FORUM AEROSPACE INNOVATION

REPORT AND WHITE PAPER

INNOVATION
IN A SUSTAINABLE SUPPLY CHAIN: A GLOBAL CHALLENGE

MARCH 2012

Organized by:

AÉRO MONTRÉAL
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In collaboration with:

CRIAQ
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Aéro Montréal wants to thank **Industry Canada** for its financial support allowing for the completion of this White Paper of the Aerospace Innovation Forum 2011.

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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

- **François Caza,** Vice President & Chief Engineer, Bombardier Aerospace
- **Nadia Bhuiyan,** Associate Professor and Associate Director, Concordia Institute for Aerospace and Design Innovation (CIADI)
- **MarieChantal Chassé,** President, JMJ Aéronautique
- **Patrick Champagne,** Vice President, Engineering, Esterline CMC Electronics
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- **John Maris,** President, Marinvent
- **Stéphane Blais,** Flight Operations Project Director, Marinvent
- **Mario Modafferi,** Director Research & Technology, Chief Design Engineer, Pratt & Whitney Canada
- **Philippe Molaret,** Vice President, R&D, Aerospace Division, Thales Canada
- **Hany Moustapha,** Director, AERO-ETS; Senior Fellow and Manager of Technology Programs, Pratt & Whitney Canada
- **Pierre Rioux,** Director, Research Canada, Bell Helicopter Textron Canada
- **Sylvain Savard,** President, Avianor
- **Marc St-Hilaire,** Vice President Global Engineering & Technology, CAE Inc.
- **Stephen Yue,** Professor, Chair, Lorne Trottier Chair in Aerospace Engineering, Professor James McGill, McGill University
- **Carlos Trindade,** Aerospace Consultant, ACE Consulting
- **Dominique Leroy,** Advisor, Aerospace, Defense & Marine Branch, Industry Canada (observer)
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Communauté métropolitaine de Montréal

Québec

Canada

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EXECUTIVE SUMMARY

The 2011 Aerospace Innovation Forum featured presentations and lively discussions focused on two interrelated themes: the supply chain and the innovation chain. As illustrated in the diagram below, these two driving forces of the aerospace industry must be balanced and coordinated. In this regard, the various agencies that support the industry must work with the Aéro Montréal Cluster and CRIAQ to maximize the positive impact
of various projects underway to improve the competitiveness of this important sector of the economy. The objective in the next few years, which was the subject of this Forum, is clear: "to strengthen this industrial cluster by intensifying innovation in all its forms, and to develop innovation capabilities among all the stakeholders of the cluster, including SMEs."

Firstly, the supply chain must be continuously optimized: externalization, cost reduction, risk sharing and integration are all industry themes and concerns that were raised repeatedly by various speakers at the Forum. Aéro Montréal's 2011 Aerospace Innovation Forum especially targeted Québec SMEs that need to be increasingly innovative in order to integrate within global supply chains and position themselves on innovative programs for aircraft of the future.

Secondly, the innovation chain must include all stakeholders in accelerated processes, featuring multiple players working simultaneously on more complex and larger projects. Suppliers will have to accelerate their pace of innovation, and join forces to create leverage with prime contractors. Innovation has to increase in absolute intensity, and include more collaboration. This requires more planning, communication and coordination to ensure that the innovation is more fluid and bears fruit throughout the supply chain and at all stages of the innovation process, from idea to commercial product, through procurement and manufacturing. Practitioners, consultants, managers and entrepreneurs shared their views and experiences in this regard in numerous workshops and plenary sessions of the Forum.

Finally, experts, consultants, and representatives of government agencies spoke during the Forum about the challenges and the big questions: how to improve and make more accessible support mechanisms, tools and frameworks required to enhance the competitiveness of the aerospace cluster? One of the integrating themes of the Forum was the role of catalyst projects, clusters, consortia and governments in improving overall performance in innovation while reducing the costs and risks of various actors in the supply chain: prime contractors, Tier-1 suppliers and SMEs.

In conclusion, it's clear that the changes being promoted and continuously implemented need to be better integrated and planned together. A series of challenges are emerging for each type of stakeholder: prime contractors, Tier 1 suppliers, SMEs, clusters and consortia, and governments.

This White Paper concludes by suggesting courses of action for Aéro Montréal as a mobilizing and unifying force for all of these stakeholders: financing, catalyst projects, international cooperation, enhancement of competitiveness and integration of SMEs, as well as improvement of collaborative innovation capabilities.

RECOMMENDATIONS AND COURSES OF ACTION FOR THE AÉRO MONTRÉAL AEROSPACE CLUSTER

1.INTEGRATE PUBLIC AND PRIVATE SECTOR INTERVENTIONS

Better integrate the involvement of the public and private sectors, especially to give birth to large Canadian catalyst projects that will broaden and complement Québec catalyst projects. Encourage the Canadian government to develop a strategy for innovation in the aerospace sector along the same lines as Québec's.

2.INCREASE THE ACCESSIBILITY, HARMONIZATION AND STABILITY OF FINANCIAL AID PROGRAMS TO ENCOURAGE LONG-TERM INVESTMENT IN INNOVATION AND ACCELERATE THE FINANCING CYCLES

Facilitate and maintain, over the long-term, the structuring and financing of innovation in supply chains. Also encourage the consolidation and administrative simplification of programs to increase the scope, effectiveness and efficiency of funding mechanisms that encourage local, national and international collaborations, the integration of SMEs and knowledge transfers.

3.BETTER LEVERAGE INTERNATIONAL ALLIANCES

Facilitate more company access to large international catalyst projects through various existing initiatives, for example programs such as CANNAPE (Canadian Networking Aeronautics Program for Europe), CRIAQ, or initiatives that could open doors abroad such as the greener aircraft (SA²GE) catalyst project, as well as the Canadian technology demonstrators' framework program.

4.IMPROVE AND INCREASE THE ROLE OF INTERMEDIARY ORGANIZATIONS

Continue the development and strengthening of CRIAQ towards more advanced TRL[1] in support of technology demonstrator programs and promote a greater participation by companies, universities and research centres outside Québec. Ensure the sustainability of the GARDN network through the renewal of its funding.

5.BENCHMARK AND CONTINUOUSLY IMPROVE THE INNOVATION CAPACITY OF THE AEROSPACE CLUSTER

Like the MACH[2] initiative aimed at improving the capacities of suppliers in the supply chain, strengthen an initiative to improve individual innovation capacities as well as the overall effectiveness of all stakeholders that collaborate in innovation chains: prime contractors, integrators and equipment manufacturers, SMEs, universities and research centres.

6.ACCELERATE, IN A SUSTAINABLE AND STRUCTURED WAY, THE INNOVATION PROCESS THROUGHOUT THE AEROSPACE CHAIN

Study what would be necessary to implement in the aerospace cluster in order to accelerate innovation and reach the commercialization stage, making innovation the real engine of wealth creation for our industry. Various support measure scenarios should be considered soon after an analysis is completed of specific needs and capacities of existing innovation and demonstration infrastructure of our aerospace industry:

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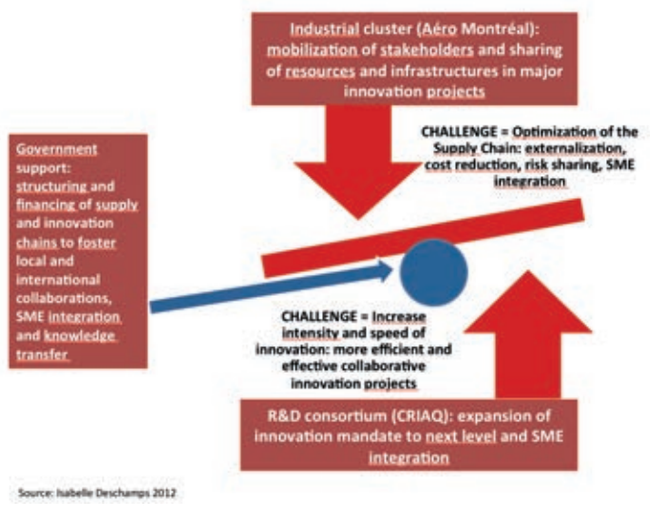
[1] *Technology Readiness Level*

[2] *Aéro Montréal's MACH initiative is a program to support the competitiveness of Québec aerospace suppliers. Based on three priority areas: excellence in leadership and innovation, excellence in planning the workforce, and operational excellence, it provides SMEs with maturity audit of 15 key business processes, a training program, recognized certification and a sponsorship relationship with a customer. In addition, a new initiative (called Aéro-PING), led by Aéro Montréal's Innovation Working Group, is currently starting to study systematically the interactions among innovation players, and the strengths and weaknesses of collaborative processes. It is also establishing a basis for comparison with other clusters in order to identify areas for improvement and recommend the best mechanisms for collaborative innovation tailored to the Aéro Montréal Cluster.*

- Increase in innovation capacity and greater involvement of SMEs in innovation.
- Identification of a broader collaborative mode for technology demonstration projects, which would improve access to expertise in universities, even at stages approaching commercialization.
- Access to strategic funding for infrastructure shared nationwide. This can be achieved by sharing existing infrastructure, such as CNRC facilities, through catalyst projects and/or technology demonstrators; by establishing new complementary infrastructure grouped around one or several sites; or by creating true permanent hubs bringing together all players in aerospace innovation.

Two aerospace industry challenges to tackle: The supply chain and the innovation chain



PROGRAM

WELCOMING REMARKS

Suzanne Benoît, President, Aéro Montréal
Clément Fortin, President and CEO, CRIAQ
François Caza, President of the Innovation Working Group of Aéro Montréal and Vice President and Chief Engineer, Bombardier Aerospace
Gilles Labbé, President of the Board, Aéro Montréal and President and Chief Executive Officer, Héroux-Devtek

FORUM OPENING REMARKS

Sam Hamad, Minister of Economic Development, Innovation and Export Trade of Québec

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Anthony L. Velocci Jr., Editor-In-Chief, Aviation Week & Space Technology

INNOVATION IN THE BOMBARDIER GLOBAL FAMILY SUPPLY CHAIN

Stéphane Leblanc, Vice President & General Manager, Global Business Unit, Bombardier Aerospace

TOWARDS THE FUTURE PLATFORMS: 787, A350, CSERIES AND BEYOND

Rob Dewar, Vice President CSeries, Bombardier Aerospace
Axel Flaig, Senior Vice President CoC Flight Physics, Engineering, Airbus
Edward P. Petkus, Director – Deputy Chief Project Engineer 787 Derivatives, Boeing Commercial Airplanes

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The Honourable Christian Paradis, Minister of Industry and Minister of State (Agriculture), Government of Canada

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Gary Waissi, Professor, Technology Management, Arizona State University, Aerospace and Defense Research Collaboratory
Jorge Gutiérrez de Velaco, President of the UNAQ (Universido Nacional Aeronautica de Querétaro) and Technical Coordinator of the RIIAQ (Network of Research and Innovation in Aeronautics of Queretaro)
Tetsuo Kikuta, Innovation Specialist in Supply Chain Development, Japan

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Moderators: MarieChantal Chassé, President and CEO, JMJ Aéronautique and **André Bazergui,** Special Advisor, CRIAQ
Claude Lessard, President, Delastek
Denys Lapointe, Vice President, Design & Innovation, BRP
Michel Carrier, Director, Major Accounts, Business Development Bank of Canada
Charles Gagnon, Director, Technology Business Development, IREQ, Groupe Technologie, Hydro-Québec

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Jim Quick, President & Chief Executive Officer, AIAC
Fernando Jimenez, Vice President, International, Arizona Commerce Authority
Charles Magnan, Director, Business Development, Mecachrome

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Kader Berkane, Director, Think Business Innovation
Raymond Machabee, Vice President, Advisory Services, Aerospace & Defense, Mahindra Satyam

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Raphaël Duflos, Vice President Procurement and Supply Chain, Aerolia

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Claude Michel, Senior Vice President, Head of Solvay - Solar Impulse Partnership, Solvay

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Maria Della Posta, Senior Vice President, Sales & Marketing, Pratt & Whitney Canada

Giovanni Bertolone, Executive Vice President, Operations, Finmeccanica

Alain Coutrot, Deputy Director, Research and Technology, SAFRAN Group

Ofer Klein, Director Research & Development, Aerospace Division, Elbit Systems

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Pierre Bourassa, Manager, NSERC-Québec

Bogdan Ciobanu, Director General, National Research Council Canada Industrial Research Assistance Program (NRC-IRAP)

Roch Chouinard, Director, Strategic Aerospace and Defence Initiative (SADI) Program, Industry Canada

Christyne Tremblay, Deputy Minister, Ministère du Développement économique, de l'Innovation et de l'Exportation

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Moderator: Pascal Désilets, General Manager, Centre des technologies en aérospatiale (CTA)

Philippe Hoste, CEO, Sonaca Montréal / President of the Supply Chain Committee, Aéro Montréal

Rod Jones, Executive Director, Ontario Aerospace Council

Wendell C.Wiebe, Executive Director and General Manager, Manitoba Aerospace Association

SMES AND INNOVATION: SUCCESS STORIES

Moderator: Pierre Dicaire, Director Aerospace Manufacturing Technology Centre - NRC

Graeme G. Keeping, Chief Executive Officer, IsoGrid Composites Canada

Gail Comeau, Engineer, Cathode production, Quality assurance, Soudure JM Tremblay

Clémentine Gallet, CEO, Coriolis Composites SAS

Pierre-Olivier Therrien, Supervisor, Manufacturing Engineering Expertise Center, Bombardier Aerospace

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Barry Kohler, President, Bell Helicopter Textron Canada

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Moderator: Valérie Bécaert, Executive Director, CIRAIG

Jean-Pierre Dubé, President, JPD Conseil, Avianor Project

Bruce Parry, Manager, Corporate Social Responsibility, Bombardier Aerospace

Olivier Malavallon, Pamela-life Project Director, Environmental Affairs Airbus, Projet TARMAC Aerosave (Airbus)

William Carberry, Deputy Director, Aircraft Fleet Recycling Association (AFRA), Boeing

GREEN INITIATIVES: BUSINESS OPPORTUNITIES FOR SMES

Moderator: Gilles Savard, Dean, Research and Innovation, École Polytechnique de Montréal

Sylvain Cofsky, CEO, GARDN

Clément Fortin, President and CEO, CRIAQ

Pierre Rioux, Manager, Research & Development, Bell Helicopter Textron Canada and Member of the Board of SA²GE

COLLABORATION TO FOSTER INNOVATION ACROSS THE SUPPLY CHAIN – THE RESEARCH CONSORTIA EUROPE

Moderator: Yves Lafortune, Directeur, direction Europe, Ministère du Développement économique, de l'Innovation et de l'Exportation

Thilo Schönfeld, Deputy Director International Affairs, Aerospace Valley (France)

Michael Muth, Managing Director, ASIS Saxony (Germany)

Michal Pilecki, Project Manager, Aviation Valley (Poland)

CONCLUSION

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

Suzanne Benoît, President, Aéro Montréal

FORUM REPORT

> ***"The Wright Borthers created the single greatest cultural force since the invention of writing. The airplane became the first World Wide Web, bringing people, languages, ideas and values together"***
>
> **Bill Gates, CEO, Microsoft Corporation**

INTRODUCTION: INNOVATION IN A SUSTAINABLE SUPPLY CHAIN, A GLOBAL CHALLENGE

With a century of innovation, Canada's aerospace industry is today recognized as a national and international treasure. The Greater Montréal area has witnessed the gathering of local entrepreneurs, multinational giants and leading researchers into an industrial cluster that is the envy of the great cities of this world. All this is the result of collective and collaborative work, without which the technological and commercial success of aerospace companies in the region would never have emerged.

Challenges are present at all stages of the innovation process, ranging from invention in the laboratory to on-time delivery of the commercial product, passing through prototypes, detailed engineering, procurement, fabrication and assembly. All stakeholders of the Aéro Montréal Cluster work in an integrated manner, creating a seamless and more efficient innovation chain. This greater coordination and integration of all stakeholders will be even more pervasive and vital in the future given the many ambitious projects related to next-generation aircraft, including greener aircraft.

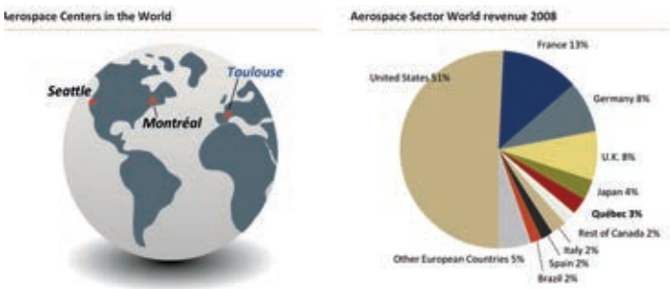
A MATURE GROUPING

As noted at the opening of 2011 Aerospace Innovation Forum by Suzanne Benoît, President of Aéro Montréal, it's thanks to the maturity of this group, in which all members of Aéro Montréal are working collectively to ensure the competitiveness of the aerospace industry, that the industry's current results have been achieved and that the future can be viewed with optimism.

Aéro Montréal in numbers

- 212 companies in the region, totaling $11.7 billion in sales, 80% exported
- Over 42,000 people work in the aerospace sector
- One person of 96 in Montréal works in this sector
- These companies together generate over 55% of total Canadian aerospace production and 70% of total research and development expenditures in the country.

The aerospace industrial cluster ranks sixth worldwide in terms of aerospace sales behind the United States, the United Kingdom, France, Germany and Japan. In addition, the Greater Montréal region is the second world capital in terms of density of aerospace jobs.



The message of the President of Aéro Montréal is clear: "It is essential that everyone, the private and public sectors, continue to support this industry to maintain our position and remain among the leaders, with France, Germany and Japan. Our strength lies in the mobilization of all our stakeholders. The aerospace industry occupies a prominent place in the Québec economy and represents an important creator of wealth, given the jobs generated and the number of companies that invest in it."

The objective of the coming years, which was the subject of the Forum, is clear: "to strengthen this industrial cluster by intensifying innovation in all its forms, and developing innovation capabilities among all members of the cluster, including SMEs."

THE CHALLENGE OF AEROSPACE SMES

Aéro Montréal's 2011 Aerospace Innovation Forum especially targeted Québec SMEs that need to be increasingly innovative in order to be able to integrate with global supply chains and position themselves on innovative programs for future aircraft. SMEs will have to accelerate their pace of innovation, and join forces to create leverage with prime contractors.

INVESTING IN INNOVATION IN ALL ITS FORMS

For François Caza, Chair of Aéro Montréal's Innovation Working Group and Vice President, Chief Engineer at Bombardier Aerospace, companies need more than ever to invest in research and development to meet the demands of a highly competitive global marketplace. "To position themselves on future aircraft programs and in the supply chain of prime contractors, Québec companies must innovate technologically, but also in management. **Global success requires that innovation touches all aspects of the company: product management, financial management and management of human resources. This reflex to anticipate the long-term, devoting needed resources to research, requires strategic planning that takes into account all the constraints in the short term."**

SHARING EXPERIENCES

Innovation, for a company, must be lived every day. It requires properly identifying the ever-changing needs of potential customers, being aware of new concepts that can meet these needs, developing these concepts to understand the safety, functional and economic aspects, and by demonstrating the return on investment. To maintain its competitive edge, the Québec aerospace industry should emphasize its distinctive competencies and ensure that innovation is a central preoccupation of all stakeholders.

It is in this unifying perspective that Aéro Montréal, Québec's aerospace cluster, together with CRIAQ, committed to promoting major events such as the 2011 Aerospace Innovation Forum. It was an event awaited by members of the local and international aerospace industry. Aéro Montréal, this year celebrating five (5) years of existence, is proud to have held the Forum. It brought together nearly 700 participants, including 200 from 10 different countries, who had various opportunities for meetings, plenaries and workshops designed to facilitate networking among stakeholders and to foster a good environment for innovation and collaboration.

This Forum provided an opportunity to share various regional realities with representatives from around the world and learn from industry practices, consultants and government agencies. **A networking of these players integrated in the supply chain and a collective learning of best practices in innovation constitute the two vital levers for tackling together the challenges facing an industry whose products have to reach unparalleled performance levels in terms of competitiveness, customer satisfaction, operational performance and sustainable development.**

A MOBILIZATION ROLE FOR AÉRO MONTRÉAL AND CRIAQ, CO-ORGANIZERS OF THE FORUM

Aéro Montréal aims to integrate members of the aerospace cluster and intensify cooperation among them to support various major industrial projects, such as the greener aircraft. This project, called SA²GE³, integrates with projects known as catalysts, initiatives proposed by the Québec government as part of the *Québec research and innovation strategy 2010-2013* (QRIS). These projects, which were presented at the Forum, aim to mobilize a large number of companies and researchers around promising technologies. They are powered by consortia such as CRIAQ, and supported by specific government programs with structuring objectives. Several examples and local, national and international variants were presented at the Forum.

It is also in this spirit of mobilization that Aéro Montréal established the MACH initiative. This is a program designed to strengthen companies and the supply chain structure by leveraging special collaborative links among customers and suppliers, as well as by ensuring the implementation of strategies and projects that will help fill gaps in integration capabilities in Québec. As discussed at the Forum, the MACH initiative, like other initiatives in Ontario and Manitoba, aspires to develop a local world-class supply chain.

[3] *SA²GE (Systèmes Aéronautiques d'Avant-Garde pour l'Environnement)*

SECTION 1: SUPPLY CHAIN

OPTIMIZATION OF THE SUPPLY CHAIN: EXTERNALIZATION, RISK SHARING

Attending aircraft manufacturers, Airbus, Bombardier Aerospace and Boeing, in turn presented the various technological challenges that lie ahead. It is clear from their presentations that future platforms will feature major changes in technology.

Other challenges were raised during various presentations. All called for redesigned business models and stressed the close relationship between commercialization and innovation. This need for strong connections, direct and fast, leads to increased innovation in new ways, which are often tackled using external channels to facilitate quicker development of innovations.

For example:

Airbus

- Strong technology evolution from A300 to A380
- 350 will feature forefront technologies including adaptive wings, active load controls, composite structures and the most advanced systems

Bombardier Aerospace

- CSeries will include the latest technology available for single aisle aircraft (advanced engines, FBW flight controls, NextGen and SESAR ready navigation systems
- To ensure a reliable product, extensive ground testing of all systems is required (CIASTA)

Pratt & Whitney Canada

- Customer focus innovation must cross all aspects of the business, not just Engineering

Finmeccanica

- Global companies are pushing innovation, along with competitiveness, profitability and global market positioning. Emerging technologies are the object of high value collaboration, whereas baseline technologies are the object of outsourcing to low cost areas. The new business model includes building technology networks, establishing innovation KPIs and optimizing operations to lower costs.

Safran

- Innovation includes three steps: research, technology demonstration and product demonstration. Innovation can be enhanced by including technologies external to the aerospace industry

Elbit

- Extensive opportunities for innovation in surveillance and all weather navigation (using enhanced and synthetic vision systems)

The Forum highlighted the significant challenges ahead for integrators and equipment manufacturers who are strategically positioned between the aircraft manufacturers and their own supply chain.

According to Patrick Champagne of Esterline CMC Electronics, multiple strategies are required.

GRAPHIC 1: A need for multiple strategies

Multiple Strategies Needed – Why?

Need for ideas

- How to get the differentiators?
- How to understand the operational environment of our products?
- How to trigger new ideas and turn them into marketable solutions?

Need for funding

- How to do more with less investment?

Need for the right Highly Qualified Personnel

- How to get, develop and maintain the required personnel?

Need for strong supply-chain

- How to get the right partners/suppliers?

Leveraging customer funding

- Because of the niche markets and some customization, CMC is able to get customer funding
- Leading to a zig-zag product evolution ; generally consistent with product roadmap, but addressing very specific customer requirements
- Forcing solutions with commonality and design for multiple applications

Selecting innovative companies as partners in systems solutions

"Risk-sharing"; we invest, they invest

- Importing technologies from other fields – aerospace is NOT where Electronics evolve
- Military infrared sensors led to Enhanced Vision Systems sold in Business Aviation
- Ethernet led to AFDX network used on A380

Source: Esterline CMC Electronics

Héroux-Devtek, which like the rest of the industry faces accelerated development cycles and changing customer needs, stressed, through Martin Brassard, the fact that constraints must be incorporated into increasingly complex designs.

GRAPHIC 2: Integrator's challenges in innovation

Source: Héroux-Devtek

One of the challenges faced by integrators is to develop autonomously, explained Raphaël Duflos of Aerolia. Following the spin-off of basic parts and Airbus nose fuselage activities, Aerolia today possesses technologies, skills and methods to design and manufacture a wide range of products and services. The company wants to expand its product portfolio to other non-Airbus companies to reduce the share of Airbus to 50% of its revenues.

GRAPHIC 3: Sourcing strategy

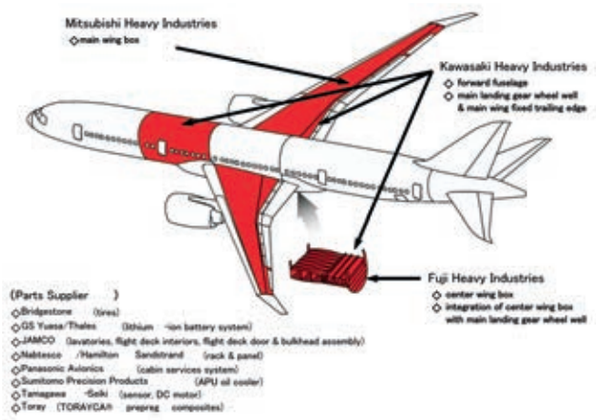
GRAPHIC 4: Sourcing strategy

Source: Aerolia

STRENGTHENING OF INTERNATIONAL NETWORKS: EFFICIENCY AND EFFECTIVENESS

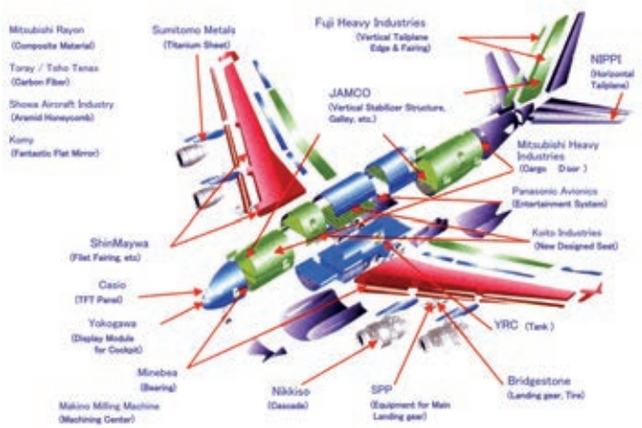
In his presentation, Tetsuo Kikuta, a specialist in optimizing the supply chain, described the systematic approach advocated in Japan to insert domestic firms into international aerospace networks. This model was retained as part of the V-2500 engine development program. The Japanese industry already ranks 6th in the aerospace supply chain for various components - fuselage, parts, engines, equipment, electronics - behind European and American chains. The contribution and involvement of various Japanese companies that supply the industry with various components of the planes are shown schematically next:

GRAPHIC 5: Supply chain of the Japanese aerospace industry in the Boeing 787 program



Source: Tetsuo Kikuta

GRAPHIC 6: Supply chain of the Japanese aerospace industry in the Airbus 380 program.



Source: Tetsuo Kikuta

The Japanese supply chain has established strong exchange links with Canada. These links are part of the objective of reducing program costs related to the V-2500 engine. This program targets subcontractors capable of providing sophisticated leading-edge components while controlling costs. Canada is a partner of choice, and every Canadian company involved has helped to strengthen ties between Canada and Japan. The cost reduction process of the Japanese program was initiated more than 20 years ago. The

collaboration is based on an approach to choose the best partners based on predetermined criteria such as certification, quality, etc. Each company involved in the V-2500 program is inserted into a specific link in the supply chain.

A systematic approach is applied to each component, each part and each supplier, while keeping in mind the overall goal: a highly effective management of the global supply chain where cost reduction is related to the quality of international suppliers. For illustration purposes consider these results: the changing of certain international suppliers has led to a 65% reduction in costs; 20% of the reduction comes from negotiating new commercial agreements with suppliers. With the help of international partners, the Japanese cluster has been able to achieve the desired objectives in terms of gradual reduction of production costs over the years.

EMERGENCE OF RIIAQ (COLLABORATIVE INNOVATION NETWORK AEROSPACE QUERÉTARO)

The development and strengthening of aerospace clusters is often done by stages: first the manufacturing capabilities of companies that will form the supply chain are built. Then, in parallel, the innovation capacities in the targeted region are developed. These steps are now being taken by our neighbours to the south, in Mexico and Latin America, explained Jorge Gutiérrez de Velasco Rodriguez of RIIAQ. He recently set up a manufacturing and innovation network centered on an industrial cluster comprising 29,000 jobs in central Mexico.

GRAPHIC 7: Statistical portrait of the Querétaro Aerospace Valley cluster

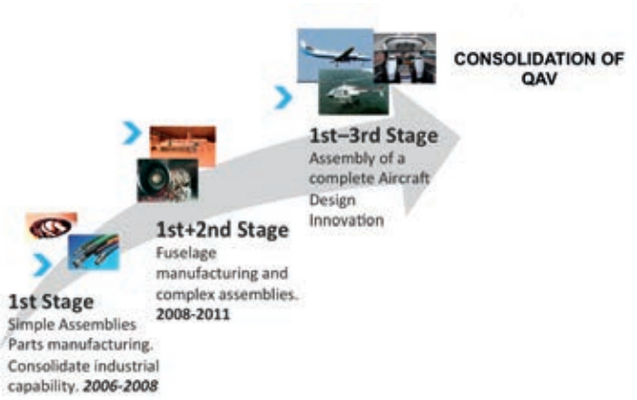
RIIAQ in numbers

- Manufacturers and assemblers: 84% of jobs
- 50 active members, including three (3) MRO
- R&D intensity: 3 large R&D centres, 3 teaching institutions, 1 consortium
- Major groups present: Bombardier Aerospace, Safran and others
- 45 research centres

Source: RIIAQ

The network of collaborative innovation was launched in 2009, and has been built stage by stage. The first challenges were to obtain company buy-in and develop the education and R&D system to support it. Its current challenge is being able to establish flexible public policies to support new companies coming to set up in Querétaro, local SMEs and industrial R&D.

GRAPHIC 8: Schematic portrait of the evolution of the Querétaro Aerospace Valley cluster



The observations of companies to date: there has been enough support and funding to fuel the development of manufacturing capacities (stage 1). However, there is a need for governmental support to achieve stages 2 and 3: assembly of a full plane and increased involvement of regional companies in design and innovation. Like local Québec initiatives such as the MACH initiative, Mexican companies are calling for support for SME networking and linkages, as well as for the improvement of company operations through better management processes.

BEST PRACTICES AND MENTORING INITIATIVES OF LOCAL SME SUBCONTRACTORS

THE MACH INITIATIVE

The MACH initiative is a collaborative public-private program of $15 million over five (5) years developed by Aéro Montréal to support, at peak, 70 suppliers in their efforts to enhance competitiveness. The program provides access to:

- a set of tools to improve their competencies aligned with key business processes arising from the MACH Framework for Excellence
- support through OEM mentoring
- a recognized certification process
- annual financial support for the addition of expertise, training and/or mentoring
- a visibility program in support of supplier business development

GRAPHIC 9: MACH's three strategic orientations

Source: Aéro Montréal

The MACH Framework for Excellence is a management system developed by Aéro Montréal to help suppliers in evaluating their performance, identifying performance gaps and determining the actions necessary to improve and better position themselves in the supply chain.

It prioritizes three fundamental levers for improving the competitiveness of a supplier:

1. Leadership Excellence;
2. Operational Excellence;
3. Excellence in planning and developing the workforce.

The process has a maturity scale of five levels, MACH 1 to MACH 5, which allows measuring a supplier's mastery of fifteen key business processes (audit of nearly 800 assessment points). It includes a performance label for visibility and increased recognition of suppliers.

GRAPHIC 10: The MACH process

Source: Aéro Montréal

The preferred approach within the MACH initiative is evolutionary and revolves around the various levels of stakeholders in the supply chain: first, each of the four (4) prime contractors work with integrators on top of the supply chain (Tier 1 suppliers) to better coordinate their actions. Subsequently, these integrators will do the same with their Tier 2 to 4 suppliers.

Within this program, whose central objective is to enhance the collaboration of players in the chain, project managers act as "mentors" to their preferred suppliers. It is expected that the improvement and sharing of common management methods, as well as the establishment of various coordination and liaison mechanisms among players at different levels of the supply chain, are necessary preliminary steps to encourage more collaboration and outsourcing. The more connected and coordinated players will have more confidence, and entrust more responsibilities to preferred

suppliers. They will also work on more long-term collaborative basis. This will facilitate knowledge transfer, accelerate the innovation process and the launch of new products by the players at the highest level in the chain.

- Twenty (20) SMEs are currently involved in a first phase lasting from 12 to 14 months. 70 companies are targeted over a total period of five (5) years.
- The MACH initiative focuses on creating strong collaboration to promote innovation. Supply chains are never static. They form and reform according to the demands of each customer. This is known as an efficient collaboration.
- The MACH initiative will therefore encourage the establishment of strong collaborative relationships between customers and suppliers to increase pro-activity and innovation within companies.

GRAPHIC 11: Customer-supplier alignment

Source: Aéro Montréal

MANUFACTURING ADVANCED PARTNERSHIP (MAP) INITIATIVE

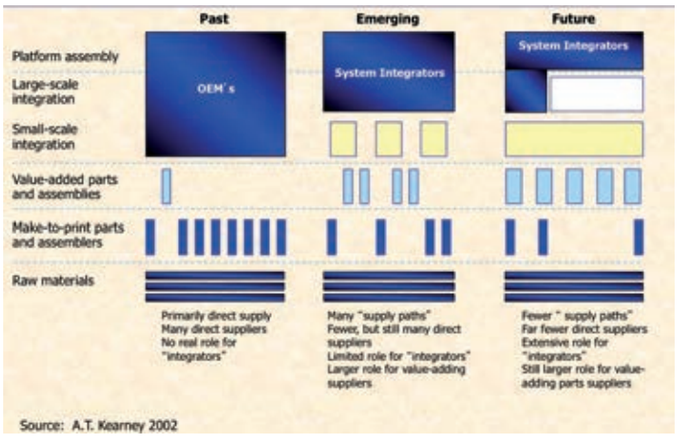
Ontario's aerospace industry regroups several companies, including SMEs that are part of the supply chain of major players in the Canadian aerospace industry, such as Bombardier Aerospace, Bell Helicopter Textron Canada, and Héroux-Devtek. The structure of the supply chain can be represented as shown in the next table. It includes a fairly standard hierarchical structure with well-defined roles for the actors involved at various stages within the supply chain. The process of forming the cluster is inspired by the Kearney model shown below.

GRAPHIC 12: Ontario Aerospace – Major sub-clusters

Cluster	Tier 1	Tier 2	Tier 3	Tier 4	Employees
Aerostructures	1	13	42	29	12,400
Landing Gear and Flight Control Actuation	4	13	19	18	9,000
Avionics & Flight Management	2	24	12	3	5,500
Turbine Engines	1	6	17	12	2,900
Environmental Conditioning & Electric Power	2	2	3	2	1,900
MRO	7	10	11	2	7,200

Source: Ontario Aerospace Council

GRAPHIC 13: The global aerospace supply chain



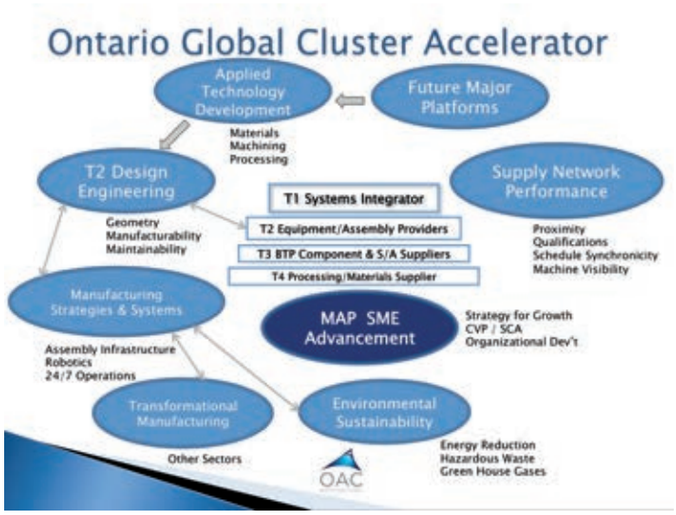
Source: Ontario Aerospace Council

Ontario has also introduced MAP, a method to support the development of business strategies which is exclusively designed for SMEs. MAP is a multi-step process.

1. A targeted process (5 days over 10 weeks);
2. Managers of SMEs identify a few strategic priorities and some actions;
3. Often, decisions concern human resources;
4. Several important decisions: investments, competitive position, new customers, etc.;
5. Alignment: Strategic Decisions – Company Capability – Human Resources.

MAP operates on the basis of expert teams of professionals. At the heart of the MAP process is support for SME management teams by coaches and mentors. This aerospace cluster is based on an iterative process of acceleration in which the various actors in the chain (OEMs, Tier 1, 2, 3 and 4 suppliers) work together (diagram below).

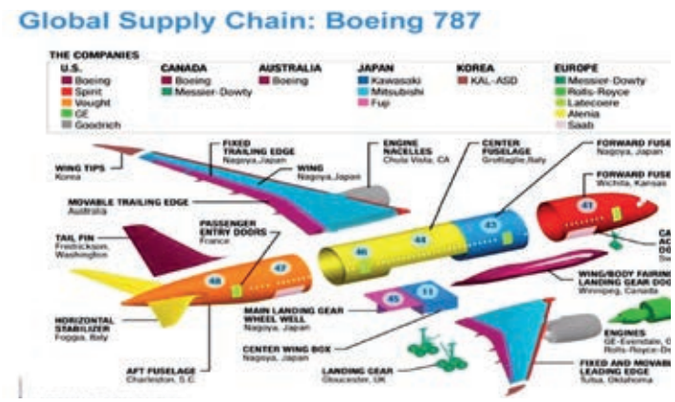
GRAPHIC 14: Ontario cluster accelerator



Source: Ontario Aerospace Council

The process allows for the integration of the Ontario supply chain industry into the global supply chain, which is dispersed globally for major projects. The most telling example is that of integration in the supply chain for the Boeing 787.

GRAPHIC 15: Integration in the Boeing 787 supply chain



Source: Ontario Aerospace Council

MANITOBA AEROSPACE COMPETITIVE EDGE INITIATIVE

Manitoba Aerospace Association's mission is to put companies, organizations and individuals in contact with the aerospace industry in Manitoba. Manitoba Aerospace supports the industry in finding labour, suppliers or investors, and in seeking business opportunities in the global supply chain.

Manitoba ranks in third place in Canada in terms of sales generated in this industry, or $1.6 billion. Manitoba Aerospace has implemented an industry mentoring program to support the industry in developing its competitiveness. Manitoba Aerospace Competitive Edge is a program that is divided into six (6) axes.

GRAPHIC 16: Competitive edge

Manitoba Aerospace Competitive Edge

1. Developmental Model: Learner to World Class
2. 11 Foundational Processes
3. Benchmarking against the Model with confirmation tools to assist
3. Training and Coaching on the Foundational Processes
4. Mentoring utilizing senior operations expertise
5. Steering Committee for Oversight and Management

Source: Manitoba Aerospace Association

GRAPHIC 17: The developmental model

Source: Manitoba Aerospace Association

In addition, the Manitoba Aerospace program has developed a process that is based on eleven (11) founding processes. These 11 elements serve as anchors for the management of a benchmarking process that includes five metrics.

GRAPHIC 18: Benchmarking process

Source: Manitoba Aerospace Association

The benchmarking process is modeled on the aerospace cluster Northwest of England Aerospace Alliance (NWAA), which was introduced at the 2011 Aerospace Innovation Forum held in Montréal in 2009. This process represents only a part of the Manitoba Aerospace program. Like the MACH initiative in Québec and MAP in Ontario, one of the central objectives is to mentor SMEs in their innovation processes and integration within the global supply chain.

GRAPHIC 19: The Manitoban process

Source: Manitoba Aerospace Association

NATIONAL AND INTERNATIONAL COLLABORATIONS

CANADA/U.S. AND EUROPE COLLABORATION: STRENGTHENING THE INDUSTRY'S COMPETITIVENESS WITHIN THE GLOBAL SUPPLY CHAINS

As explained by Jim Quick of the Aerospace Industries Association of Canada (AIAC), the three major players in the world aerospace industry, namely Canada, the United States and Europe, support increased collaboration among aerospace industries in these major areas through projects linking players in the global supply chain. Initiatives were launched by AIAC and representatives of the governments concerned in 2007.

Two key partnerships have proven effective:

- The demonstration program of Canadian technologies
- The Canadian Aeronautics Networking Project for Europe (CANNAPE)

Canada's objective through the Canadian technology demonstrator program is to support the competitiveness of the Canadian aerospace industry and to secure the participation of Canadian companies in the global supply chain. Canada is targeting all platforms, present and future, in contrast with U.S. efforts centered on Boeing. In addition, efforts target increasing the industry's innovation capacity in eight specific (8) technology areas and to deliver products or components in three (3) strategic areas of the aircraft: structure, systems and propulsion (table below).

GRAPHIC 20: AIAC: Canada-US Future Major Platform

1. Aligning existing Industry Portfolio support mechanisms to facilitate technological development;
2. Prioritizing technologies necessary to participate on current and future aircraft platforms including major upgrade programs (e.g. Airbus A320 NEO, Boeing 737 MAX);
3. Assisting Canadian companies in becoming suppliers to commercial platforms that offer the best opportunities.

3 Strategic Areas	8 Technology Areas
– Structures	– Product Development
– Systems	– Manufacturing
– Propulsion	– Environment
	– More Intelligent Systems
	– Advanced Materials
	– Avionics
	– Electric Systems
	– Human Performance

Source: AIAC

CANADA /EUROPE: CANNAPE (CANADIAN NETWORKING AERONAUTICS PROJECT FOR EUROPE)

The second international collaboration initiative is the Canadian Aeronautics Networking Project for Europe (CANNAPE), which aims to increase R&D collaboration. Specifically, CANNAPE promotes the participation of companies and Canadian research teams in FP7 (Framework Programme No 7) projects. Also, CANNAPE wants to establish a roadmap for identifying more accurately areas of collaboration around certain technological themes by sharing an interest with Europe. This activity will strengthen the competitiveness of the industry for the benefit of all partners and form a link between innovation and supply chains on both continents.

SECTION 2: INNOVATION CHAIN

STRENGTHENING, EXPANSION AND ACCELERATION OF THE INNOVATION CHAIN

THE COMMERCIAL CONTEXT: AEROSPACE INNOVATION AT THE SERVICE OF CUSTOMERS

Québec is counting on the technological and manufacturing leadership of its prime contractors to propel the Montréal aerospace cluster to further success worldwide. But the 2011 Aerospace Innovation Forum identified issues related to competitiveness. The aerospace industry is faced with more demanding customers. These demands are being influenced by many technology innovations that are becoming available, often from other industrial sectors, such as multimedia. We need to accelerate and keep up with global innovation, which is following the lead of high-tech sectors such as telecommunications and software intelligence on the one hand, and new advanced materials and composites on the other.

In their presentations, industry observers invited to the Forum, including Mr. Anthony L. Velocci Jr., Editor-in-chief of *Aviation Week & Space Technology,* emphasized the elements that will allow our industry to venture further and make innovation a daily challenge. He welcomed the dynamism of Aéro Montréal, which has demonstrated strong leadership since its inception, contributing to bringing together stakeholders with the goal of accelerating innovation. Several objectives and achievements of Aéro Montréal are contributing to this objective of accelerating innovation: introducing structural approaches to collaboration, opening international development avenues for Québec aerospace and, most recently, setting up a support initiative for SMEs.

Prime contractors who highlighted their challenges to delegates during various Forum sessions were unanimous on this issue of accelerating innovation. Among aircraft manufacturers specialized in niches where the clientele is especially demanding, such as Bombardier Aerospace, the new credo of innovation is as follows:

GRAPHIC 21: Bombardier Aerospace – Innovation with the supply chain of the Bombardier Global family

- Innovation is about customers, they are the ones who should drive innovation
- Aerospace customers are world leaders who shape the economy
- Our business is to provide them with solutions for safety, comfort, connectivity, entertainment, crew areas, avionics, etc.
- Aerospace does not follow the pace of consumer product evolution. Faster application of new technologies is required.

Source: Bombardier Aerospace

These plenary presentations sparked discussions on a central issue present throughout the Forum:

How can aircraft manufacturers accelerate the innovation process while controlling costs and risks, and by making maximum use of partners in the supply chain?

A series of workshops, focusing on the open innovation process, modes of collaboration and project management tools attempted to provide some insight. Their content is summarized in the following section.

BEST PRACTICES IN INNOVATION AND COLLABORATION

LESSONS LEARNED FROM AN EXAMPLE OF OPEN INNOVATION IMPLEMENTATION

An inspiring case was presented, that of Hydro-Québec, an open innovation pioneer in Québec. This presentation powerfully underscored the benefits of applying the precepts of open innovation to improve the efficiency of the innovation process. However, Charles Gagnon, responsible for implementation of the open innovation initiative at Hydro-Québec, also highlighted the issues and challenges of this approach, which requires working differently with all its partners, as well as modifying a set of processes and management tools in the company.

GRAPHIC 22: Issues raised by the implementation of open innovation at Hydro-Québec

1. Strong leveraging power (external contributions by partners, complementary expertise, potentially shorter lead times and reduced risk)
2. New achievements for Hydro-Québec, impossible by working within the closed innovation paradigm
3. Optimal solutions for Hydro-Québec
4. Tool availability and processes establishment
5. Internal information sharing (technology watch, network of contacts, external benchmarking, market intelligence, travel and conference reports, etc.)
6. Intellectual property protection: fear by researchers that external partners might «steal» their ideas
7. Partnering vs Outsourcing: fear by research managers and researchers that R&D be outsourced (instead, external expertise sought to complement internal expertise)
8. Length of negotiation: Too much time spent and too many parties involved in negotiating and finalizing partnership agreements
9. First and foremost, open innovation involves a change in corporate culture!

Source: Hydro-Québec

GRAPHIC 23: The benefits of open innovation at Hydro-Québec

Many benefits are now proven: Companies like Hydro-Québec may have much to gain from open innovation:

- Reduction in innovation project costs
- Reduction in project duration
- New ideas as input to the innovation project pipeline
- Significant value created by external partnerships and collaborative efforts: increased leverage impact
- Products better suited to meet all market needs and thus having greater commercial impact

Source: Hydro-Québec

Another leading company in its management of innovation through partnerships agreed to explain its approach in order to inspire the aerospace industry. This was Bombardier Recreational Products (BRP), specializing in recreational vehicles. BRP has distinguished itself from its competitors and propelled its global sales through a process of innovation, changing “the rules of the game” and “leaving its comfort zone.”

BRP’s presentation focused on the preliminary design phases, which are crucial in a context where customers have multiple profiles and for which innovative design concepts must often quickly be launched, as well as new products and target clienteles. At these early stages of the innovation process, creative people within the company are stretched, as are the select group of partners. Overall, to effectively integrate all decisions and all activities of the innovation process, BRP has developed a systematic approach that integrates the innovation process in the phase-gate process. This approach has two objectives: to generate new products continuously (horizon 0-5 years) and to introduce new paradigms that challenge existing products (5-10 year horizons).

EXAMPLES OF SUCCESS OF COLLABORATIVE INNOVATION IN AEROSPACE

Several industrial companies, SMEs and prime contractors came to present their collaborative projects and discuss success factors as well as future challenges, both amongst themselves and with Forum participants.

Delastek managers explained the basics behind the success of their company: innovation, which is anchored on two principles 1) developing strong partnerships and 2) better meeting customer needs:

> **"Innovation must be part of our daily lives and be based on customer needs. Innovation lies not only in the product, but also in practices… To be a success I think innovation has to take into account strong partnerships based on mutual trust, our ability to take risks, and to execute the company's vision, as well as be on the lookout for trends and new technologies, allowing us to be more efficient in how we do things."**

Source: Claude Lessard, President, Delastek

The Delastek approach also teaches us that SMEs must innovate on a more sustained basis, but also more effectively and efficiently. They must coordinate with all stakeholders in the supply chain and keep up with the pace. To do this, they must incorporate more sophisticated methods of management.

GRAPHIC 24: Innovation management principles

- Delastek innovates through integration and connection in the whole chain supply.
- The challenge is to connect Accounting with Engineering: They must be well balanced.
- Innovate continuously on the product otherwise you will be out of business.
- SMEs used to work guided by feelings, but they now have to focus more on concrete process

Source: Delastek

Another interesting example of cooperation between an SME and a prime contractor within an innovation project was discussed at the Forum. This case brought Bombardier Aerospace together with Coriolis. They explained, in turn, the challenges of this partnership as experienced from their respective viewpoints.

- The interest for SMEs to embark on such an undertaking is clear: Bombardier Aerospace gives them scope, expertise, growth and development prospects.
- Bombardier Aerospace, meanwhile, relies on the following qualities of SMEs: availability, flexibility, ability to establish a true partnership.
- It is clear that multiple factors contribute to the success of such collaborations between innovative SMEs and multinationals: passion, confidence, skills and partnerships.

Finally, discussions at the Forum dealt with the need for government agencies and centres of expertise, such as NRC institutes, to support SMEs in their financing and improving their innovation capabilities and various processes in order to qualify them to become effective partners with prime contractors. ISOGRID and Groupe Tremblay attested to these financing needs.

COLLABORATIVE PROJECT MANAGEMENT TOOLS AND SOFTWARE

TOOLS TO MANAGE STRUCTURAL PROJECTS IN "REAL TIME"

A workshop at the Forum was devoted to various project management tools which have to be adjusted to plan and control aerospace projects involving many participants located in multiple partners, often spread across the planet.

According to the representative of Dassault Systems, the main problem is that of communication. Communication problems are numerous and frequent.

- Companies operate in silos.
- This generates a lot of delays and errors.
- Project management must be performed in real time.

GRAPHIC 25: Real-time program management

Source: Dassault Systèmes

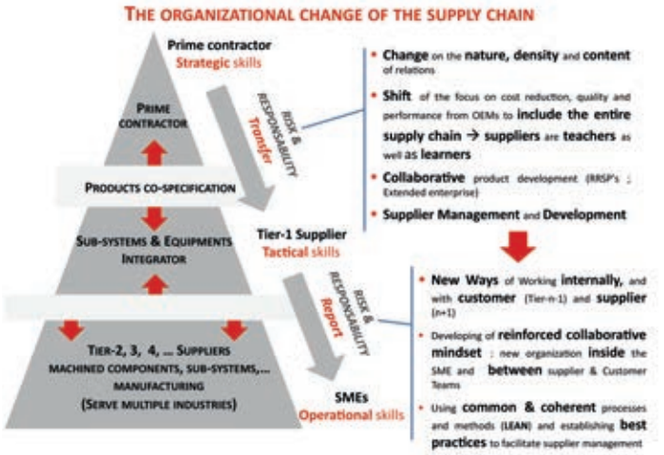
An example of a success story, A&D Avionics Business, was presented. It illustrates how effective tools for multi-party project management in real time can significantly improve the success of these projects. This company was able to increase its R&D efforts by 20 to 25% without having to increase staff.

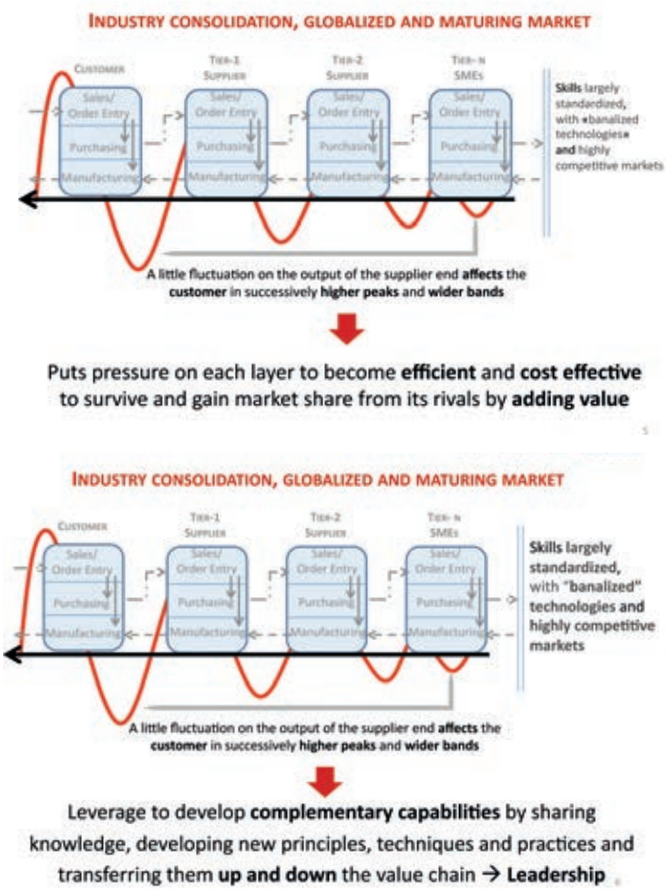
AN APPROACH FOR SMES

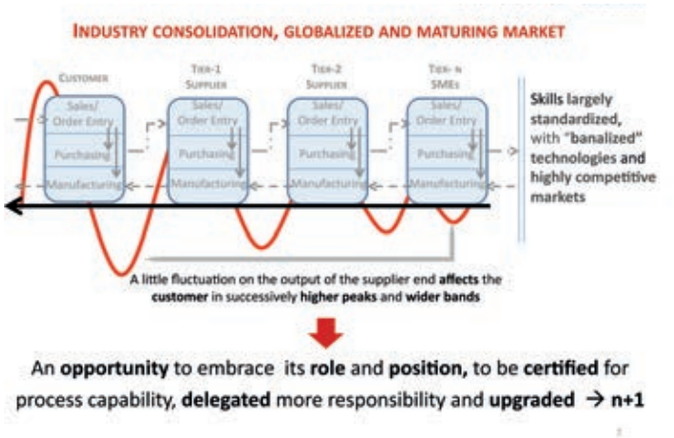
Kader Berkane, consultant representing the consulting firm Think Business Innovation, shared with the audience his mentoring experience with European SMEs in a process designed to enhance their role in supply and innovation chains.

He said SMEs have a huge innovation potential. They should be supported so that they can capitalize on this potential to the benefit of the local aerospace industry. It is important for them to take advantage of all the development opportunities in the aerospace industry: with a modest but careful investment in R&D they can reap major benefits by positioning themselves as a partner of choice for prime contractors.

GRAPHICS 26, 27, 28 & 29: SME challenges in aerospace







Source: Think Business Innovation

ISSUES: TACKLE INNOVATION, EFFICIENCY AND SHORT LEAD TIMES?

All activities of the aerospace industry must be better integrated and connected, including activities subsequent to innovation activities, manufacturing and commercialization, namely during the operation of airplanes by customers. Indeed, in a spirit of faster innovation, more connected to customer needs, it becomes imperative to maintain a sustained interrelationship with users. Solutions developed by specialist consultants from Mahindra Satyam were presented at the Forum. These specialists assist partner companies, large and small, in what they consider to be a "paradigm change" for many services provided by aerospace companies.

Two fundamental questions were raised about the ways in which manufacturers can combine innovation, efficiency and risk management:

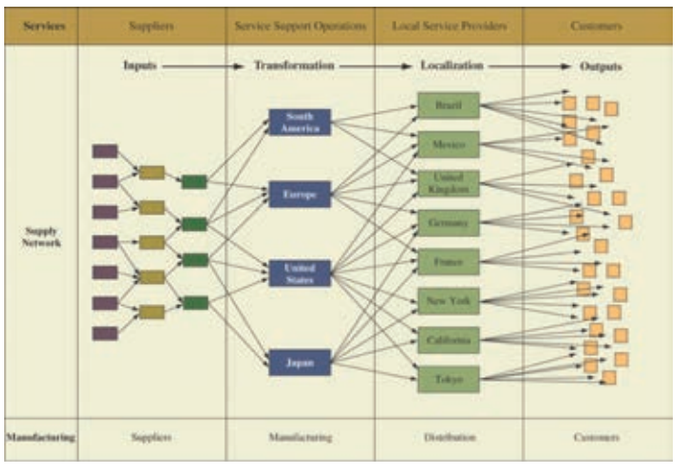
1- How can we deliver profitable aircraft system support in an environment demanding new business models?

> **"… the complex systems found in aerospace and defense «require more sophisticated relationships between service buyers and suppliers.» In these industries, it's «very hard to guarantee product availability due to significant uncertainties in product reliability and usage as well as inherent product complexity, resulting in large risks to both the customer and service provider."**

2- Ever-changing and increasingly rigorous compliance requirements: How to reduce risks associated with compliance audits, disruptions, and governance?

> **"Navigating the labyrinth of export compliance is difficult for many companies regardless of their size. Those who fail to be vigilant may face hefty fines and criminal charges as well as see their businesses fail."**

GRAPHIC 30



Source: Mahindra Satyam

CATALYST AND INTEGRATOR REGIONAL PROJECTS:

GREENER AIRCRAFT, A CHALLENGE AND INCENTIVE FOR COLLABORATION

Catalyst projects represent a structuring turning point for innovation practices in Québec. These are public-private partnerships totalling more than $390 million. In world-class sectors where Québec stands out, they aim to support the industry's vision and leadership. Moreover, these catalyst projects lead, ultimately, to the establishment of greener economic development.

Source: MDEIE

On March 30, 2010, the Québec government announced its new *Québec Research and Innovation Strategy* (QRIS), which included five (5) catalyst projects.

- The greener aircraft
- The electric bus
- The biorefinery of forest resources
- Écolo-TIC
- A fifth project to be determined

SA²GE: THE QUÉBEC AEROSPACE CATALYST PROJECT

This major catalyst project aims to demonstrate leading-edge aerospace technologies designed to reduce the industry's environmental footprint. It is by far the largest project in this new Québec government strategy. It seeks to accelerate innovation among prime contractors in the Québec aerospace industry and support the participation of SMEs and the research community as part of sub-projects. It will require an investment of approximately $150 million and will run for four years. This initiative aims to produce better performing aircraft with a reduced environmental footprint and lower operating costs. The Québec government will invest $70 million against a contribution of $80 million from industry.

The SA²GE project supports the Québec aerospace industry which is recognized by the Québec government as being strategic for the province's industrial base. Furthermore, this industry generates high-level jobs. It is also an industry that performs more than 70% of the total Canadian aerospace R&D, all in Québec.

The SA²GE project aims to mobilize many companies, large and small, universities and research centres around a common project to develop a greener aircraft. The greener aircraft project will focus its research around the following elements:

1. Composite fuselage structures (leaders: Bombardier Aerospace, Bell Helicopter Textron Canada)
2. Next-generation compressors (leader: Pratt & Whitney Canada)
3. Landing gear of the future (leader: Héroux-Devtek)
4. The integration of the avionics in cockpit instruments (leader: Esterline CMC Electronics)
5. The modular integration of avionics for critical systems (leader: Thales Canada)

The main economic benefit that would result from this project will be the increased competitiveness of this industrial sector. The SA²GE project should lead to the development of a more efficient supply chain with a more varied offer. This will be the case not only on a national level, but even more so on an international level in the context of the integration of a global supply chain.

Pierre Rioux, an executive at Bell Helicopter Textron Canada and board member of the SA²GE catalyst project, presented during the Forum the challenges of catalyst projects such as SA²GE from the perspective of prime contractors. The term "major development project" is restricted to these major projects which mobilize, quite uniquely, a wide diversity and large number of players: big industrial groups, equipment suppliers and integrators, SMEs, universities, and government research centres.

The SA²GE project, a catalyst for collaboration and integration in supply chains.

All these "green" initiatives are also business opportunities for SMEs who are able to identify challenges and propose innovations that respond to environmental imperatives.

GRAPHIC 31: Bell Helicopter Textron Canada – Bombardier Aerospace aircraft composite fuselage structures

Source: Bell Helicopter Textron Canada

AIRCRAFT RECYCLING: THE LIFE CYCLE CHALLENGE

Québec is currently the site of an innovative and rallying project, initiated by local companies such as Avianor who want to contribute to the emergence of a chain of actors involved in all phases of the life cycle of an aircraft, from design up to decommissioning and reuse of elements of its components.

GRAPHIC 32: Stakeholders of a potential hub in the Laurentians

Source: JPD Conseil – Projet Avianor

The project, presented to the Forum by Jean-Pierre Dubé of Avianor, aims to create a global centre of excellence for the green deconstruction of aircraft at the end of their life. This centre would bring together the best industry partners, associations and institutions. The specific objectives are summarized as follows:

Deconstruct:

- 4 commercial aircraft in 2012
- 15 commercial aircraft in 2013
- 22 commercial aircraft in 2014

Re-employ, refabricate, recycle and valorise at least:

- 80% of the mass of aircraft in 2012
- 90% of the mass of aircraft in 2015

The context presented is encouraging: around 6,000 airline aircraft will reach the end of their commercial life in the next 20 years. The market is emerging, and still little regulated in North America. However, the needs are there and the lack of good management practices for aircraft at the end of life increases the risk associated with the following:

> the inevitable leakage of fluids during storage and handling of the aircraft

> exposure to hazardous materials used in the aircraft and their possible dispersal

> the uncontrolled reintroduction of unapproved parts by the black market into the spare parts market

GRAPHIC 33: Examples of reuse

Source: JPD Conseil – Projet Avianor

MAJOR CORPORATIVE INITIATIVES

A global company like Bombardier Aerospace has to be at the forefront of environmental considerations, which are a part of commercial issues. It needs to exercise leadership on the various actors in the cluster, including all members of its local and global supply chain. From the perspective of the complete recycling of aircraft, all facets of the aircraft design are in play with a vision of sustainable lifecycle management.

Bruce Perry of Bombardier Aerospace briefed participants on the initiative called *Process for Advanced Management and Technologies of Aircraft End of Life.*

The Project Objective: to develop general methods and test them on an experimental platform to dispose of and/or implement recycling processes and dedicated infrastructure for end-of-life aircraft and helicopters, which includes;

- **Developing general methods and testing them on an experimental platforms to optimize recycling opportunities**
- **Implementing recycling processes that can become profitable with a dedicated infrastructure for end-of-life aircraft and helicopters**
- **Provide accurate information on the end-of-life of aircraft and bring data into life-cycle assessments**
- **Ensure that lessons learned are considered in our future Design process**

GRAPHIC 34: Process for Advanced Management and Technologies of Aircraft End of Life

Source: Bombardier Aerospace

GREEN AVIATION RESEARCH & DEVELOPMENT NETWORK (GARDN): A UNIFYING MECHANISM

GARDN is a federal network of excellence aimed at encouraging the development of technologies that reduce noise and greenhouse gas (GHG) emissions around airports. In a sustainable development process, the environmental impacts in a product's lifecycle must be taken into account.

In addition, GARDN is a vector to support the development of a skilled and creative workforce in our universities in the fields of environmental technologies. The ultimate goal of GARDN's activities is to reduce the aerospace industry's GHG production, and thereby its ecological footprint.

Like the great family of the Canadian aerospace industry, GARDN's research themes encompass several aspects to make the aircraft greener.

- Noise Reduction
- Reduction of GHG emissions
- Materials and manufacturing processes
- Optimization of airport operation
- Optimization of aircraft operation
- Alternative Fuels
- Managing the life cycle of products

GRAPHIC 35: Current world projects

Source: GARDN

SECTION 3: INTEGRATOR THEMES

R&D CONSORTIA: BROADENING THE INNOVATION MANDATE TOWARDS THE NEXT LEVEL AND SME INTEGRATION

Several aerospace industry clusters in various parts of the world have established innovative and effective approaches to bring stakeholders together and foster collaboration. These various initiatives are the result of concerted efforts by manufacturers themselves,
as well as by government development agencies and research communities. Each of these unifying "models" has advantages, but also contains gaps to be filled. The review of these models during the Forum facilitated a better understanding for all participants.

A summary of some interesting features of two U.S. models (States of Arizona and Ohio), as well as the Québec evolving model of CRIAQ, is presented below.

ARIZONA AEROSPACE AND DEFENSE RESEARCH COLLABORATORY

Arizona Aerospace and Defense Research Collaboratory is a consortium of universities, research centres and industry. Its objective is to foster collaboration among stakeholders and to maximize available resources to carry out innovation projects. This collaboration aims to improve the business environment for the aerospace sector in Arizona. In addition, it aims to strengthen the competitiveness of the industry and build a solid base of entrepreneurship.

The supply chain includes more than 1,300 companies, mainly SMEs. Nearly 40,000 people work directly in the aerospace industry in Arizona, of which two thirds are from the military sector. The industry generates more than $4 billion in wages in this southwestern state. All major industry players are present in the aerospace cluster, including Bombardier Aerospace.

GRAPHIC 36: The major players in Arizona Aerospace

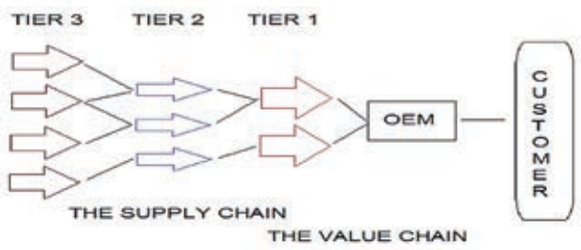
Source: Arizona Commerce Authority

Arizona receives nearly 4% of its contracts from defence. This represents more than $11 billion and ranks the state 4th in terms of value of contracts in 2011. With regard to military activities, including products from aerospace, Arizona ranks among the leaders in terms of exports.

A trading partner with Canada, the State of Arizona has seen its exports to Canada increase for 10 years. However, it is interesting to note that Canada maintains a solid positive trade balance with this region.

The Arizona Manufacturing Extension Partnership (MEP) has mandated Arizona State University, College of Technology and Innovation to conduct a comprehensive study of Arizona's aerospace supply chain. The objectives of this study are to identify the needs and difficulties in Lean Manufacturing and the supply chain. The study will build a database of the aerospace industry and include the factors affecting the Tier 1-2-3 suppliers.

GRAPHIC 37: The supply chain and the value chain



Source: College of Technology and Innovation, Arizona State University

To do this, researchers will conduct a survey of suppliers to measure the use of good business practices currently employed by industry, as well as to identify the industry's vision and needs for the implementation of these good practices. The database will become a tool for comparing companies that participated in the study. It will allow comparisons in terms of business practices around eight (8) criteria.

GRAPHIC 38: Arizona Aerospace and Defense Research Collaboratory

1. Company demographics
2. Leadership
3. Customer satisfaction and innovation
4. Workforce strategies
5. Supply chain management
6. Lean process improvement
7. Sustainability and green
8. Global engagement

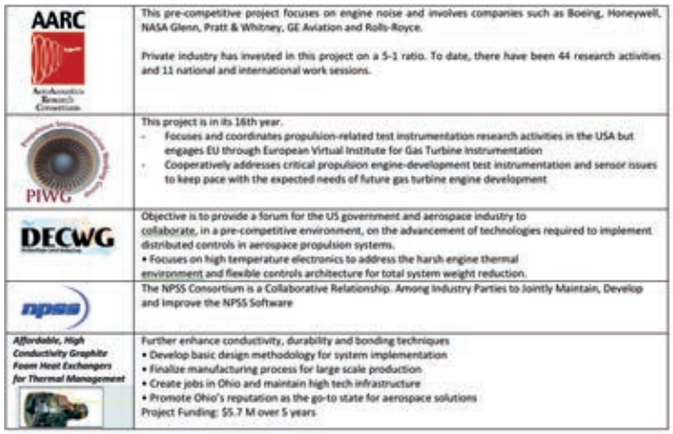
Source: College of Technology and Innovation, Arizona State University

OHIO AEROSPACE INSTITUTE

The Ohio Aerospace Industry plays a strategic role. Aerospace research in Ohio focuses mainly around the following stakeholders: a NASA research centre, namely the Glenn Research Center, 24 prime contractors in aerospace, over 46 SMEs, and ten universities that offer doctorates in aerospace. The basic principle of this consortium is based on the fact that the market will need more than 29,000 aircraft, worth $3.2 trillion, by 2028. In addition, to increase the efficiency and environmental quality of air carriers, research is oriented towards low-noise supersonic aircraft.

The Ohio Aerospace Institute has identified three areas of intervention in its mission: 1) education, 2) R&D, and 3) fostering collaboration and innovative solutions. Currently, there are more than 20 partnership projects that are financed by federal funds in Ohio. Here are a few examples of collaborative projects currently underway:

GRAPHIC 39: Examples of collaborative projects



Source: Ohio Aerospace Institute

CRIAQ

CRIAQ is at the heart of the Montréal aerospace cluster's R&D. Through its mission, the research consortium seeks to increase innovation in the aerospace industry in Québec and Canada by encouraging industry collaboration (prime contractors, equipment manufacturers and SMEs) with universities and research centres. It also seeks to increase knowledge on technological and scientific themes described below. This is also made possible by the better preparation of students, from undergraduates to highly qualified graduates, according to industry needs.

CRIAQ in numbers, is a collaboration with:

- 19 universities, 600 researchers, $116 million invested
- 32 SMEs, 46 companies altogether
- 3D-Semantix, example of spin-off from a CRIAQ Project

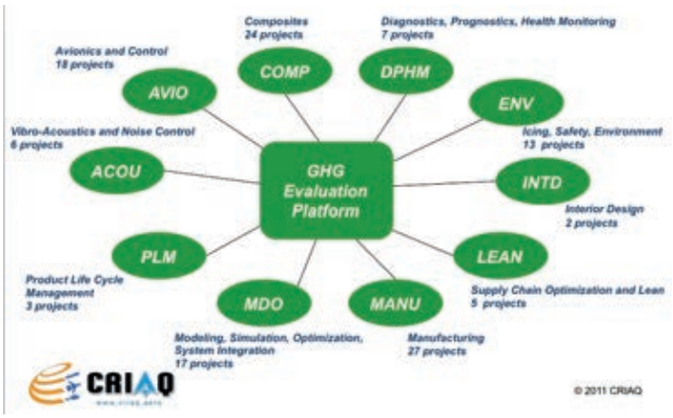
CRIAQ research projects centre around scientific and technological themes identified as priorities by the industry. These projects are carried out collaboratively and pre-competitively and include, since 2011, a mandatory component in sustainable development. Some of these projects could be directly linked to catalyst projects that

spur the aerospace industry. This could happen when CRIAQ's mandate is expanded to include a funding structure necessary to achieve higher TRL, and indirectly, by the use of more basic research in current CRIAQ projects. This requires working R&D projects in an interdisciplinary way, often by combining several themes.

GRAPHIC 40: Research themes

Source: CRIAQ

GRAPHIC 41: Contribution of CRIAQ research themes to GHG reduction



Source: CRIAQ

In addition, CRIAQ has just been included as a major player in national collaborations (universities and research centers outside Québec, GARDN, greener aircraft) and international ones (missions, exchanges, international projects, CANNAPE). It is working with various government levels and programs.

CRIAQ is celebrating its 10th anniversary in 2012, and has taken the opportunity to define its strategic direction for the next ten years through "Vision 2022."

This vision includes six recommendations:

- Making the 10th anniversary a springboard for CRIAQ
- Developing performance indicators and assessing the impacts of CRIAQ projects
- Launching the "CRIAQ Community" platform
- Creating CRIAQ TRL 4+ and an expanded CRIAQ
- Improving education through research and the creation of the "CRIAQ Academy"
- Implementing the CRIAQ "Out of the Box" open method

Two fundamental questions are affecting the evolution of CRIAQ in an effort to better support innovation not only in the early stages, but at all phases of the process involving various stakeholders in the innovation chain:

- How can we link the supply chain and technology development?
- How can we benefit from a fast turnaround time in R&D – development?
- How can we raise SMEs involvement in CRIAQ projects?

GOVERNMENT SUPPORT: STRUCTURING AND FINANCING OF THE SUPPLY AND INNOVATION CHAINS TO FOSTER COLLABORATIONS, SME INTEGRATION AND KNOWLEDGE TRANSFER

PUBLIC AID PROGRAMS AND GOVERNMENT INNOVATION STRATEGIES: TOOLS TO DEVELOP THE SUPPLY CHAIN

The role of various levels of government goes far beyond financial support: it is a structuring contribution that encourages collaboration and improved management practices, both to improve the efficiency of the supply chain at all hierarchical levels and to accelerate the innovation chain at all stages, from idea to commercial product.

FEDERAL FUNDING

Guest of honor at the Forum, the Honourable Christian Paradis, Canadian Minister of Industry and Minister of State (Agriculture), believes the aerospace industry must be kept at the forefront of the global aerospace industry.

"Innovation in the aerospace sector generates significant economic benefits for Canadians. This is why the government continues to support the economy with a balanced and prudent financial management, never losing sight of the long-term competitiveness of this sector that creates jobs.

[...]

Innovation is already a maxim for Aéro Montréal. Examples range from Pratt & Whitney Canada's global flight testing facilities, CAE flight simulators, the revolutionary Bombardier Aerospace *CSeries*, or the expertise of Héroux-Devtek in landing gear. The Canadian government offers many programs to support innovation and facilitate the integration of companies in global value chains."

STRATEGIC AEROSPACE AND DEFENCE INITIATIVE (SADI)

SADI is a program managed by the Industrial Technologies Office, a specialized Industry Canada service organization. Available to businesses of all sizes operating in the aerospace, defense, space industry and security sectors, this program provides repayable contributions for strategic projects whose launch and success are a source of benefits for Canadians.

SADI's objective of SADI is to stimulate innovation and excellence for new products and services in order to strengthen the competitiveness of Canadian companies in these key sectors of the economy. The program also aims to facilitate collaboration between research institutes, universities, colleges and the private sector. Particular emphasis is placed on facilitating collaboration between companies and educational institutions.

As presented by Roch Chouinard, SADI Program Director at Industry Canada, the benefits for companies are as follows:

- **Find a solution to a problem –> innovation**
- **Develop a new technology –> competitive advantage**
- **Develop a new process –> increased productivity, reduced costs**
- **Improve performance and operations –> competitiveness**
- **Access recognized specialists worldwide –> innovation**
- **Strengthen R&D –> shorten lead times to market**

THE NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL OF CANADA (NSERC)

The Natural Sciences and Engineering Research Council of Canada (NSERC) aims to support university research and innovation. The organization works at the university research level in several ways:

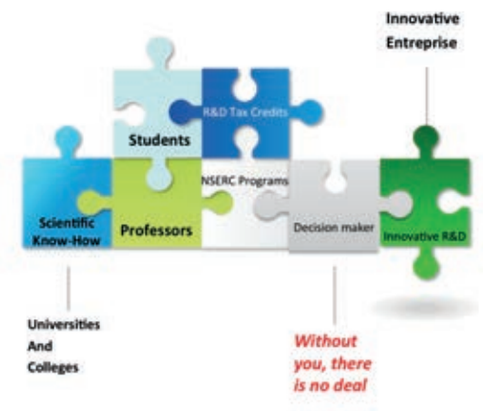
> To support the creation and transfer of knowledge

> To support high level training and use of this knowledge

> To stimulate the creation of partnerships between industry and research.

NSERC has a budget of over $1 billion, a third earmarked for university-industry research partnerships. Use of NSERC tools by the aerospace industry has grown steadily over the past decade. The use of NSERC programs has more than doubled since 2000. NSERC established programs to facilitate partnerships in small projects, to increase access to its programs for SMEs. The success of these initiatives depends on the contribution of all stakeholders who mentor SMEs.

GRAPHIC 42: The NSERC, how it works and is financed



Source: CRSNG

In addition, NSERC supports over a dozen chairs in the industrial sector. These industrial chairs are financed in collaboration with industry leaders such as Pratt & Whitney Canada, Bombardier Aerospace and Bell Helicopter Textron Canada.

GRAPHIC 43: Industrial chairs at a glance

Chairholder	Aeronautical Chair Title	Funding Over 5 years
Dr. Alain Berry/ Dr. Stéphane Moreau/ Dr. Noureddine Atalla Sherbrooke	NSERC Industrial Research Chair in Aviation Acoustics	$2,502,000
Dr. Yusef Altintas/ Dr. Hsi-Yung Feng UBC	NSERC/ Pratt & Whitney Canada Corp. Industrial Research Chair in Virtual High Performance Machining	$1,100,000
Dr. Wagdi Habashi Mc Gill	NSERC-J. Armand Bombardier Industrial Research Chair of Multidisciplinary CFD, with the participation of Bell Helicopter Textron and CAE Inc	$1,400,000
Dr. Jean-Yves Trépanier Polytechnique	NSERC-J.-A.-Bombadier-Pratt & Whitney Canada Industrial Research Chair in Integrated Design toward Efficient Aircraft (IDEA)	$2,500,000
Dr. Hany Moustapha ÉTS	NSERC-P&WC Industrial Research Chair on Propulsion System Integration and Optimization	$727,200
Dr. Sam Sampath U of T	NSERC/P&WC Industrial Research Chair in Aviation Gas Turbine Combustion/Emissions Research and Design System Optimization	$800,000

Source: CRSNG

NSERC has established a new industrial chair program for colleges. The first chair of its kind to emerge is at the Aerospace Technology Center - CTA. This new type of industrial chair is designed to support the training of a highly-skilled workforce and enhance the transfer of knowledge between academic centres and the aerospace industry.

Finally, NSERC is a key partner of CRIAQ. NSERC programs fall squarely within this collaborative approach and transfer knowledge to support improved industry competitiveness.

INDUSTRIAL RESEARCH ASSISTANCE PROGRAM OF THE NATIONAL RESEARCH COUNCIL CANADA (CNRC-IRAP)

CNRC-IRAP is the Canadian government's tool of choice to support SMEs in all their innovation activities. Its support to SMEs in the aerospace sector is undeniable, for decades. In addition to direct contributions to companies through the interventions of its Industrial Technology Advisors (ITAs), IRAP is part of the Canadian government's various strategic and structuring initiatives.

GRAPHIC 44: IRAP business model

Source: Conseil national de recherche du Canada

Beyond the funds available to support research and innovation projects in companies, CNRC-IRAP is a national business network allowing entrepreneurs to have access to specialized resources in several areas.

CNRC-IRAP has nearly 200 advisors in over a hundred offices across Canada. Generally speaking, the majority of these advisors have management experience in SMEs, 34% have been entrepreneurs and 75% have 2nd cycle university training.

IRAP works with other federal agencies to support structuring initiatives aimed at strengthening the innovative capacity of all actors of the aerospace supply chain:

- Supports CRIAQ to facilitate the integration of SMEs in a collaborative approach across Canada (TRL 1-5)
- Supports research and development consortium in composites involving SMEs and Canadian OEMs (TRL 4-6)
- Unmanned Aerial Vehicle (UAV) Systems: support for flight demonstration of Beyond Visual Range flight in Canadian Airspace and IAR strategy

STRATEGY AND FINANCING IN QUÉBEC

According to the Québec government, represented at the Forum by Sam Hamad, Minister of Economic Development, Innovation and Export, the aerospace industry occupies a prominent place in Québec. It generates annual revenues of nearly $12 billion and employs over 42,000 people. It brings together some 212 companies that help create a competitive supply chain globally.

This industry accounts for 70% of Canadian research and development investments in aerospace. It is currently ranked first in the field of R&D in Québec's manufacturing industry, which gives Montréal the prestigious title of aerospace world capital. To maintain this enviable position in a highly competitive market, the industry must join forces to strike strategic partnerships and adopt an attitude favourable to innovation.

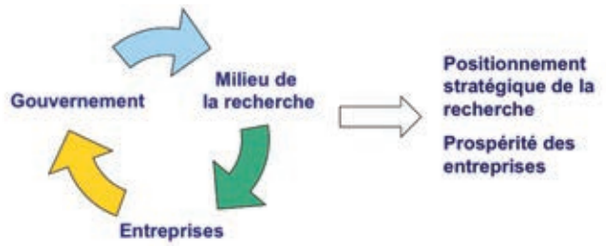
The aerospace industry is experiencing a period of great change, both technologically and operationally. While maximizing its competitiveness, it should seek to minimize the environmental impact of air transport, which represents a significant challenge. That is why the Québec government is providing ongoing support to various initiatives implemented by this sector.

The *Québec research and innovation strategy* (QRIS) aims to support innovation in industrial sectors in Québec, including the aerospace industry. The greener aircraft catalyst project, included in this strategy, is a prime example.

AN INNOVATION STRATEGY FOR QUÉBEC: QRIS

As part of irreversible trends in the support and management of innovation in industry, the Québec government has adopted a new approach for collaborative innovation: open innovation. It is now recognized in many sectors and in various parts of the world that, to accelerate innovation and quickly bring high-quality products to market, it's necessary to increasingly make use of open innovation practices.

GRAPHIC 45: Open innovation practices



Technology development involves increasingly complex processes. The globalizing business environment is also adding to the complexity of the technology innovation process.

VARIOUS ASPECTS OF QUÉBEC GOVERNMENT SUPPORT

Collaborative innovation requires more than the transfer of advanced technologies within an industry. It relies on management practices that make the industry competitive in all respects.

SMEs that are part of the supply chain must adopt advanced business practices. Governments must also contribute to the implementation of effective tools to keep the industry competitive.

QRIS, with a budget of over $2 billion, is based on four pillars of support for research and innovation. The contribution of this strategy to the aerospace industry covers the various stages and facets of the innovation process:

- The best business practices in companies.
- The development of new technologies or products.
- Support for pre-competitive research consortia.
- The implementation of catalyst projects aimed at supporting the technological development of key sectors of the Québec economy.

CONCLUSION: SUMMARY OF THE CHALLENGES, FUTURE OBJECTIVES AND RECOMMENDATIONS

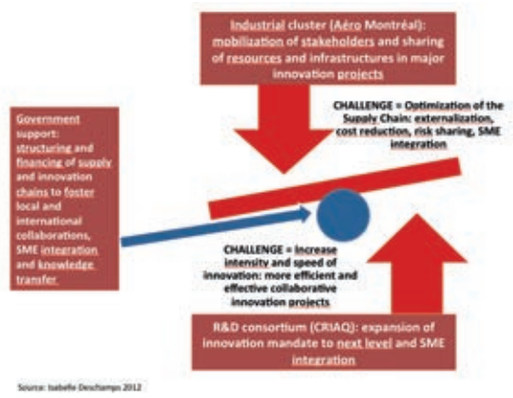
IMPACTS AND ISSUES: POINTS OF VIEW OF VARIOUS STAKEHOLDERS IN THE CHAIN

There were numerous observations generated during the closing plenary of the 2011 Aerospace Innovation Forum. More than ever, in an international context that is financially troubled yet promising in terms of innovation, the aerospace industry can and should play a leadership role. This sector is strategic for the development of Québec and Canada given the leverage it has on other industrial and technology sectors that supply it. This is why the various catalyst projects are so important.

Here are some issues drawn from the presentations. They clearly illustrate the need to balance and coordinate efforts to improve the efficiency of the supply chain on the one hand, and accelerate innovation on the other.

- **Since prime contractors are focusing on their integration role, Tier-1 suppliers must assume greater responsibility in terms of innovation in products and supplier management**
- **Aerospace must introduce product innovations much more quickly into the industry**
- **Collaboration between educational institutions, industry and government institutions is vital to innovation**

Two aerospace industry challenges to tackle: The supply chain and the innovation chain



DOMINO EFFECTS OF VARIOUS CHANGES: ALL PLAYERS MUST ADJUST THEMSELVES TO ONE ANOTHER.

The synthesis of the various sessions helped to highlight the various issues related to the management of more intense and accelerated innovation throughout the aerospace supply chain.

PRIME CONTRACTOR CHALLENGES

Prime contractors must change their perception and assume risks on a shared basis in the future. The biggest challenge for them is to innovate in the way they structure and manage their supply chain. They should especially make room for external innovative initiatives from their preferred suppliers. This is an essential condition for a substantial improvement in their innovation capability:

Summary of issues for prime contractors

> Partnerships in risk management are the solution for encouraging innovation.

> In the next ten years, the industry will change in a way difficult to predict today.

> The greatest innovations will take place in how the supply chain is managed.

> Project managers should allow Tier 1 suppliers to introduce new technologies.

Implications for prime contractors:

a. They need to amplify the intensity in innovation, but not at any cost, and without slowing down the speed. They should also take into account increased technical risks due to the complexity.

b. They need to innovate faster because customers today are demanding.

c. They should turn to specialized subcontracting, and to the acquisition of existing technologies.

d. Innovation projects in collaboration need to be more efficient and effective.

e. Prime contractors should delegate more, and trust their Tier 1 partners and their specialized subcontractors to innovate together.

TIER 1 SUPPLIER CHALLENGES

Technological innovation will necessarily lead to innovation in terms of management. The supply chain will be transformed. Above all, it becomes imperative that collaborative relations on new foundations be established and managed to enhance relations between prime contractors and Tier 1 suppliers.

Summary for Tier- 1 suppliers

- Tier 1 must find ways to make products with higher added value, not just cheaper
- Tier 1 suppliers improvements needed:
  - Lean supply chain
  - Reduced total cost of ownership
  - High standards of ethics and performance
  - Be prepared for international globalization

Implications for Tier-1 suppliers from Québec:

a. Outsourcing of R&D by prime contractors requires Tier-1 suppliers to further integrate into supply chains.

b. Tier-1 suppliers must refine their business strategy and offer products with high added value.

c. Tier-1 suppliers must become real players on the world stage.

SMEs CHALLENGES

Many SMEs active in the aerospace industry and wishing to increase their presence attended the Forum. Several of them, pioneers in working with major contractors, integrators and researchers, spoke about their practices, the benefits they have gained, and lessons learned.

Summary of challenges for SMEs

- Innovation must be part of the SMEs daily life and driven by customer needs.
- SMEs need to innovate in methods and management processes, and not just in product innovation.
- Collaborations, partnerships, mutual trust and willingness to take risks are essential for SMEs. They also need a long term vision as well to anticipate new trends in technology. SMEs need to develop product offerings and flexible services, offering value-added and tailored to the needs of their customers.

Implications for SMEs

a. They must develop a higher level of maturity in terms of management systems, on both a strategic and operational level, as well as in financial management.

b. They must systematically improve themselves to be positioned as preferred suppliers in the supply chain.

c. They must work on longer-term horizons and more in “partnership” in innovation matters to benefit from all the leverage effects resulting from collaborative innovation.

GOVERNMENT CHALLENGES

Government agencies attending the Forum play a leading role in the implementation of all the changes required in established supply chains, as well as in the more systematic introduction of collaborative innovation methods in emerging innovation chains.

Much of governmental involvement is in the form of direct financial support, but they must also become more involved in providing expertise in management, international commercialization, intellectual property, etc. to truly support the collaboration chains:

a. Government funding is more than ever becoming vital, given the high risks.

b. National financial levers must be competitive with countries that are competing in the supply chain.

c. The effects of financial leverage need to be complementary, hence the need to coordinate programs and simplify access to these programs, especially for SMEs.

d. Funding of programs must be further stabilized and adapted to better support large-scale collaborative projects.

CLUSTERS AND CONSORTIA CHALLENGES

The mandate of industrial clusters, such as Aéro Montréal, and industrial R&D consortia, such as CRIAQ, are constantly evolving. A healthy dose of leadership is needed to introduce many changes and new directions required by the various players in aerospace. Unifying organizations such as clusters need to be aware of best practices, and use mechanisms for transferring and disseminating them.

The 2011 Aerospace Innovation Forum represents a part of the response to these imperatives. Some fundamental questions inspired the agenda of the Forum, whose main goal was to share concerns about, and possible solutions, to the following complex issues:

- How can SME's capacities in supply chains be increased?
- How can we organize our R&D efforts?
- What new forms of intervention should be taken by public institutions?
- How should we take advantage of aerospace clusters and international collaborations?

Implications for industry consortia and clusters:

a. Industrial clusters and the various regroupings in the form of consortia have, more than ever, a crucial role to play in terms of mobilizing stakeholders.

b. They must help to establish new bases for pooling R&D resources in major shared infrastructure projects.

c. They must support and advocate to provide an environment that facilitates technological demonstration, an important element in reducing risk for the supply chain and positioning it in the future of the industry.

RECOMMENDATIONS AND COURSES OF ACTION FOR THE AÉRO MONTRÉAL AEROSPACE CLUSTER

1.INTEGRATE PUBLIC AND PRIVATE SECTOR INTERVENTIONS

Better integrate the involvement of the public and private sectors, especially to give birth to large Canadian catalyst projects that will broaden and complement Québec catalyst projects. Encourage the Canadian government to develop a strategy for innovation in the aerospace sector along the same lines as Québec's.

2.INCREASE THE ACCESSIBILITY, HARMONIZATION AND STABILITY OF FINANCIAL AID PROGRAMS TO ENCOURAGE LONG-TERM INVESTMENT IN INNOVATION AND ACCELERATE THE FINANCING CYCLES

Facilitate and maintain, over the long-term, the structuring and financing of innovation in supply chains. Also encourage the consolidation and administrative simplification of programs to increase the scope, effectiveness and efficiency of funding mechanisms that encourage local, national and international collaborations, the integration of SMEs and knowledge transfers.

3.BETTER LEVERAGE INTERNATIONAL ALLIANCES

Facilitate more company access to large international catalyst projects through various existing initiatives, for example programs such as CANNAPE (Canadian Networking Aeronautics Program for Europe), CRIAQ, or initiatives that could open doors abroad such as the greener aircraft (SA^{2}GE) catalyst project, as well as the Canadian technology demonstrators' framework program.

4.IMPROVE AND INCREASE THE ROLE OF INTERMEDIARY ORGANIZATIONS

Continue the development and strengthening of CRIAQ towards more advanced TRL[1] in support of technology demonstrator programs and promote a greater participation by companies, universities and research centres outside Québec. Also, ensure the sustainability of the GARDN network through the renewal of its funding.

5.BENCHMARK AND CONTINUOUSLY IMPROVE THE INNOVATION CAPACITY OF THE AEROSPACE CLUSTER

Like the MACH[2] initiative aimed at improving the capacities of suppliers in the supply chain, strengthen an initiative to improve individual innovation capacities as well as the overall effectiveness of all stakeholders that collaborate in innovation chains: prime contractors, integrators and equipment manufacturers, SMEs, universities and research centres.

6.ACCELERATE, IN A SUSTAINABLE AND STRUCTURED WAY, THE INNOVATION PROCESS THROUGHOUT THE AEROSPACE CHAIN

Study what would be necessary to implement in the aerospace cluster in order to accelerate innovation and reach the commercialization stage, making innovation the real engine of wealth creation for our industry. Various support measure scenarios should be considered soon after an analysis is completed of specific needs and capacities of existing innovation and demonstration infrastructure of our aerospace industry:

- Increase in innovation capacity and greater involvement of SMEs in innovation
- Identification of a broader collaborative mode for technology demonstration projects, which would improve access to expertise in universities, even at stages approaching commercialization.
- Access to strategic funding for infrastructure shared nationwide. This can be achieved by sharing existing infrastructure, such as CNRC facilities, through catalyst projects and/or technology demonstrators; by establishing new complementary infrastructure grouped around one or several sites; or by creating true permanent hubs bringing together all players in aerospace innovation.

[1] *Technology Readiness Level*

[2] *Aéro Montréal's MACH initiative is a program to support the competitiveness of Québec aerospace suppliers. Based on three priority areas: excellence in leadership and innovation, excellence in planning the workforce, and operational excellence, it provides SMEs with maturity audit of 15 key business processes, a training program, recognized certification and a sponsorship relationship with a customer. In addition, a new initiative (called Aéro-PING), led by Aéro Montréal's Innovation Working Group, is currently starting to study systematically the interactions among innovation players, and the strengths and weaknesses of collaborative processes. It is also establishing a basis for comparison with other clusters in order to identify areas for improvement and recommend the best mechanisms for collaborative innovation tailored to the Aéro Montréal Cluster.*

Aéro Montréal wants to thank its partners for their support in organising the 2011 Aerospace Innovation Forum

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