Consortium de recherche et d'innovation en aérospatiale au Québec
Consortium for Research and Innovation in Aerospace in Québec

Presentation of CRIAQ

Rzeszow, March 2009

Introduction

CRIAQ is a not-for-profit consortium created in 2002 for the purpose of promoting and performing precompetitive industrial research projects

Funding sources :

- ***Ministry of Economic Development, Innovation and Export of Québec (MDEIE)***
- ***Industry, Universities, Research Centers***
- ***Natural Sciences and Engineering Research Council of Canada (NSERC)***
- ***Québec Fund for Research in Nature and Technologies (FQRNT)***

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MISSION

Increase competitiveness of Aerospace Industry and enhance collective knowledge base through a better training of students

OBJECTIVES

- ***Collaborative Research Projects*** ***(distinct projets, industry driven, multiple partners)***
- ***Innovation*** ***(Full IP coverage)***
- ***Training*** ***(Students in every project)***
- ***Promotion*** ***(support student forums and compétitions)***
- ***National Collaborations*** ***(non-Québec universities, CRIAC)***
  international ***(missions, exchanges, projects)***

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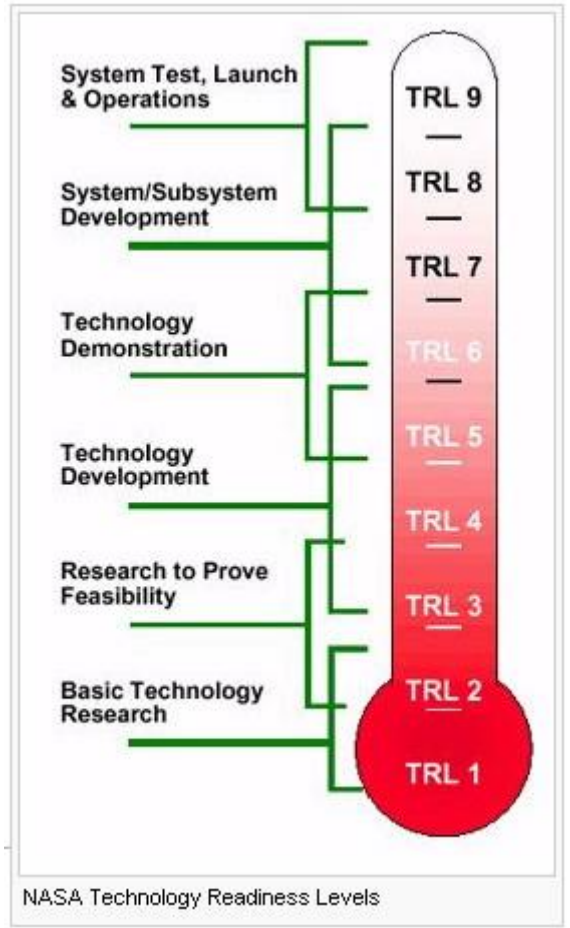
Québec Aerospace Industry at a Glance

(2008 figures - MDEIE)

- ***236 companies, 42 400 employees and sales of $ 12.3 billion in 2007.***
- ***Québec's aerospace industry is the fifth largest in the world, behind the USA, UK, France, and Germany.***
- ***Québec accounts for 50 % of employment and for almost 60% of Canadian aerospace activity.***
- ***Prime contractors and Original Equipment Manufacturers = 90% of sales and almost 75% of total employment.***
- ***70% of Canadian aerospace R&D takes place in Quebec:***
  - ***P&WC and Bombardier are among the top ten R&D spenders in Canada. CAE is No.3 in R&D in aerospace and among the top 30 companies in Canada.***
  - ***Aerospace is the leader in R&D in the Québec Manufacturing sector.***
- ***80% of Québec production is exported***
  - ***Aerospace is ranked first amongst Quebec manufacturing exporters in 2007.***
- ***One of every 182 people works in aerospace in Québec.***

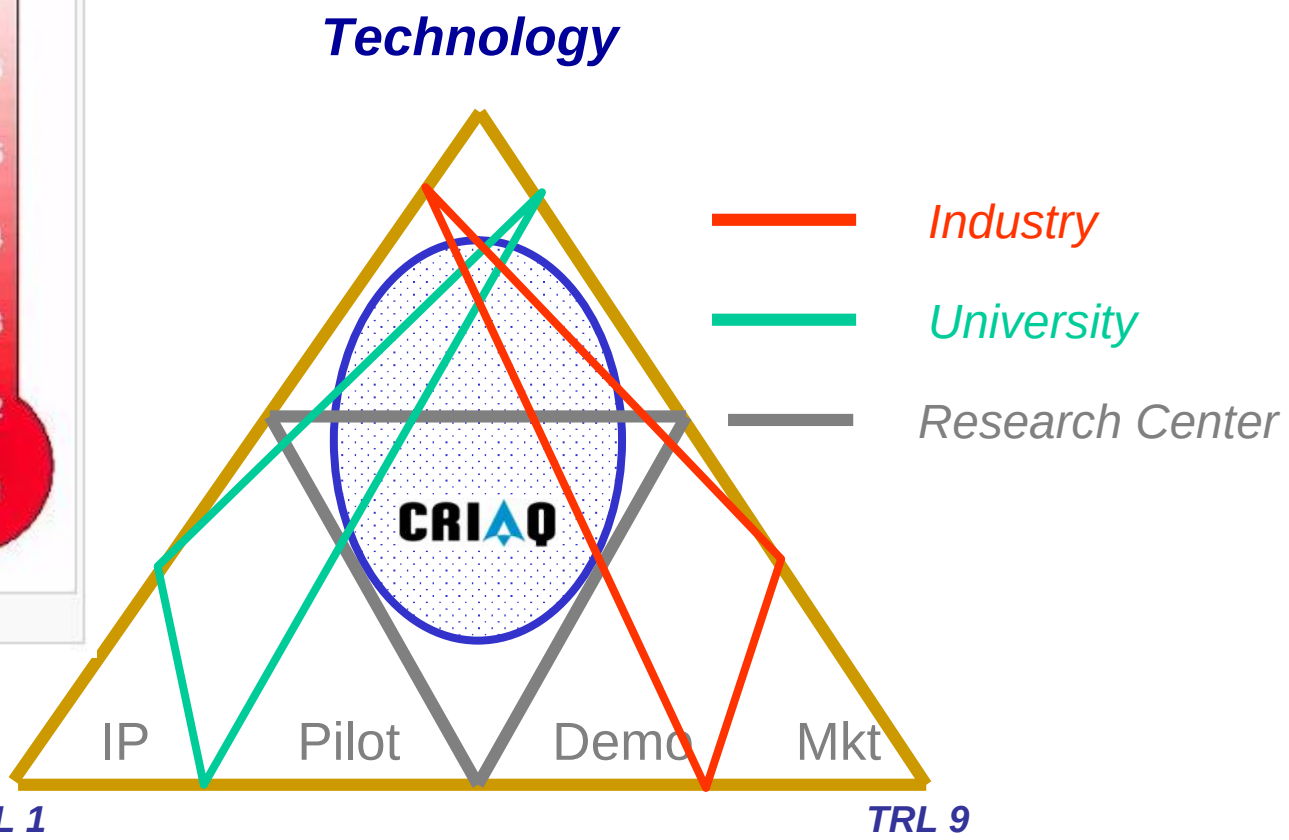
Source: MDEIE



NASA Technology Readiness Levels

The Innovation Triangle

Research Performers



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MEMBERSHIP

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PARTNERSHIPS

NSERC CRSNG

nano québec

ICIP CIPI

Non-Quebec Universities

UNIVERSITY OF TORONTO INSTITUTE FOR AEROSPACE STUDIES
Faculty of Applied Science and Engineering

Carleton UNIVERSITY
Canada's Capital University

RYERSON UNIVERSITY

UNIVERSITY OF ALBERTA
EDMONTON, ALBERTA, CANADA

Waterloo

uOttawa

UBC

University of Victoria | British Columbia Canada

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Board and Executive Committee

***Executive Committee Members** (sitting) : André Bazergui (CRIAQ, CEO), Walter Di Bartolomeo (PWC), Philippe Molaret (Thales; Treasurer), Fassi Kafyeke (Bombardier; Vice-Chair), Christophe Guy (École Polytechnique; Vice-Chair), Guy Lambert (Bell Helicopter Textron Canada, Chair), Christophe Pierre (U. McGill), Claude Bédard (ETS, Secretary), Simon Durham (MDS-PRAD), avec Claude Lessard (Delastek, Chair of Research Committee)*

***Les membres et observateurs du CA** (standing) : Alain Bourque (for Patrick Champagne, CMC-Electronics), Dominique Sauvé et Karen Packwood (CRIAQ), Robin Drew (Concordia), Christian Ou imet (Turbomeca Canada), Chantal Vernier (CRIAQ), Martin Lévesque (Marquez), Claude Baril (Composites Atlantic), Sylvain Ri endeau (for Marc Donato, MDA), Pierre Dicaire (for Jerzy Komorosky (CNRC-IAR), Suzanne Benoît (Aéro Montréal), Luc Lachapelle (PATT), Raymond Panneton (U. Sherbrooke), Jean Dubuc (L-3Com), Joe Marcheschi (Avior), Kostas Stavrianos (for Chris Bark ey, Rolls-Royce Canada), Bernard Strauss (MDEIE), Jean-Christophe Cuilliere (for Georges Abdul-Nour, UQTR), Louise Dandurand (Concordia), Hany Moustapha (PWC, Honorary Member), Pascal Desil ets (CTA), Jean Nicolas (U. Sherbrooke, Honorary Member), Carlos Trindade (CRIAQ).*

*Not on photo: **Giuseppe Ombra (DEMA aeronautics), John Mannarino (MSS), Adolfo Klassen (CAE), Mathieu Dumouchel (MicroStep). Nick Giannias (Pregasis), Pierre Labelle (CDCQ), Jean-Claude Piedboeuf (ASC), Armineh Garabedian (Globvision), Louis Veuilleux (Sologlobe), Patrick Lessard (Prob otik), Mathieu Boisclair (Maetta), Sorin Busuioc (SCDS-Pro), Claude Gilbert, (UQAC), Emmanuel Maes (Mecachrome), Séjourné Morin (ScyForm), Jean-Pierre Ouellet (UQAR), Camil Poulin (Air-Terre Équipment), Jacques Saada (AQA), Martin Belanger (Opal-RT), Jean-Pierre Labelle (CDCQ), … (ARTEC), Alphonso Minicozzi (Minicut), Paul Stafiej (Sonaca-NMF), Pierre Prémont (FQRNT), … (UQAM), … (AIAC), Bogdan Ciobanu (CNRC-PARI)***

A Special Synergy

Third Research Forum 2006-03-06	***Fourth Research Forum 2008-04-17***
225 attended (including 90 from industry)	***290 attended (including 100 from industry, 20 international)***
16 new projects	***40 new projects***
Open to Non-Quebec Universities	

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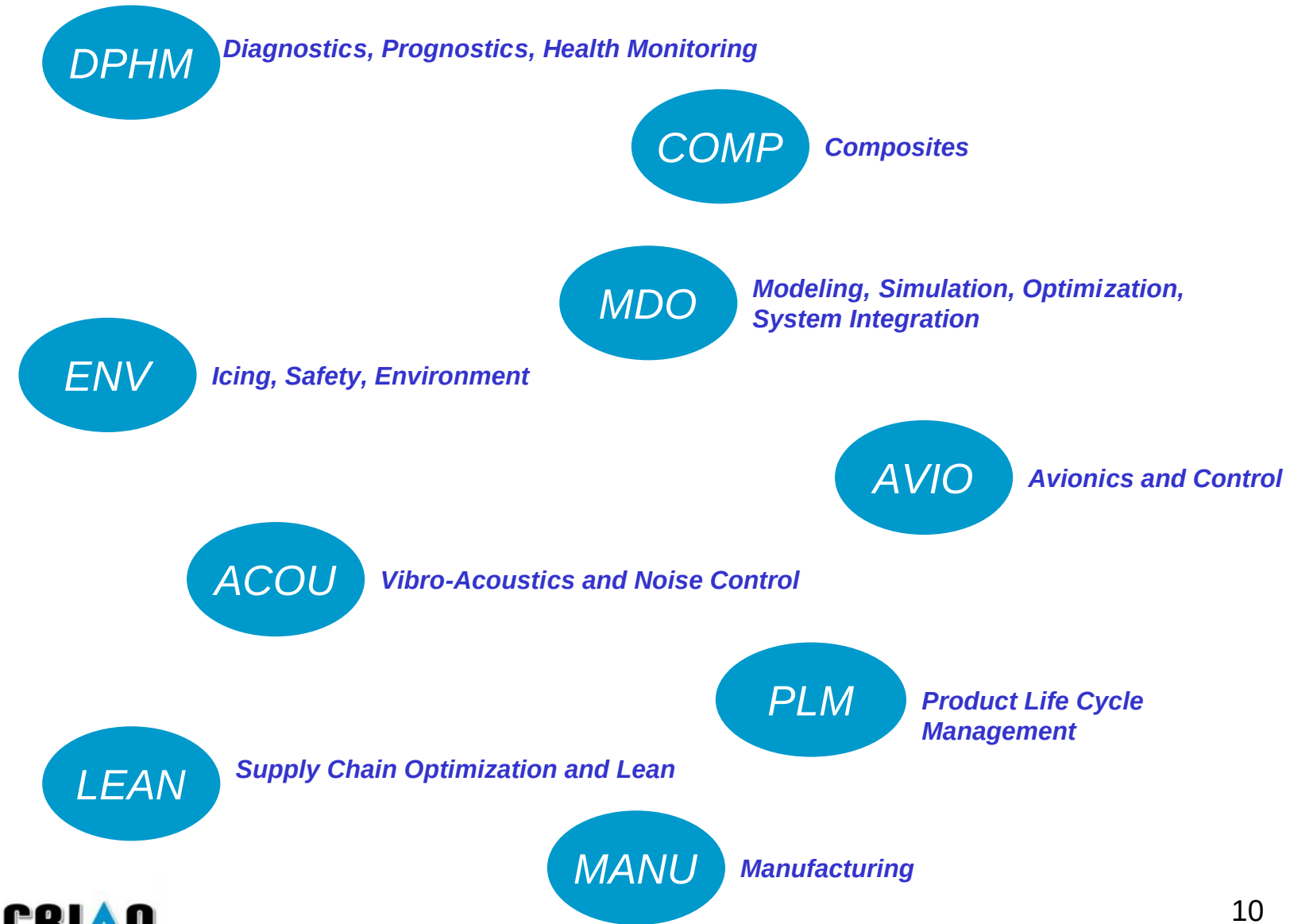
Research Themes



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Intellectual Property

Background IP *identified in the specific Project Agreement including computer software will be owned by the original owner. Any Background IP included in the Foreground will be subject to the specific provisions that have been agreed upon in the Project Agreement.*

Foreground IP *owned by Project Partners whose researchers have effectively contributed to its generation and in proportion to the percentage of innovative contribution as specified in a Disclosure of Invention to be filed by the inventors. The Background IP remains exclusively owned by the original owner.*

Licensing *: Industrial Project Partners obtain an exclusive world-wide royalty-free license for aerospace applications on any Project Foreground IP owned by University Partners or NRC; specific benefits sharing or financial compensation may be addressed to in the Project Agreement.*

Publication*: Subject to the limitations of the Non-disclosure clause in the Project Agreement, publication rights are guaranteed to all Project Partners. Use in teaching and academic research is also guaranteed.*

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Project Selection Process

- ***Research Forum***
  - *Industry needs*
  - *Thematic Workshops*
  - *Leads to Executive summaries*
- ***Research Committee***
  - *Evaluation of Executive summaries*
  - *Industry Commitment secured*
- ***Board***
  - *Approval*
- ***CRIAQ***
  - *Researchers informed and invited to prepare full proposal (NSERC-CRD)*
  - *Team meetings, exchanges*
  - *Thorough follow up and guidance*
  - *IP Agreement and SOW negotiations*

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Project Follow-up Process

- ***Individual Agreements***
  - *University and Industry Principal Investigators*
  - *Specific timetables and deliverables*
- ***Team meetings***
  - *Follow-up meetings every other month (or more)*
  - *Full meetings (reports and presentations) bi-yearly*
  - *CRIAQ participation (when possible)*
- ***Progress reports to CRIAQ***
  - *Co-signed by Principal Investigators*
  - *Bi-yearly (Including yearly report to NSERC)*
  - *Reviewed by Research Committee*
- ***Payment to University following Industry approval***

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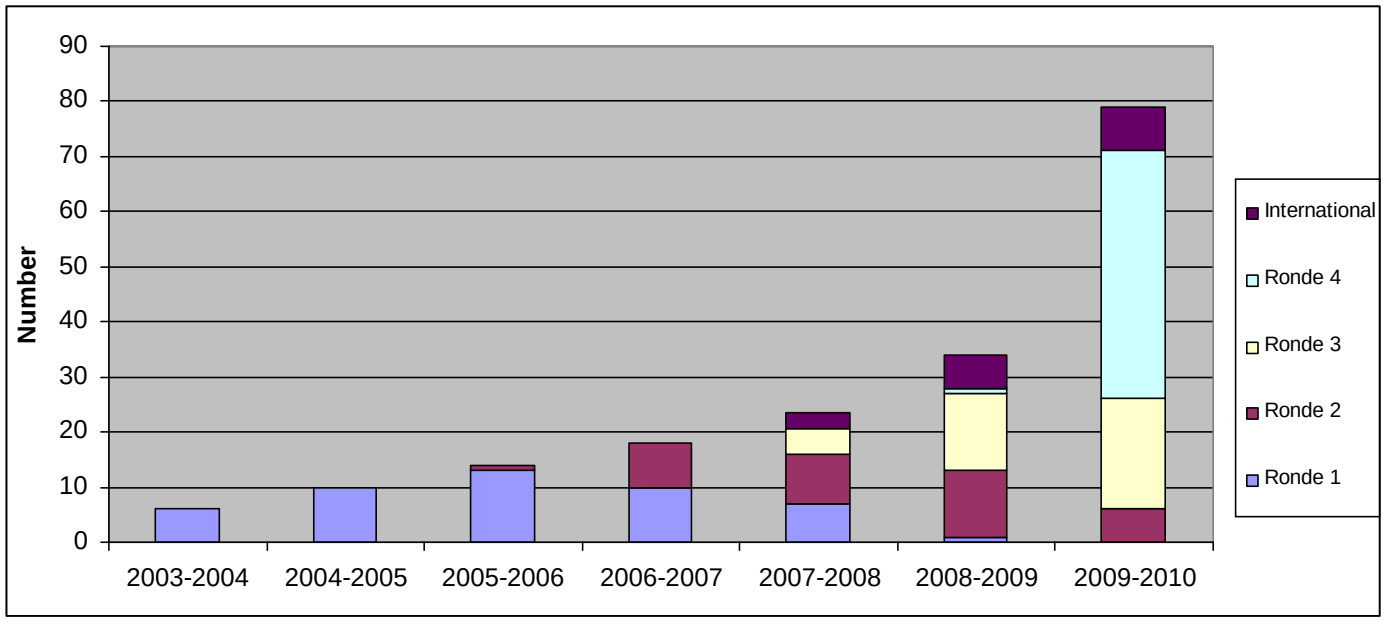
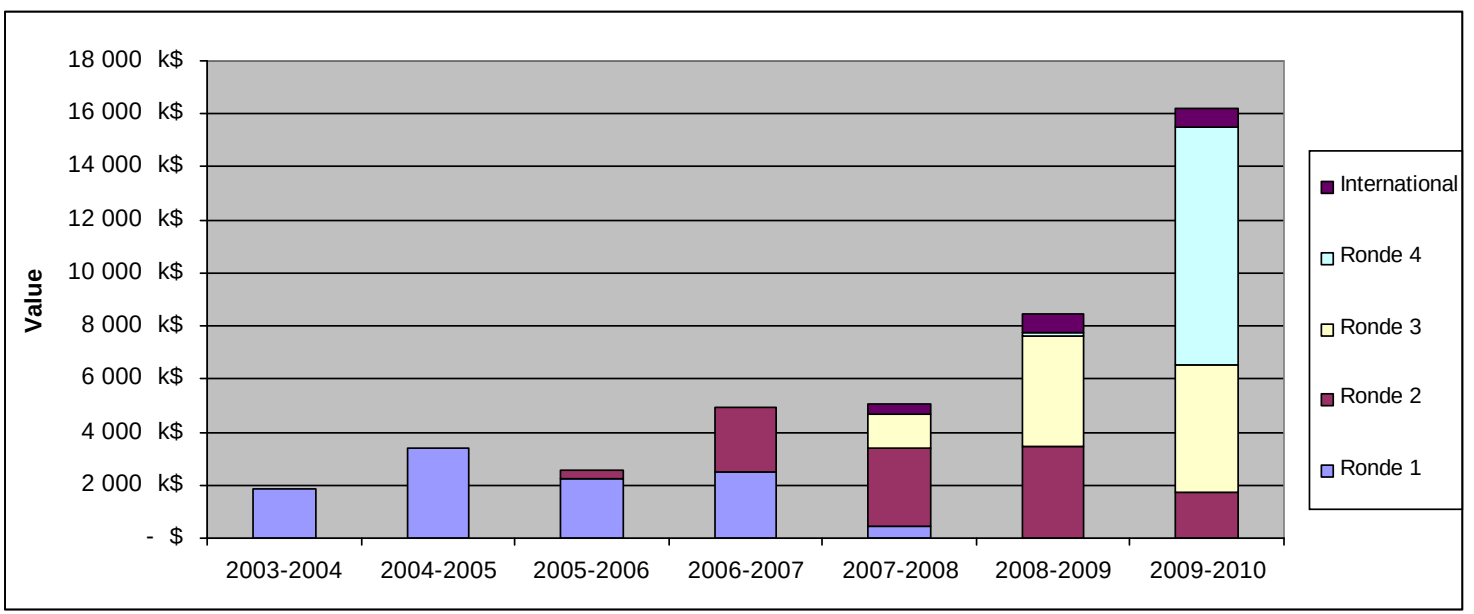
Growth of projects





A dynamic collaborative research activity (Projects since 2003)

Research Projects													
Theme		Tot.	Round 1	Round 2		Round 3			Round 4		International		
			Compl.	Current	Under Evaluati	Current	Under Evaluati	In prep.	Under Evaluati	In prep.	Current	Under Evaluatio	In prep.
ACOU		5	1			4							
AVIO		5	1		2				2	1			
COMP		13	3	2		2	1		5	5			1
DPHM		6	2	1		1	1		1				
ENV		5		1		1			2	8		1	
LEAN		1						1	1				
MANU		14	2	3			1	2	7	5	1		1
MDO		11	3	2					1	1	4	1	3
PLM		5	1	1	1	1		1	1				
Totals		65	13	10	3	9	3	4	20	20	5	2	5
Industry (cash)	M$	11.5	2.2	2.2	0.5	1.4	0.7	To be confir-med	4.0	To be confir-med	0.5	0.1	To be confir-med
Industry (in-kind)	M$	14.3	3.7	2.2	0.7	2.5	0.7		4.0		0.5	0.1	
Public Funding (MDEIE, NSERC, others)	M$	30.2	4.5	4.6	2.1	3.9	2.1		11.9		1.0	0.1	
Total Value	M$	55.9	10.4	9.0	3.3	7.7	3.6		19.8		1.9	0.3	

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Productivity

	06-07	07-08
Students		
Post-doc	8	**14**
Ph.D.	25	**54**
M.Sc.A.	41	**87**
Undergraduate trainees	6	**62**
Employees		
Research Associates	20	**30**
Technicians	8	**10**
Scientific Output		
Publications (Peer review)	35	**53**
Conferences (Peer review)	50	**50**
Technical Reports	70	**142**
Software transferred to Industry	10	**10**

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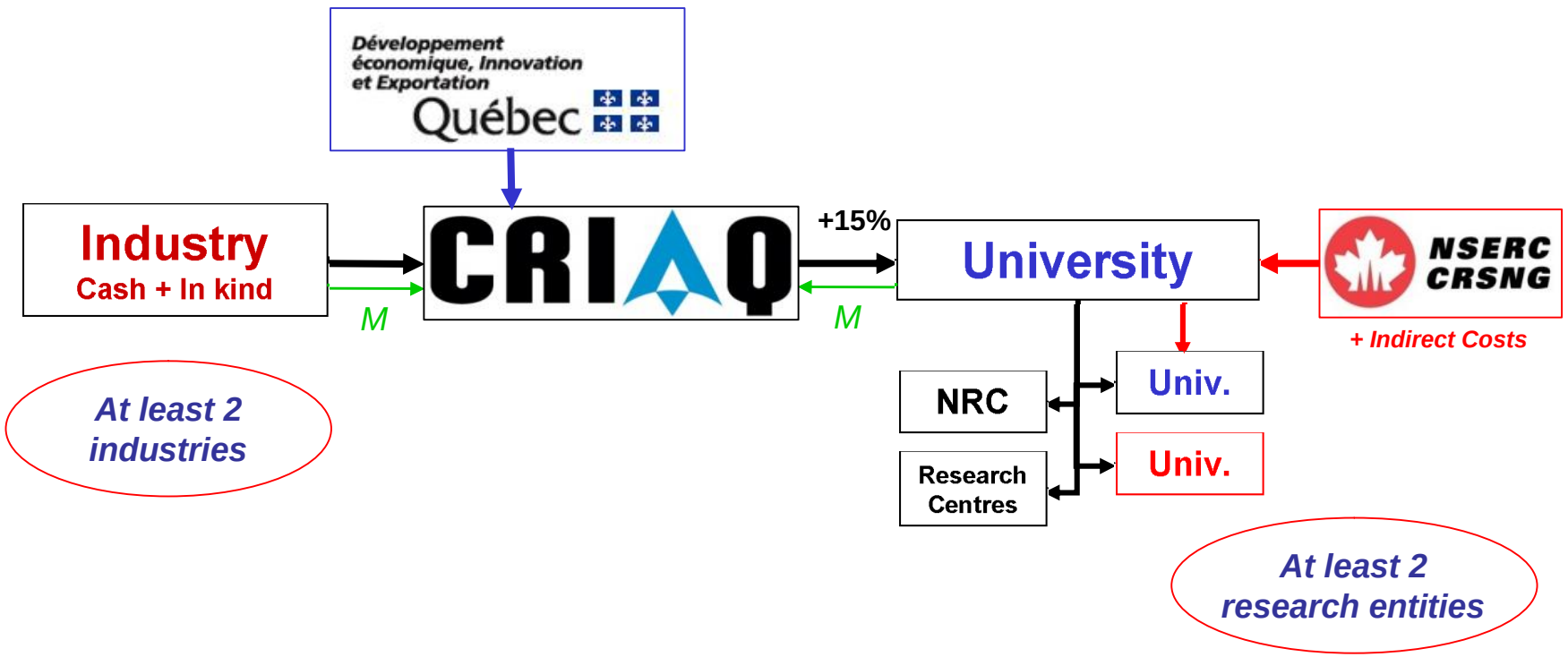
Project Financing



M … Membership fees

International

- ***France***
  - ✓ *2004-02 Quebec Ministerial mission to France (Paris, Bordeaux, Toulou se)*
  - ✓ *Special budget by MDEIE to CRIAQ for Québec-Aquitaine activities*
  - ✓ *Several French missions to Québec*
  - ✓ *2006-11 Mission to Toulouse and Bordeaux (CRIAQ delegation of 13)*
  - ✓ *2007-11, Rendez-vous technologiques in France*
  - ✓ *2008-04, Special Symposium as part of Aeromat Montreal activities, fo llow up 2008-05 (several projects identified)*
  - ✓ *2008-07, Symposium in Bordeaux*
  - ✓ *2009-07, Follow-up simposium*
- ***Belgium***
  - ✓ *2004-05 MOU with CENAERO (Wallonia)*
  - ✓ *Exchanges with Flanders*
  - ✓ *2005-2008 CRIAQ researcher funded through the IVe Commission Mixte de Coopération Québec/Wallonie-Bruxelles (with UCL researcher)*
  - ✓ *2007-12 Participation in project selection for Skywin*
- ***Italy***
  - ✓ *2005-02 MOU with CIRA during visit of Campania Region*
  - ✓ *2007-02 MOU with Campania Region during visit of Minister in Montreal*
  - ✓ *Several Italian missions to Québec*
  - ✓ *2006-2009 two CRIAQ researchers funded through the VIe Sous-commission mixte Québec-Italie (with researchers from CIRA)*
  - ✓ *2007-2008 Special Campania Region budget to fund Italian researchers to spend time in Québec*

International (cont'd)

- ***India***
  - ✓ *2006-11 Quebec Ministerial mission to India (CRIAQ delegation of 10): Mumbai, Bangalore, Delhi*
  - ✓ *2007-2010, two industry-driven joint projects funded. Several more in preparation*
  - ✓ *2008-01 Industry-University mission to India: Bangalore, Kanpur, Delhi*
  - ✓ *2008-04 Indian delegation spends week in Montreal and attends 4th CRIAQ Forum*
  - ✓ *2009-05 Quebec delegation to IISc centenial, NAL and IITM 50th anniversaries*
- ***UK***
  - ✓ *Several contacts with UKTI*
  - ✓ *Mission 2007-10-15 to 19*
- ***USA***
  - ✓ *2008-03-27 Visit of SE-US delegation and special seminar*
- ***Mexico***
  - ✓ *2008-04 Delegation from Queretaro attends 4th CRIAQ Research Forum*
- ***Bavaria***
  - ✓ *2008-05 Signature of MOU with BavAIRia*
  - ✓ *2008-06 Visit of Bavarian delegation*
  - ✓ *2009-04, Mission in preparation*
- ***China***
  - ✓ *2008-11 Quebec Premier's Mission*
- ***Singapore***
  - ✓ *2009-04 Mission expected in Quebec*

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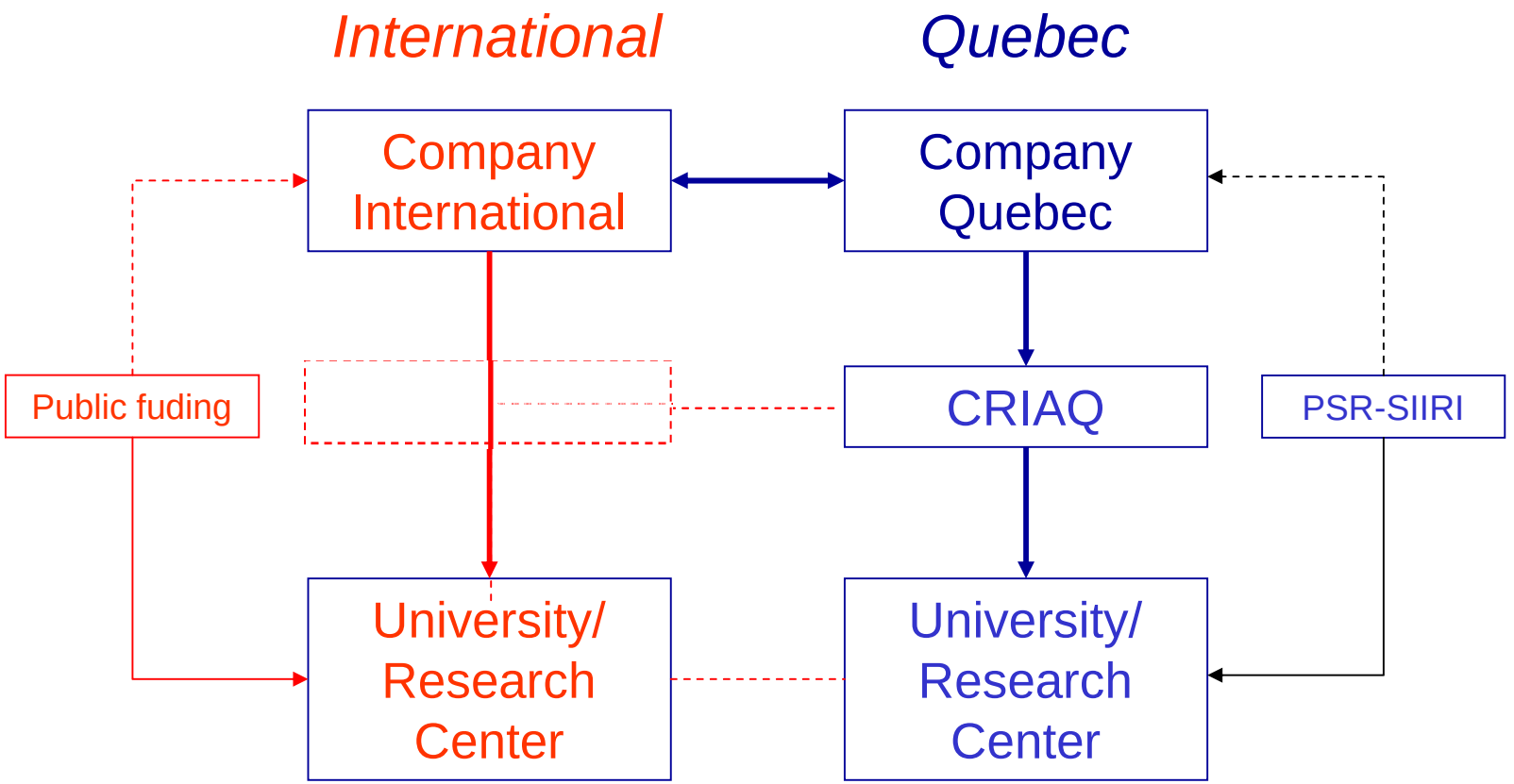
CRIAQ model very well received

International R&D collaboration
Industry driven project Scenario



The CRIAQ ingredients

- ***Launched on solid bases***
  - ✓ *Targeted Funding*
    - ✓ *Valorisation-Recherche Québec (Major Projects Program)*
    - ✓ *FQRNT (Strategic Networks Program)*
  - ✓ *Industrial and University Champions*
  - ✓ *Strong Industry financial support*
  - ✓ ***Presence in Québec of a strong Aeronautics Industry with major OEM 's.***
  - ✓ *Buy in by Universities and Research Centers*
- ***Sustained Financial Support***
  (MDEIE, CRSNG, FQRNT, Industries, Universities/Research Centers)
- ***The Research Forum Formula***
- ***The Quality of the Research Teams***
  - ✓ *Close collaboration (1 University and 1 Industry leader)*
  - ✓ *The best University Researchers (recognized by NSERC)*
- ***The Special Programs in support of Researchers***
  - ✓ *Funding of Research Personnel*
  - ✓ *Travel costs, Guest researchers*
- ***The Programmes in support of Students***
  - ✓ *Research initiation for Undergraduates*
  - ✓ *Competitions*
  - ✓ *Student Forums*

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The CRIAQ ingredients (cont'd)

- ***The multipartership***
  - ✓ *Minimum 2 industries and 2 research entities*
- ***Inclusiveness***
  - ✓ *All of the CRIAQ members are represented on the Administration B oard (18 members + observers)*
  - ✓ *Similar arrangement for the Research Committee*
  - ✓ *A strong Executive Committee*
- ***Role of Facilitator***
  - ✓ *Close collaboration with all participants (Industry, universitie s, Research Centers, Government, Granting Agencies)*
  - ✓ *Management team's constant attention and fast response*
  - ✓ *No duplicate effort (we do not reinvent the wheel)*
  - ✓ ***Huge effort to solve Intellectual Property Issues***
- ***Thorough Follow-up***
- ***Strong Network***
  - ✓ *Québec, Canada, International*

Conclusions

CRIAQ …

- ***Unique Model***
- ***Light networked structure***
- ***Strong financial support from Government, (Included in Quebec's Research and Innovation Strategy)***
- ***Financially supported by and Strategic for Industry, Universities, and Research Labs***
- ***Hundreds of researchers, specialists and students***
- ***Active in national and international scenes.***

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ANNEX 1

1st round Projects

First Round Themes and Projects

2nd round

3rd round

(All Completed)

COMPosites

- ***1.1 Bonded composite wingbox***
- ***1.2 High performance thermoplastic composites***
- ***3.1 Impact modeling of composite aircraft structures***

MANUfacturing

- ***1.7 Brazing,large gap, Martensitic and Austenic SS***
- ***1.8 High performance machining of light alloy components***

ACOUstics

- ***2.2 Improving acoustic environment in rotary and fixed wing airc raft***

MDO

- ***3.2 Integration of real-time flight simulation and CFD***
- ***3.4 Global model parameter estimation technology***
- ***4.1 Multidisciplinary Optimization Standardization Approach for integration and Configurability (MOSAIC)***

PLM

- ***4.3 Integrated Product-Process Change Management System (IP2CM)***

AVIOnics

- ***5.3 Dynamic Test Bed for FMS***

DPHM

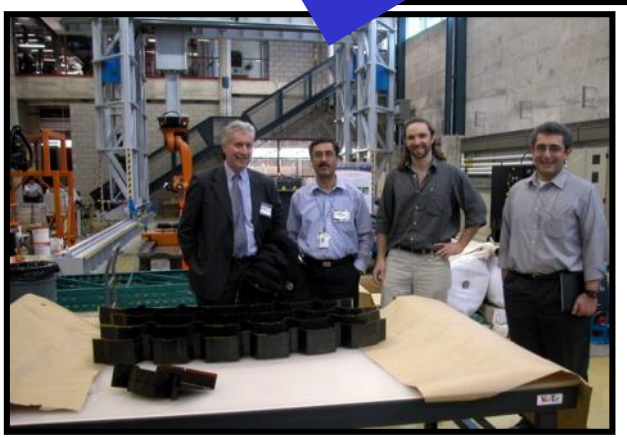
- ***6.1 Microsystems for in situ health monitoring of aircrafts***
- ***6.2 MEMS for jet engine control and monitoring***

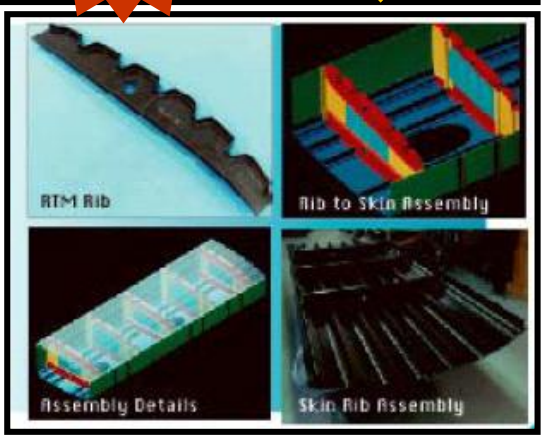
1.1 Bonded Wingbox Survivability Demonstration Program

Suong Van Hoa, hoasuon@vax2.concordia.ca
Robert Fews, rfews@bellhelicopter.textron.com

Also major funding from Technology Partnership Canada program (T PC) and NRC's Office of Callaborative Technology Development

- *Analysis, design and manufacture of a composite wing using a novel tooling philosophy and primary bonded joints.*
- *The project was successfully completed in August 2005*
- *It ranks as one of the largest composite structures ever fabricated in Canada. The project comprises toughened epoxy, thick composites, bonding, trimming and hole making, RTM, NDI technologies.*





1.2 Development of Low-Cost Aircraft Structural Components using High-Performance Thermoplastic Composites

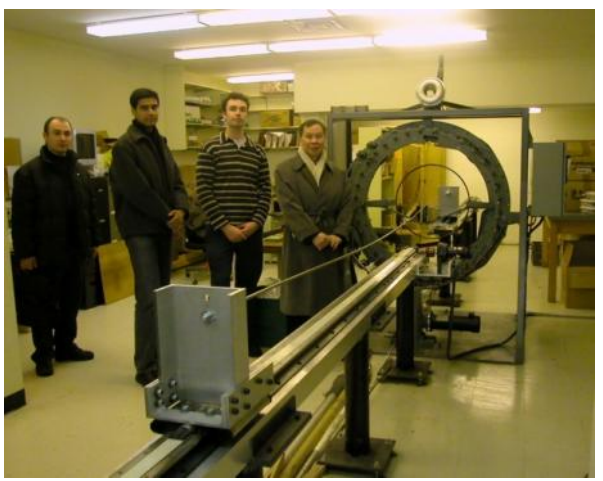
Suong Van Hoa, hoasuon@vax2.concordia.ca
Fassi Kafyeke, fassi.kafyeke@aero.bombardier.com

Université Concordia University
Université du Québec École de technologie supérieure
CNRC-NRC
BOMBARDIER
Bell Helicopter A Textron Company

Development, using thermoplastic composites, of:
- ***A portion of a wing box panel.***
- ***A cross tube that is a part of a landing gear for helicopters.***

Thermoplastics are light weight and low cost materials.

Completed 2008-01



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1.7 Development of Brazing Process Applied to Martensitic and Austenitic Stainless Steels, and Nickel Superalloys

Philippe Bocher, philippe.bocher@etsmtl.ca
Alain Bouthillier, Alain.Bouthillier@pwc.ca

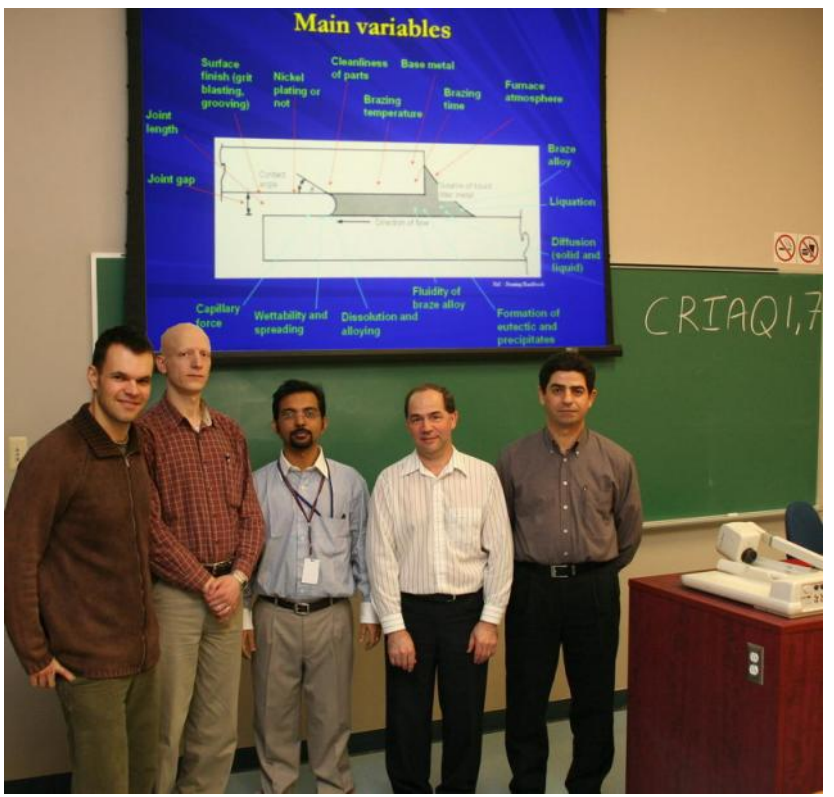
Université du Québec
École de technologie supérieure

Pratt & Whitney Canada
A United Technologies Company

Université Concordia University

CNRC-NRC

Study the behaviour of commercially available brazing alloys to join together different stainless steels used in gas turbine engines. The optimization of brazed alloys will be performed based on the manufacturing process and the fatigue properties of brazed joints.



Completed 2009-01

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1.8 Optimization of High Performance Machining of Light Alloy Aerospace Components

René Mayer, rene.mayer@polymtl.ca
Don McIntosh, don.mcintosh@pwc.ca

ÉCOLE POLYTECHNIQUE MONTRÉAL

Pratt & Whitney Canada
A United Technologies Company

Université du Québec
École de technologie supérieure

BOMBARDIER

High performance machining of light alloy components is studied using experimental and model based approaches to optimize machine and process parameters for high speed machining. Objective: gain in quality and productivity.

Completed 2007-01

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2.2 Improving the Acoustic Environment in Fixed and Rotary Wing Aircraft

Alain Berry, alain.berry@usherbrooke.ca
Fassi Kafyeke, fassi.kafyeke@aero.bombardier.com

- **Provide industry with state-of-the-art simulation tools to analyse the acoustic environment of aircraft**
- **Develop innovative active control techniques to reduce structure-borne sound inside helicopters**

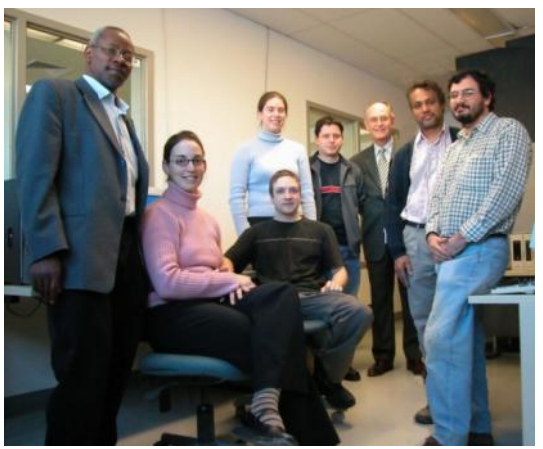
Completed 2006-12

ADRIQ 2007 Finalist

3.1 Impact Modeling of Composite Aircraft Structures

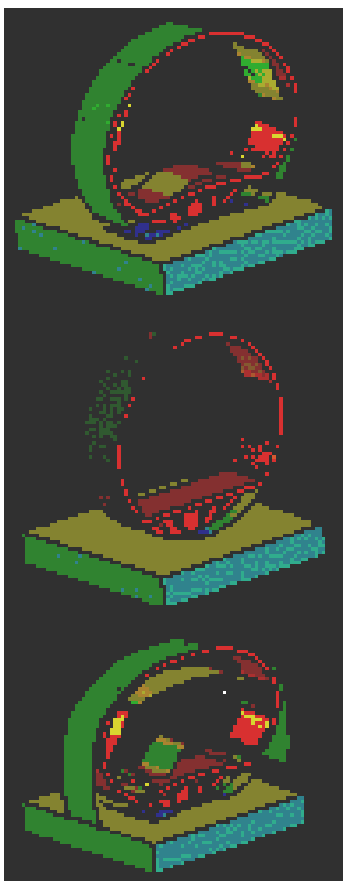
Augustin Gakwaya, augustin.gakwaya@gmc.ulaval.ca
Alain Colle, acolle@bellhelicopter.textron.com

- **Develop a methodology for analysis and certification of composite aircraft components subjected to bird impact based on the Finite Element Method.**
- **Develop a design and analysis methodology for rotor fragment containment structures made of composite materials.**
- **Model and simulate selected industrial airframe or aero-engine parts under specified impact and crash loading conditions.**



ADRIQ 2008 Finalist

Completed 2008-05



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3.2 Integration of Real-Time Flight Simulation and Computational Fluid Dynamics

Marius Paraschivoiu, paraschi@me.concordia.ca
Gerhard Serapins, gerhard.serapins@cae.com

Quantification of real-time flight simulation models using state-of-the-art computational flight dynamics techniques in lieu of actual flight test data. Although such an approach has wide range of applications, the proposed work will concentrate on the training flight simulators.

Completed 2007-08

3.4 Development of Global Model Parameter Estimation Technology

Ruxandra Botez, ruxandra.botez@etsmtl.ca
Edward Lambert, elambert@bellhelicopter.textron.com

New technologies will be developed to improve the generation of helicopter aerodynamic mathematical models from flight test data using parameter estimation techniques. Objective is to reduce the number of test flights.

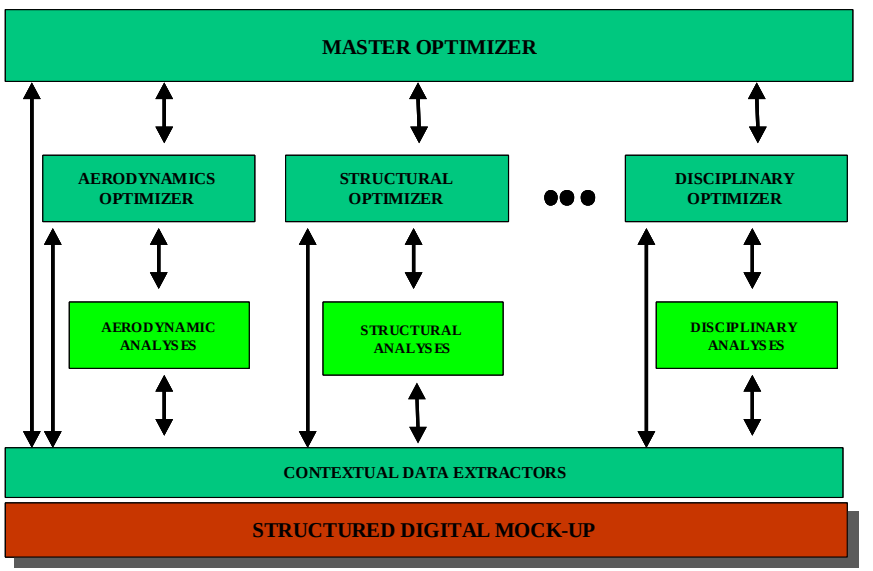
Completed 2007-01

4.1 MOSAIC - Multidisciplinary Optimization Standardization Approach for Integration and Configurability

Jean-Yves Trépanier, jean-yves.trepanier@polymtl.ca
François Pépin, francois.pepin@aero.bombardier.com

Develop multidisciplinary design optimization capabilities. Incl udes development of standardization approaches for data exchange and specialized components for analysis and optimization in an MDO context.

Completed 2007-11



4.3 IP2CM: Integrated Product Process Change Management

Roland Maranzana, roland.maranzana@etsmtl.ca
Pierre Gamache, pierre.gamache@pwc.ca

Université du Québec – École de technologie supérieure
Pratt & Whitney Canada – A United Technologies Company
École Polytechnique Montréal
McGill
BOMBARDIER
Université de Sherbrooke

Develop a generic interoperability mechanism to define, develop and validate models, methods and tools to provide the interoperability required to achieve an integrated product and process change management throughout a product life cycle.

Completed 2007-05

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5.3 Dynamic Test Bed for Flight Management Systems

Henry Hong, henhong@vax2.concordia.ca
Sohel Fares, Sohel.Fares@CMCElectronics.ca

Development of a real-time dynamics test bed (DTB) which will serve as a comprehensible design / test tool for the flight management system (FMS). The DTB will facilitate more efficient and more economic designs of FMS systems.

Completed 2008-03

6.1 Microsystems for In-Situ Health Monitoring of Aircraft

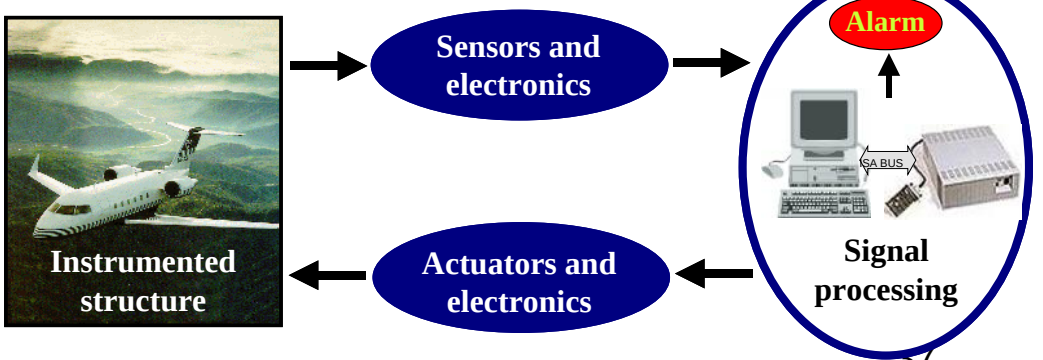
Patrice Masson, patrice.masson@usherbrooke.ca
Fassi Kafyeke, fassi.kafyeke@aero.bombardier.com

UNIVERSITÉ DE SHERBROOKE
BOMBARDIER
Université du Québec – École de technologie supérieure
SINTERS
ÉCOLE POLYTECHNIQUE MONTRÉAL
McGill

- *Reduce high costs associated with periodic prescribed inspections of aircraft, usually requiring dismantling of some components of the structure, by the development of an in- situ structural health monitoring (SHM) system.*

- *The system will provide, either passively or actively, real-time in-situ structure load transfer profiles, identifying the efficiency and health of the structure, to an on-board data acquisition system. Load profiles will be analyzed and evaluated against pre-set failure threshold marks for the issuance of an alarm signal.*

Completed 2007-11



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6.2 MEMS for Control and Monitoring of Gas Turbine Engines

Ion Stiharu, istih@vax2.concordia.ca
Patrice Dionne, patrice.dionne@pwc.ca

- **Prove concept of MEMS-based control and monitoring systems for gas jet engines through integration of existent systems**
- **Develop a pressure sensor to measure the dynamic pressure in a high temperature environment.**
- **Implement temperature sensors for health monitoring or development testing purposes**

Completed 2007-10

ANNEX 2

2nd round Projects

2nd Round Themes and Projects

1st round

3rd round

MANUfacturing

- 1.12 Gear Hardening by Induction
- 1.20 Erosion and Wear Resistant Coatings for Engine Components and Helicopters
- 4.6 Hydroforming

COMPosites

- 1.14 High Conductivity Carbon-Epoxy Composites
- 1.15 RTM optimization for composites

DPHM

- 1.18 Health monitoring with advanced NDT techniques

ENVironment

- 2.8 Anti-Icing Systems for Small Helicopter Rotor Blades

MDO

- 4.14 Gear Train Design Optimization
- 7.1 Aerolastic Wing Research

PLM

- 1.19 Radio Frequency Identificaiton Devices (RFID) for Overhaul/Repair
- 4.7 Drawingless Product Development

AVIOnics

- 5.5 Formal Methods in Model-Driven Avionics Software Development
- 5.6 Software Architecture in Avionique andAeronautics

1.12 Induction Hardening of Bevel Gears for Aerospace Applications

Philippe Bocher, ETS
S.Sundararahan, PWC

Université du Québec
École de technologie supérieure

Pratt & Whitney Canada
A United Technologies Company

Université Concordia University

AIR/GROUND EQUIPMENT INC.
AIR/TERRE ÉQUIPEMENT INC.

Université du Québec à Rimouski

NSERC CRSNG
Funding approved
Start 2007-04

Investigate the induction hardening behaviour of aeronautic martensitic steels in order to control the hardening patterns and predict the field performance of manufactured gears. The model will also be used to develop contour hardening on bevel gears.

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www.criaq.aero

1.14 Development of carbon/epoxy composites with high electrical conductivity and electromagnetic shielding effectiveness for aircraft applications

Suong V, Hoa, Concordia
Robert Fews, BHTC

Funding approved
Start 2006-09

Develop methods to make composite materials that are electrically conductive to provide protection for electrical components contained inside composite boxes against electrical spike coming from different sources in an aircraft.

1.15 Optimized Design of Composite Parts by RTM

Larry Lessard, McGill
Robert Fews, BHTC

McGill

Bell Helicopter
A Textron Company

DELASTEK

ÉCOLE POLYTECHNIQUE MONTRÉAL

CNRC-NRC

NSERC CRSNG

Funding approved
Start 2005-11

Develop an optimized design, analysis and manufacturing process for composite materials, using the Resin Transfer Moulding (RTM) process as a technology demonstrator. An expert system will be developed which will integrate and optimize the RTM process.

Completed 2009-02

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1.18 Development of Intelligent Health Monitoring System for Rotating Machinery and Structural Components

Aouni Lakis, École Polytechnique
Usamah Saeed, PWC

Funding approved
Start 2006-06

The work on this project will be done in 3 steps: 1) Identifying the gaps in the state-of-art in the monitoring of rotating machinery. 2) Developing a prototype online monitoring system for gears and bearings. 3) Characterizing faults by estimating their size in qualitative and quantitative terms.

1.19 Investigation of RFID based Tracking, Control and Execution Systems

Amar.Ramudhin@etsmtl.ca
Dominic.Varvaro@pwc.ca

Université du Québec
École de technologie supérieure

Pratt & Whitney Canada
A United Technologies Company

McGill

Sologlobe

Investigate how RFID can be leveraged to increase operational productivity by improving the flow of material on the shop floor and in the supply chain, its impact on business processes (planning, monitoring, etc) and the ROI for the aftermarket organization.

In reevaluation

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1.20 Erosion Resistant Coatings for Aerospace

Jolanta Sapieha, École Polytechnique
Frédéric Bérubé, P&WC

Funding approved
Start 2006-01

NanoQuébec Collaboration

Novel erosion and wear resistant coatings compatible with aircra ft engine components and helicopters will be developed. Critically compare the performance of binary, ternary and quaternary coatings with a structure control led on nanometer scale fabricated by complementary vacuum deposition methods.

2.8 Low-Energy Ice Protection System Applied to Small Rotorcraft

Jean Perron, UQAC
S. Chowdhury, BHTC

Funding approved
Start 2006-06

Setting up and experimentally validating a tool for predicting rotor blade ice accretion and shedding modes. Identifying from the results obtained the design parameters of an ice protection system based on latest technologies for main rotor blades of small helicopters.

4.6 Process Modeling Tools Development for the Virtual manufacturing of Aerospace Components by Tube Hydroforming

Augustin Gakwaya, Laval U.
Jean Savoie, PWC

Tube hydroforming is a new manufacturing technology that offers significant advantages and provides high quality products at lower life cost values.

Start 2007-05
Under NSERC Evaluation

4.7 Drawingless Product Development Process

Louis Rivest, ETS
Weston Waldron, PWC

Funding approved
Start 2006-09

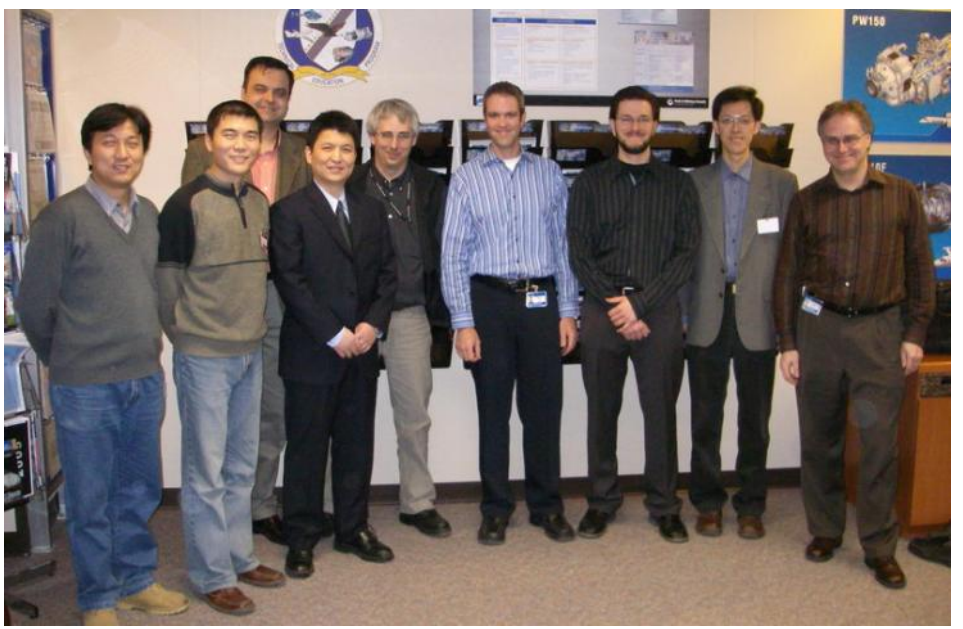
Eliminating engineering drawings from well established product development processes requires assessing 3D tools' actual capabilities and devising new processes to convey engineering data.

4.14 Product Design Optimization with Integration of Computational Tools

Aurelian.Vadean@polymtl.ca
David.Venditti@PWC.ca

Funding approved
Start 2006-01

Develop a methodology for design optimization for aircraft components through an example of gear train design. An optimization system will be built based on integration of GIDS and CATIA gear data.



5.5 Exploring Formal Methods in Model-Driven Development of Certified Avionics Software

Ettore.Merlo@polymtl.ca
Pierre.Labreche@CMCElectronics.ca

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Université du Québec
École de technologie supérieure

Esterline
CMC Electronics

CAE

PRESAGIS

MANNARINO
SYSTEMS & SOFTWARE INC.

Reduce the costs of certified avionics software using MDD and formal methods.

Under NSERC Evaluation

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5.6 Software Architecture in Avionics and Aeronautics

Luc.Bois@polymtl.ca
Pierre.Labreche@CMCElectronics.ca

Study and apply best practices in the field of Software Architecture, in the specific context of software developed in the avionics/aeronautics domains, in presence of high reliability, high availability and certifiable software systems.

To begin 2009
1 year
Feasibilty study

7.1 Laminar flow improvement on an aeroelastic research wing

Ruxandra Botez, ETS
Philippe Molaret, Thales Canada

Université du Québec
École de technologie supérieure

THALES

ÉCOLE POLYTECHNIQUE MONTRÉAL

CNRC-NRC

BOMBARDIER

NSERC CRSNG

Funding approved
Start 2006-10

Investigate the design and demonstrate feasibility of an aeroelastic aircraft wing capable of modifying its geometry in real-time during flight in order to optimize the performance of the aircraft for a range of flight conditions.

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ANNEX 3

Third Round Projects

Third Round Projects

1st round

2nd round

ACOU1 New liner technologies and local expertise for characterization and fabrication of nacelle acoustic treatments
ACOU2 Active control of transmission noise in helicopters
ACOU3 Sound field rendering in aircraft cabins
ACOU4 Embedded Damping Elements in Composites

PLM 1 Digital Product Data Mining for PLM: Application to Cost and Inspection Features extraction and interpretation (in preparation)
PLM 2 Collaborative Development for Product Life Cycle Management

DPHM3 Damage prognosis for condition-based maintenance of aircraft structures
DPHM4 Decision Support System for Fleet Health Monitoring and Prognosis

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Third Round Projects (Cont'd)

MANU1 Burr prediction/avoidance & deburring of light alloys and nickel-based superalloys (in preparation)
MANU2 High Performance Milling of Monolithic Aerospace Structures (in preparation)
MANU3 Effect of bulk residual stresses on the final geometry of machined parts (in preparation)
MANU4 Processes and Materials for repearable anti erosion coatin gs (in preparation)

COMP1 Out of Autoclave Composite Aerospace Structures Manufacturing
COMP2 Buckling and post-buckling behavior of monocoque composite cylinders
COMP3 Static and fatigue high temperature behavior of braided composites used in the aeronautics industry
COMP5 Thermoplastic composite tail-boom concept demonstrator

ENV 1 Super-hydrophobic surface coating for aircraft icing protection
ENV 2 SPALL Evaluation of nanostructured thermal barrier coati ng spallation mechanisms under thermal gradient exposure (in preparation)

ACOU_1 Development of New Liner Technologies and Local Expertise for Characterization and Fabrication of Nacelle Acoustic Treatments

Noureddine Atallah, Université de Sherbrooke
Sid-Ali Meslioui, PWC

Funding approved
Stard 2007-01

Development of new nacelle acoustic liners that are both commercially viable and top acoustic performers

ACOU_3 Sound Field Rendering in Aircraft Cabins

Alain Berry, Université de Sherbrooke
Robby Lapointe, Bombardier

Financement accordé
Début 2008-04

Build an 'Acoustic Siumulator' to specially emulate to spatially emulate the acoustic environment of aircraft cabins. The simulator would have the capability to reproduce various noise sources (engine, drive, turbulent boundary layer, air climate …) in a specific cabin environment, with their representative frequency content, spectro-temporal and spatial attributes. Combined with vibroacoustic prediction software, the simulator would also be able to simulate various noise control scenarios. The flexibility of the simulation will allow for rapid comparisons between competing proposed solutions to noise problems, resulting in objective measurement of subjective preferences

ACOU_2 Active control of transmission noise in helicopters

Alain Berry, Université de Sherbrooke
Pierre Rioux, Bell Helicopter Textron Canada

Funding approved
Start 2008-01

The goal is to validate the effectiveness of active control in a real environment. The general objective is to extend the laboratory active control system developed under CRIAQ 2.2 to a system capable of flight demonstration that will allow the engineering demonstration of the feasibility of the system in a real environment. The helicopter platform used in project 2.2 will also be used for this research project. However, the plan is to also look at what challenges would need to be addressed in order to adapt this technology to other helicopter platforms considering the significant differences in drive systems and structural paths.

ACOU_4 Embedded Damping Elements in Composites (EDEC)

Annie.Ross@Polymtl.ca
Sophie.Girard@Artec-spadd.com

Develop a low-cost, low-weight, low-noise composite that will satisfy helicopter industry requirements. The specific objectives:

- ***Identify and characterize vibro-acoustic treatment materials that will be compatible with the composite manufacturing processes, and that will allow the component to maintain its strength, stiffness, damage tolerance, ability to be finished and to be repaired.***
- ***Develop a composite material vibro-acoustic damping treatment capable of yielding high vibration attenuation and high acoustic insulation for frequencies of 10 – 2 000 Hz.***
- ***Predict vibration insertion loss and acoustic transmission loss from numerical model simulations.***
- ***Verify and quantify experimentally the actual vibration and noise attenuations achieved on representative prototypes.***
- ***Verify and quantify experimentally the mechanical behavior and fatigue damage of the prototypes.***
- ***Provide design guidelines and implementation procedures for industrialization purposes.***

Funding approved
Start 2008-01

PLM_2 Collaborative Development for Product Life Cycle Management

Vince.Thomson@McGill.ca
Warren.Hall@pwc.ca

NSERC CRSNG

Funding approved
Start 2007-12

McGill
Pratt & Whitney Canada
A United Technologies Company
UNIVERSITÉ DE SHERBROOKE
BOMBARDIER
Concordia University
CAE
ÉCOLE POLYTECHNIQUE MONTRÉAL
Rolls-Royce
Université du Québec
École de technologie supérieure
Esterline
CMC Electronics

Given a global environment where partners, suppliers and affiliates have different capabilities with respect to project and product data management, different environments for regulations with respect to protection of intellectual property (IP) and technology export, and different levels of information technology skills. The objectives of the project are to develop:

1. methods that provide effective data sharing dynamics for as wide a set of technical capabilities among partners, suppliers and affiliates as possible,

2. methods that provide a suitable environment for the protection of IP and the adherence to security regulations, and

3. models for information management for sharing data internally and externally. .

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DPHM_3 Damage Prognosis for Condition - Based Maintenance of Aircraft Structures

Patrice.Masson@uSherbrooke.csa
Jerome.Pinsonnault@aero.bombardier.ca

A damage prognosis approach is developed to enable condition-based maintenance of aircraft strutures. Part of this project is also a continuation of the project 6.1 The main objective of the project is to demonstrate a Damage Prognosis strategy by combining usage monitoring and structural monitoring. The specific objectives are:

• Demonstrate a sensor localization and optimization strategy for loading measurements in aerospace structures;

•Demonstrate early detection strategies for damages in aerospace structures;

• Demonstrate damage localization and propagation monitoring stra tegies;

•Assess commercially available sensors and actuators for the prop osed strategies;

• Design dedicated MEMS sensors and actuators for the proposed st rategies;

• Propose an approach for combining load and defect detection str ategies for efficient damage prognosis of aerospace structures.

• Demonstrate the damage prognosis approach on a simple case in f light test.

Under NSERC Evaluation

DPHM_4 Decision Support Systems for Aircraft Engine Fleet Monitoring and Prognostics

Khashayar Khorasani, kash@ece.concordia.ca
Louis-Michel.Trottier@pwc.ca

Funding approved
Start 2008-09

Develop integrated software algorithms for novel hybrid architectures consisting of computational intelligence and model-based approaches for providing decision support systems for aircraft engine fleet monitoring and prognosis.

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COMP_1 Out of Autoclave Composite Aerospace Structures Manufacturing

Pascal.Hubert (McGill)
Robert Fews (BHTC)

Funding approved
Start 2008-08

The main objective of this project is to investigate the relationship between the performance (mechanical, quality) and the production costs (tooling, cure cycle) associated with the manufacturing of a composite airframe structure using out-of-autoclave technologies.

Suitable materials must be identified and characterized to establish a database of properties that can be compared to autoclave processed composites. Optimum processing conditions and cure cycles must be determined for both the OOA prepegs and VARTM cured in an oven.

A suitable representative sub component will be identified and tested in order to assess the production costs using OOA technology. The production costs will include tooling, processing, cycle time and floor space required for OOA composite structure production.

COMP_3 Static and Fatigue High Temperature Behaviour of Braided Composites

Martin Lévesque (École Polytechnique)
Stephen Caulfeild (PWC)

This project aims at developing theoretical predictive models fo r static as well as fatigue behaviour of braided composites which are compatible with the de sign tools of the industrial partners. Models validation will be carried out on co upons and small-scale components.

1. Verify the thermo-oxidative stability of the composite material.

2. Obtain an analytical model for predicting the overall behavio r of a braided composite material used at high temperature.

3. Obtain a numerical (FE) model for predicting the overall beha vior of a braided composite material used at high temperature.

4. Obtain a macroscopic fatigue predictive model for a braided c omposite use at high temperature

5. Implement these models into a FE code and validate the predic tions against experimental data obtained from coupons and small scale componen ts.

Under NSERC Evaluation

COMP_5 Thermoplastic Composite Tailboom Concept Demonstrator

Suong Van Hoa (Concordia)
Robert Fews (BHTC)

Funding approved
Start 2008-08

The objectives of the project are :

- *Develop manufacturing techniques for long tubular structures mad e of thermoplastic composite materials (carbon/PEEK) using laser heated fiber place ment process.*
- *Develop techniques for the Non Destructive Testing of the qualit y of the tubular structures made using the proposed technique.*
- *Develop techniques for the joining of other thermoplastic access ories onto the tubular structure made using the above mentioned process.*

ENV_1 Superhydrophobic Surface Coatings for Aircraft Ice Protection

Ali Dolatabadi, dolat@me.concordia.ca
Alberto.Pueyo@aero.bombardier.com

Development of fundamental and practical information regarding the application of super-hydrophobic surface coatings for aircraft wing leading edges on the protected and unprotected areas to mitigate icing. This will be primarily an experimental study, but numerical models will also be developed to better understand dynamic liquid shedding for heated and unheated surfaces.

The objectives of this project are:

(a) to develop a fundamental understanding of liquid shedding of superhydrophobic surfaces as a way of mitigating icing for unprotected area aft of the leading edge.

(b) to use the fundamental understating generated to provide practical information and tools to allow screening of various types of superhydrophobic surfaces for icing mitigation at the leading edge or the area aft of it.

1-year
Feasibility study
2008-01

ANNEX 4

Fourth Round Projects

Fourth Round Projects

AVIO-402	Critical Communication and Smart Sensors
AVIO-403	Cosmic Radiation & Effect on Aircraft Systems
AVIO-404	Antenna Optimization on Composite Aircraft & Antenna Design
COMP-406	Mechanics of Advanced Fiber Architecture
COMP-407	Flaw growth thresholds in Composites
COMP-409	Development of New Composite Draping Analysis Method based on Solid Modeling
COMP-410	Practical Failure Modeling & Validation for Composite and Metallic Aircraft Structures
COMP-411	Thermoplastic Skid Landing Gear for Light Helicopters
COMP-412	Compression Moulding Technology for Aerospace Industry Complex Integrated Parts
COMP-413	Effect of Automated Fiber Placement (AFP) on Structural performance
COMP-414	Prebond NDI for Adherend Contamination
COMP-415	Mechanical Behavior of Composite Laminates Following Extreme Space Environment
COMP-416	Manufacturing of Primary Composite Structure Prototype with Thermoplastics

The above projects were identified during the CRIAQ 4th Research Forum, 2008-04-17

and are being prepared for launch in 2009-2010

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Fourth Round Projects (Cont'd)

DPHM-410	In-situ SHM Sensors for Composite Structures
ENV-403	Light Weight Power Electronics
ENV-404	Electric Actuation of Flight Controls
ENV-405	Devlopment of a Hybrid Emergency Generation for a More Electric Aircraft
ENV-406	Exploration of Novel Fuels for Gas Turbines
ENV-407	Water to augment Engine Power
ENV-408	Low Energy Thermal Anti-Icing
ENV-411	Composite Recycling (reducing the carbon footprint)
ENV-412	End-of-Life Aircraft
ENV-414	Low Power Deicing Systems for Light Helicopters - Phase 2
ENV-415	Evaluation of Hail Impact Design concepts coupled with Experiments and Modeling
LEAN-405	Lean Costing in Engineering

Fourth Round Projects *(Cont'd)*

MANU-405	Brazing Process Optimization for Structural Aerospace Applications
MANU-406	Laser Assisted Spinning of Aerospace Alloys
MANU-407	Robust Machining Processes
MANU-409	Automated Deburring and Part Finishing
MANU-412	Machining of Al-Li Alloys
MANU-413	Optimization of Machining process of Graphite/epoxy and multilayer Materials
MANU-414	Optimization of NC Program
MANU-415	Friction Stir Welding - Al Alloys
MANU-418	Automated NDT
MANU-419	Water Erosion Resistance Coating
MANU-421	Direct Laser Deposition
MANU-422	Automation for Low-Volume Production
MDO-403	Helicopter Rotor Fuselage Wake Interaction
MDO-404	Modeling and simulation of new generation and distribution system architectures for more electrical aircrafts (MEA) and engines (MEE)
PLM-404	Management of Manufacturing Tolerances

International Projects

6 projects with India, proposed by Pratt & Whitney Canada in collaboration with Infotech (India):

1. ***Film Cooling Technologie for Turbine Airfoils .***
   Concordia U with National Aerospace Laboratories (NAL, Bangalore)
2. ***Optimization of Elliptical Spray Fuel Nozzles .***
   Concordia U with IISc, IIT-Madras et NAL
3. ***Slinger Combustion Systems of Gas Turbine engines .***
   Laval U with IIT-Kanpur et NAL
4. ***Fretting wear of Turbine assemblies***
   McGill with IIT-Madras
5. ***Turbine Rim Seal Research.***
   Laval U with NAL
6. ***Desensitized Tip Design in Compressors*** *(under evaluation)*
   École Polytechnique de Montréal with IIT-Bombay

Funding : PWC, MDEIE (PSR-SIIRI Program), CRIAQ with contribution by Indian Organisms

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Support of Student Activities

In addition to supporting many graduate students working on research projects …

CRIAQ,, with the financial support of FQRNT, …

- ***Is the principal partner of the Student Aerospace Forums***
- ***Offers an Internship program for undergraduate students to work within the research teams (PIRA)***
- ***Sponsors teams participating in official aerospace competitions***

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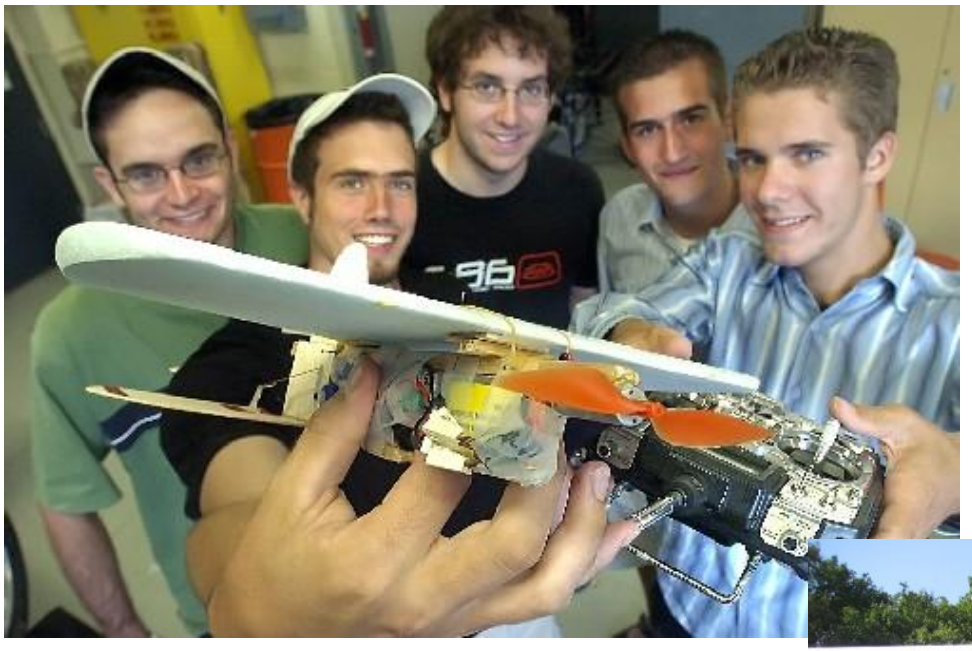
Student Competitions



Miniature Aerial Vehicle
Université de Sherbrooke

Toulouse
2007

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SAE Cargo Plane École Polytechnique de Montréal Team

2007

2005

Dronolab

2006
École de Technologie Supérieure

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SAE Cargo Plane École de Technologie Supérieure Team

2007

2006

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SAE Cargo Plane
Université Laval Team

2007

SAE – Aerodesign - 2008
“Micro Class” Competition
Concordia “Mini Stringers” Team

Student Forums

3rd Aerospace Student Forum

École Polytechnique

September 2004

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4th Aerospace Student Forum
Université de Sherbrooke
September 2005

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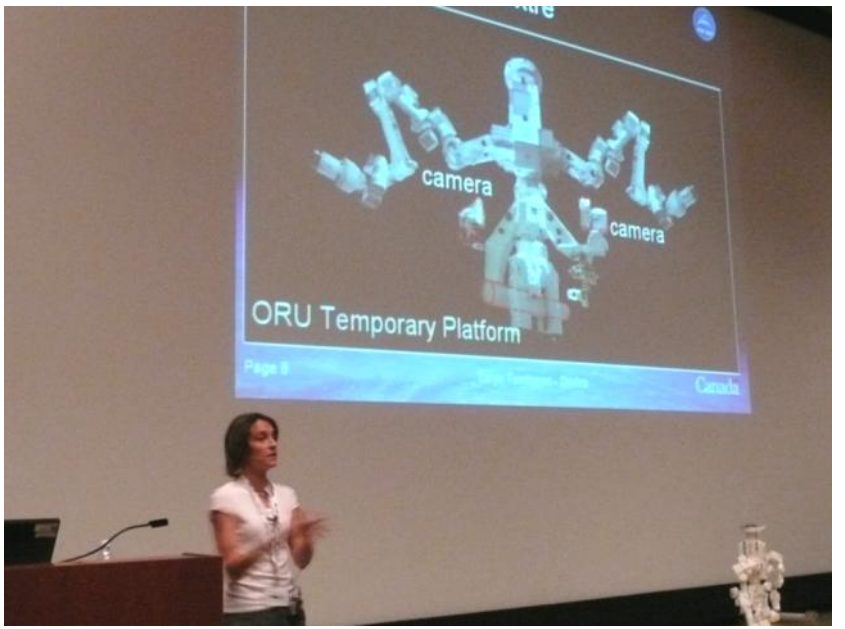
5th Aerospace Student Forum - Université Laval
29 September 2006

6th Aerospace Student Forum
McGill University
14 and 15 September 2007

7th Aerospace Student Forum
Concordia University
24 and 25 September 2007



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