and environmental standards and air transport system that seamlessly integrates with other transport networks.

The air transport system is a huge global network. Consequently, the above requirements are no longer local. If the developing countries want to play an equal and integrated part in international economy, they have to respond in kind to the highest standards of safety and environment and prove that they have become part and parcel of its entrepreneur's culture. This can partly be achieved by increasing airports' capacity and establishing supportive public policy and regulations. However, regulation is only one of the means by which the society ensures that its values and priorities are reflected in the procedures and operations of the air transport industry. It is equally important for investors to see the implementation of these regulations in practice before they have full confidence in the system.

For example, safety of the European Aviation is now regulated by an independent, fully empowered pan-European Aviation Safety Authority (EASA). Its authority covers all aspects of the safety of civil aviation, including air traffic management, airport operations, aircraft certification and associated licensing of personnel and its decisions are mandatory to all member countries. As a result, Air traffic management now applies to a 'single European Sky' in which air space is assigned and managed as though national sovereign zones no longer existed (European Commission, 2001). This allowed all European traffic control providers, whether or not they are privatised, to reach world-class standards of efficiency. A high degree of global standardisation, particularly with the USA, has also been achieved for safety rules. For example, EASA now also looks at new aircraft certifications on behalf of the FAA of the USA. This is significant as it proves that safety is a common concern for the whole global air transport network.

There are essentially two lessons here for the developing world to learn. The first one is that the independence of the civil aviation authorities from the influence of the airport and airline operators is crucial in ensuring the safety of the air transport system. Representation of the regulated in the regulator's board, as often the case in the developing world, would inevitably give rise to conflict of interests and legislative guarantees should be put in place to prevent it. The second is the huge advantage that a unified regional civil aviation authority can bring to the system in terms of increasing efficiency, reducing cost and improving integration with the rest of the world. Accordingly, an African civil aviation authority uniting the African Union members or an equivalent Arab civil aviation authority for the Arab League could be quite feasible. Similar regional Asian or Latin American ones could also be established as an initial step towards a unified international system that can integrate the global network.

The aerospace industry has benefited a lot from the digital revolution that is enabling huge strides to be made in aircraft design, production, manufacturing, maintenance and operating and traffic management, as explained above. There will be vital impacts on flight systems, where much greater integration will bring top line operation, minimal fuel consumption and dramatic improvements in safety standards. This will, in turn, bring great potential for increased capacity. The implementation of integrated electronic systems will also greatly facilitate communications, improve reliability and remove causes of unscheduled maintenance. The developing world needs to keep pace with these developments.

Indeed, these challenges should also be seen as an opportunity for the developing world to catch up with the rest of the developed world. However, this can only be achieved via heavy investment in technology transfer, training of personnel as well as securing the right environment for sustainable development that allows local talent to flourish and contribute towards building an efficient air transport system. This, in turn, requires achieving political stability, creating a true investment-attractive climate, both in legislative and implementation terms, building infrastructure and training personnel to improve skills and nurture innovation. It is worth noting here that training is really key in technology transfer and is seriously lacking in the developing world. To put this in context, as noted in Rhoades and Petree (2005), despite a projected increase of around a 100 000 jobs in the aviation sector in the Gulf Coastal region over the period 2004–2014, there are only a few universities that offer degree education in the field of aviation/aerospace in the Middle East at the present time. The aerospace engineering course offered by King Fahd University of Petroleum and Minerals (KFUPM) in Saudi Arabia is one such example. As a result, there is still a huge gap between demand and supply for such courses throughout the region. Remember, as Brace *et al*. (1999) puts it, technology cannot be contained in a machine or a piece of software, it has an element of motivation and personal 'know how'. Likewise, technology does not automatically yield innovation; imagination and first class marketing skills are also required. These could only be achieved through rigorous training.

5.2 The case for Africa

Obviously, all the recommendations discussed above are equally applicable to Africa as a developing continent. However, the main barriers to implementation seem to be the corruption, political instability and lack of investment. Corruption seems to be endemic in Africa. The Economist Intelligence Unit ViewsWire (2008) noted that Africa's economy has grown much faster since 2000, but fears regarding corruption have risen too. This is supported by Transparency International's survey, which shows that Africa's average score on its Corruptions Perceptions Index has fallen steadily since 2000, reaching a new low of 2.75 out of a possible ten in 2008 (Transparency International, 2008). Sixty-four percent of the 47 sub-Saharan countries ranked in the 2008 survey scored less than three out of ten, a level that, according to Transparency International, indicates 'rampant corruption'. Another 14 scored between 3 and 5, indicating that corruption is perceived as a 'serious challenge by country's experts and businessmen'. Just three states, namely Botswana, Cape Verde and Mauritius, scored above the index's mid-point. Political instability, on the other hand, is self-evident. With civil wars and bloody power struggles in Sierra Leon, Nigeria, Sudan, Somalia and Zimbabwe, to name but a few, becoming daily News in the Media, Africa stands as the politically least stable continent in the world. However, interestingly enough the African countries cited in Section 2 as enjoying economic boom through commerce or tourism success are among the most politically stable and identified by Transparency International survey as amongst the least corrupt in Africa and, probably, showing signs of improving in this respect since 2000. This shows that good governance, political stability and economic success are arguably inter-linked, as attracting investment requires political stability with a strong anti-corruption drive. Realisation of this dream necessitates a cultural change in Africa to bring about the right attitude towards sustainable development.

Therefore, the route map for Africa is clear, but is there enough will for implementation?

6 Conclusions

The projected huge increase in demand for air transportation over the next 20 years or so outpaces current airports capacity and systems capability and, hence, necessitates the development of highly efficient air transport systems that addresses society's future needs and concerns.

In this new system, performance of the air traffic management system would be enhanced by reduced separation standards, flexible spacing and sequencing of aircraft on the ground and in the air, use of new equipment, procedures and infrastructure enabling increased service of under-utilised airspace, airport and runways, improved and tailored weather forecasts and new and enhanced technologies and procedures to reduce environmental effects of noise and emissions. This will also bring with it step change in aircraft design, performance and capability as well as the development of new concepts of a responsive air traffic management that takes advantage of aircraft and ground system automation.

The required new technologies, supported by standardisation of global rules and procedures that allows for an efficient system, will present challenges while opening new opportunities globally at all stages from research through to implementation.

The developing world can share these opportunities via heavy investment in infrastructure, technology transfer, training of personnel as well as securing the right environment for sustainable development that allows local talent to flourish and contribute towards building an efficient air transport system. This, in turn, requires achieving political stability and creating a truly investment-attractive climate, both in legislative and implementation terms.

Africa has the potential to share these opportunities owing to its central geographical location combined with growing regional economy and flourishing trade and tourism. However, a strong anti-corruption drive, that brings political stability and, hence, attracts investment, is necessary. A cultural change is required.

Acknowledgements

Thanks and gratitude to Mr. Adrian Miller, Support and Parasitic Drag Skill Group Leader at Airbus UK, for revising the draft of this paper before publication. His comments and views were highly appreciated.

Although both authors are employees of Airbus, this paper represents their own personal opinions and does not reflect the company's official view in any way, shape or form.

References

Airbus (2008) 'Global market forecast 2007–2026', Airbus Report, UK.

Brace, G., James-Moore, M., Broughton, T. and Raja, V. (1999) 'Artificial insemination breeds sterile technology – innovation needs people', *TTI Conference*, Melbourne.

Daggett, D., Eelman, S. and Kristiansson, G. (2003) 'Fuel cell APU for commercial aircraft', Presented at *AIAA/CAS Int. Air & Space Symp. and Exposition: The Next 100 Y*, AIAA Paper No. AIAA 2003–2660, Dayton, Ohio, USA.

Economist Intelligence Unit ViewsWire (2008) 'Growing more corrupt', http://www.economist.com/agenda/displaystory.cfm?story_id=12448676&fsrc=rss.

Enders, G. (2008) 'Merger mania', *Flight International*, UK, 8–14 April.

European Commission (2001) 'European aeronautics: a vision for 2020: meeting society's needs and wining global leadership', Report of the Group of Personalities to the European Community, Published by the Office of for Official Publications of the European Communities, Luxembourg, Ref: L-2985, January.

Federal Aviation Administration (FAA) (2004) *Aerospace Forecast, Fiscal Years 2004–2015*, USA, March.

International Civil Aviation Organisation (ICAO) (2004) 'Annual report of the council', International Civil Aviation Organisation, Doc 9851, Montreal, Canada, http://www.icao.int/icao/en/pub/rp04_en.pdf.

ISO Standards (2008) *ISO 15288, Engineering Systems*, UK.

Ogilvie, F. (2008) 'Private communications', *Airbus Expert Briefing*, Filton, Bristol, UK.

ONE (2008a) 'Clean energy for the aircraft of the future', *Airbus ONE Magazine*, April.

ONE (2008b) 'Promising future for alternative fuels', *Airbus ONE Magazine*, June.

Pritchard, D. and MacPherson, A. (2007) 'Strategic destruction of the Western commercial aircraft sector: implications of system integration and international risk-sharing business models', *The Aeronautical Journal*, Paper No. 3166, May, Vol. 111, No. 1119, pp.327–334.

Rhoades, D.L. and Petree, D. (2005) 'Aviation education in the Middle East: sustaining growth and indigenous development – the case of the GCC', *World Review of Science, Technology & Sustainable Development Journal*, Vol. 2, No. 2.

Rolls Royce Forecast (2004) *NBAA Convention News*, 13 October, p.22.

Salmon, C.M. and Motevalli, V. (2008) 'Aviation safety priorities in emerging air transport systems', *Journal of Aircraft*, Vol. 45, No. 4.

Transparency International (2008) 'Worldwide corruption perception index of countries', Transparency International, http://en.wikipedia.org/wiki/Corruption_Perceptions_Index#CPI_Ranking_.282002.E2.80.932008.29.

UN (1997) *The Kyoto Protocol to the United Nation's Framework Convention on Climate Change*, Kyoto, Japan.

US Department of Transportation (2004) 'Next generation air transportation system: integrated plan', Report by the Joint Planning & Development Office, http://www.jpdo.gov/iwp.asp.