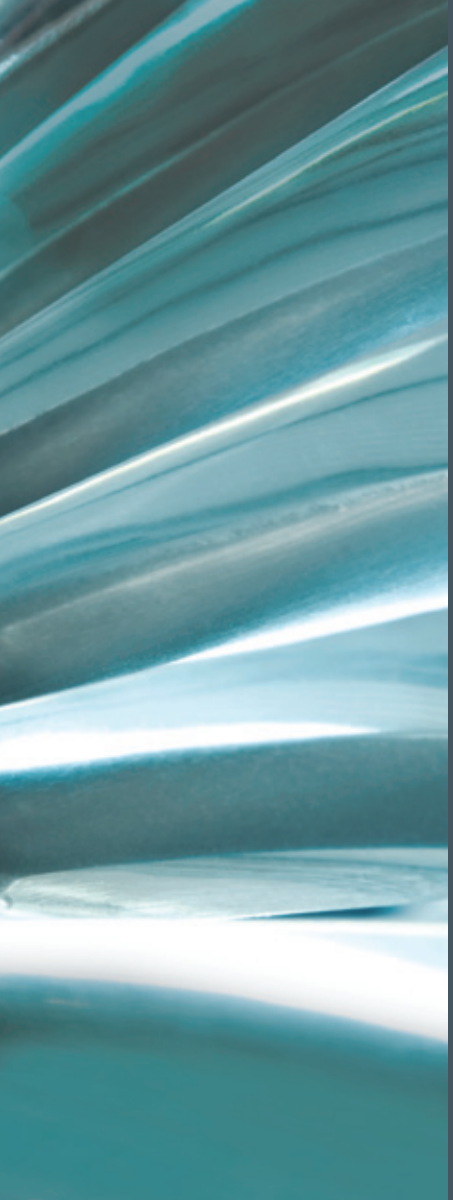

FORUM AEROSPACE INNOVATION 2009

AEROSPACE CLUSTERS:

A WORLD OF INNOVATION

POSITIONING AEROSPACE CLUSTERS IN A GLOBAL CONTEXT

REPORT ON THE AEROSPACE INNOVATION FORUM 2009

April 2010

ORGANIZED BY:

AÉRO MONTRÉAL
Aerospace Cluster of Metropolitan Montréal

www.aeromontreal.ca

IN COLLABORATION WITH:

CRIAQ
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This document was written by Ms. **Isabelle Deschamps** and Mr. **Stéphane Lacharité** of École de technologie supérieure under the guidance of Aéro Montréal's Innovation Working Group.

THE AEROSPACE INNOVATION FORUM IS AN INITIATIVE OF THE INNOVATION WORKING GROUP OF AÉRO MONTRÉAL.

The Innovation Working Group's mandate is to establish the aerospace innovation strategy of the Greater Montréal region, to identify and coordinate projects in support of the innovation strategy in collaboration with other organizations involved in innovation, in order to maximize the output of all stakeholders.

Members of the Innovation Working Group:

- Chair: François Caza, Vice President & Chief Engineer, Bombardier Aerospace
- André Bazergui, President-CEO, Consortium for Research and Innovation in Aerospace in Québec (CRIAQ)
- Stéphane Blais, Project Engineer, Air Operations, Marinvent
- Patrick Champagne, Vice President, Engineering, Esterline CMC Electronics
- Pascal Désilets, General Director, Centre technologique en aérospatiale (CTA)
- Pierre Dicaire, Director, NRC's Aerospace Research Institute, Aerospace Manufacturing Technology Centre
- Jean Dubuc, Manager, CF-18 Fleet Management and Structural Technology, L-3 MAS (Canada)
- Fassi Kafyeke, Director Strategic Technology and Senior Engineering Advisor, Bombardier Aerospace
- Philippe Molaret, Vice President, R&D, Aerospace Division, Thales Canada
- Hany Moustapha, Senior Manager, Technology Programs, Pratt & Whitney Canada
- Marius Paraschivoiu, Associate Professor, Department of Mechanical and Industrial Engineering, Concordia University
- Pierre Rioux, Director, Research Canada, Bell Helicopter Textron Canada
- Marc St-Hilaire, Vice President, Core Engineering, CAE
- Jack-Eric Vandenbroucke, Technology Transfer Manager, École de technologie supérieure (ÉTS)

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FOREWORD

SUZANNE M. BENOÎT

CEO, AÉRO MONTRÉAL

FRANÇOIS CAZA

CHAIR OF THE INNOVATION WORKING GROUP, AÉRO MONTRÉAL, AND VICE PRESIDENT AND CHIEF ENGINEER, BOMBARDIER AEROSPACE

The year 2009 marked Canada's Centennial of Flight. The Silver Dart took to the air on February 23, 1909, becoming the first engine-powered, heavier-than-air flight in Canada. The innovation demonstrated by the pioneering team behind the "Aerial Experiment Association," headed by Alexander Graham Bell, inspired many generations of passionate engineers who have all contributed to the growth of Québec's aerospace sector.

One hundred years later, the Aerospace Cluster of Metropolitan Montréal is, along with Seattle and Toulouse, one of the world's largest aerospace centres, accounting for 60% of Canada's aerospace activities. With a little more than $12 billion in revenue and 80% of its production sold outside the province, this is Québec's number two export sector.

Moreover, Québec's aerospace industry accounts for nearly 70% of all aerospace research and development spending in Canada and boasts more than 10,000 engineers and scientists who are actively working to create a bright future for our aerospace companies. In this regard, Aéro Montréal, in collaboration with CRIAQ, the Consortium for Research and Innovation in Aerospace in Québec, has organized in December 2009 its second forum dedicated to aerospace innovation.

The Aerospace Innovation Forum is a rallying event and the only one of its kind targeting the Québec, Canadian and international aerospace industry, representatives from universities and research centres, students and trade journalists. This two day event featured conferences and workshops on the current and future strategic challenges of aerospace innovation in Québec and abroad. In addition, an exhibition of technologies and B2B meeting sessions offered participants a comprehensive overview of technology developments and business opportunities.

With international competition intensifying rapidly, innovation is now more than ever a strategic centrepiece for all the world's aerospace clusters. Under the theme **"Aerospace clusters: a world of innovation,"** the forum helped pinpoint the major trends in aerospace innovation, identify collaboration opportunities among the various international clusters as well as develop courses of action for the Québec industry to remain competitive in the global market.

EXECUTIVE SUMMARY

Aéro Montréal, the Aerospace Cluster Metropolitan Montréal, in collaboration with CRIAQ, the Consortium for Research and Innovation in Aerospace in Québec, has held on December 7 and 8, 2009 its second edition of the conference dedicated to aerospace innovation in Canada, the Aerospace Innovation Forum 2009.

Co-chaired by Suzanne M. Benoît, CEO of Aéro Montréal and François Caza, Chair of the Innovation Working Group of Aéro Montréal and Vice President & Chief Engineer, Bombardier Aerospace, the Forum's theme was "Aerospace Clusters: A World of Innovation". This event aimed at exposing the best practices developed by different international aerospace clusters to stimulate innovation, at identifying the strategic issues surrounding proprietary technologies of tomorrow's aircraft and at establishing avenues of collaboration between clusters.

The Aerospace Innovation Forum 2009 has gathered more than 400 managers and researchers of the Canadian and international aerospace industries. With the guest of honor, Mr. Clément Gignac, Minister of Economic Developpement, Innovation and Export Trade of Québec, the Forum's program presented more than 50 speakers, including representatives of seven international aerospace clusters.

The event's B2B portion has allowed for 112 meetings, giving the chance to 63 SME from Québec, Canada and abroad (France, Germany, United States, Italy, Spain) to meet "face to face" with the innovation managers of 13 Québec prime contractors and OEMS, and close to 40 technology exhibits form companies universities and research centers.

An overview of presentations given at the Forum confirms the industry's positioning through a concerted vision of sustainable development. This is demonstrated, among other ways, by the pursuit of efficiencies in security matters and management of the industry's impact on the environment. It was clear from discussions that aerospace is at the crossroad of several waves of changes that will influence corporate behaviour in the medium and long terms. Markets are moving geographically and specializing, manufacturing sites are organizing globally and, more than ever, manufacturers need to come together in "clusters" and form international alliances to create synergies that spur innovation and wealth creation. R&D projects need to be planned long-term and be integrated within the major platforms, as evidenced by the Future Major Platforms (FMP), Smart Affordable, Green Efficient (SAGE) and Green Aviation Research & Development Network (GARDN) initiatives, whose significance will be summarized later in this document.

Seven (7) themes emerged from the Innovation Forum 2009. They correspond with the challenges and issues of the industry, and form a continuous loop (see Diagram 1):

1. Concerted vision towards sustainable development
2. Rapid technological progress and acceleration of performance improvement curves
3. Need for a critical mass of R&D programs and national and global R&D frameworks
4. Expansion of national and regional clusters in aerospace
5. Multiplicity and complexity of technological innovation focal points and the trend toward open and collaborative innovation
6. Challenges of human resource development and the management, transfer and sharing of expertise
7. Challenge of evolving clusters such as Aéro Montréal: inter-regional, inter-cluster and inter-sectoral linkages.

Diagram 1: Aerospace Issues and Challenges

Source: I. Deschamps, ÉTS

The review presented in this Report fully confirms the complex and systemic nature of innovation, of its daily management and challenges regarding its governance, from the point of view of stakeholders and managers of aerospace clusters. Much has been accomplished but much remains to be done, given that the aerospace industry is changing rapidly and that the clusters are structuring themselves worldwide.

How to position the aerospace clusters in a global and rapidly changing context? Each course of action is important, but the coherence of these decisions and actions, and cooperation among the stakeholders, will all be crucial. This is because it is now impossible to shape the future of aerospace without taking into account the inextricable links among all the measures to be put in place. These draw on technological, strategic, structural and managerial innovations, locally and internationally.

- **Technological innovations:** Accelerated developments focused on sustainable development and the needs of the industry in terms of efficiency, capitalizing on multidisciplinary work and teamwork.
- **Strategic and structural innovations:** Promotion of "open innovation," European and global alliances (emerging countries), strengthening of university-industry-education links, establishment of more
- **Managerial innovation:** Development of cluster members by strengthening the supply chain, development of R&D capacity of suppliers, empowerment of SMEs in terms of management capabilities, as well as facilitating collaboration through mechanisms, consortia, portals, demonstration platforms.

The Forum conclusions can be linked to four main recommendations in support of the development of aerospace innovation in the medium and long terms.

RECOMMANDED PROJECTS

1. PROMOTE AND DEPLOY INVESTMENT IN MAJOR INITIATIVES:

Support and facilitate the deployment of the latest initiatives by Aéro Montreal and the Government of Canada such as SAGE, FMP, GARDN,..., These constitute essential mechanisms to guide and stimulate progress and to integrate innovation stakeholders in collaborative R&D programs, by making maximum use of groupings such as CRIAQ.

The goal is to maximize the effects of financial leverage, as well as technological and commercial synergies.

2. TURN RESOLUTELY TOWARDS SUSTAINABLE DEVELOPMENT:

Better promote sustainable development within the Aéro Montréal cluster and support practical efforts by each member to turn towards sustainable development: the Greater Montreal aerospace industry has already taken a step in this direction by setting up the **CAETRM** and implementing it through **GARDN**, responding to social demands and supporting the objectives of local governments in reducing its ecological footprint.

We must now ensure that initiatives such as GARDN produce results and optimize the capabilities of CRIAQ as a mechanism for cooperation between research and the industry. Many complementary courses of action are possible: to give sustainable development initiatives visibility in the community, to encourage researchers in aerospace and young graduates to consider areas of interest that are compatible with sustainable development by giving them financial incentives and bringing them closer to the needs of industry and citizens, etc.

3. INTEGRATE SMEs IN THE SUPPLY AND INNOVATION CHAINS:

Develop and implement, by leveraging best global practices, a program to enhance the innovation capabilities of SMEs **who are cluster members, as well as mechanisms for cooperation between contractors and subcontracting SMEs, with the goal of qualifying SMEs to become not only suppliers but also world-class innovators**.

This major structuring project for the cluster will be supported by various initiatives, such as the sharing of best practices with other clusters, benchmarking, and conducting a diagnostic of existing management and organizational capabilities. They also include training

and sponsorship of SMEs and financial, material, human and logistical support for future collaborative innovation projects that will follow.

Close collaboration will be required with a number of agencies and organizations already working with aerospace SMEs, including:

- AQA, which includes industry SMEs
- CTA, which supports the technological development of SMEs in aerospace, with the backing of two government departments, the MELS and MDEIE
- The Canadian Government's CNRC-IRAP program, a partner for many decades of innovative Canadian SMEs
- Natural Sciences and Engineering Research Council of Canada (NSERC), which has long financed university and collaborative R&D projects, and which has recently instituted a series of programs to encourage and stimulate partnerships between SMEs and universities

The increase in **mechanisms linking SMEs and large aerospace companies will be the proposed theme of the Aéro Montréal's next Innovation Forum**.

4. STRENGTHEN LOCAL and INTERNATIONAL LIAISONS OF THE AÉRO MONTRÉAL CLUSTER:

Establish a variety of liaison mechanisms with stakeholders in aerospace, both within the cluster and externally, locally and internationally, so that strategies and actions are coordinated and supported and their impact increased through the introduction of multiple synergies:

- Liaisons between Aéro Montréal and other industry clusters in Greater Montreal and Québec in the areas of materials, nanotechnology, aluminum, energy, environment and sustainable development, medical technologies, information technologies and communications;
- Initiate steps, together with government agencies, to integrate Aéro Montréal cluster stakeholders in the European framework programs for research, or in any other international collaboration initiative. This will allow it to benefit locally from a critical mass of financial resources and expertise, thereby maximizing the strategic, commercial and technological impact for the entire community.
- Aéro Montréal leadership in the creation of a Global Carrefour of Aerospace Clusters, which would serve to further exchanges and synergies and position the Québec aerospace industry as a key hub in the global industry.

In conclusion, the challenges facing the industry are numerous and interrelated, as illustrated in the diagram below.

Diagram 2 : Recommended Actions

The Aéro Montréal cluster, through its position and mission as a **catalyst**, supported by CRIAQ in its position as an **integrator**, is playing an increasing consulting role in championing **collaboration**: it has to act both as a visionary and as a rallying force.

CASE 1: DEPLOY major initiatives such as demonstration programs up to the final stages of commercialization, finance initiatives and assemble the necessary critical mass;

CASE 2: GUIDE R&D and innovation towards sustainable development, promote successes;

CASE 3: CONSULT diverse stakeholders and develop the supply chain, qualify sub-contractors and worldwide innovators, enhance the capacity of small companies in the face of globalization, together with stakeholders and organizations on-site;

CASE 4: INTEGRATE stakeholders of all types and origins, link up local constituents and position the Québec aerospace industry on the world stage.

PROGRAM

INNOVATION BEST PRACTICES IN AEROSPACE CLUSTERS FROM AROUND THE WORLD

François Caza	President of the Innovation Committee of Aéro Montréal and Vice President and Chief Engineer, Engineering, Bombardier Aerospace
Xavier Aubard	Delegate, Cooperation and Management, Aerospace Valley
Walter Birkhan	Clustermanager Service, PR, Marketing, Luftfahrtstandort Hambourg
David Bailey	Executive Director, Operations, Northwest Aerospace Alliance
Giuseppe Acierno	President of District Committee, Distretto Aerospaziale Pugliese
Antonio Ficarella	Full Professor, Faculty of Industrial Engineering, University of Salento
Kevin Steck	Chaiman, Pacific Northwest Aerospace Alliance.
Martin Haunschild	President, BavAIRia
Marek Bujny	Vice-President, SME Council, Aviation Valley and Vice President, Ultratech Ltd
Andreas Kaden	President, Berlin-Brandenburg Aerospace Allianz

PRODUCT DEVELOPMENT

Integrated design and manufacturing, Virtual prototyping, testing and integration, Advanced product development strategy, Life analysis, Prognostics and health management

Richard Forster	Partnerships Manager, Research & Technology, Airbus
Charles Litalien	Vice President, Turboprop and Turboshaft Engines, Pratt & Whitney Canada
Ross Menger	Chief Engineer, Commercial Business, Bell Helicopter Textron

AVIONICS

Augmented/synthetic vision systems, Fly-by-wire/light

Christian Delaveau	Innovation Director, RT& Engineering Directorate, Thales Aerospace Division
John Maris	President, Marinvent Corporation
Mike Mena	Director, Advanced Cockpit Programs, Gulfstream Aerospace

ENVIRONMENT

Noise Emissions Reduction, Fuel Burn, Materials of Concern

Christian Bulgubure	Vice President Aerodynamics, Airbus
Nathalie Duquesne	Manager Research and Technology Strategy, Liebherr Aerospace
Alan H. Epstein	Vice President, Technology and Environment, Pratt & Whitney

MORE INTELLIGENT SYSTEMS

Sensors, Morphing Systems

Leonardo Lecce	Full Professor of Aeronautical Structures, Department of Aerospace Engineering, *Università di Napoli "Federico II*
Fidèle Moupfouma	Chief Aircraft Electromagnetic Hazards Protection Engineer, Bombardier Aerospace
Ion Stiharu	Professor and Director of CONCAVE Research Centre, Department of Mechanical and Industrial Engineering, Concordia University

AIR TRAFFIC MANAGEMENT

Carlos Cirilo	Assistant Director, Safety Operations and Infrastructure, IATA
Christopher Dalton	Chief, Air Traffic Management (ATM) Section, ICAO Air Navigation Bureau, ICAO
Eugene Hoeven	Director ICAO Affairs, CANSO
Paul McCarthy	IFALPA Representative ICAO, IFALPA, ICAO

MANUFACTURING

Lean, Joining, Advanced assembly processes, Robotics, Inspection and Repair, Near net shape manufacturing

Alain Landry	Manager, Composites Development, Core Engineering, Bombardier Aerospace
Éric Guénard	Industrialization Manager, Bombardier Aerospace
Paul Oldroyd	Chief, Xworx Manufacturing Research & Technology, Research & Engineering Department, Bell Helicopter Textron

MORE ELECTRIC SYSTEMS

Electric power generation & distribution, Actuation, Power management, Environmental control systems

Kevin Dooley	Fellow Advanced Technology, Pratt & Whitney
Avraham Ardman	Chief Systems Engineer, Core Engineering-MEA, Bombardier Aerospace
Pascal Thalin	Manager R&T Program – Flight Control Systems, Sagem Défense Sécurité (Groupe SAFRAN)

ADVANCED MATERIALS

Thermosets, Liquid composite moulding, Advanced metallic alloys, Thermoplastics, Nano materials, Coatings

Joël Larose	Coordinator, Material Technology, Pratt & Whitney Canada
Luigi Scatteia	Project Engineer, CIRA
Mauro Ussorio	Composites Engineer and Project Controller, IMAST

HUMAN PERFORMANCE AUGMENTATION

Synthetic training environments, Human machine interface

Norah Link	AVS Product Development Lead, CAE
Philip Church	Vice President, Neptec Design Group
John Maris	President, Marinvent Corporation

PREPARING THE CLUSTERS FOR THE FUTURE

François Caza	President of the Innovation Committee of Aéro Montréal and Vice President and Chief Engineer, Engineering, Bombardier Aerospace

FORUM REPORT

INTRODUCTION

The aerospace industry is a vital economic sector for Québec. With just over $12 billion in revenues and 80% of production sold outside the province of Québec, it is the province's second largest export sector.

In addition, the Québec aerospace industry accounts for nearly 70% of all expenditures on aerospace research and development in Canada. The dynamism of CRIAQ, co-organizer of the Forum, and its leadership role in collaborative R&D, are no strangers to this success. The Aerospace Cluster of Metropolitan Montreal ranks among the world's three largest clusters in this sector.

This forum strengthen the facilitator role of Aéro Montréal, co-organizer of the Forum, within the Québec aerospace cluster and among its international collaborators, by addressing stakeholders in the Québec, Canadian and international aerospace industry. The Forum also targeted other innovation stakeholders, such as universities, research centres and policy makers.

In 2009, the Forum was part of celebrations marking the centenary of aviation in Canada. On February 23, 1909, the Silver Dart took off, becoming the first powered flight in Canada of a flying machine heavier than air. The innovation shown by the team of pioneers from the "Aerial Experiment Association," headed by Alexander Graham Bell, has inspired several generations of passionate engineers who have contributed to the aerospace industry in Québec and Canada.

OBJECTIVES AND CONTRIBUTIONS OF THE FORUM

The Aerospace Innovation Forum 2009 aimed to examine **trends** and **major issues** of the industry in the area of innovation. Unpredictable fluctuations in oil prices and environmental concerns around the world put the theme of sustainable economic development at the heart of this overall discussion.

The event was also an opportunity for local and international participants to update themselves on the governance of clusters, both on strategic and organizational levels and in terms of technology. Several workshops compared the innovation systems of different aerospace clusters in Europe and the United States. Others focused on **emerging technology trends** and approaches in the design, production and operation of new equipment and services on board aircraft and in airports of the 21st century.

The Forum was intended primarily to facilitate meetings, to move ourselves forward, and to explore avenues for local and international collaboration to better position our aerospace industry in a highly competitive global environment where only innovation can provide the necessary edge.

An overview of presentations given at the Forum confirms the industry's positioning through a concerted vision of sustainable development. This is demonstrated, among other ways, by the pursuit of efficiencies in security matters and management of the industry's impact on the environment. It was clear from discussions that aerospace is at the crossroad of several waves of changes that will influence corporate behaviour in the medium and long terms. Markets are moving geographically and specializing, manufacturing sites are organizing globally and, more than ever, manufacturers need to come together in "clusters" and form international alliances to create synergies that spur innovation and wealth creation. R&D projects need to be planned long-term and be integrated within the major platforms, as evidenced by the Future Major Platforms (FMP), Smart Affordable, Green Efficient (SAGE) and Green Aviation Research & Development Network (GARDN) initiatives, whose significance will be summarized later in this document.

OVERVIEW OF FORUM OBSERVATIONS

Seven (7) themes emerged from the Aerospace Innovation Forum 2009. They correspond with the challenges and issues of the industry, and form a continuous loop (see Diagram 1 below):

1. Concerted vision towards sustainable development
2. Rapid technological progress and acceleration of performance improvement curves
3. Need for a critical mass of R&D programs and national and global R&D frameworks
4. Expansion of national and regional clusters in aerospace
5. Multiplicity and complexity of technological innovation focal points and the trend toward open and collaborative innovation
6. Challenges of human resource development and the management, transfer and sharing of expertise
7. Challenge of evolving clusters such as Aéro Montréal: inter-regional, inter-cluster and inter-sectoral linkages

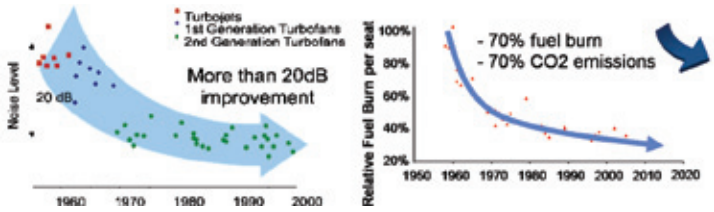
Diagram 1: Aerospace Issues and Challenges

Source: I. Deschamps, ÉTS

involved. It could also feature an openness to various kinds of partnerships to develop the multiple technology solutions required to significantly reduce the environmental footprint of air traffic. Several speakers supported the central idea that their collaboration in R&D, design, testing and commercialization has contributed significantly to recent technological successes.

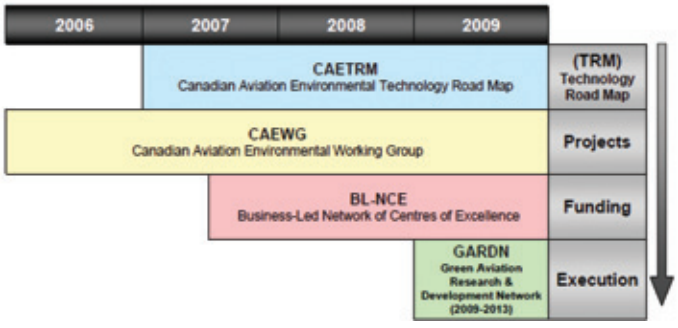
The innovations of "breakthroughs" necessary to achieve the objectives of the industry require, and will continue to require in the future, that many stakeholders, public and private, small and large companies, put their shoulders to the wheel of collective innovation. Innovation in this sector has grown exponentially in recent years. Between 1960 and 2000, the industry cut aircraft noise levels by more than 20dB and fuel consumption and CO2 production by more than 70%. Over the next few years, to have the same impact, the dual challenges of creativity and collaboration in innovation will be more difficult to meet. The initiatives proposed by influential members of the cluster – such as CAETRM (Canadian Aviation Environment Technology Roadmap) initiated by Bombardier and the NRC, and the more recent GARDN (Green Aviation Research & Development Network) initiative involving 5 companies and 7 universities, reflect the Canadian aerospace industry's determination to integrate sustainable development into all aspects of its future development and to achieve this through major projects.

Diagram 2 : Evolution of Environmental Performances



Source: Airbus

Diagram 3: Technology and Funding Roadmap



Source: GARDN

THEME 1: VISION OF SUSTAINABLE DEVELOPMENT

Environmental issues were central to all the Forum themes. To meet significant challenges, collaborative innovation is an effective and desired approach by many stakeholders. This could take the form of greater consultation and coordination among all the stakeholders

Diagram 4: GARDN Research Themes

Source: GARDN

THEME 2: NEED FOR RAPID TECHNOLOGY DEVELOPMENT

The *Advisory Council for Aerospace Research in Europe* (ACARE) has established objectives for reducing environmental impacts through the development of green technologies:

Vision 2020 of the *Advisory Council for Aerospace Research in Europe* (ACARE) :

- Halve emissions of carbon dioxide (CO2) emissions by air transport.
- Reduce emissions of nitrogen oxide (NOx) by up to 80%.
- Significantly reduce noise from air transport.

The Forum was an opportunity to present different strategies and technologies that will meet this vision. Although this issue transcended all the workshops, the breakout sessions on environment specifically focused on this topic. Three speakers presented a few trends that are designed to improve the efficiency of aircraft:

- Christian Bulgubure, Airbus
- Nathalie Duquesne, Liebherr Aeropace
- Alan H. Epstein, Pratt & Whitney

In a world where the customer is looking for faster transportation, at a lower cost and more safely, the industry faces considerable challenges in terms of responding to environmental issues.

"Green" engines

The challenge for engine research and development teams is to efficiently combine **power, lightness and reliability**.

To achieve the target of reducing consumption and CO_2 emissions, what does this mean for these companies?

Allocation of potential reductions:

- 20% must come from the aerodynamic efficiency of aircraft
- 20% must come from the engine
- 10%must come from a more optimized management of air traffic

This can be achieved only by radical innovations such as the integration, for example, of new sensors, new engine designs or a better penetration of electrical systems to replace hydraulic and pneumatic systems. However, one major constant emerged from these conferences: multidisciplinary work and, above all, collaborative research. These have been put to the forefront by leading companies in the industry to stimulate radical innovation and achieve ambitious goals at a reasonable cost, through sharing.

THEME 3: THE NEED FOR A CRITICAL MASS IN R&D

THE AEROSPACE INDUSTRY IN EUROPE

In September 2009, the President of the European Commission, Mr. Jose Manuel Barroso, outlined Europe's research policy. It aims to strengthen measures to reduce carbon emissions. Electricity production, the transportation sector and the development of electric cars are at the heart of this policy. Mr. Barroso stressed the need to intensify and focus European research efforts in key areas. This research should respond to industry needs.

The message is clear: we must bring the European research policy to a more advanced stage, and invest at a sufficient enough level to generate significant future results from major initiatives such as Clean Sky and European Green Cars.

The Seventh EU Framework Program (called FP7) has been allotted $7.46 billion for 2007-2013.

27 members of the European Union and partnering countries, Israel, Norway, Switzerland and Turkey are participating in this initiative.

Two phases have been carried out to date. A third phase was launched in July 2009 with a European budget of 108 million euros. This phase was to be completed on January 14, 2010, with following targets:

2010 targets of major R&D projects in Europe

- *The Greening of Air Transport*
- *Improving Cost Efficiency*
- *Pioneering the Air Transport of the Future*

Moreover, the European Commission has launched two initiatives with China and Russia on specific subjects (below). These projects will also be supported by public funds from their respective governments.

Collaborative research subjects with China and Russia

- *Flight Physics*
- *Production*
- *Aerostructure*
- *Maintenance*
- *Propulsion*
- *Flight Management*
- *Systems & Equipment*
- *Human Factors*
- *Avionics*
- *Airports*
- *Design Systems & Tools*

THEME 4: EXPANSION OF NATIONAL AND REGIONAL CLUSTERS

NATIONAL INNOVATION SYSTEMS

In addition to the Aéro Montréal cluster, the Forum offered an opportunity to present six (6) aerospace clusters, each with its specific features. It appears that the European clusters presented have specialized considerably and expanded in recent years. They are positioning themselves through supranational, national and regional strategies. We can also note that some of these strategies operate in a process explicitly based on the tenets of open innovation. This has been the subject of several national comparative studies and recommendations for economic policies that have been widely disseminated in Europe (by the OECD, see References section) and which will be discussed in the next Theme. It is interesting to describe the operations and results of these clusters in order to benchmark and compare these approaches, policies, structures and modes of governance with the operating modes of the Aéro Montréal cluster. The idea is to eventually generate ideas for improvement and identify opportunities for synergistic collaborations.

AEROSPACE VALLEY (FRANCE)

Aerospace Valley's strategy is part of the Advisory Council for Aeronautics Research in Europe (ACARE) vision and that of the Council for Research in Civil Aviation (CORAC). It revolves around four (4) focal points shown below:

- Environment
- Health and Safety
- Quality and Cost
- Efficient Air Transport System

Diagram 5: ACARE and CORAC Objectives

Source: Aerospace Valley

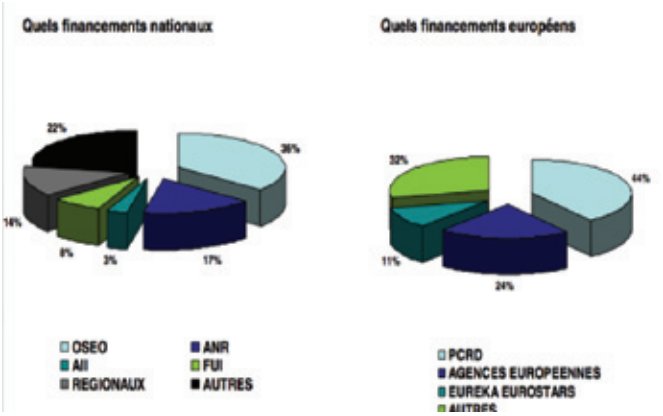
The main research and technology(R&T) orientations of R&T of the Aerospace Valley are part of **a global and collaborative approach**, illustrated below.

Diagram 6: The Main R&T Orientations of CORAC

Source: Aerospace Valley

- Aerospace Valley is composed of 540 members, seven colleges, 260 SMEs, volunteer facilitators, 1.6 million euros annual budget. The cluster acts as an intermediary and facilitator for industry stakeholders, research and training.
- Over 270 projects have been selected as part of the activities of the aerospace cluster. In the planning of competitive hubs, 171 of these projects have received public and private funding worth 115 million euros.
- However, the total value of projects amounts to more than 520 million euros, of which half comes from private funds. The public share is divided between the national and European governments, as shown below.

Diagram 7: Distribution of Public Financing



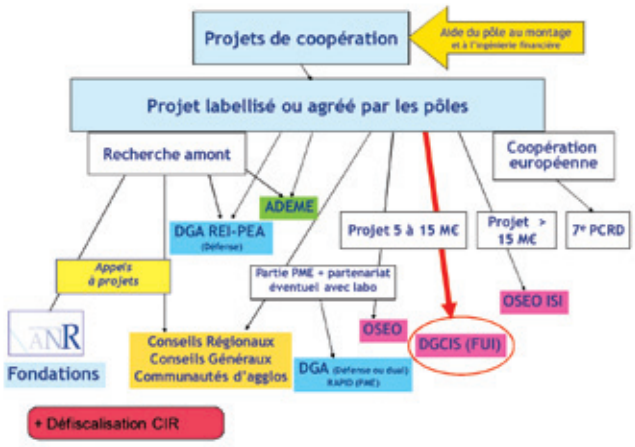
Source: Les Echos, dec. 2009

Among the 1,222 contributors to Aerospace Valley projects, 26% came from large groups, 26% from SMEs and 48% from research centres. The project leaders are divided almost equally between large contractors and research centres.

Project funding for the Aerospace Valley cluster comes from several levels of government. The funding chart shows the distribution of financing sources. Each of these financings is part of specific policies or strategies, which are linked directly or indirectly to the aerospace industry.

The following diagram provides an overview of the dynamics surrounding the financing of R&D projects in the context of the Aerospace Valley. Projects may enrol in several sectors: regional, national or European. These projects have created more than 11,000 high-level jobs over 4 years.

Diagram 8: R&D Project Financing Sources



Source: Aerospace Valley

In conclusion, we can all be inspired by the objectives of the Aerospace Valley cluster.

The ecosystem of the aerospace hub in France is based on several focal points such as international collaboration. Indeed, the hub targeted 11 countries for collaborative activities from 2009 to 2010. It wants to strengthen relations with French clusters which have an international vocation, and foreign clusters. It also promotes SMEs in their activities abroad while developing, for the cluster and its members, international positioning, training and research.

The eight strategic objectives of the Aerospace Valley cluster:

1. Reinforce world leadership in civil aviation
2. Reinforce European leadership in Space
3. Strengthen a position of excellence in embedded systems (including ground transportation: road and rail)
4. Establish the cluster's role as a global reference for Training and Research
5. Facilitate and coordinate the network of French aviation and aerospace clusters
6. Enhance the innovative potential of SMEs and start-ups in aviation, aerospace and embedded systems.
7. Provide a bulwark against potential threats by adapting to the constraints of globalization while maintaining a strong technological base in France.
8. Promote a sustainable development policy.

NORTHWEST AEROSPACE ALLIANCE (UK)

The Northwest Aerospace Alliance (NWAA), located in northwest England, is the regional trade association for the aerospace industry.

The NWAA, founded in 1992, has more than 800 industry members. The association is composed of a team of 17 full-time staff that should double in 2010.

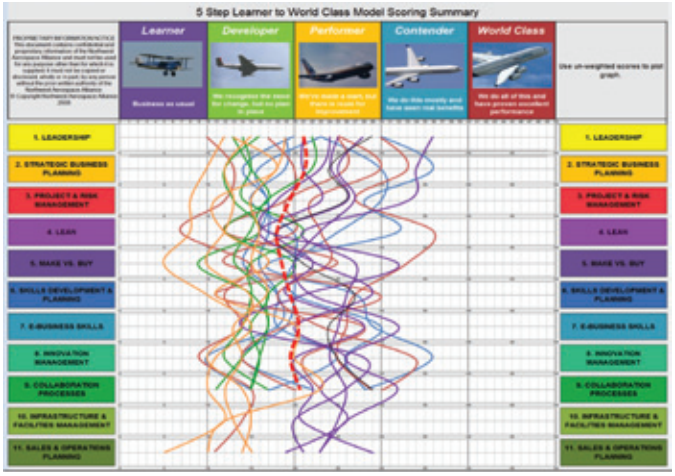
Although the cluster has existed for over 18 years, in 2004 the association had to refocus its mission around productivity objectives. Several weaknesses in the cluster were then diagnosed: a lack of communication in the supply chain; cultural problems; a poor understanding of international standards; little investment in human capital development.

The NWAA responded with a strategy based on a rationalization of suppliers, by restructuring and getting closer to stakeholders in the supply chain. These activities were integrated into the Aerospace Supply Chain program. Compared to the pyramid found in traditional supply chains, the model chosen is based on a staggered tiering structure.

Development of SME capacity

In this core program, the NWAA implemented a model based on five (5) learner steps and development of aerospace SMEs based on their behaviour and performance in the supply chain. This model involves a SME moving from "Learner" status to "World Class," through the intermediate stages of "Developer," "Performer" and "Contender." The approach is based on international benchmarking for each activity to determine the baseline. On this basis, strategies are implemented to advance the SME's activities and move it closer to step 5.

Diagram 9: Five Steps of the Aerospace Supply Chain Excellence Program



Source: Northwest Aerospace Alliance

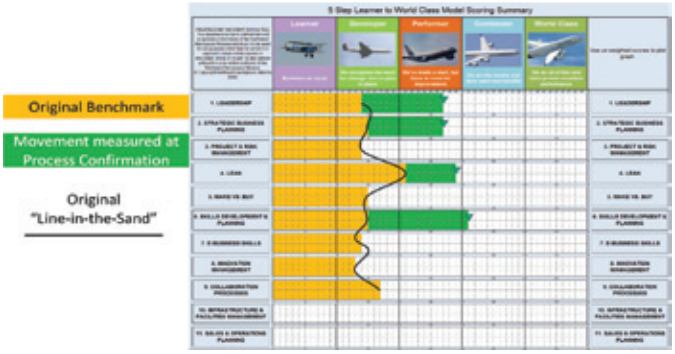
The model describes the characteristics and capabilities expected from companies for each of the steps:

Learning = Development = Performance = World Class

Each of the 11 key processes to be mastered mainly involve approaches and methods of management and aptitudes related to "soft skills," e.g., leadership, strategic planning, project and risk management, innovation management, collaboration and production.

A program has been put in place to assess (benchmark) each company at the start and properly plan its development moving forward. The chart below shows the state of companies at the original benchmark (Yellow) and the status of progress in each category (green) since the initial benchmark activity.

Diagram 10: Improvement in Best Practices



Source: Northwest Aerospace Alliance

Integrated knowledge and expertise management of the cluster: maximizing synergies

The Aerospace Supply Chain Excellence (ASCE) aims to develop individual companies within the cluster. Supplier Development is the framework program. However, to establish a common strategy for all stakeholders in the cluster, we recognized the importance of having a common language. Effective communication based on a common understanding of objectives facilitates a better dynamic and integration of diverse elements in the cluster, and the introduction of various required technological and organizational innovations (see the 4 diagrams below).

The cluster aims to build bridges between all its members to share knowledge and to bring them together towards the same vision and common values.

The regional strategy for the cluster is based on the sharing of best business practices. It identifies opportunities for organizational innovation to improve the collaborative approach of companies.

The cluster identifies various regional core capabilities and ranks them based on the desired strategies in matters of supply (make versus buy), control and protection.

In summary, it appears that this regional cluster has fully understood changes in the business environment. It has put forward a clear development vision. A vision based on open or collaborative innovation to create a world-class cluster that will be a winner among global clients.

The cluster has already delivered its first phase, ASCE 1. The second phase is underway for the integration of stakeholders in the cluster who are integrators (OEMs), the supply chain, schools, technology centres and economic development agencies. ASCE 1 defines the tiering structure for industry suppliers from the Northwest and supports the foundations of a common culture, language and processes. ASCE 2 recognizes the need to create the "close coupled," the knowledge base of the cluster, the integration of industrial players and infrastructure support.

Diagram 11: Development Steps

Source: Northwest Aerospace Alliance

The various sources of expertise, creativity, entrepreneurship and collaboration ("skills") in the aerospace industry are being organized to foster the creativity and innovation needed to create a high level of value-added.

AEROSPACE IN THE APUGLIAN REGION (ITALY)

The main objectives of this cluster are to extend a policy of dialogue under the umbrella of the EU Cluster Alliance and thereby promote transnational cooperation among the clusters under the aegis of a European meta-cluster. (See diagrams below)

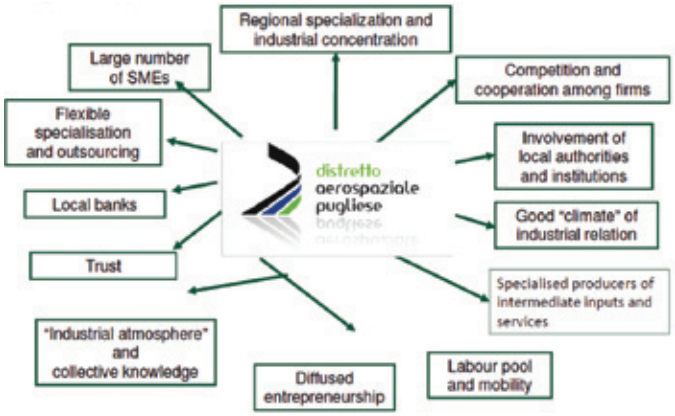
Diagram 12 : The Italian Metadistretto

Source: Distretto Aerospaziale Pugliese

Due to its geographical position, Apulia can be a strategic base for exchanges between Europe and other regions of the Mediterranean.

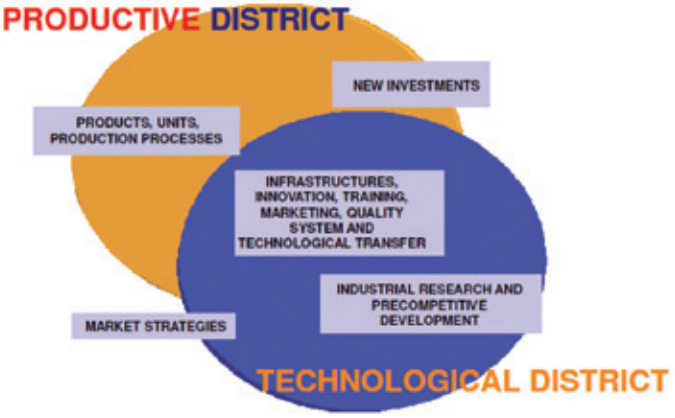
The harmonious coming together of all stakeholders in the region based on principles of cooperation, flexibility, business climate, collectivism, entrepreneurship, specialization, etc.

Diagram 13: Strengths of the Apulian Aerospace Cluster



Source: Distretto Aerospaziale Pugliese

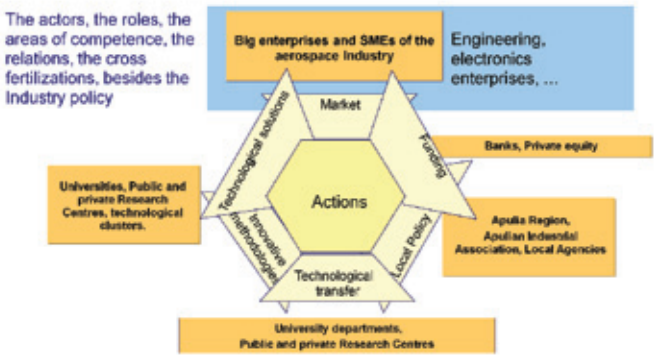
Diagram 14: Integration Between Production and Technology Development



Source: Distretto Aerospaziale Pugliese

Beyond industrial policies, each group of stakeholders (universities, contractors, SMEs, agencies) are contributing in full synergy.

Diagram 15: Methodology and Intervention Tools



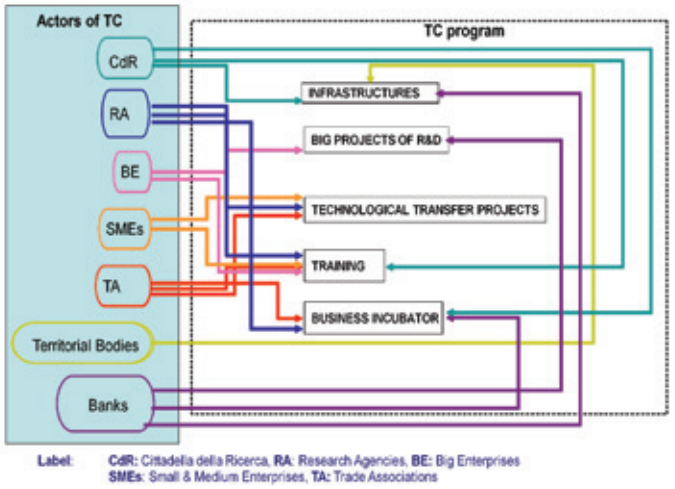
Source: Distretto Aerospaziale Pugliese

The supply chain of the Apulian cluster features a variety of specialties centered on key skills in machining, fabrication and assembly:

- Precision machinery for manufacturers
- Light alloys for mechanical work
- Manufacture of composite materials
- Metal structures
- Specialized assembly
- Electronics and printed circuit boards
- Electrical assembly
- Electrical and electronic equipment

The dynamic of the cluster is shown as follows; multiple interrelationships are needed to achieve the desired collective innovation (see diagram below).

Diagram 16: Role and function of a Technological Cluster



Source: Distretto Aerospaziale Pugliese

In summary, the approach of the leaders of this cluster is to establish an integrated structure and infrastructure where linkages among all the innovation stakeholders are encouraged. It involves the establishment of a truly regional innovation system that goes far beyond a simple regrouping of companies. This approach of formalizing the structures of clusters mirrors models that are promoted in Europe by the OECD and the European Union (see references).

HAMBURG METROPOLITAN REGION AVIATION CLUSTER (GERMANY)

Germany's cluster strategy is clearly part of a world vision. The chart below shows the German federal government's cluster strategy, which includes the Hamburg and Bavaria clusters.

Diagram 17: German Federal Government Cluster Strategy

Source: Bundesministerium der Finanzen

The Hamburg aerospace cluster model incorporates the notions of sustainable development in a global vision of industry challenges related to cost, reliability, comfort and flexibility of the cabin configuration.

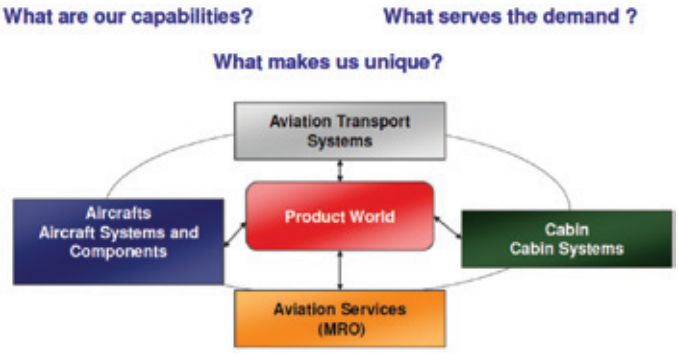
Diagram 18 : Excellence Cluster Strategy

Source: Aviation Cluster Hamburg Metropolitan Region

Three priority projects in Germany

1. Technology related to the cockpit and cabin innovation
2. Expand MRO skills for the new generation of aircraft
3. The airport of 2030

Diagram 19: Fields of Expertise in Hamburg



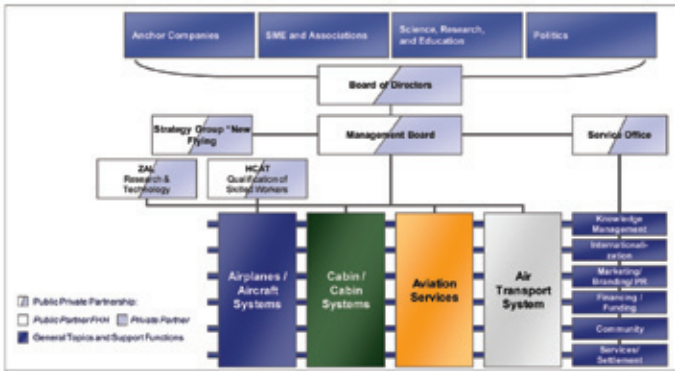
Source: Aviation Cluster Hamburg Metropolitan Region

R&D investments will reach € 80 billion over the next 5 years.

Financing 50% by industry and 50% by the Federal Ministry of Education and Research (see diagram)

The cluster's strategy relies on a sophisticated network.

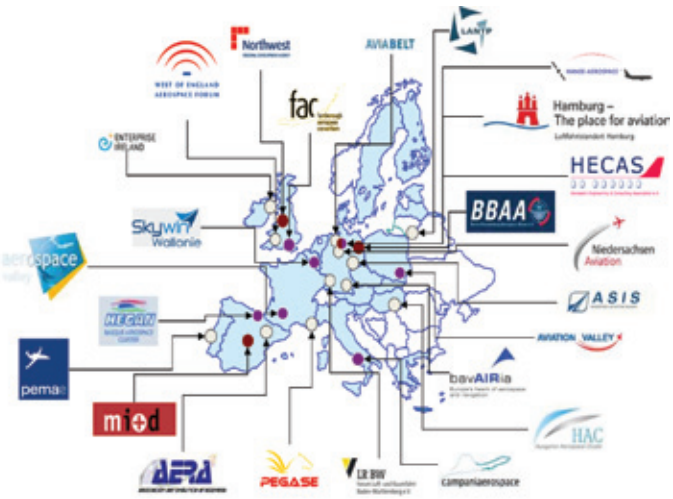
Diagram 20: Cluster Organization



Source: Aviation Cluster Hamburg Metropolitan Region

Moreover, the national cluster is part of a broader European strategy...

Diagram 21 : European Aerospace Cluster Partnership (EACP)



Source: Aviation Cluster Hamburg Metropolitan Region

BAVARIAN AEROSPACE CLUSTER (GERMANY)

BavAIRia is an organization funded by the Bavarian government to manage aerospace and satellite navigation clusters.

This organization was founded in 2006 with 40 organizations and includes over 150 members today.

BavAIRia integrates major players from the industry, science and politics in a non-partisan body to facilitate cooperation in innovative projects.

Diagram 22: BavAIRia Strategic Activities

Source: BavAIRia

It seems very clear from this cluster's presentation that development of the business network and specialized management expertise are core activities; the business side is favoured with specific programs encompassing commercialization, globalization, and the revision of business models promoting openness and cooperation. Even technological developments are oriented towards partnership and financing. The "value added" of the cluster is therefore focused on all the enablers and catalysts of technological innovation in an "open" fashion rather than on R&D investment as such.

AVIATION VALLEY (POLAND)

- The development of this Valley is based on three sectors: Agriculture/Tourism and Aerospace
- The participants are: aviation, universities, European funds
- The "old image" is diminishing: the region is becoming high-tech, with a manufacturing sector that is agile and efficient
- The structure of the Polish cluster relies mainly on large private companies such as: P&W, EADS, Safran Group, Goodrich, etc.

Aviation Valley was founded in 2003. It consisted of 18 participants and 9,000 employees. Today, the cluster represents more than 77 members and 22,000 jobs

Objectives:
To support the industry in reducing costs related to the supply chain, attract investors and influence the education system. The cluster has had a world-class training center, CEKSO, since 2005. It has a budget of 24 million euros for its operations. Moreover, the cluster operates international cooperative projects with other clusters, including one in Finland.

Poland is positioned as four (4) times less expensive than Western Europe given its expertise.

In summary, the Polish cluster is determined to dust off its image and take its place on the European and world scene based on its long history in the industry and its structural advantages. This gives it an attractive combination of low costs and leading-edge expertise. It intends to take advantage of European framework programs and collaborate internationally with other clusters.

PACIFIC NORTHWEST AEROSPACE ALLIANCE (PNAA) (USA)

NPAA is a non-profit organization that promotes the growth and success of the aerospace industry in the Pacific Northwest. NPAA had more than 90 members in 2009. The organization provides seminars, offers business opportunities and organizes networking events. The best known of these events is the annual conference of the NPAA, which usually takes place in February.

The **Washington Aerospace Cluster**, organized around Boeing, appears to be the largest of its kind in the United States. The cluster brings together more than 7,000 engineers and over 650 companies. Moreover, Airbus is providing more than $ 1.2 billion in contracts to firms in the cluster.

The network of supplier companies operates in several specialties such as:

- Avionics
- Aircraft cabins
- Composites
- Engineering
- Aircraft interiors
- Tools

Innovation in the cluster revolves around the university hub of the **University of Washington**. More than $25 million annually is invested in aeronautical research and to build a close relationship with the general contractor, Boeing. The emphasis is on advanced materials and structures.

Among the collaborative research initiatives, the Boeing-UW-WSU collaboration program is developing the *Boeing Fuel cell project*. It seeks to develop a *solid oxide fuel cell* (SOFC) for use instead of *Jet A fuel*.

To support technology transfer, the **SIRTI incubator** frames projects. The multi-sectoral incubator works in aviation, but also in the areas of biotechnology, environmental technology and energy.

Some examples of projects of the University of Washington (**Tech Aerospace Center**): in collaboration with the university, Boeing and Heatcon are working in the following areas:

- *Composite repairs using thermal mapping and leak detection;*
- *Develop noise resistant speech recognition for command and control avionics;*
- *ElectroImpact: Develop low-voltage electromagnetic riveting system.*

Collaborative projects across sectors and other State clusters are desirable to further develop the cluster.

AÉRO MONTRÉAL CLUSTER (CANADA)

Pillar of employment

The Aerospace Cluster of Metropolitan Montreal includes 234 companies accounting for 40,000 jobs in Québec. This represents a major portion of the Canadian aerospace industry, consisting of 400 companies, 83,000 employees and $26 billion in revenues in 2008. The cluster is the Canadian leader in the export of high technology goods and services since 80% of its sales are from exports. It is a pillar of economic development: one worker in 95 in Montreal has a job related to aerospace.

World-class companies and dynamic SMEs

The Aerospace Cluster of Metropolitan Montreal is also a leader in the field of regional and business jets, avionics, commercial helicopters, aircraft engines, flight simulators, landing gear and satellite systems. Moreover, the cluster has a competitive supply chain in the fields of electronics, systems, communications and maintenance. The Greater Montreal is one of the few places in the world where an entire aircraft can be designed, developed and manufactured within a radius of 30 km. SMEs in the region contribute significantly to this value chain, and are increasingly involved in innovation. The Québec Aerospace Association (AQA), the association which unites them, recently updated its mission and strengthened its leadership role in the development potential and competitiveness of aerospace SMEs. Specific recommendations to further stimulate innovation in SMEs and their integration in the cluster will be made in the conclusion.

The Aerospace Cluster of Metropolitan Montreal is composed of world-class OEMs:

- Bell Helicopter Textron Canada, a leader in the design, production and commercial support of helicopters for the commercial market;
- Bombardier Aerospace, the world's third biggest manufacturer of civilian aircraft and the world leader in regional jets;
- CAE, a world leader in the field of flight simulation, modeling and crew training for civil and military aviation;
- Pratt & Whitney Canada, the world leader in the manufacture of engines for regional and business aircraft and helicopters.

The Aerospace Cluster of Metropolitan Montreal is also composed of a wide range of equipment manufacturers and MROS:

- Aveos, an expert in the maintenance and repair of commercial aircraft;
- CMC Electronics, a specialist in navigation, vision and integration of cockpit systems;
- Heroux-Devtek Inc., a leader in the design, development and manufacture of landing gear;
- L-3 Communications MAS (Canada) Inc., a key player in the maintenance and upgrading of military aircraft;
- Messier-Dowty Inc. (groupe SAFRAN), a leading manufacturer specializing in the manufacture of landing gear;
- Rolls-Royce Canada Limited, one of the biggest names in the repair of aircraft engines and turbine design for industrial use;
- Sonaca Montreal, a leading global manufacturer of aircraft wings;
- Thales Canada, a leader in the integration of onboard systems in avionics suites and electronic flight controls;
- Turbomeca (Groupe SAFRAN), a key player in the maintenance and repair of helicopter engines.

Training and Advanced Research

The Aerospace Cluster of Metropolitan Montreal can rely on a highly-qualified workforce thanks to a network of specialized institutes, universities and colleges in Québec. This allows for the annual addition of more than 3,600 engineers and technicians that support the sector's competitiveness. In terms of R&D, the cluster can count on an exceptional capacity for innovation. It builds on initiatives such as the Consortium for Research and Innovation in Aerospace in Québec, which focuses on pre-competitive research projects (CRIAQ). Adding to this consortium are the Canadian Space Agency, the Aerospace Manufacturing Technologies Centre (NRC-AMTC), the Industrial Materials Institute of CNRC (IMI), specialized colleges and liaison centres such as the Centre technologique en aérospatiale (CTA), Institut national d'optique (INO), Centre québécois de recherche et développement de l'aluminium (CQRDA), Centre de recherche industrielle du Québec (CRIQ), etc.

Major initiatives

For more than five (5) years, numerous initiatives from various combinations of public and private members of the Montreal cluster have aimed to improve links among its members, to guide R&D work, to combine innovation efforts to achieve the ambitious objectives described above, and thus differentiate itself and carve out a place among the world leaders.

The CAETRM roadmap has served as a guide to working groups, which led to the development of the GARDN centre of excellence, which has a long-term horizon, from 2009-2013, to assure achievement of **objectives such as applied research, training of qualified personnel, transfer of technology to companies**, partnerships including SMEs, etc

Diagram 23: Technological Needs and Capacity of the Canadian Industry

Source: CAEWG

This map has paved the way for planned initiatives in order to develop all the technologies and capabilities required for the next decade, through the Future Major Platform (FMP) and the SAGE program (Smart, Affordable, Green and Efficient) initiatives, which have recently been the subject of requests for government support. They will take place from 2010 to 2014 and will integrate seamlessly into the entire value chain, including SMEs, all technologies required for the future.

THEME 5 : TECHNOLOGY INNOVATION AND COLLABORATION

THE AREAS OF TECHNOLOGICAL INNOVATION

The Montreal cluster has a major asset in terms of development and technological innovation, CRIAQ, a one-of-a-kind pre-competitive collaborative research consortium that resulted from lengthy collaboration among various private and public players in the industry. The 2009 Forum helped to raise awareness about many projects resulting from this regrouping, as well as those of some international experts invited to the Forum. We have grouped presentations on trends, innovations and achievements in the area of technological performance within nine (9) thematic workshops:

- **Product Development:** Integrated design and manufacture, virtual prototyping, testing and integration, advanced product development strategy, life analysis, prognosis and health management;
- **Avionics:** Synthetic/Augmented Vision Systems, Fly-by-wire/light;
- **Environment:** Reduction of noise emissions, fuel consumption and polluting emissions, harmful materials;
- **Intelligent Systems:** Sensors, morphic systems;

- **Air Traffic Management:** Infrastructure, Communications, Navigation, Surveillance;
- **Manufacturing:** Case Studies in Automation;
- **Electrical:** Power generation and distribution, actuation, power management, environmental control systems;
- **Advanced Materials:** Thermosets, liquid composite molding, advanced metal alloys, thermoplastics, nanomaterials, coatings;
- **Human Performance:** Synthetic training environments, Human-machine interface.

OVERVIEW OF RECENT TRENDS AND ACHIEVEMENTS DISCUSSED AT THE FORUM

Product Development

- Contractors such as Airbus are continually seeking to differentiate themselves: they are looking for unique combinations of simplicity, comfort, safety, sophistication.
- The "focus" of engine manufacturers such as P&WC is on "green" products, integrated life cycle.
- The need to validate products with large contractors.

Avionics

- Avionics specialists such as Thales and CMC Electronics are seeking to improve their ability to maximize integration of new knowledge through creativity processes, exploration of opportunities and management of the innovation process.
- Systems are integrating and merging increasingly complex technologies (e.g. CMC Electronics – cockpit for the T-6B, Marinvent, Gulfstream Aerospace).
- Technology is more than ever at the service of crew performance and man-machine integration is a key area of integration technology.

Environment

- Major advances are being made in reducing environmental footprint.
- Breakthrough technologies in several areas: load control, sensors, predicting clear air turbulence (e.g., Airbus).
- Design work is multidisciplinary in order to achieve these ambitious goals.
- They are seeking to model the complete envelope of the aircraft; modeling of fluid dynamics (CFD) can shave 6 months off an airplane development program.
- Other future objectives: surface quality, contamination (insects), de-icing, reliability, laminar flow.
- Increased use of electrical power for systems that used to be big consumers of mechanical energy (Liebherr Aerospace).
- Engines must combine low gas emissions, low noise, power, light weight and reliability (P&WC).

Intelligent Systems

- Composite materials pose challenges in terms of protection against electromagnetic effects and lightning that can significantly disrupt the operation of electronic systems.
- The use of vibration captors and acoustics to locate cracks and understand the causes, challenges of certification of these systems.

Air Traffic Management

- The optimization of air traffic has huge potential savings in fuel and reductions in pollution and noise, but its success requires an ability to implement solutions that involve very lengthy validation phases.
- The establishment of international standards is key.

Manufacturing

- Manufacturing became the subject of collaborative innovation after the advent of new automated processes for the manufacture of large primary structures made of composite materials. (see Bombardier project described below, see the box on success stories).
- Process development projects include phases of characterization, testing, forecasting, repair, inspection, etc.
- Advances in robotics are leading to time savings of 30 to 35%, lower risks and higher quality for the assembly of metal panels (Bombardier).
- They are seeking to apply automation to reduce costs while taking into account complexity, repeatability and accuracy (Bell Helicopter).

Electrical Systems

- Innovative electrical systems will be introduced in all functions of the aircraft (Safran Group), and thus lead to new paradigms when it comes to analyzing economic factors; this requires multiple disciplines (Bombardier).
- The complete life cycle of aircraft is taken into account (Bombardier).

Advanced Materials

- The materials area is huge since it serves to improve weight, durability, environment, cost and performance (P&WC).
- There is work to be done to optimize material choices: because the applications are very specific, materials must pass integration tests in the value chain and nanotechnology is creating new options (P&WC).
- The introduction of nanoscience requires more fundamental R&D to understand the relationships between morphology and the properties of nano-composites (Italy).
- R&D efforts on new materials, including nanotechnologies, require intersectoral collaboration (aerospace, transportation, chemicals, medical, electronics, etc.).

Human Performance

- Substantial improvements in tools to assist pilots and increase safety.
- Technologies developed for the military sector could be transferred to the civilian sector.

INSPIRING CASE STUDIES

Some industrial and institutional members of Aéro Montréal have been important participants in successful initiatives regarding collaborative innovation projects. We cite two as examples.

Collaboration benefits:

- Sharing of intellectual capital, equipment, facilities, best practices, costs and outcomes
- Allows OEMs to access new technologies for next generation aircraft
- Allows suppliers to increase Tier1 capabilities
- Synergy Government, OEMs and SMEs
- Accelerating the demonstration of technologies... industry stays viable

CASE No.1 — Bombardier-Composite Fuselage and Tail boom collaboration projects

Collaboration approach, cost sharing, technology demonstrators

Collaborators : Bombardier, NRC, Bell Helicopter, Composites Atlantic limited

Project focus

- Develop automated manufacturing : cost, weight, quality
- Composite support technologies : characterization, inspection; Certification issues, etc.
- Automated Fiber Placement (AFP) from 2006 to 2009
- Tailboom testing at NRC, Composite Forward Fuselage, Conductive Bonding NRC Process

Barrel Pressure Testing Objectives:

- Prediction, damages, repair, inspection
- Many tests involved: flammability, acoustic, moisture, interference, structural health
- NRC full scale Viper 4000 AFP machine financed by DEC and installed at Composite Atlantic Ltd facility in Mirabel
- AFP Manufacturing: Fuselage manufacturing process development on full-scale mandrel manufactured by PCM (Québec City); full-scale fuselage segment demonstration article manufactured in October 2009 with material from CYTEC

Results: IMPROVEMENTS: reduction in touch hours, part count, fasteners count, cycle time, tooling, floor space, weight

Case No. 2 — Bombardier-Robotized Assembly system for nose fuse panels

Successful collaboration project between NRC and Bombardier Aerospace

Problems: Assembly of mid-sub is made with automatic riveting machine with manual positioning: Repetitive work, low performance, tighter quality control required

> Reduce time, risks, human interventions
> Increase quality, modernization

4 phases: 2004 to 2009: feasibility, demonstration, integration, transfer

Challenges:

> **Management Risks:** First Robotic project, Success Pressure. R-D project in a traditional structure, rigid costs & delays
> **Technology Risks:** Complex solution, very tight tolerance of location

Results: Reduce time by 30%-35%, eliminate health and safety risks and increase quality

COLLABORATION IN R&D AND OPEN INNOVATION

The review in the previous sections of presentations on the clusters' successful models, as well as workshops above describing recent technological achievements and citing the success stories of technological development, converge toward a central conclusion: the era of collaboration in innovation (now called "open innovation" by most private or public bodies) is now well under way! It is clear that the most active regions in aerospace are trying, through various mechanisms of coordination, consultation, training, exchanges and transfer of expertise, to further increase the capacity of their stakeholders to innovate together. Organizational innovation is therefore as important as technological innovation. Promoting organizational innovation in all its forms is becoming a central item on the agenda of leaders of all the aerospace clusters, here and elsewhere.

How can Québec and Canada position themselves along the lines of European cluster models and local success stories presented above? If we have already seen several cases of successful technology collaborations, some of which were shown at the Forum (see boxes), it is undoubtedly because we have the R&D infrastructure and have implemented solid and productive structural initiatives such as CRIAQ. These successes, achieved through dozens of collaborative projects, have created a climate of trust. Without this favourable context, it would have been difficult to generate solid reviews and strategic directions such as CAETRM, which have recently led in turn to concrete cooperation projects, conducted under the auspices of initiatives such as GARDN and SAGE. A decade of more "open" collaboration and innovation within the Aéro Montréal cluster, supported by CRIAQ, has today led to the sharing and adoption of common goals. It has become easier to identify practical targets and the key "drivers" for the future of aeronautics and to facilitate execution by pooling human resources, expertise, business networks and financing.

Several questions come to the minds of leaders in the country's aerospace sector to meet the challenge of increasing collaborative innovation:

- Can we cope with the challenges considering the financial constraints of companies?
- Can we share the development costs of new technologies?
- Can we sustain the funding of R&D through collaboration?

"Future Major Platforms" Program

Future Major Platforms (FMP) is an industry led initiative in collaboration with the government of Canada to better position Canadian aerospace industry to supply the next generation of commercial aircraft. Through this initiative, Canadian industry has identified major commercial platforms that offer the best opportunities for Canadian firms. In addition, the FMP's Technology Working Group has developed a list of priority technology areas that are key for the Canadian industry's participation in the identified platforms.

Other activities of the FMP initiative include development and implementation of 'capture plans' to assist Canadian companies in becoming suppliers to the identified OEMs."

Among the topics raised during the Forum, a central point became clear: the critical importance of the FMP program and the National Technology Demonstration Program to facilitate collaboration. It is critical to understand that without this type of platform, it will be risky to provide realistic solutions to the dilemma of technological performance and industry growth in a context of globalization, competition on costs, financing that is difficult to access, and the imperatives of sustainable development.

The speakers acknowledged the need to improve the competitiveness of SMEs by increasing the Canadian content of the new platforms. The demonstration programs planned in the FMP must reduce the growing gap between the needs of integrators (OEMs and Tier 1 suppliers) on the one hand, and the capacity of their sub-contractors (Canadian Supply Chain), on the other (especially SMEs).

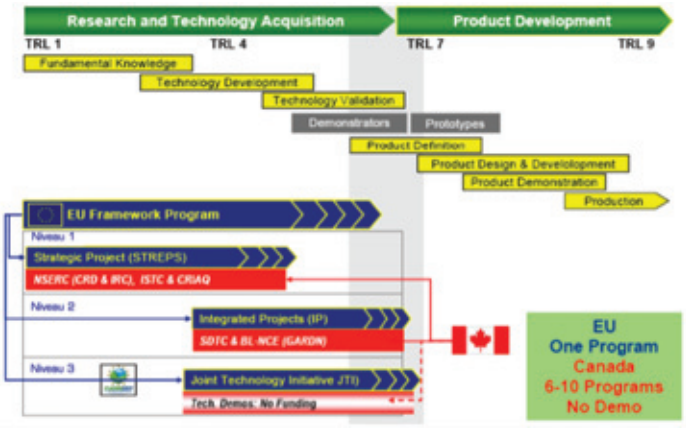
The demonstration program should also promote the development of Tier1 capabilities in Canada by facilitating a consortium approach that strengthens system integration capabilities.

The objective of a technology demonstration program is to advance innovations in later phases of the innovation process, namely to bring new technologies to the stage called Readiness Level 7 by 2014, in order to introduce them on a new platform at the time of entry to service. This initiative will increase the value added of the local production chain and increase exports. In addition, the program will increase the technology and innovation capacity of SMEs. Collaboration among OEMs, Tier 1 suppliers and SMEs will favour this action and contribute to the development of highly qualified personnel (HQP) for the aerospace industry. It will also involve universities and specialized colleges in technology demonstration programs.

National demonstration programs

The Canadian aerospace industry is proud of its long tradition of collaborative research, which has proven itself and has produced many results. This tradition is now recognized as one of the pillars of the industry's future, and is one of the key ingredients which will underpin the National Technology Demonstrators Program. Indeed, despite Canadian advances, and as shown below, when one compares them with the European innovation systems, it becomes clear that our approaches do not cover the intermediate stages of the innovation process, namely demonstration of the concept and prototyping.

Diagram 24: Comparison of Canadian and European Innovation Systems



Source: European Commission and AIAC/Industry Canada

The SAGE Program

To overcome the shortcomings outlined above with regards to integration and demonstration, the SAGE program recently proposed by Aéro Montréal for Québec will have the following characteristics:

- A collaborative program of $ 120 million to $ 150 million over three or four years
- 50% of non-repayable contributions from Québec, 50% industry funding
- 10 to 15 companies participating
- Large companies, equipment manufacturers and Small and Medium Enterprises (SMEs)

Diagram 25: SAGE Project

SMART Intelligent Systems	Integrated and intelligent systems, Air transport system optimization Enhanced passenger comfort
AFFORDABLE Initial and Operating Cost	To build: design, manufacturing and materials To operate: reduced fuel consumption, maintenance and navigation fees
GREEN Environmentally Friendly	Reduced noise (5-10dB), CO2 (25%) and NOx (30%), Fuel consumption (25%), Materials of Concern (Chromium, etc) Alternative fuel, Hazardous waste elimination, Green metrics for Eco Design
EFFICIENT Performance and Operation	Advanced aero concepts , Advanced materials, more electric airframe Power management systems, Integrated thermal management of propulsion system, Value added innovative design

Source: Aéro Montréal

THEME 6: HUMAN RESOURCES AND EXPERTISE

MANPOWER AND EDUCATION

Although the "focus" of the Aerospace Innovation Forum was not human resources, this issue transcended all presentations and discussions. This is not surprising, given the environmental challenges and the need to accelerate technology innovations while limiting increases in costs. Humans need to do more with less.

- The human as a customer is at the heart of environmental concerns, safety, comfort. Humans must be better integrated in the development cycle of products.
- **Knowledge and human know-how**, their exchange and transfer, are also of concern to all **researchers and developers**: how to harness the creativity of employees, encourage teamwork among engineers, mobilize multidisciplinary teams and increase productivity?
- Aircrafts are becoming increasingly intelligent; **the machine is in the service of man**, which requires being more involved to better adapt technologies and incorporate them more easily. **The man-machine interface** and flight safety are at the heart of the concerns of designers of the intelligent aircraft.

The Aerospace Cluster has always put human resources at the centre of its activities. A special Forum organized by Aéro Montréal was held on this subject in 2008. The cluster benefits from several strengths in the region: 50,000 engineers in Montreal, including 9,000 in aerospace; unique training programs, both at universities and technical colleges (CTA, ÉNA, ÉMAM, IFA), with 3,600 annual graduates. But a trend is emerging: human resources need to now be more specialized, better trained, on an ongoing basis, etc. We need to enhance their skills in general. Numbers are not all that counts: so do quality and expertise, and we must better integrate graduates into companies.

All the representatives of various clusters, from France, Germany, Poland, also mentioned human resources, their training and integration as one of the most pressing challenges.

DEVELOPMENT, TRANSFER AND EXCHANGE OF EXPERTISE

Given that the aerospace clusters are resolutely entering an era of collaboration, and that the trend is towards the decentralization of R&D towards the supply chain, there is clearly a major challenge in terms of enhancing knowledge and skills in SMEs, including scientific, technical and managerial skills.

This transfer and sharing of knowledge will be achieved through traditional training, but also through networking, mentoring and coaching, which are integrated in structured capacity improvement programs, such as those described by the cluster leaders above.

THEME 7 : CHALLENGES FOR THE AEROSPACE CLUSTERS

STRENGTHENING COLLABORATION MECHANISMS

University/research centres/companies collaboration

The Montreal region is already considered to be a world centre of excellence in aerospace, given the success of CRIAQ and the presence of various sources of advanced knowledge in all key areas identified at the Forum as being critical areas for the future of aerospace. This expertise and R&D work, which is advancing the region further, come from multiple research and development organizations that already have a tradition of collaboration: four universities, two of the five largest engineering schools in the country, the Canadian Space Agency and the CNRC with two research centres and one satellite centre, as well as a vibrant network of colleges, technical centres, liaison and transfer centres.

Demonstration platforms: integration mechanisms for SMEs

Despite these advances, most collaborative projects have, to date, involved mainly large companies, research centres and universities. SMEs are often isolated players when it comes to innovation (the latest update of OECD countries places us 24th among developed countries, and the Canadian Government describes this behaviour as "insular"). To increase their integration and facilitate technology transfer to SMEs, and ultimately enable them to build their capacity for independent innovation, one of the main recommendations of the Montreal cluster is the establishment of a **National Technology Demonstrator Program**. This recommendation has been the subject of an official request to the Review Committee on the Québec Research and Innovation Strategy (SQRI).

Why this emphasis? Because we must maintain the momentum and continue to invest in innovation, increase the pace of technology investments, and above all do so by integrating SMEs.

- Initiatives such as GARDN (Green Aviation Research & Development Network) and SAGE (Smart, Affordable, Green, Efficient) are essential. GARDN is a Business-Led Network of Centre of Excellence (BL-NCE) which focuses on increasing private sector investment in Canadian research, and optimizing the timeline between research and commercialization stages. The BL-NCE program was introduced by the Government of Canada in 2007-2008 with a budget of $46 million over four years.
- AIAC should be supported in its promotion of the FMP program.
- Special attention is paid to the supply chain through the work of Aéro Montréal Supply Chain and Innovation working groups, which aim to bring together integrators (OEMs and Tier 1 suppliers) and subcontractors (SMEs) and better align the Canadian industry with other countries.

All these initiatives converge toward one goal: to prepare all cluster players, small and large, to face global challenges and benefit from the many technological and commercial development opportunities.

CREATION, ENRICHMENT AND DIVERSIFICATION OF INTER-REGIONAL, INTER-CLUSTER AND INTER-SECTORALS LINKS

Decentralization of global R&D and development of SME capabilities in the supply chain

The globalization of the aerospace industry and the clear tendency of the giants to apply open innovation are providing opportunities for Canadian companies of all sizes to qualify as suppliers and developers for giants such as Airbus, which expressed its interest in this regard at the Forum. Airbus wants to expand geographically its quest for opportunities for collaborative research with companies in the greater Montreal area (see box). Such behaviour is confirmed by general trends of large multinationals in many sectors, as cited in recent reports in Europe. An extract is quoted here.

"The global innovation networks have a significant impact on the innovation systems of countries and regions. Ecosystems and innovation networks of multinational corporations often serve as bridges between regional or national systems of innovation across borders, and they therefore put in contact various actors in science and technology from different countries. They often connect industrial hubs and parks of various disciplines in numerous countries, since multinational companies are seeking new know-how, recognizing that benefits often arise from geographical proximity. They expect results from these international R&D activities, namely integration into local innovation networks in host countries, and a positive effect on the competitiveness of their business in their country of origin. Their activities will benefit from the return of technology to the country of origin, since any new discovery made by the global innovation network may also affect the country of origin." (OECD).

Airbus's intentions in innovation matters in collaboration with its suppliers

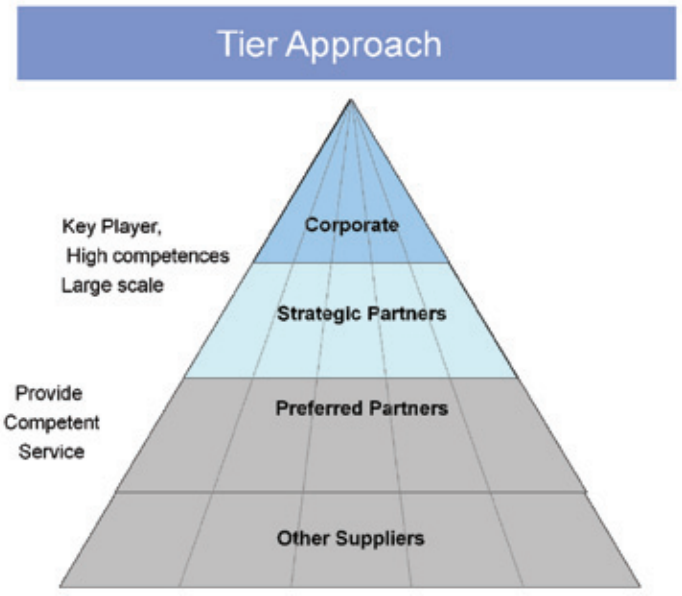
Tier 1 Reduction in the number of subcontractors

Airbus has reduced the number of subcontractors (Tier 1) to enable better management and better control of the entire supply chain, while keeping key technologies internal.

- Transfer to Tier 1 and partners who share the risk of large-scale integration and certain value-added assemblies, according to their capacity to share infrastructure costs, R&D costs and risks in general.
- Transfer more costs associated with developing the supply chain. The Tier 2 and 3 suppliers will need direct assistance from federal and provincial governments. Need to build a network with partners.
- The need for game-changing technologies to ensure the survival of companies in Western countries.

The Canadian industry must get closer to Tier 1s. The Canadian industry needs to promote projects with research institutes The federal and provincial governments play a key role in supporting partners Airbus will assist its partners in various ways: specifications, guidelines, audits, networks.

Diagram 26: Tier Approach



Source: Airbus

INTER-CLUSTER COLLABORATION OPPORTUNITIES

Several potential projects for the sharing of best practices were identified during discussions at the Forum. We include one below. We will cite other more specific projects in the section containing recommendations.

Project to share practices: Portal/Tools for communication and collective exchanges

Diagram 27: BavAIRia's ACCESS Aeronautics Portal

Source: BavAiRia

CONCLUSIONS AND RECOMMENDATIONS

THE CHALLENGES AND ISSUES

A review of the various subjects discussed at the Forum highlights the key elements and demonstrates their systemic nature.

Issues and challenges:

Concerted vision towards sustainable development

Rapid advance of technologies and performance and the need to accelerate the performance improvement curve

The need for a critical mass of R&D programs through national and global R&D framework programs

Expansion of national and regional aerospace clusters and their increasing role

Multiplicity and complexity of technology innovation focal points and the trend towards open and collaborative innovation

Issues of human resources and management, the transfer and sharing of expertise: the need for enhancement and integration of HR

Issues of the evolution of clusters such as Aéro Montréal: inter-regional, inter-cluster and inter-sectoral linkages

Issue 1: Market globalization and challenges of sustainable development.

- Concerns about safety, comfort and respect for the environment are becoming standard across the globe. (Global warming, oil prices, etc.).
- There is a worldwide race to rapidly find solutions at a reasonable cost.
- Increased pressure from BRIC countries.
- Roadmaps such as CAETRM and Centers of Excellence such as GARDN are local responses to these pressing challenges.

Issue 2: Acceleration and increased complexity of technological development

- The aerospace industry is at the crossroad of technological improvements in all aircraft components and in all stages of the innovation process: new designs, new materials, new methods of modeling, new "intelligent" components, new manufacturing processes, etc.
- R&D teams are multiparty and multidisciplinary and work in integrated teams composed of leading researchers, designers, manufacturers and specialists, which are scattered across the planet.
- A veritable "puzzle" of expertise and knowledge must be assembled, which requires careful planning and cooperation over a long period of time and extends beyond the industry. The presence of consortia bringing together players in aerospace, such as CRIAQ, and groups focused around broad and multi-sectoral themes such as GARDN, becomes more essential than ever.

Issue 3: Critical mass in R&D investment, national and global programs

- The economic and financial crisis was accompanied by a global reduction in private R&D investment, but the aviation industry must avoid falling into the trap of short-term constraints and build its future. The intensity of R&D in the industry shows no signs of abating. (See references, OECD, June 2009.)
- Billions of dollars are needed. This critical mass can only be achieved by transnational regroupings in framework programs.
- Canada has a poor track record regarding participation in major international programs. Recent Canadian government reports commented on Canada's and Québec's "insular" culture, one that is not oriented toward collaboration and open innovation. (See references, Council of Canadian Academies.)
- So there are challenges to be met in this respect. Governments, leaders of clusters and OEMs alike must work together in FMP-type programs, as mentioned above, to achieve the necessary critical mass in the absence in Canada of framework programs.

Issue 4: Expansion of aerospace clusters and their increased role

- Clusters such as those presented at this Forum will have a greater industry role to play in the future because there is an increasing need to establish a common vision and bring stakeholders together, and then mobilize members into action within collaborative projects. Each cluster should develop its business model and define its areas of value added.
- The Forum confirmed the importance of national, regional and sectoral leadership to achieve the necessary direction and cooperation. Clusters can undoubtedly assume this role, which will require them to work with authorities to strengthen the national and regional innovation system.
- However, it also emerged that a national aerospace technology strategy (to include a national collaborative demonstration program) and clearer international collaborative agreements are essential to support Canadian aerospace industry and the clusters.

Issue 5: Multiplicity of technological innovation focal points and the trend towards open and collaborative innovation

- Increased and more widespread recognition that no single person or company can innovate alone.
- The aerospace industry is under enormous pressure... innovation is a central solution to face many of the challenges on several fronts simultaneously.
- A sharing of best practices and knowledge in Québec, Canada, North America, Europe and on a global basis is becoming necessary to accelerate development and reduce costs and risks.
- It is necessary to identify the key technologies that will serve as a focal point for collaborative projects and future Platform demonstration projects.
- SMEs and universities must pick up the ball and get involved with the large groups (OEMs): open innovation will work and "pay off" only if all the players get on board.

Issue 6: Competition for labour and brainpower and the need for a plan to enhance and integrate human resources

- The presence of qualified human resources in sufficient quantity, but a need for specialization, continuous training.
- Management, transfer and sharing of expertise: integration of business graduates.
- Requires a long-term strategy for sustainability of employment and skills development.
- Enhancement of skills of SMEs becomes a barrier if not addressed through specific programs to benchmark and enhance their skills.

Issue 7: The strategic and structural evolution of clusters such as Aéro Montréal:

- Aerospace clusters are changing: there is a creation, strengthening, enhancement and diversification of inter-regional, inter-cluster and inter-sectoral linkages.
- The need for a policy to attract and retain innovative companies in Canada and Québec.
- The need to integrate them into the global R&D mandates of giants such as Airbus because they are the engine of collaborative innovation.
- Desperate need to support the development of skills of SMEs and integrate them into supply chains.
- Trend towards inter-cluster collaboration, based on complementarities, drawing on models of supranational governance established by the European Union (see references, OECD).

Enviable position of Québec and Aéro Montréal: need to build on the achievements

- **Reputation:** Strengths of the Canadian aerospace industry recognized by our partners and customers worldwide.
- **Size:** Achieved critical mass, some specializations (design, research, manufacturing, assembly): strengths that facilitate seeking partnerships with complementary clusters.
- **Diversification:** Commercial diversification and complementary technologies (not dependent on one market, one player).
- **Value Chain:** Unique position as an integrator, presence of players who can make an entire aircraft.
- **Strong surrounding environment:** Presence of other industrial clusters and complementary technologies: possible synergies (TIC, nanotechnology, optics, safety, materials, specialized transportation, green technologies, power) both from a local and international viewpoint.
- **Academic, scientific and technical hub:** Benefits from the presence of CRIAQ consortium and recently GARDN, an intensity of university and government R&D, as well as many sources of skilled labour.

COURSES OF ACTION

The review presented in this Report fully confirms the complex and systemic nature of innovation, of its daily management and challenges regarding its governance, from the point of view of stakeholders and managers of aerospace clusters. Much has been accomplished but much remains to be done, given that the aerospace industry is changing rapidly and that the clusters are structuring themselves worldwide.

How to position the aerospace clusters in a global and rapidly changing context?

Each course of action is important, but the coherence of these decisions and actions, and cooperation among the stakeholders, will all be crucial. This is because it is now impossible to shape the future of aerospace without taking into account **the inextricable links among all the measures to be put in place. These draw on technological, strategic, structural and managerial innovations, locally and internationally: cooperation, partnerships, complementarity and integration**.

Courses of action: A world of innovations

Technological innovations: Accelerated developments focused on sustainable development and the needs of the industry in terms of efficiency, capitalizing on multidisciplinary work and teamwork.

Strategic and structural innovations: Promotion of "open innovation," European and global alliances (emerging countries), strengthening of university-industry-education links, establishment of more formal links between clusters, sectors and regions; wider deployment of demonstration programs.

Managerial innovation: Development of cluster members by strengthening the supply chain, development of R&D capacity of suppliers, empowerment of SMEs in terms of management capabilities, as well as facilitating collaboration through mechanisms, consortia, portals, demonstration platforms.

VISION AND RECOMMENDATIONS

The Forum was a special opportunity for discussion and reflection about the possibilities of developing aerospace clusters. It also looked at mechanisms, programs and structures to be emphasized so that stakeholders in these clusters can evolve and continue to be a source of prosperity for their host regions. We must take into account the achievements to date and carefully choose the next areas of development and growth.

Achievements of Aéro Montréal

The Aéro Montréal cluster is already firmly established, and the various examples of successes of its members, reported at the Forum, show a maturity that bodes well for the future. The CRIAQ consortium has won its spurs, partnerships between the industry and the many sources of knowledge are proving successful, technological improvements are emerging on all fronts, both in materials, software, design methods and manufacturing. **We must extend this basis of collaboration and make it even more effective so that R&D projects can succeed commercially.**

Trends and Challenges

More recently, the Aerospace Cluster of Metropolitan Montreal has not been immune to the global trends cited by international representatives of the various clusters at the Forum: it must resolutely turn towards **the globalization of R&D, the integration of value chains and innovation chains, collaboration among SMEs and major contractors and among researchers and technology integrators (OEMs)**, all influenced by higher civic and environmental awareness.

Advantages of the Metropolitan Montreal Aerospace Cluster

The Forum highlighted the strengths of the Metropolitan Montreal Aerospace Cluster and the dynamism that drives its leaders and its members: an **internationally-recognized** hub for manufacturing and specialized assembly, **concentration of R&D and education systems**, mechanisms to facilitate effective **partnerships**, presence of a **large variety of specialties**, all creating a rich source of interdisciplinary and sectorial synergies

Objectives of Aéro Montréal

Several specific measures were expressed or suggested during the Forum; these aimed to share, among partners of the various aerospace clusters in the world, visions of the future of the aerospace industry, and to identify best practices to capitalize on this promising future.

To enhance the overall positioning of the Aéro Montréal cluster on the world stage, we present four (4) recommendations, which have the following objectives:

- Capitalize on the strengths of Aéro Montréal, maximize the use of levers such as CRIAQ;
- Prepare the cluster for global challenges through national demonstration programs and FMPs;
- Leverage the full potential of recent integrating initiatives such as SAGE and GARDN;
- Strengthen all the links that bind the cluster stakeholders, especially SMEs.

RECOMMENDED PROJECTS

1. PROMOTE AND DEPLOY INVESTMENT IN MAJOR INITIATIVES:

Support and facilitate the deployment of the latest initiatives by Aéro Montréal and the Government of Canada such as SAGE* , FMP, GARDN,... These constitute essential mechanisms to guide and stimulate progress and to integrate innovation stakeholders in collaborative R&D programs, by making maximum use of groupings such as CRIAQ.

The goal is to maximize the effects of financial leverage, as well as technological and commercial synergies.

* The Government of Québec announced in its last budget on March 30, 2010, a non refundable financial contribution of $ 70 million over 4 years for the Québec aerospace industry's $150 million demonstration project on the ecological aircraft.

2. TURN RESOLUTELY TOWARDS SUSTAINABLE DEVELOPMENT:

Better promote sustainable development within the Aéro Montréal cluster and support practical efforts by each member to turn towards sustainable development: the Greater Montreal aerospace industry has already taken a step in this direction by setting up the **CAETRM** and implementing it through **GARDN**, responding to social demands and supporting the objectives of local governments in reducing its ecological footprint.

We must now ensure that **initiatives such as GARDN produce results and optimize the capabilities of CRIAQ as a mechanism for cooperation between research and the industry**. Many complementary courses of action are possible: to give sustainable development initiatives visibility in the community, to encourage researchers in aerospace and young graduates to consider areas of interest that are compatible with sustainable development by giving them financial incentives and bringing them closer to the needs of industry and citizens, etc.

3. INTEGRATE SMES IN THE SUPPLY AND INNOVATION CHAINS:

Develop and implement, by leveraging best global practices, **a program to enhance the innovation capabilities of SMEs who are cluster members, as well as mechanisms for cooperation between contractors and subcontracting SMEs, with the goal of qualifying SMEs to become not only suppliers but also world-class innovators.**

This major structuring project for the cluster will be supported by various initiatives, such as the sharing of best practices with other clusters, benchmarking, and conducting a diagnostic of existing management and organizational capabilities. They also include training and sponsorship of SMEs and financial, material, human and logistical support for future collaborative innovation projects that will follow.

Close collaboration will be required with a number of agencies and organizations already working with aerospace SMEs, including:

- AQA, which includes industry SMEs
- CTA, which supports the technological development of SMEs in aerospace, with the backing of two government departments, the MELS and MDEIE
- The Canadian Government's CNRC-IRAP program, a partner for many decades of innovative Canadian SMEs
- Natural Sciences and Engineering Research Council of Canada (NSERC), which has long financed university and collaborative R&D projects, and which has recently instituted a series of programs to encourage and stimulate partnerships between SMEs and universities;

Sous-traitance Industrielle Québec (STIQ), a network of subcontractors, and CAMAQ, a pivotal organization for aerospace manpower training , both well-established Québec entities working together to improve the skills of SMEs and their ability to qualify as world-class subcontractors. The increase in mechanisms linking SMEs and large aerospace companies will be the proposed theme of the Aéro Montréal's next Innovation Forum.

4. STRENGTHEN VARIOUS LIAISONS OF THE AÉRO MONTRÉAL CLUSTER, LOCAL AND INTERNATIONAL:

Establish a variety of liaison mechanisms with stakeholders in aerospace, both within the cluster and externally, locally and internationally, so that strategies and actions are coordinated and supported and their impact increased through the introduction of multiple synergies:

- Liaisons between Aéro Montréal and other industry clusters in Greater Montreal and Québec in the areas of materials, nanotechnology, aluminum, energy, environment and sustainable development, medical technologies, information technologies and communications;
- Initiate steps, together with government agencies, to integrate Aéro Montréal cluster stakeholders in the European framework programs for research, or in any other international collaboration initiative. This will allow it to benefit locally from a critical mass of financial resources and expertise, thereby maximizing the strategic, commercial and technological impact for the entire community.
- Aéro Montréal leadership in the creation of a **Global Carrefour of Aerospace Clusters**, which would serve to further exchanges and synergies and position the Québec aerospace industry as a key hub in the global industry.

In conclusion, the challenges facing the industry are numerous and interrelated, as illustrated in the diagram below.

Diagram 28: Recommended Actions

The Aéro Montréal cluster, through its position and mission as a catalyst, supported by CRIAQ in its position as an integrator, is playing an increasing consulting role in championing collaboration: it has to act both as a visionary and as a rallying force.

CASE 1: DEPLOY major initiatives such as demonstration programs up to the final stages of commercialization, finance initiatives and assemble the necessary critical mass;

CASE 2: GUIDE R&D and innovation towards sustainable development, promote successes;

CASE 3: CONSULT diverse stakeholders and develop the supply chain, qualify sub-contractors and worldwide innovators, enhance the capacity of small companies in the face of globalization, together with stakeholders and organizations on-site;

CASE 4: INTEGRATE stakeholders of all types and origins, link up local constituents and position the Québec aerospace industry on the world stage.

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ACRONYMS AND ABBREVIATIONS

ACARE	Advisory Council for Aerospace Research in Europe
AFP	Automated Fiber Placement
AIAC	Aerospace Industry Association of Canada
AQA	Association québécoise de l'aérospatiale (Québec Aerospace Association)
ASCE	Aerospace Supply Chain Excellence
BL-NCE	Business Led Network of Centres of Excellence
BRIC	Brésil, Russie, Indes, Chine
CAEWG	Canadian Aviation Environmental Working Group
CAETRM	Canadian Aviation Environment Technology Roadmap
CFD	Computer fluid dynamic
CORAC	Conseil pour la recherche en aéronautique civil
CQRDA	Centre québécois de recherche et développement de l'aluminium
CRIAQ	Consortium for Research and Innovation in Aerospace in Québec
CRIQ	Centre de recherche industrielle du Québec
CRSNG	Conseil de recherches en sciences naturelles et en génie du Canada
CTA	Centre technologique en aérospatiale
ÉMAM	École des métiers de l'aérospatiale de Montréal
ÉNA	École nationale d'aérotechnique
ÉTS	École de technologie supérieure
FMP	Future Major Platforms
FP7	Seventh Framework Programme (septième Programme cadre)
GARDN	Green Aviation Research & Development Network
HQP	Highly Qualified Personnel
IFA	Institut de formation aérospatiale
IMI	Institut des matériaux industriels
INO	Institut national d'optique
ITT	Information and Telecommunications Technologies
JTI	Joint Technology initiative
MDEIE	Ministère du Développement économique, de l'Innovation et de l'Exportation du Québec
MELS	Ministère de l'Éducation, du Loisir et du Sport du Québec
MRO	Maintenance, Repair & Overall
NRC	National research council of Canada
NSERC	Natural Sciences and Engineering Research Council of Canada
NWAA	Northwest Aerospace Alliance
OECD	Organisation for Economic Co-Operation and Development
OEM	Original Equipment Manufacturer
PARI	Programme d'aide à la recherche industrielle du CNRC
PME	Petite et moyenne entreprise
PNAA	Pacific Northwest Aerospace Alliance
SAGE	Smart, Affordable, Green, Efficient aircraft
SME	Small and Medium Enterprise
SQRI	Stratégie québécoise de la recherche et de l'innovation
STIQ	Sous-traitance industrielle Québec
TRM	Technology Readiness Level

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