Air Transport Net

AirTN
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STUDY ON THE GLOBAL RESEARCH, TECHNOLOGY & DEVELOPMENT LANDSCAPE IN CIVIL AERONAUTICS

June 2009

Final Report for AirTN FP6 Work Package 4

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1. Objective

1.1 The objective of AirTN-FP6 work package 4 was to develop an overall view of the global competitiveness civil aeronautical landscape. This report provides an overview and analysis of the aeronautics industry in each of the countries identified by the network and considers their suitability for collaborative research in AirTN-FP7.

2 Description of Work

2.1 The UK was tasked with describing the global civil aeronautics research, technology and development landscape. In the selected countries outside the European Union the following were considered:

- Funding structures available for aeronautics
- Types of research undertaken in different global regions (fundamental, applied etc)
- Major aeronautics programmes
- Key industry and international supply chain issues
- Activities of other organisations (e.g. national research establishments technology centres and universities)
- Potential for international collaboration.

2.2 This would be achieved by identification of relevant information, face to face meetings with relevant government officials, work shops, analysis, reporting and dissemination.

2.3 An objective of the AirTN-FP6 project was to define possible pilot trans-national project partners with an appropriate budget to be approved by the AirTN Board. Any pilot trial action will be based on the principle of "no cross border funding". AirTN-FP7 has a target to have three trans-national projects.

3. Deliverables

3.1 The UK agreed to hold two work shops on competitiveness with reports following each work shop, and deliver a final report covering the global research, technology & development landscape in civil aeronautics.

4. Process

4.1 The UK gathered existing information and conducted internet based research on civil aeronautics research landscape for countries outside Europe, with major aeronautics capabilities. The information was circulated prior to AirTN members the first work shop in London on 18 January 2007, which was attended by AirTN members plus some international managers from industry. The work shop provided the focus for the countries and areas that should analysed. These were:

- Research funding mechanisms and centres of excellence/research facilities for countries with major aeronautics capabilities; and
- Growing competition from Dubai, Mexico and Singapore.

4.2 The work shop provided the steer of the countries that should be analysed and topics that may be of interest.

a) Australia, Brazil, Canada, China, India, Japan, Russia, South Africa, the United States and Ukraine in respect of funding mechanisms, centres of excellence and collaboration potential; and

b) Dubai, Mexico and Singapore because of their developing aerospace capabilities and competition.

4.3 AirTN undertook missions to the United States, Russia and China to develop networks of contacts in order to consider the possibilities for international collaboration whilst gaining a more in depth understanding of capabilities and strategies. Reports of these are available on the AirTN Virtual Laboratory. AirTN then held an International Conference on Aeronautics Research & Technology in London on 13th and 14th March 2008, with representatives from Australia, Canada, South Africa, the United States, the Ukraine and across Europe. Its aim was to develop a collective understanding of international research, technology and development requirements, funding and processes for civil aeronautics. It also provided the opportunity to identify possible partners and suitable themes for future alignment of joint research and technology projects in civil aeronautics. The presentations by international representatives, European Commission and AirTN work package leaders are available on the AirTN Virtual Laboratory and website. The conference was then followed up with missions to Brazil, Canada and South Africa.

4.4 A summary of the funding mechanisms and an assessment of the collaboration potential for the identified countries are given in section 5, and countries developing aerospace capabilities are given in section 6.

5. Funding Mechanisms, Centres of Excellence and Collaboration Potential

Australia

5.1 The Australian aerospace industry operates in both the civil and defence markets and is a mixture of foreign and domestic companies. It is a supplier in the international market across a range of niche technologies predominantly in sub systems and components and has a strong interest in retaining aerospace in defence.

The leading players are BAE Systems Australia, Australian Aerospace (a subsidiary of Eurocopter); Boeing Australia and Hawker de Havilland (a Boeing subsidiary). These four companies generate nearly a half of the industry's revenue, and are supported by a large numbers of SMEs.

5.2 The Australian aerospace sector employs 20,000 people with annual revenue of about A$3.9 billion, 25% of which comes from exports. Activities include:

- aircraft component manufacturing for civil and military aircraft including helicopters,
- maintenance and repair,
- light aircraft manufacturing,
- system design and development,

- aviation training, and
- air traffic management products.

5.3 The presence of BAE Systems and Boeing in Australia is mainly in the areas of systems integration and maintenance, repair and overhaul. The principal aero-structure component manufacturer, Hawker de Havilland, exports the majority of its civil and military products to Boeing; Airbus; Bombardier; Lockheed Martin and BAE Systems. GKN Aerospace Engineering Australia has designed 13% of the parts for the Joint Strike Fighter and was the third largest engineering design contractor on the project after Lockheed Martin and Northrop Grumman. There are also a number of successful small aircraft producers such as Gippsland Aeronautics that produces up to 25 light aircraft a year.

5.4 The Australian aerospace industry is supported by federal and state government and research organisations, which is known as the national innovation system. A number of government funded bodies conduct research and development in a variety of fields, in collaboration with industry.

5.5 A review of the National Innovation System, used to fund research, was undertaken to identify gaps and weaknesses in the innovation system and to develop proposals to address these. It is expected that innovative intensive industries such as aerospace will particularly benefit from an improved innovation system. The review's recommendations are being considered by the federal government in preparation for a White Paper in 2009.

5.6 The Defence Science and Technology Organisation is the Australian government's lead agency in science and technology defence related projects and works closely with industry and the science and technology community to support Australia's defence and national security capabilities. With an annual budget of over A$440 million the Defence Science and Technology Organisation facilitates collaboration with industry, through strategic alliances, industrial agreements and collaborative research projects.

5.7 The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is Australia's national science agency. It is the country's single largest employer of scientists, with more than 6,500 people conducting research at fifty seven sites in Australia and around the world. CSIRO focuses on solutions for industry, society and the environment, working on new ways to improve quality of life, as well as the economic and social performance of a number of industry sectors.

5.8 Research and testing is also carried out at a number of universities. The Centre for Hypersonics run by the University of Queensland conducts research into hypersonic flight, including test facilities, air-breathing engines, rocket flight testing, aerothermodynamics, computational fluid dynamics and optical diagnostics.

5.9 For example, as part of its HyShot Flight Programme, the Centre had the world's first experimental flight of an air-breathing scramjet in 2001. Sponsorship for the programme came from the Defence Evaluation and Research Agency in the UK, National Aeronautics and Space Agency (NASA, USA), the German Aerospace Centre (DLR) and the National University Korea.

5.10 The programme's success has led to the establishment of the Australian Hypersonics Initiative, a collaborative project between a number of universities, state governments and the Australian Department of Defence. The parties are marketing the newly developed hypersonics technology and the initiative is now also sponsored by NASA and has been engaged in testing on the HyCAUSE programme with the United States' Defence Advanced Research Projects Agency (DARPA).

5.11 Another programme aimed at encouraging research and development is the Cooperative Research Centres programme. An Australian government funded initiative aimed at fostering research, turning Australia's scientific innovations into new products and making its industries more efficient and competitive.

5.12 The programme's emphasis is on collaboration between business and researchers to maximise the benefits through utilisation, commercialisation and technology transfer. It also has a strong education component with a focus on producing graduates with skills relevant to industry needs. The programme supports fifty eight Cooperative Research Centres operating across a wide spectrum of sectors. The aerospace manufacturing industry is strongly represented in the Cooperative Research Centre for Advanced Composites Structures.

5.13 The Cooperative Research Centre for Advanced Composites Structures has an international reputation in the field of composites research, which has been successfully applied to a range of programmes including the F-111 replacement panels. In 1997, a programme was established with the Defence Science and Technology Organisation to investigate the viability of using composite structures as substitutes for aluminium aircraft panels. Supported by the Australian Defence Forces and Hawker de Havilland, the programme set out to develop a cost-effective generic methodology with composite panels centred on reducing low volume manufacturing costs. As a result Hawker de Havilland won tier 1 status on the 787.

5.14 Despite Australia's emerging capacity to develop and produce aerospace technologies and products, the aerospace industry continues to face significant challenges in positioning itself in the global market, but the industry is adjusting to having a supplier role rather than being an integrator.

5.15 The Australian government's defence and industry policy is aimed at identifying ways to work with industry in developing and sustaining capabilities. This includes leveraging defence purchases of foreign equipment to open up export opportunities, assisting local industry to grow skills and capabilities, and encouraging investment in research and development of innovative technologies.

5.16 In response to this policy, Boeing opened the Office of Australian Industry Capability to work with the Australian Department of Defence and industry to identify opportunities within Boeing's major civil and defence programmes, as well as key supplier partners. This provides greater opportunity for companies to compete for work based on a best value for money basis. A similar programme for Australian industry participation is also being undertaken by European Aeronautic Defence and Space (EADS) to encourage participation in their supply chain.

5.17 In March 2008 Boeing launched the Australian Phantom Works Branch, a research and development centre with sites in Melbourne and Brisbane. This Phantom Works Branch provides research and development support services for Boeing's Australian business units and acts as a focal point for collaboration with local universities, private sector research and development providers, the Commonwealth Scientific and Industrial Research Organisation and the Defence Science and Technology Organisation.

5.18 BAE Systems has an Unmanned Airborne Vehicle Experimentation System project in Australia. With a technology base in South Australia and a testing site in Victoria is now the primary site for BAE Systems' Unmanned Aerial Vehicle development. BAE Systems allows other companies to use the existing infrastructure for testing.

5.19 The Australian Department of Innovation, Industry, Science and Research is the lead ministry responsible for the sponsorship of the aerospace industry. One way in which the Australian government has worked closely with its industries has been through Action Agendas. Between 1996 and 2007, thirty eight action agendas were established to help industries develop strategies for growth, agree on priorities, and commit to change. Action agendas complemented other policies and programmes aimed at improving economic growth, productivity, and the competitiveness of Australian industry.

5.20 Each action agenda was industry-led by a steering group, and placed particular emphasis on identifying actions that industry itself could take to realise its full potential. Accordingly, they encouraged industry to develop solutions to their problems that did not involve the injection of large amounts of government funding.

5.21 The Aerospace Industry Action Agenda's report went to the Cabinet for approval before the implementation phase. This gave the government a better understanding of the industry and enabled a more effective action by government agencies to address impediments to the industry's growth. The key themes of the recommendations were:

- Establishment of a single industry association
- Positioning for global supply chains
- Investing in skills and research
- Accessing markets
- Certifying for global competitiveness, and
- Mobilising the local supply chains

5.22 The action agenda has encouraged industry to see the defence and civil aerospace market as part of an integrated aerospace market instead of as two largely stand-alone markets. It also opened up new ways for the industry to work collaboratively, using clusters and networking in a model called Team Australia.

5.23 The Aerospace Industry Action Agenda has successfully informed the policy development process, for example government facilitation of access to global supply chains is the basis of a new programme called the "Global Opportunities Program". The Department of Defence has also drawn on the analysis and ideas in the Action Agenda in formulating the Defence Industry policy statement to establish a commercial opportunity programme for all projects valued at over A$50 million.

5.24 By fostering unity and a willingness on the part of industry participants to co-operate on common issues, the Aerospace Action Agenda was an important factor in responding to these changes. It stimulated the formulation of a sector-wide perspective on industry competitiveness and growth, and the communication of this perspective to government by industry leaders. As well as improving the dialogue between government and industry, the Action Agenda set out a new strategic direction for the sector based on identifying and capitalising on market opportunities.

5.25 Completion of the Action Agenda has led to the establishment of the Australian Aerospace Industry Forum. The Forum is made up of the CEOs of Raytheon, GKN Australian Engineering Services and Hawker de Havilland. The Forum addresses issues such as improving global market access, industry promotion and increasing research and development through a series of working groups, and provides an aerospace voice to government on current issues.

5.26 The government and industry has addressed issues and developed strategies to ensure the sustained development of the local industry. A number of positive outcomes have resulted including:

- the decision to join the System Development and Demonstration phase of the Joint Strike Fighter programme, enabling Australian firms to bid for work and gain contracts valued at US$160 million;
- a government grant to Boeing subsidiary, Hawker de Havilland, from the Strategic Investment Fund to enable it to become a tier 1 supplier for the moveable trailing edges for Boeing's 787 aircraft;
- the provision of A$3.6 million in innovation funding to support the development of techniques for identifying aircraft fatigue before it leads to structural breakdown.

5.27 However, the Action Agenda programme has been discontinued and replaced with “industry innovation councils” as a result of a change of government. The incoming administration did not consider all of the action agendas were as successful as the one conducted for the Aerospace industry. It considered many action agendas were a case of "set and forget", and therefore decided to introduce a number of Industry Innovation Councils involving active participation of business, union, government and researchers to lead sectors into greater innovation and hence greater productivity and competitiveness.

5.28 Australia has internationally recognised research and testing facilities and is open to the idea of having international collaborative research projects. The aerospace industry is supported by funding federal and state mechanisms that are compatible with the European funding models, which would make joint projects and the alignment of Calls relatively easy to implement. Australian industry and government have an agreed strategy being led through the Australian Aerospace Industry Forum, which provides a clear route to explore opportunities for joint projects. However, the size of the aerospace industry; its distance from Europe; its focus on defence related activities and its position of primarily being involved in Boeing aircraft platforms limits the opportunities for co-operation to a number of themes, such as carbon fibre composite materials, niche components, unmanned air vehicles etc.

Brazil

5.29 The Brazilian aerospace industry is the largest in the southern hemisphere, producing civil aircraft, helicopters, structures, engines, on board systems and equipment, and air traffic control systems. Maintenance, repair and overhaul services are also provided to civil and military aircraft including major checks, structural modifications, engine and components overhaul. Some companies are FAA (Federal Aviation Administration) and EASA (European Aviation Safety Agency) approved. Defence products include weapon systems, equipment, system integration and aircraft for the Brazilian air force. The sector is supported by services, engineering, parts manufacture and assembly. Engineering schools/research establishments (Comando-Geral Tecnológica Aerospácial, and the Instituto Tecnologico Aeronautica) specialised in aeronautics, and most companies are based in São José dos Campos in the State of São Paulo. There are an estimated 850 companies active in the aerospace sector in Brazil of which the leading exponents are Embraer, Liebherr, C&D, Aernova, Sobraer and Sopeçaero, Latecoere, Mectron, Avibras, HTA, Graúna Aerospace, Automata Thyssen Krupp, Winnstal, Friuli and Geometra.

Statistics

	2004	**2005**	**2006**	**2007**
Annual Turnover (US$ billion)	**4.2**	**4.3**	**4.3**	**6.2**
Export (US$ billion)	**3.5**	**3.7**	**3.9**	**5.6**
Employment	**18,000**	**19,800**	**22,000**	**25,200**

Segmentation

2004	2005	2006	2007
-Aeronautics: 89,6% -Defence: 9,23% -Space: 0,14%	-Aeronautics: 87,3% -Defence: 9,29% -Space: 0,24%	-Aeronautics: 90,8% -Defence: 5,78% -Space: 0,41%	-Aeronautics: 91,3% -Defence: 6,6% -Space: 0,4%
-Export: 82,72% (3,35 % of Brazilian exports)	-Export: 90% (3.1 % of Brazilian exports)	-Export:90,5% (3.06 % of Brazilian exports)	-Export:90,8% (3.06 % of Brazilian exports)

5.30 Brazil's aerospace industry is however, principally, Embraer, which started as a small turboprop manufacturer and has grown into a major competitor to Bombardier, producing regional jets and business aircraft. Embraer has had production problems, which have led to aircraft delivery delays and some deferrals. Embraer reported a loss for the first quarter of 2009 as result of the recession, due to airlines cancelling aircraft orders or delaying deliveries. It now expects to deliver 242 aircraft in 2009, compared to a previous prediction of 270 aircraft. In February 2009, the company laid off about 20% of its 21,000 workers, mostly employed in Brazil. The company president has said that Embraer had hit the bottom of the recession and predicts the situation will improve by 2011.

5.31 Embraer will benefit from a new commitment from Brazil's government to purchase Embraer's military transport and refuelling jet aircraft. The defence minister announced in April 2009 that Embraer will develop a cargo aircraft for the Brazilian air force, replacing its ageing fleet of Lockheed Martin-made C-130 Hercules aircraft. Embraer's KC-390 military cargo aircraft will carry up to 19 tons and 80 soldiers, but deliveries are not expected to begin until 2015. The twin turbofan aircraft will have mid-flight refuelling capability, and be deployed in surveillance of the Amazonian region.

5.32 Most of the Embraer supply chain is located overseas. Partners are secured through risk-sharing and are based in the United States and Europe. The main partners are Sobraer (wing, controls surfaces and engine pylons); Latecoere (central fuselage sections and forward fuselage doors); Aernova (vertical and horizontal stabilisers, rudder, elevators and rear fuselage); GE (engine and nacelles); Hamilton Sundstrand (tail cone, APU, air management and electrical systems); Honeywell (avionics); C&D (passenger cabin and cargo compartment interiors); Parker (hydraulic, flight control and fuel systems); GKN (windows); and Rolls-Royce (engines). Although, Embraer was a public company until 1994, it is now very much market driven, partly because the majority of its board have a financial background. The company was fortunate that several products developed towards the end of its state ownership proved to be “cash cows” which provided it with a strong financial position from which it could develop further aircraft. The Brazilian government “Uniäo” still retains a golden share in Embraer.

5.33 Brazil has some issues that are adverse to commercial development, such as it has a complicated taxation system which can add significant costs to selling into and setting up in the country. Also, Brazil does not have a system whereby Intellectual Property generated by universities and research establishments is taken up by industry. Thus Intellectual Property is often focused on the domestic market and Brazilian industry does not pick up key technologies and these remain unused. The country is, therefore, encouraging universities to produce more patents. It is important that such universities are encouraged by successful cases of Intellectual Property exploitation. Brazilian Intellectual Property can be exploited internationally through the establishment of Brazilian spin-off companies or joint ventures. It also needs to be borne in mind that Embraer is fairly conservative in respect of new technologies and therefore tends to incorporate only mature technologies into new aircraft programmes. There is also no government strategy for aeronautics, partly because the industry is dominated by one company. However, it is generally accepted that the government is committed to providing grants for research into environmentally friendly and green products, and this could be one area for international collaboration.

5.34 The Brazilian National Bank (BNDES) provides export credit to the aerospace industry, and also provides investment loans for long term projects. Interest rates in Brazil have been traditionally much higher than those in Europe and the United States, which has made capital projects expensive. BNDES is a federal public company linked to the Ministry for Development, Industry & Trade and finances long term loans to enhance the country’s development and competitiveness. The bank typically provides loans at around 6% whereas on the open market interest rates can be above 20%.

5.35 The national innovation agency “Financiadora de Estudos e Projetos” (FINEP) is accountable to the Ministry of Science and Technology. Its main objectives are to promote innovation in products, processes and services. FINEP funds research in

companies, universities, technology institutes, research centres and other public and private institutions. It manages various funding programmes, whose main activities are:

- increasing knowledge and experience of science and technology;
- research, development and innovation in products and processes in the private sector;
- improve the quality and added value of products, processes and services for the domestic and international markets;
- promote social inclusion and reduce regional disparities.

5.36 FINEP's support covers all stages of the technological development cycle: basic research, applied research, innovation and product development, services and processes. FINEP also supports the incubation of technology based enterprises, the implementation of technology parks, the structuring and consolidation of research processes, development and innovation within already existent enterprises and the development of markets. FINEP is interested and able to collaborate on international projects, but it does not have the complete autonomy to set the agenda of work. That authority needs to be given by the Ministry of Science and Technology and for international projects the Ministry of Foreign Affairs. It would, therefore, be necessary to identify the projects with the Brazilian authorities whilst consulting FINEP so that it can make it happen under the bilateral agreements. This should be relatively simple as FINEP's support mechanisms are broadly compatible with European schemes, and are based on fourteen technology themes. Aeronautic projects are able to bid under which ever theme best matches the projects aims. There have been a number of aeronautic related projects in recent years including radar and unmanned air vehicles. However, it appears that the majority of aeronautic projects have had a defence application and were partly designed to encourage greater and better co-operation between the armed forces.

5.37 The other public body important to the aerospace industry is the State of São Paulo Research Foundation (FAPESP), as it is one of the main funding agencies for scientific and technological research in the country. It has an annual budget of around US$2 billion, and provides project funding of between 20% and 70% for research - dependent on the project risk. However, funding is generally around 50% of the cost of the project. The State of São Paulo's constitution determines that 1% of the State's revenue must be dedicated to FAPESP. Even though companies are actively sought to enter into collaboration agreements, the funding is given to the state organisation involved, such as Comando-Geral Tecnológica Aerospácial, and the Instituto Tecnologico Aeronautica. FAPESP's funding is therefore considerable and as such has difficulty in allocating all the monies. The foundation also has full autonomy in the analysis and selection of the proposals supported, and all proposals are peer reviewed, many including reviewers from outside of the country. FAPESP's administrative costs must not exceed 5% of the amount it invests in research.

5.38 The State of São Paulo has the best universities in the country (including the aeronautics department of the University of São Paulo in São Carlos) and the two research institutes São José dos Campos dedicated to aeronautics. FAPESP is linked to the State of São Paulo's Secretariat for Higher Education. It funds research and scholarships in all scientific disciplines, plus other activities such as studies, exchanges and the dissemination of science and technology in São Paulo. Scholarships and financial awards are the traditional means offered by FAPESP for the promotion of

scientific and technological research, particularly in biological and health sciences, Earth sciences, plus all fields of engineering, agrarian science, applied social sciences, linguistics and humanities and the arts.

5.39 The scholarships are for graduate and post-graduate students in teaching and research institutions in the State of São Paulo. Financial awards are for researchers in teaching and research institutions in the State of São Paulo who hold a minimum qualification of doctorate. Scholarships and financial awards are allocated within three types of funding: "Regular Lines", "Special Programmes" and "Technological Innovation". The Regular Lines are geared towards responding to spontaneous demand (the so-called "over the counter" demand) from researchers attached to the universities and research institutions based in the State of São Paulo. They represent a solid support for the research proposals freely conceived and delineated by the scientific and technological community in the State of São Paulo. The Special Programmes are geared to correcting existing (or even predicted) funding shortfalls in the State Science and Technology System. Whereas, the Technological Innovation funding comprises a variety of programmes in which the research projects have potential to develop new technologies with practical application. Candidates seeking support from FAPESP, within the Regular Lines or the Special Programmes, can all the proposals submitted to FAPESP are assessed on the basis of scientific and technological merit and according to their compliance with FAPESP's priority criteria. This evaluation is undertaken by peers chosen from a pool of scientists of recognised competence, and according to the nature and area of knowledge in which each project. For this purpose, FAPESP has a network of more than six thousand volunteer advisors, the majority being active researchers in the State of São Paulo, besides several hundred scattered throughout Brazil and abroad.

5.40 The most suitable FAPESP scheme would be the Research Partnership for Technological Innovation (PITE), which supports projects of scientific and technological research in partnership with institutions and businesses based in the State of São Paulo. It has been designed to develop business knowledge. The projects are carried out in higher education and research institutions with FAPESP and business partner funding. FAPESP have said that the scheme could be adapted to involve international partners.

5.41 Associação das Indústrias Aeroespaciais do Brasil is the national trade association based in São José dos Campos. The membership's activities cover aeronautics, space and defence, including design, manufacture and MRO. The Associação das Indústrias Aeroespaciais do Brasil manages the relationship with the congress, national and state governments and is a primary contact for international bodies.

5.42 The Brazilian aerospace industry has well trained engineers, and its government is supporting the development of its national capability in green technologies, unmanned air vehicles, radar, computational fluid dynamics, undercarriages, composite structures and engine manufacture, particularly final assembly of engines. Embraer has suffered problems with its joint ventures in China and may be more open to conduct research with European organisations as a result. The funding agencies FINEP and FAPESP have funding mechanisms compatible with those in Europe. Both agencies have significant funds available and appear to be open to suggestions for international collaborative research projects that would involve universities, research institutes and industry. Brazil, therefore, offers real opportunities for international collaboration, apart from its lack of

suitable SMEs. Possible technology themes for collaboration could be advanced manufacturing techniques, assembly technologies, Micro-Electrical-Mechanical-System, unmanned air vehicles and alternative fuels.

Canada

5.43 The Canadian aerospace industry consists of 400 companies employing 79,000 people, with reported sales of C$22 billion in 2006[1]. The industry is ranked fifth in the world in terms of sales and employment and third after the United States and France in respect of civil aircraft production. The industry is almost unique in that seventy-eight per cent of production is for civil use, with the remainder divided between small defence and space programmes. Only 20% of the production is for the domestic market with the remainder of the output exported. It has a highly-qualified and specialised work force, with 3,000 new aerospace university and college graduates entering the workforce each year. Aerospace represents 5% (C$9 billion) of the country's manufacturing GDP, however it contributes 11% of all Canadian industrial research and development spending (C$1.2 billion) in 2006. Canada, also, offers one of the most favourable R&D tax credits in the OECD countries.

5.44 Canada produces regional aircraft, business jets, commercial helicopters, small gas turbine engines, flight simulation equipment, landing gear, and space applications. The industry's core competences are in the supply of:

- Airframe structural assemblies
- Wing structure assemblies
- Power conversion and distribution systems
- Integrated electronic controls
- Environmental conditioning systems
- Air traffic control and management systems
- Communications systems
- Maintenance, repair and overhaul

5.45 Industry Canada is the focal point for the government and industry strategy, known as the National Aerospace and Defence Strategic Framework. Its aim is that "Canada will be home to a growing, innovative and diversified industry, recognised as a leader in serving global aerospace and defence markets and a preferred location for investment." The government works with the industry in the following areas:

- Securing strategic aerospace and defence investments;
- Technology development and commercialisation;
- Skills development;
- Trade policy and trade development initiatives;
- Sales financing;
- Security and the environment; and
- Procurement.

[1] Source: Aerospace Industries Association of Canada

5.46 Industry Canada is also the ministry responsible for the sponsorship of the aerospace industry, and manages the "Strategic Aerospace and Defence Initiative" that was launched in 2007. The Initiative's objectives are to:

- encourage strategic research and development that will result in innovation and excellence in new products and services;
- enhance the competitiveness of Canadian aerospace and defence companies; and
- foster collaboration between research institutes, universities, colleges and the private sector.

The Initiative is expected to invest C$900 million in the period 2008-2013, and with funding to reach a maximum of C$225 million per year. The monies are provided to companies on a repayable loan basis, rather than through grants. Moreover, as with all the Canadian funding mechanisms there is no requirement for collaboration between companies.

5.47 Industry Canada also oversees the "Industrial and Regional Benefits Program" that provides the framework for using federal government procurement to obtain long term industrial and regional development. This is a contractual commitment by contactors to place work in Canada as a result of winning orders from the Canadian defence programme. This is mandatory for projects over C$100 million, but discretionary for those below that threshold. In 2008 C$10 billion was under contract. The "Industrial and Regional Benefits Program" objectives are focused on long term industrial and regional development:

- High quality technology as identified through a key technology list developed by industry stakeholders;
- Lasting economic value for Canadian industrial base;
- Provide opportunities and access to export markets for Canadian industry; and
- Enables Canadian company participation in the global value chain.

5.48 The "Industrial and Regional Benefits Program" is designed to raise awareness to international companies of the capabilities of Canadian industry, and encourage bidders to partner with Canadian companies. In preparing proposals, bidders are expected to identify activities that make good business sense, regardless of where they are performed in Canada.

5.49 The Canadian aerospace has a number of other sources from which research funding can be obtained, however the source is dependent on the Technology Readiness Level and the nature of the technology theme. For example there is the "Sustainable Development Technology Canada", which is a non-profit making foundation that finances the development of clean technologies in relation to climate change, clean air, water and soil. It manages two funds:

- C$500 million "SD Tech Fund" late stage development and pre-commercial demonstration, particularly on climate change solutions.
- C$500 million "NextGen Biofuels Fund" is always open for applications for large demonstration facilities for the production of renewable fuels.

5.50 There is also the National Sciences and Engineering Research Council of Canada, which is an independent government agency that promotes research through an annual budget of C$958 million. It funds universities and companies to undertake basic research to develop the next generation of scientists and engineers.

5.51 Then there is "Scientific Research and Experimental Development Program", which encourages companies, through federal tax incentive, to conduct research. This is supported by complimentary programmes in most provinces. Investment tax credits vary from 20% to 35% of research expenditure which is dependent on the amounts of expenditure and the size of the company. Eligible projects areas are experimental development, basic and applied research and supporting activities. And then finally there is the National Research Council Canada a federal agency that includes 20 research institutes, industrial partnership facilities; the Canadian Institute for Scientific & Technological Information, and the management of the "Industrial Research Assistance Program". In 2006 it reported expenditure of C$835 million and income of C$166 million, with 4,300 employees.

5.52 The Canadian research establishment is the National Research Council Canada's "Institute for Aerospace Research" which has an annual budget of C$64 million and facilities in Ottawa and Montreal. It specialises in aerodynamics, flight research, structures & materials, propulsion and manufacturing technology. Its infrastructure includes wind tunnels; research aircraft; test rigs; engine, combustion & material testing; aero acoustic reverberant chambers and a flight recorder playback centre. The Institute's strategy is based on strengthening the science base, whilst supporting federal priorities in aerospace in order to broaden the sector's capabilities.

5.53 Canada offers one of the best opportunities for collaboration with Europe based on the compatibility of its funding mechanisms; its primary focus on civil aeronautics; highly skilled workforce; and Industry Canada's willingness to co-operate. There is a wide range of technology themes: such as environmental related projects (the Canadian government offered C$11 million support in May 2009 for a programme called "GARDN" that is focussed on environmental technologies that will use centres of excellence to carry out the projects), advanced manufacturing, composite structures, flight mechanics, super-cooled large droplet icing, atmospheric and environmental investigations, anti-corrosion coatings, nanotechnologies.

China

5.54 China is involved in the whole range of aerospace activities although it lags behind Western countries technologically by a decade or more. Inward investment by Western firms, seeking to take advantage of the low-cost base and strategic sourcing opportunities is however raising the country's aerospace knowledge base. The Chinese strategy for the civil aviation industry is to produce an indigenous aircraft for the domestic and international markets and to develop and implement a modern indigenous air traffic management system.

5.55 The Aviation Industry Corporation of China (AVIC) consists of 200 subsidiary organisations. It manufactures Chinese and Russian designed fighters and smaller aircraft and helicopters; commercial aircraft components for Airbus, Boeing, Rolls-Royce and Pratt & Whitney; airborne and ground support equipment; weaponry and fire control

systems. The company has launched a global recruitment drive for senior executives, the first time a Chinese defence company has publicly looked beyond the nation's borders for talent. The newly restructured AVIC appears to be primarily interested in attracting Chinese-born technicians and managers who have worked in the military and aviation industries in the West. However, it has said that it is open to hiring people of all nationalities. China reports high employment numbers for its aerospace industry (around 430,000), but it is unclear how these are calculated and the types of activities that are included in the statistics. It is therefore estimated that 50% of these are actually involved in aerospace related activities.

5.56 China's Harbin aircraft company has a joint venture with Embraer to assemble ERJ-145 regional jets in China. The venture has been a moderate success, with the Chinese ordering reasonable numbers of regional jets to keep the production line running. It has helped Embraer recently win a big 50 aircraft E190 (large regional jets) order from China.

5.57 Before the on-set of the recession, China predicted high growth potential in air travel and cargo values, however 80% of aerospace production is for military use. The Chinese government is consolidating its airlines and stopped the liberalisation of the airlines. This has in effect limited the growth of aircraft to around 150 per year. Airbus has an A320 assembly plant (not manufacturing) in Tianjin. Chinese airlines will be the recipients of these aircraft. The assembly has a target to deliver four aircraft per month by 2011.

5.58 Bombardier has a partnering agreement with China to support their development of a 100-seat regional jet version of the ARJ series regional jet that is currently being developed by AVIC in China. In return the Chinese committed US$400 million to the Bombardier CSeries. China has also announced plans to develop its own 70-seat turboprop, the MA700 (through Xian Aircraft) with an entry into service date of 2015. The MA700 could share some commonality with the ARJ21 to allow pilots an easier transition between aircraft types.

5.59 Despite work on Boeing and Airbus programmes and collaborations with Embraer and Bombardier, China plans to develop its own large commercial aircraft within the next two decades. It is likely that Western manufacturers will seek to involve Chinese companies more deeply in their programmes to discourage this competition.

5.60 The Ministry of Science & Technology, the Commission of Science, Technology and Industry for National Defence, and the Civil Aviation Administration of China have responsibilities for the aerospace and aviation industries. The Ministry of Science & Technology oversees the implementation of document "973" for fundamental and basic research carried out in universities and research establishments. The ministry formulates policy on medium and long term plans for science and technology. The Commission of Science, Technology and Industry for National Defence is responsible for planning industrial development, including the joint venture of the large commercial aircraft. It manages the implementation of document "863" in respect of applied research and development. It holds the policy framework for Aviation Industry Corporation of China, plus technology policy for the development of nuclear, aerospace, aviation, shipbuilding and weaponry industries. It also leads on foreign co-operation and acquisitions, particularly those with a military application. It is by far the most powerful ministry in respect of the development of industrial policy in relation to the aerospace industry. The

Civil Aviation Administration of China is responsible for policy development and strategy for the civil aviation industry. This includes civil aviation law and regulation; safety; standards and certification; and international affair, such as air service agreements. China has sought co-operation in the initial development of new airports and supporting technologies.

5.61 China needs new air traffic management technologies to manage increased capacity. It is keen to learn from the West and as a result the United States' Federal Administration Authority has an office in China to help the Chinese through this process.

5.62 Many western companies are trying to set up joint ventures in China to help them benefit from future developments. They can offer knowledge in the hope that goodwill will pay off in terms of business deals in the future. However, there is a firm intention from the Chinese to go it alone in the future, which may see western products being closed out of the Chinese market, so that indigenous products have the opportunity to grow and mature. Intellectual Property Rights remains a key issue of working with China. This is particularly relevant as the country lags behind the West in terms of technology. There are long term business benefits for working with China due to the sheer scale of the domestic market, but the opportunities are limited for collaborative research are limited to science and basic research with universities. The European Commission has said that it wishes to have the lead responsibility for collaborative research with China, and is organising a coordinated 7th Framework Programme Call with the Chinese government based on three topics: aircraft noise prediction and control methods; flow control for drag reduction and wing aerolastic optimisation; and casting of large titanium components.

Schematic view of Chinese ministries			
	MOST	CAAC	COSTIND
Focus	Basic research	Air transport	Industrial development
Technology readiness level	1-3	4-8	4-9
Topics	Basic research & infrastructures	ATM, safety, security, airports	Aerospace programmes
Universities	Yes	Yes	Yes
Research establishments	Yes	Yes	Yes

India

5.63 India has a long established defence aerospace industry and is in the process of developing its commercial sector. The Society of Indian Aerospace Technologies & Industries, SIATI[2] the national trade association, has some 300 members, but does not publish economic or employment data of the aerospace industry. The government owned Hindustan Aeronautics Ltd is the major aerospace company in India and alone employs 30,000 people across the country. Hindustan Aeronautics Ltd has links with BAE

[2] SIATI - Society of Indian Aerospace Technologies & Industries

Systems, Rolls-Royce and licence builds aircraft such as the Hawk AJT and the Su-30MKI and designs and manufactures transport and attack helicopters.

5.64 Liberalisation of the economy during the 1990s opened up the Indian skies to private enterprise thus ending state monopoly. New airlines entered the fray. Passenger and freight traffic grew with the new airlines taking a substantive share of the market by virtue of providing better, more punctual service in a growing market. This has acted as an impetus to government and other establishments to engage in research and technology work in the civil aeronautics sector.

5.65 Establishments engaged in fundamental and applied research into materials, aero-structures, propulsion and related disciplines include the National Aerospace Laboratories (NAL), Aeronautical Development Agency (ADA - part of Ministry of Defence), Indian Institute of Sciences, thirteen Indian Institute of Technology (designated as institutes of national importance) and other leading engineering and sciences universities. These institutes and universities offer graduate, post graduate and doctoral programmes in aeronautical engineering and material sciences in addition to other technical disciplines. The National Aerospace Laboratory (as distinct from ISRO – Indian Space Research Organisation) has completed the design, development and proto type builds of two civil aircrafts, the 'Saras' and the 'Hansa'. The Saras is the first Indian multi purpose civil aircraft in the Light Transport Aircraft category. The wings and tail are of composite material. It is expected to go into commercial production in 2010. The Hansa is an all composite light aircraft with dual controls for *ab initio* training, sport and hobby flying. Aeronautical Development Agency is responsible for the design and development of the Light Combat Aircraft (LCA).

5.66 The Indian Multi-role Transport Aircraft programme, for a 60 ton military airlifter to enter service in 2013, was supposed to be a joint Russian-Indian venture; it appears that tensions within the venture (relating to lack of investment by Russia) have seen the Indian's approach Western companies about collaboration. According to Flight International India was expecting to commit to 100 transporters and have options on 100 more while Russia was expected to order 100 aircraft. India is also running a competition for a new-generation fighter aircraft; the $15bn F-X competition covers a potential buy of 126-aircraft and currently has a multi-role combat aircraft (MRCA) competition.

5.67 Indian and American officials, from the Federal Aviation Administration, signed a memorandum of understanding for a new aviation cooperation agreement in New Delhi in 2007. The Indian Aviation Cooperation Programme acts as a private-public partnership and supports India's growing aviation sector, with specific aims to improve safety, training and strengthen overall United States-India aviation cooperation. It includes United States funding for training and technical assistance.

5.68 In the recent past, commercial organisations have entered into aerospace design, development and manufacturing areas of the civil and defence aerospace sector. The larger Indian international companies, i.e. Larsen & Toubro, Mahindra, Tata, etc., either independently or through joint venture companies work with prime civil and defence aircraft manufacturers. Additionally, there are several software companies with specialist aerospace divisions. These include HCL, Infosys, TCS and Wipro.

5.69 India has a highly skilled workforce and excellent research facilities. There are a number of possible technology themes for collaboration, such as design process modelling, sensors and neural network analysis

Japan

5.70 The Japanese aerospace industry is the world's seventh-largest, exporting $6 billion annually and the government is keen to improve productivity and develop complete aircraft production capability. Japan has government backed ambitions of gaining a global civil aerospace market share of 15 percent. The industry employs around 23,000 people and is dominated by the aerospace division of the large manufacturing conglomerates; their involvement in other industrial sectors provides some protection against recession. Aerospace companies are eligible for two types of research and development credits a) 20% credit for research & development manufactured products; b) 7% credit for basic technologies, such as advanced robots and machinery; advanced processes and electronics etc. The Ministry of Economics, Trade & industry provides financial support by granting "National Project Status" to aerospace development projects, the funding can be substantial.

5.71 The launch of the Mitsubishi Regional Jet (MRJ) programme, Japan's first civil airliner project since the 1960s, follows on from an extensive stake in a number of Boeing programmes, including fully a third share in the production of the new Boeing 787 Dreamliner. Japan is rare among developed markets in Airbus having almost no share of the civil airliner market.

5.72 Japan has an internationally recognised aerospace industry, with a highly skilled workforce and an excellent research establishment, the Japan Aerospace Exploration Agency (JAXA). The aerospace industry is supported by funding mechanisms provided by Ministry of Economy Trade & Industry. However it needs a considerable amount of time and effort to develop relations with the Japanese government. Moreover, Japan has a long established relationship with the Americans, particular as a risk sharing partner on Boeing aircraft platforms. All of these factors limit the opportunities for co-operation with Europe.

Russia

5.73 The Russia aerospace industry has suffered from a lack of funds since the end of the Cold War. Passenger volumes reduced by a factor of three, and only 6% of the population used air transport as fare increased substantially, and a large number of airports closed. This meant that 55,000 communities across the federation were no longer connected by air transport. At the same time deliveries of Russian built transport aircraft nearly stopped altogether, which meant that Russia delivered less than 1% of the new aircraft worldwide during the period from 1996 to 2006. The separation of the Ukraine meant that Antonov was no longer in Russian hands and it lost its test facilities to the Baltic states. The Russian aerospace industry was structured differently to that in other parts of the world. There were several design bureaux and production plants, and the supply chain was not very well developed. But perhaps most importantly the after sales was badly organised. Aviation, therefore, attracted fewer young people as there were greater career opportunities in the oil business and information technology. This policy has now been reversed. Russia's major aerospace companies have been

amalgamated into the Unified Aircraft Corporation. The corporation's goal is that of "returning [Russian aerospace] to the world market and gaining a 5% share of mainline and regional aircraft". Over the next decade, it has been estimated that overall funding will contribute around $1.25 billion per year to Unified Aircraft Corporation. Its income should increase from $4 billion to $12-14 billion in 2015 and to $20-25 billion by 2025 (this includes civil and military). This means it will be producing 300 aircraft a year by 2025. The corporation has announced plans to develop the MS-21 single-aisle aircraft indigenously as a starting point towards challenging the Airbus and Boeing duopoly.

5.74 Russia has developed a new 60-100 seat regional jet (the Sukhoi Superjet) with help from Boeing, and is also partnered with Thales, Snecma and Alenia for the systems, engines and composite structures.

5.75 The principal research establishment to support the aerospace industry are:

- TSAGI (aerospace, flight dynamics, advanced concepts and test facilities)
- CIAM (engines)
- VIAM (material)
- GosNIIS (aviations systems and air traffic management)
- ILL-GROMOV (central flight test institute)

In contrast to most Western institutes the Russian research establishments are directly involved in product development in close co-operation with industry. The European aerospace research establishment work with their Russian counterparts.

5.76 The helicopter sector, i.e. MIL, Kazan and Kamov, has been merged into one company, Oboronprom, in which the Federal state will be a major shareholder. Ultimately the company will be responsible for design, production and servicing. Oboronprom and AgustaWestland have an agreement for the establishment of a 50-50 joint venture company in Russia to set up and run a civil AW139 helicopter Final Assembly Line. Salyut is also tasked with developing a new generation of aircraft engines.

5.77 The government has already made a number of decisions in respect of aerospace related projects:

- The three aircraft projects (regional, 150 seat and 300 seat) plus the development of a new freighter aircraft with India (which appears to have run into trouble);
- Upgrading of existing helicopters and a new two ton helicopter and a convertible tilt rotor aircraft and a number of small general purpose helicopters;
- Upgrading existing engines and the development of new engines for the MS21, SU-100 and a new helicopter engine.
- New avionic systems compatible with Western products;

5.78 Russia's state owned airline groups have also been consolidated and the potential fleet replacement demand have already been used in negotiations between Russia and Western companies to secure more work for the Russian aerospace industry.

5.79 The Russian research funding for the aerospace and aviation industries are administered by the Ministry of Economic Development and Trade; the Ministry of

Transport; and the Ministry of Industry and Power Engineering. Many European companies have offices in Russia and collaborate with Russian scientists.

5.80 The European Union has a co-operation agreement and a European-Russian working group to develop joint calls for proposals. Russia participates in EU Framework Programme projects, and the European Commission has said that it wishes to have the lead responsibility for collaborative research with Russia. It is organising a coordinated 7th Framework Programme Call with the Russian government based on five topics: novel composite structures; high-lift aerodynamics; maintenance and safety; plasma actuators for engine noise control; and simulation tools in propulsion.

South Africa

5.81 In the 1990s, the South African aerospace industry lost state protection and its primary customer the South African Defence Force. So it was forced to commercialise and integrate into the global industry. The industry now covers design, manufacture of subsystems and components, support, maintenance, conversion and upgrade of rotary and fixed wing aircraft. Its competences lie in the design and manufacture of small machined and sheet metal components, farings, ducts and piping, panels, luggage racks and galleys. The industry is principally six companies that include AeroSud and Denel Aviation, and are supported by a number of supply chain companies.

5.82 The government produced a "strategy for a sustainable, economical and growing aerospace industry". This led to the launch in 2007 of three initiatives to support its aerospace and defence industries:

- Aerospace Industry Support Initiative
- The Centurion Aerospace Village
- National Aerospace Centre of Excellence

which were aimed at:

- broadening black ownership;
- stimulating small business participation in the industry;
- enhancing skills and capacity; and
- aligning the industry to achieve the government's strategic growth objectives.

5.83 The Aerospace Industry Support Initiative is a government funding scheme designed to upgrade, enhance and position the South African aerospace industry so that it is fully integrated into the global aerospace manufacturing network. Its mission is to:

- enhance global competitiveness;
- support innovation between industry, academia and the government;
- develop and promote the industries capabilities internationally
- accelerate growth in employment and equity.

5.84 The Centurion Aerospace Village will be an industrial cluster/business park located at the edge of the Waterkloof Air Force Base in Centurion, Tshwane. This is a Department of Trade & Industry intervention made under its "Aerospace Industry Support Initiative", which is aimed at strengthening the supply chain and facilitating integration into the global aerospace markets, whilst making costs savings through the sharing of resources. It received some European Union funding.

5.85 The National Aerospace Centre of Excellence has been established at the University of the Witwatersrand to address the scarcity of skills and to undertake aerospace research programmes. It conducts research for the aerospace industry that would not have otherwise taken place. It, therefore, focuses on new or competitive technologies and products; new knowledge and skills; and technology transfer.

5.86 One of the main infrastructure sites is the Overberg Test Range in the Western Cape. It is adjacent to the Overberg Air Force Base and is owned by Denel. The facilities include missile launch pads, tracking radar, weapons systems testing, and optical missile tracking systems. These are used by a wide range of international customers.

5.87 The South African government has a number of research and technology funding mechanisms managed by the Department of Trade & Industry, which comparable to those in Europe. South Africa has developed links with Brazil and India, and would welcome the opportunity for joint Calls with Europe. South Africa has a small but highly skilled workforce supported by excellent universities in the field of aeronautics, such as Witwatersrand and Stellenbosch. The South Africa aerospace community understands how European processes operate, partly because it participates in EU Framework Programmes. There are a number of technology themes in which co-operation could be considered, such as alternative fuels, unmanned air vehicles, titanium casting; surface modelling, natural fibres and high performance computing.

The Ukraine

5.88 The Ukraine has a long history of aeronautics and space development. Antonov is the primary company that has produced reliable and economically efficient aircraft for use on unpaved airfields. These qualities have ensured that over one and a half thousand Antonov aircraft have been exported to more than 50 countries around the world. All in all more than 22,000 aircraft have been built.

5.89 Nowadays Antonov is engaged in the design and building of new aircraft prototypes as well as modifications of earlier designs, the provision of operational and product support and engineering work on extending the service life of existing aircraft. It also provides services such as basic and conversion training for flight and maintenance crews and international air charter transportation, particularly of outsized cargoes. Antonov also participates in international co-operation in equipment design and manufacture as well as the development of land transit vehicles.

5.90 Antonov has invested in computer-aided techniques in design and analysis work thereby creating a powerful engineering and research potential. In-house wind tunnel facilities enable the testing of aircraft models. All aircraft types, including the Ruslan and Mriya, can be subjected to structural tests to determine their service lives in one of the largest fatigue test laboratories in Europe. Finally, Antonov completes the development cycle of the aircraft with flight test programmes to demonstrate the compliance of the aircraft with airworthiness requirements and the customer's specifications.

5.91 The Kharkov State Aircraft Manufacturing Company produces light turboprop that compete with G-222 (Italy), C-27J Spartan (Italy/USA) and CASA CN-295 (Spain). It also manufactures the regional 50 seat turboprop An-140-100.

5.92 The Kyiv Aviation Plant "Aviant" has equipment to produce aircraft plans and tools, and it also specialises in system production. The facilities manufacture the An-32.

5.93 Motor Sich is a public joint stock company in Zaporozhye and is the only company in the Ukraine manufacturing engines for aircraft and helicopters. Motor-Sich produces the turbofan for Antonov military aircraft.

5.94 The principal Ukrainian universities with aeronautic departments are National University "Kharkov Aviation Institute"; National Aviation University, Kyiv; Dnepropetrovsk National University; and the National Technical University "Kyiv Polytechnic Institute". Collaborative research is much more likely through academia rather than with the industry. Opportunities could include unmanned air vehicles and ultra light aircraft.

6. Developing aerospace capabilities

Dubai

6.1 In 2006 the Dubai government announced plans to turn Dubai into a global aerospace hub through a new company called the Dubai Aerospace Enterprise. Dubai expects to invest some $15 billion in six operating subsidiaries across 14 market segments. By 2015 the Dubai Aerospace Enterprise is expected to employ 30,000 people. The Dubai Aerospace Enterprise is a continuation of the Dubai government's strategy to diversify away from an oil-dependent economy and is intended to take advantage of the rapid rate of aviation growth (airline and airport) that Dubai has experienced and the growing aviation and aerospace expertise that is accompanying it.

6.2 The growth is backed by the government of Dubai and companies, that is Dubai International Capital, Dubai Holding's investment arm, Emaar, a property company, Istithmar, a Dubai-based investment holding company, Dubai International Financial Centre, Amlak Finance and the Dubai Airport Free Zone Authority.

6.3 In 2006 Dubai Aerospace Enterprise signed a memorandum of understanding with Cranfield University to jointly set up the aerospace university in Dubai. Based in Jebel Ali Airport City the Dubai Aerospace Enterprise University is forecast to produce 8,000 graduates a year.

6.4 Dubai Ports World ran into opposition from US politicians who raised Homeland Security concerns that resulted in Dubai selling off its US ports. It seems Dubai may have learnt some important lessons about preparing the ground for acquisitions since then. The acquisitions of Doncasters, Standard Aero and Landmark Aviation seem to have passed with less trouble despite their US-centric businesses. However, the attempted acquisition of Auckland Airport also ran into political opposition. There is a risk that the use of state-sponsored funds to acquire holdings in foreign companies will run into growing opposition from protectionist forces.

6.5 Dubai International Airport is the premier hub in the Middle East. Dubai's ambitions to supplement this with becoming an aerospace hub have been largely supported through acquisitions, but this has faltered recently partly as a result of the recession and difficulty in acquiring new companies. The opportunities for research are,

therefore, limited to technology themes, such as maintenance repair and overhaul, environmental impact of airports etc.

Mexico

6.6 The Mexican government made aerospace a strategic economic development priority in 2000. Its industry consists of around 200 companies with a total workforce of 27,000[3], and exports worth $100 million in 2008[4]. There has been a co-ordinated approach by government and industry to attract international investment, and universities, technology colleges and higher education establishments have developed courses in aeronautics to increase the availability of skilled aerospace technicians and engineers. The Mexican aerospace industry has as a result tripled in size since 2004[5].

6.7 Historically Mexico has been attractive because of its free trade agreements with the US, Canada, the European Union and many countries in Latin America. However in 2008, all duties were removed in respect of the export of aerospace components in order to attract more investment from around the globe. There has been a growth in the number of low cost carriers and AeroMexico and Mexicana have been privatised. Mexico has been developing its Maintenance Repair & Overhaul facilities.

6.8 The country has an increasingly skilled workforce, which has been supplemented by competition between Mexican states for greater industrialisation in order to attract higher paid employment. This policy has meant a large number of international companies (predominantly from the US, Canada, France, Spain and the UK) have been enticed to set up aircraft component manufacturing facilities in the country. Notably aerospace clusters have been created in Baja California (Mexicali), Chihuahua and Queretaro, Nuevo Leon and Sonora.

6.9 Mexico's core competences lie in engine, electronic and landing system components, precision machining and fuselage insulation. Its long term aims are to assemble executive jets and develop its research and technology capabilities. But, government support programmes need to be further developed, particularly in the areas of investment strategic assistance, export financing and research and technology support. The Mexican trade association, FEMIA, has also been lobbying government to provide grants to universities and technical colleges for aerospace research and development projects[6]. CETYS University in Baja California is starting to build up its research capabilities, and would be a good contact for starting to develop relations.

6.10 Mexico's aerospace industry has developed through low cost manufacturing, and is now moving towards advanced manufacturing techniques. The country is supported by an increasing number of aeronautical engineers that further enhance its capabilities. Mexico is keen to develop research to position itself to win significant work share on future aircraft platforms from the United States, Europe and Latin America. The opportunities for international collaboration in research are limited at the moment, but are likely to increase in the coming years.

[3] Mexican Aerospace Industry Federation (FEMIA)
[4] Source: Secretaria de Economia
[5] Flight International 20/04/09
[6] Flight International 20/04/09

Singapore

6.11 Singapore wants to diversify its economy, partly through high-value manufacturing, including aerospace. As part of its strategy, Singapore will offer generous state support available to attract desirable inwards investors. The Singapore's Development Board has recently announced in light of the recession, which has seen around a fifth of projects planned for 2009 delayed, it will:

- fund "viable" projects where financing has proved difficult elsewhere;
- extend preferential tax schemes (tax holidays); and
- set aside $100million to prepare for the upturn, including provision of increased skills training in science, technology and engineering.

6.12 Asia will remain one of the key growth markets for new aircraft for the foreseeable future and increased presence in Singapore could assist sales in the region. Singapore also has the added attraction of being one of the strongest protectors of Intellectual Property Rights in Asia. Possible technology themes for collaboration are the technologies for flow control, advanced manufacturing, Intensional High Performance Computing and wireless sensing

7 Impact of the recession

7.1 When AirTN-FP6 was formulated, the market was completely different from that of today. There is a growing consensus that the civil aerospace downturn could have been the worst the industry has ever experienced; made worse by a steeper descent and shallower recovery period than has been the case in the past. Airline traffic continues to fall, with freight leading the way with passenger traffic also falling.

7.2 The aerospace industry has experienced deferrals and cancellations and a rapid deceleration in new order intakes. Airbus' announcement of production cut of 6% on its single-aisle (A320 family) programme will impact deliveries from 2010. Embraer cut regional jet production by around 10% for 2009 and laid off thousands of workers. Boeing has made 750 redundancies in Seattle, and is expected to have some production cuts in 2009 in older programmes such as the 737 family. Bombardier has had lay offs in United States and Canada (1,000 jobs) and Northern Ireland (300 contractors) due to a rapid decline in business jet demand (other US-based business jet manufacturers have announced larger cuts).

7.3 Aerospace cycle recovery tends to be influenced by economic recovery and airline demand for new aircraft. The aerospace industry needs to invest and prepare for the upturn in the market. We are now beginning to see the bottom of the recession and most industries want to emerge strong and ready for the upturn, especially in technological capabilities. The opportunities for international collaboration may be somewhat are mixed at the moment because recession, but this could be the opportunity to develop new links and opportunities for the future.

8 Conclusions on international collaboration

8.1 It is agreed that international co-operation needs to bring added value to Europe, and should support European and national policies, such as new air traffic systems; environmental challenges; and ever increasing demands for higher levels of safety and

security. The subjects for collaborative projects need to provide mutual benefit for both sides. The European aerospace community needs to be prepared to sign up to conducting collaborative activities, and international partners need to provide their own funding.

8.2 From the research conducted the European Commission has paved the way for international collaboration at a European level within the Seventh Framework Programme for China and Russia, and we should wait to see the results of these before embarking on joint programming at a national level. Canada, Brazil, South Africa, the United States and possibly India offer the best opportunities to organise joint projects in AirTN-FP7. These countries have expressed a desire to work collaboratively with Europe, and provide benefits in terms of strengths in technology (or in some cases niche technologies); internationally recognised engineers and researchers; funding available; compatible support mechanisms; and a good academic and research base. Japan and Australia have compatible funding mechanisms and technology benefits, but their geographical location and strong integration into the American platforms limit the opportunities for co-operation. Mexico, Singapore, Dubai and the Ukraine offer new opportunities and should be considered in the much longer term.

8.3 It is now for industry to now prepare joint projects if the good relationships developed between governments are to be taken forward. AirTN-FP7 will promote the opportunities to facilitate joint activities.

8.4 The following table provides an overview of the various possible international partners based on the type of industry and structure, the methods of funding available and the academic infrastructure.

	Aerospace research sector	**National or regional funding**	**Compatible funding processes with the European**	**Open to international cooperation**	**Sectoral or horizontal funding**	**Academia**
	*** airframe manufacturer ** supply chain * universities	*** regional funding ** mixture of national and regional * national funding - primary source	*** excellent ** good * standard	*** open systems ** systems could be adapted to facilitate international cooperation * restricted system	(S) Sectoral or (H) horizontal funding	*** excellent ** good * standard
Australia	**	**	***	**	H	***
Brazil	***	**	***	**	H	**
Canada	***	**	***	**	S	***
China	*	*	*	*	S	*
Dubai	*	*	*	*	H	**
India	**	*	**	**	H	***
Japan	**	*	*	*	H	***
Mexico	**	**	*	*	H	*
Russia	**	*	*	*	S	***
Singapore	**	*	**	**	H	***
South Africa	**	*	***	**	S	***
United States	***	**	***	**	S	***
Ukraine	**	*	*	**	H	**