

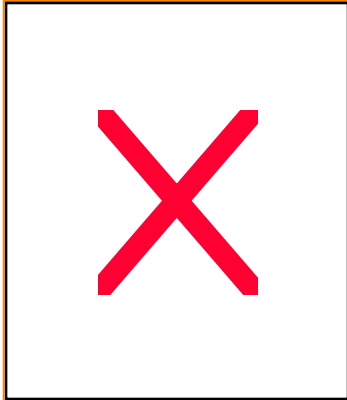
# Bombardier Aerospace R&D Initiatives



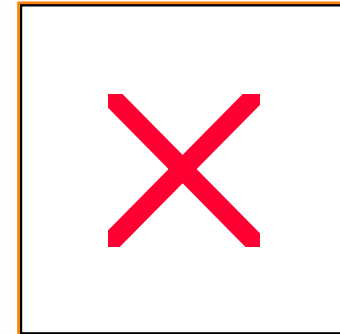
Fassi Kafyeke  
Aerodays 2006, Vienna  
June 20<sup>th</sup>, 2006

**BOMBARDIER**

# Canadian Aerospace Industry Profile



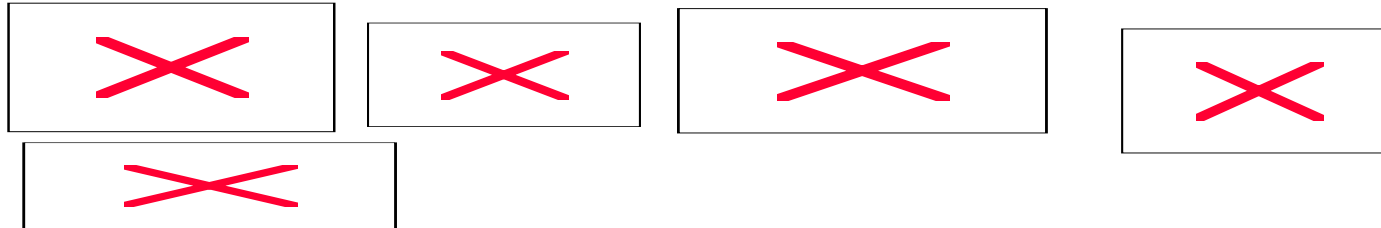
- **World ranking : 4th**
- **Annual sales : \$25 billion**
- **Export sales : \$20 billion (80%)**
- **Employment : 105,000 (65% in Quebec)**
- **R&D : \$ 900M**



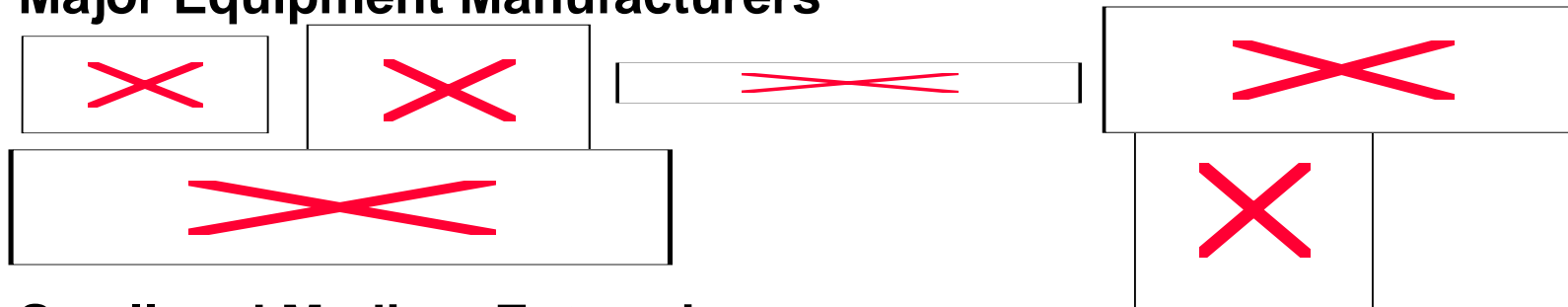
# Canadian Aerospace Industry Profile

## ■ Major Manufacturers

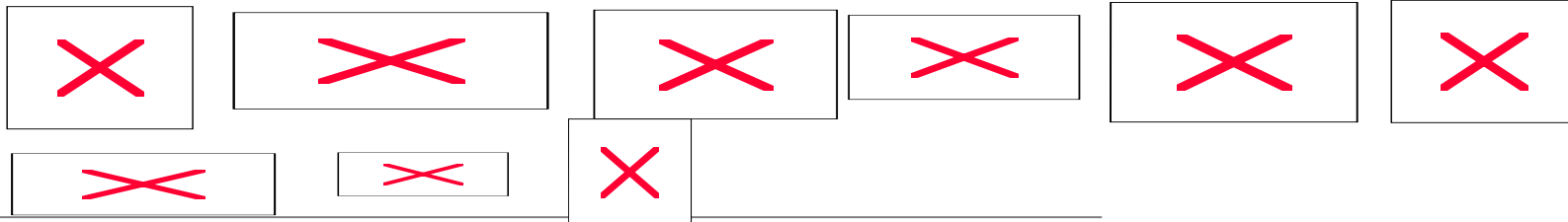
- Airplanes, Helicopters, Engines, Simulators

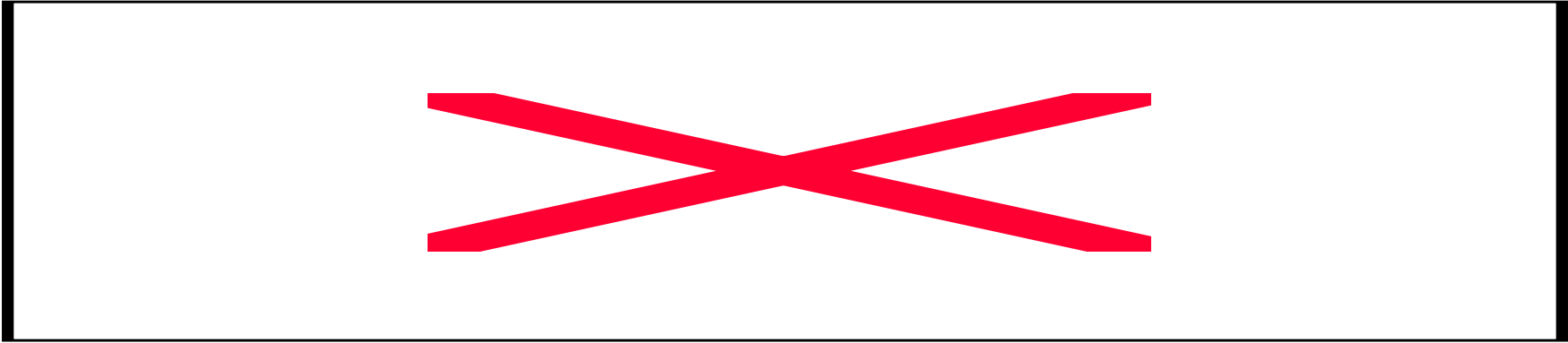


## ■ Major Equipment Manufacturers

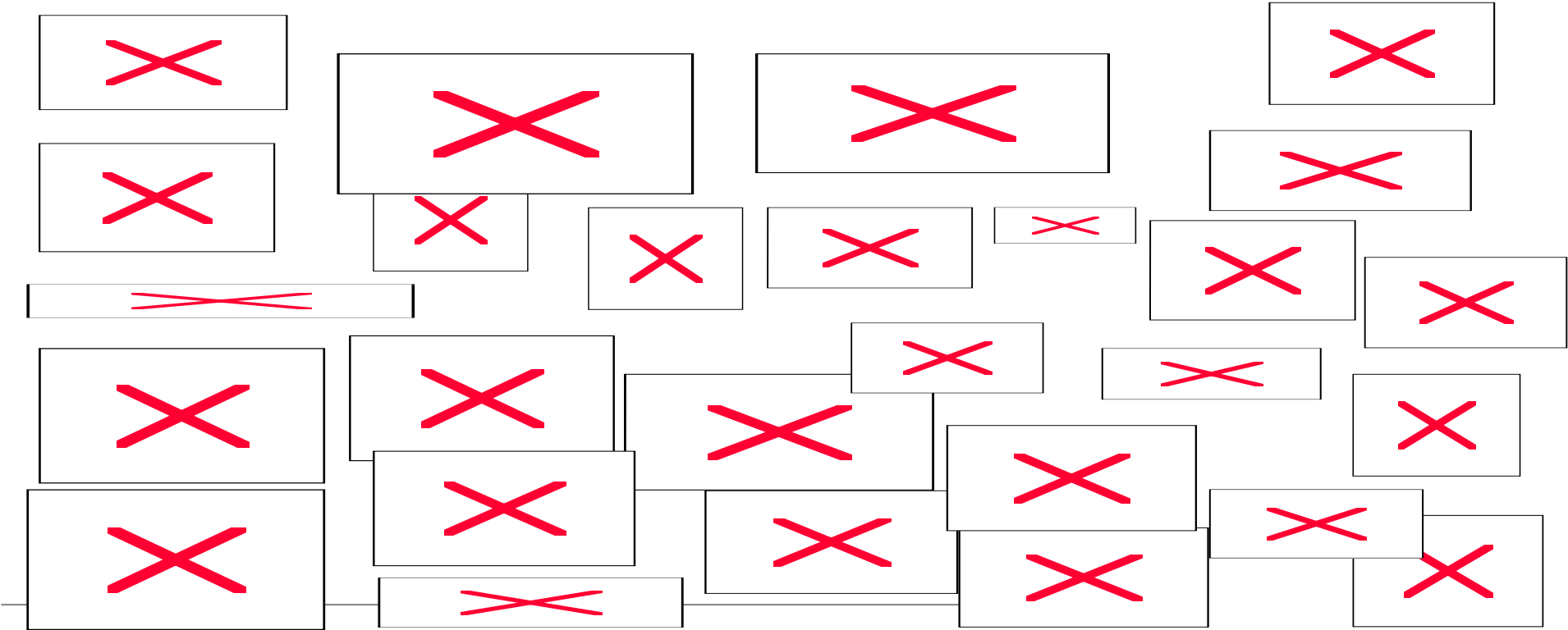


## ■ Small and Medium Enterprises





*CONSORTIUM DE RECHERCHE ET D'INNOVATION EN AÉROSPATIALE AU QUÉBEC*  
*CONSORTIUM FOR RESEARCH AND INNOVATION IN AEROSPACE IN QUEBEC*



## CRIAQ Mission and Objectives

- **Increase competitiveness of Aerospace Industry**
- **Enhance collective knowledge base... via 5 objectives:**
  - **Precompetitive Collaborative Research (Industry driven)**
    - Distinct projects in various schemes
  - **Innovation**
    - Intellectual Property issues settled
  - **Training**
    - All projects involve students
  - **Promotion**
    - Support of student forums, internships and competitions
  - **National - International collaboration**
    - Canadian aerospace partnership, MOU's, exchanges, missions

# CRIAQ Research Projects

## Funding: 25% Industries & 75% Quebec

Achievements	
<b>Current Membership</b>	<ul style="list-style-type: none"> <li>19 industries (incl.13 SME's)</li> <li>8 universities, NRC</li> <li>5 Associate members</li> </ul>
<b>13 on-going projects</b>	<ul style="list-style-type: none"> <li>40 University Researchers</li> <li>10 NRC Researchers</li> <li>30 Industry Specialists</li> <li>15 Ph.D., 60 M.Sc., undergrad trainees</li> </ul>
<b>18 Projects in preparation</b>	<ul style="list-style-type: none"> <li>130 University and NRC Researchers, and Industry specialists</li> </ul>

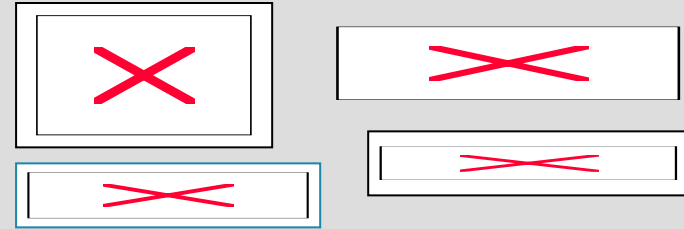
Research themes	Projects	
	On-going	In preparation
Low cost manufacturing and composites	4	7
Acoustics and icing	1	1
Modeling and simulation	3	
Multi-Disciplinary Design and System Integration	2	6
Avionics	1	3
MicroElectroMechanics	2	
Aeroelasticity		1
Heat Exchange		1
Industry (cash)	\$2.2M	\$3M
Industry (in-kind)	\$5.7M	\$4M
Public funding	\$4.4M	\$6M
<b>Total value (over 3 years)</b>	<b>\$12.3M</b>	<b>\$13M</b>

## EXAMPLES OF CRIAQ PROJECTS

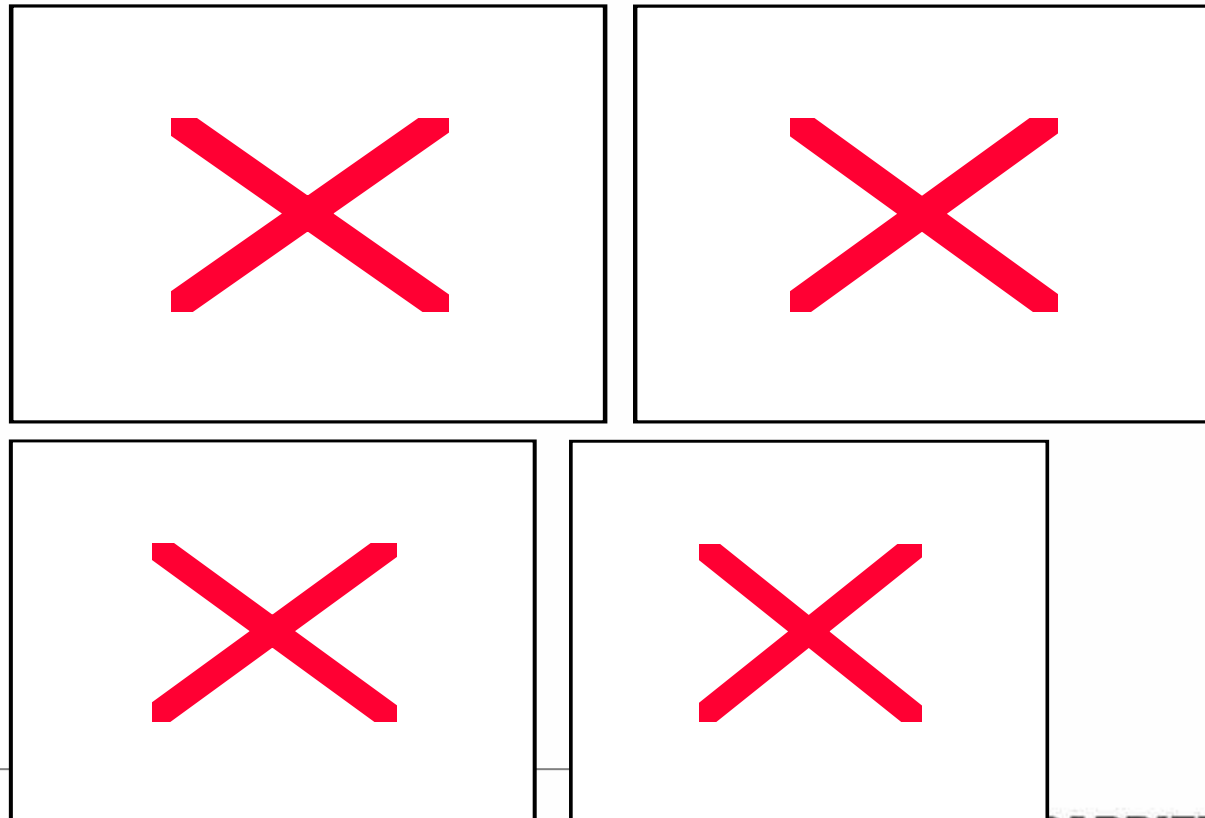
### Optimization of High Performance Machining of Light Alloy Aerospace Components

René Mayer, [rene.mayer@polymtl.ca](mailto:rene.mayer@polymtl.ca)

Don McIntosh, [don.mcintosh@pwc.ca](mailto:don.mcintosh@pwc.ca)



*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.*

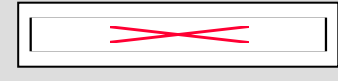
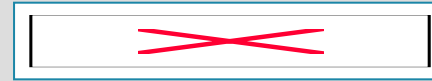


## EXAMPLES OF CRIAQ PROJECTS

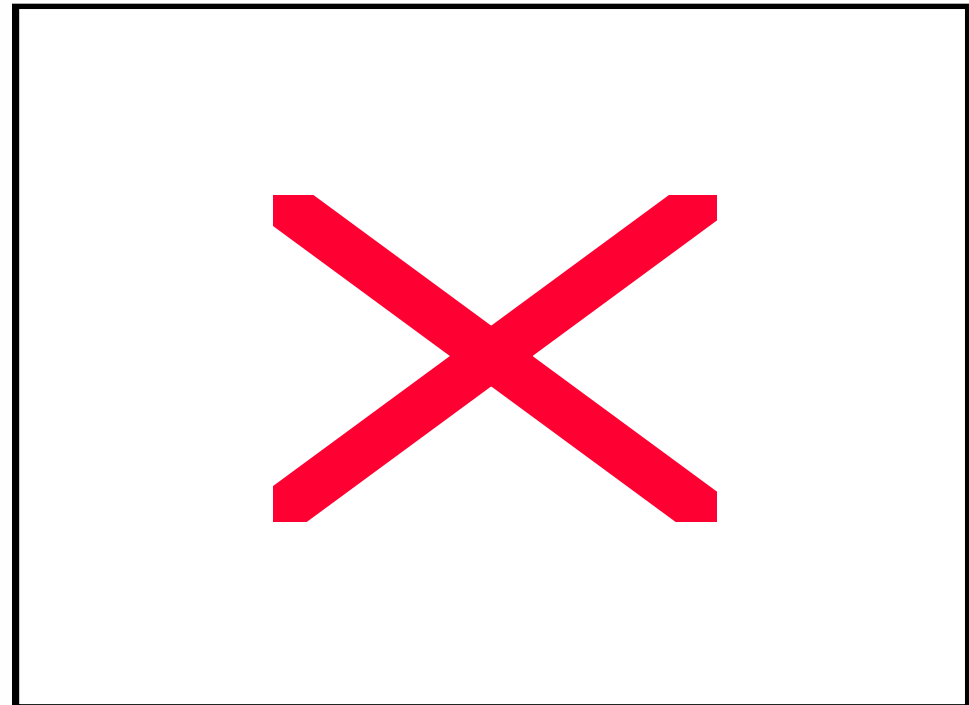
### ***Improving the Acoustic Environment in Fixed and Rotary Wing Aircraft***

***Alain Berry, [alain.berry@usherbrooke.ca](mailto:alain.berry@usherbrooke.ca)***

***Carlos Trindade, [carlos.trindade@aero.bombardier.com](mailto:carlos.trindade@aero.bombardier.com)***



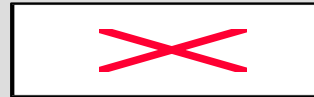
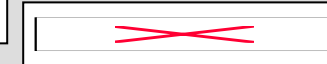
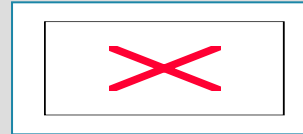
- *Provide industry with state-of-the-art simulation tools to analyse the acoustic environment of aircraft*
- *Investigate innovative passive techniques to reduce cabin noise (such as new acoustic material and trim configurations),*
- *Develop innovative active control techniques to reduce structure-borne sound inside helicopters*



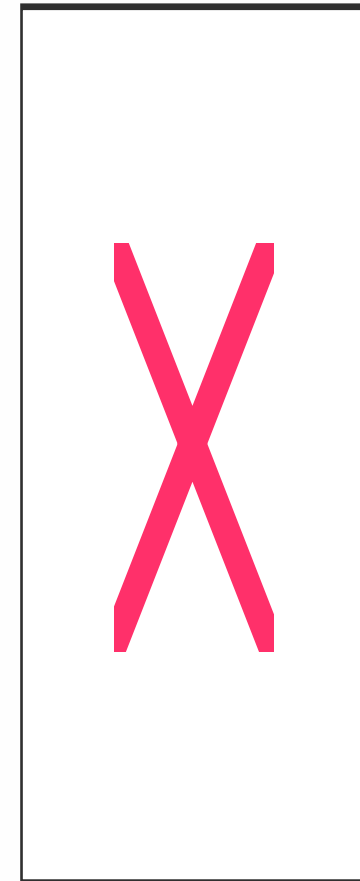
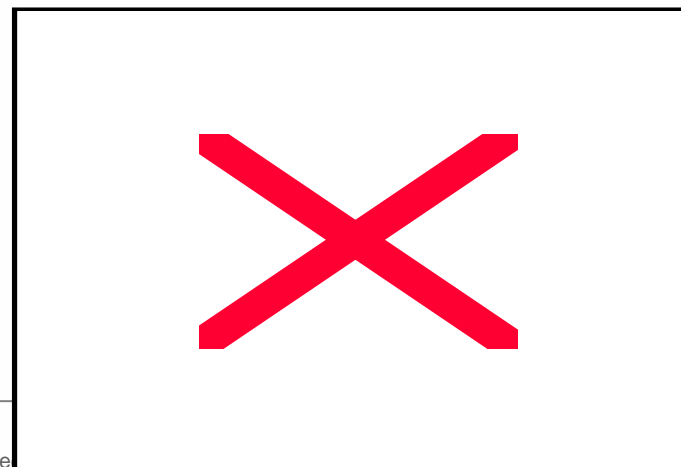
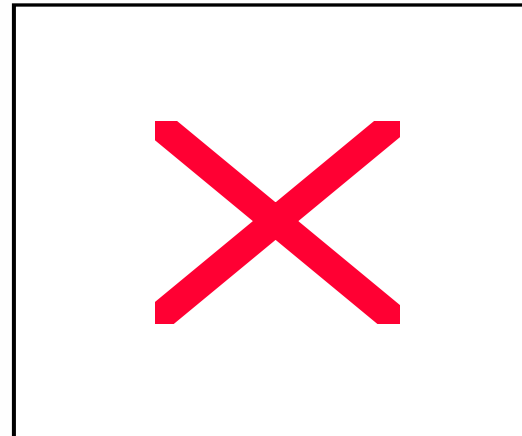
## EXAMPLES OF CRIAQ PROJECTS

### **Impact Modeling of Composite Aircraft Structures**

**Augustin Gakwaya, [augustin.gakwaya@gmc.ulaval.ca](mailto:augustin.gakwaya@gmc.ulaval.ca)**  
**Alain Colle, [acolle@bellhelicopter.textron.com](mailto: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.*

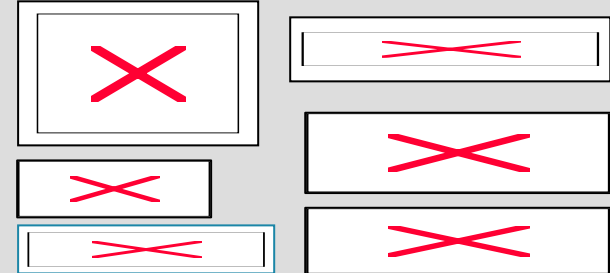


**BOMBARDIER**

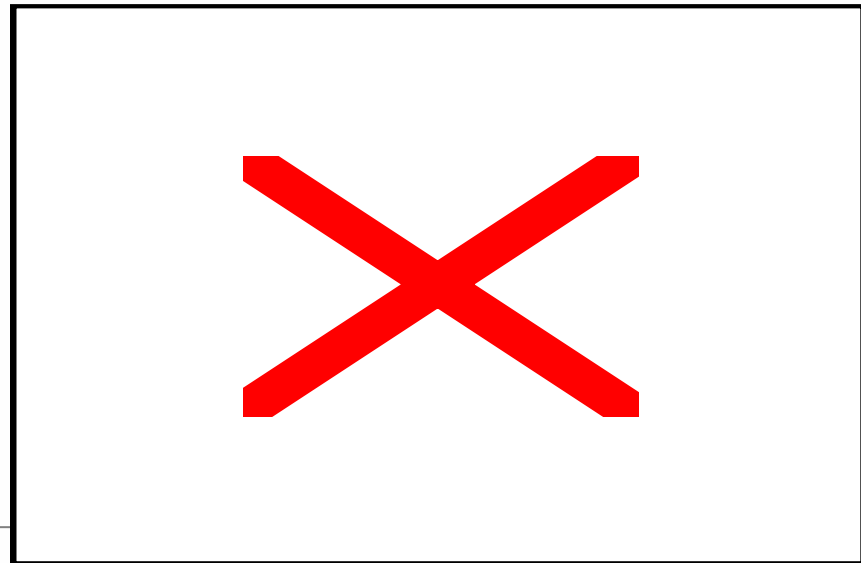
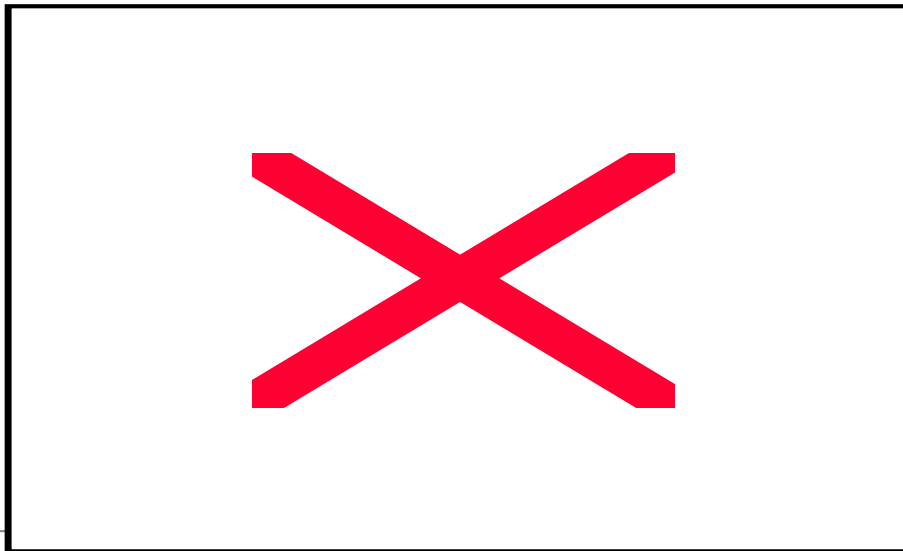
## EXAMPLES OF CRIAQ PROJECTS

### **MOSAIC - Multidisciplinary Optimization Standardization Approach for Integration and Configurability**

*Jean-Yves Trépanier, [jean-yves.trepanier@polymtl.ca](mailto:jean-yves.trepanier@polymtl.ca)  
François Pépin, [francois.pepin@aero.bombardier.com](mailto:francois.pepin@aero.bombardier.com)*



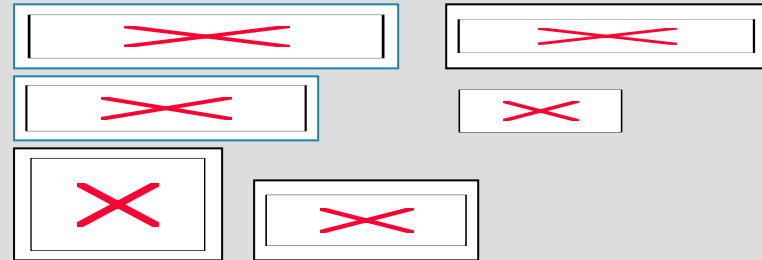
*Develop multidisciplinary design optimization capabilities. Includes development of standardization approaches for data exchange and specialized components for analysis and optimization in an MDO context.*



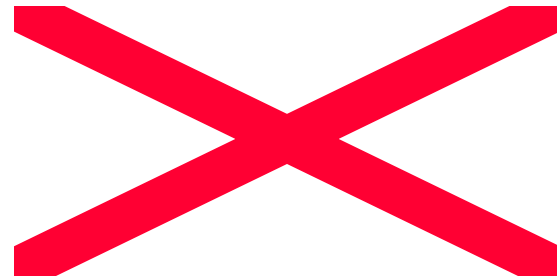
## EXAMPLES OF CRIAQ PROJECTS

### **Microsystems for In-Situ Health Monitoring of Aircraft**

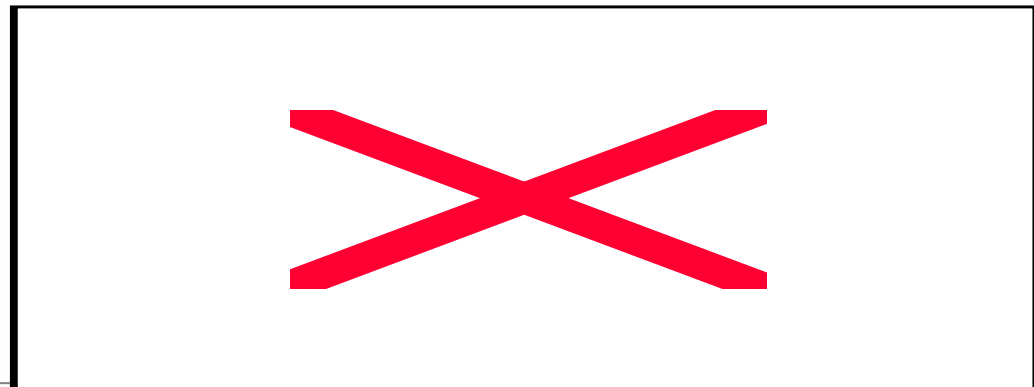
Patrice Masson, [patrice.masson@usherbrooke.ca](mailto:patrice.masson@usherbrooke.ca)  
Carlos Trindade, [carlos.trindade@aero.bombardier.com](mailto:carlos.trindade@aero.bombardier.com)



- 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.



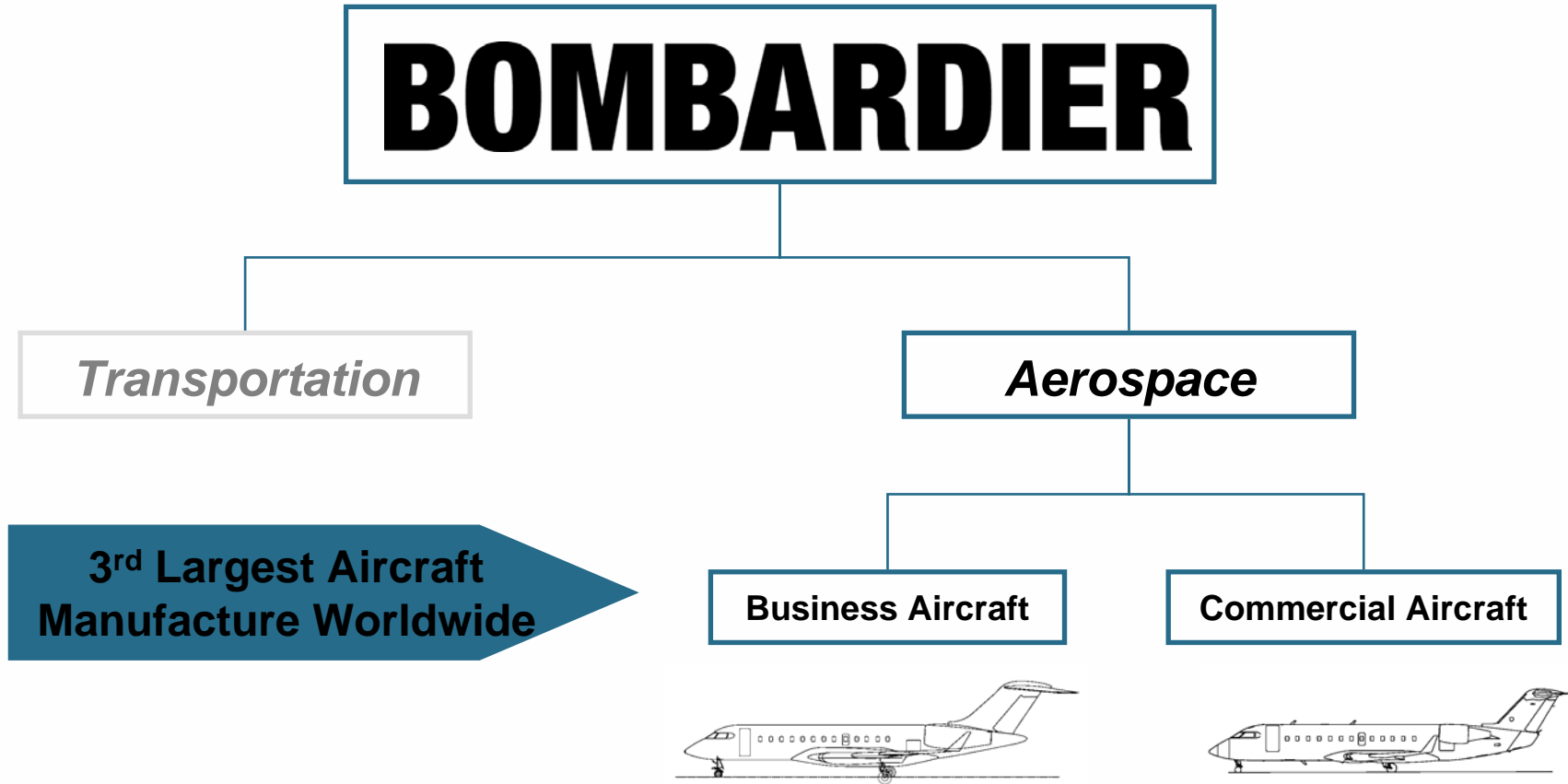
- The system will provide, either passively or actively, real-time in-situ structure load transfer profiles, identifying the efficiency and health of the structure, to an on-board data acquisition system. Load profiles will be analyzed and evaluated against pre-set failure threshold marks for the issuance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



# About Bombardier

*A world-leading manufacturer of innovative transportation solutions.*

**Bombardier is a global corporation headquartered in Canada**

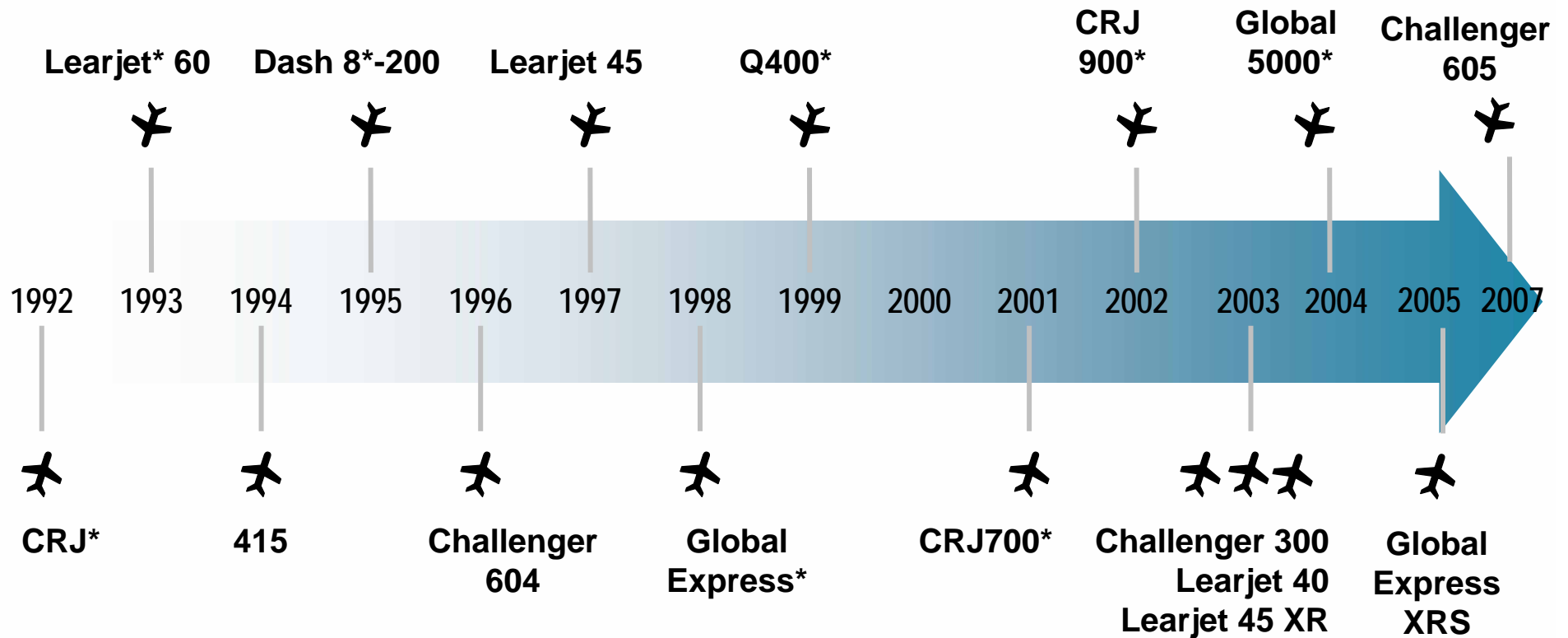


## Bombardier Aerospace

Bombardier Aerospace is a **world leader** in the design and manufacture of **innovative aviation** products and services for the commercial, business and amphibious aircraft markets. It also offers *Bombardier Flexjet* fractional ownership, *Bombardier Skyjet* aircraft charter and management, technical services, aircraft maintenance and pilot training for business and regional airlines.

# Product Development in Aerospace

*An impressive journey.*

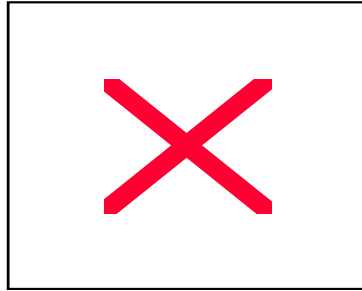


## 16 Aircraft Programs in 15 Years

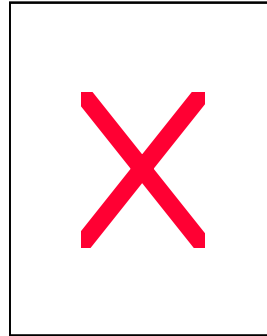
\* Trademark(s) of Bombardier Inc. or its subsidiaries.

This document contains trade secrets, financial, commercial, scientific, technical or other confidential information, the further disclosure of which will result in material financial harm to and/or prejudice to the competitive position of Bombardier Inc.

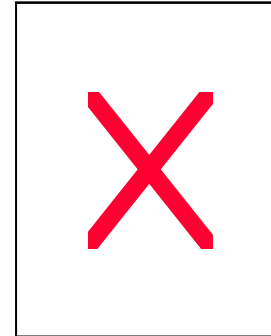
# Bombardier Business Aircraft



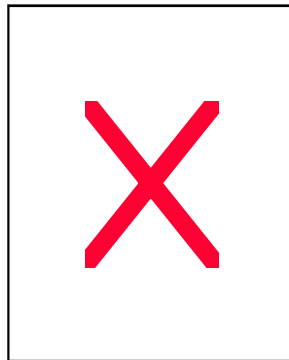
***Bombardier  
Learjet 40  
& Learjet 40 XR***



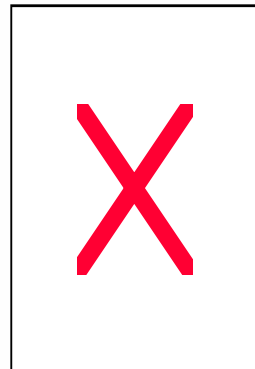
***Bombardier  
Learjet 45  
& Learjet 45 XR***



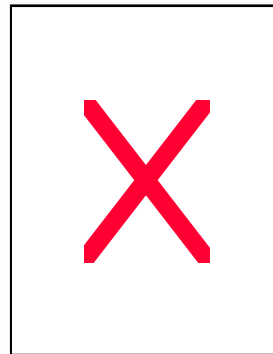
***Bombardier  
Special Edition  
Learjet 60***



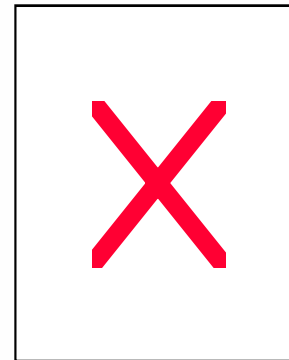
***Bombardier  
Challenger 605***



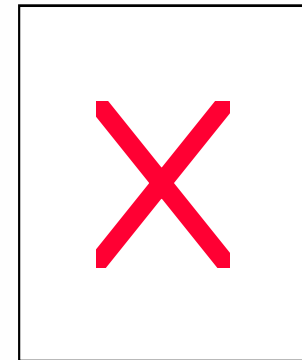
***Bombardier  
Challenger 300***



***Bombardier  
Challenger 800  
Executive  
& Corporate Shuttle***

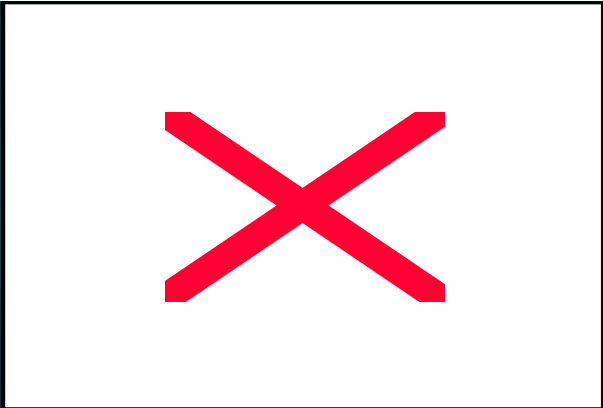


***Bombardier  
Global 5000***

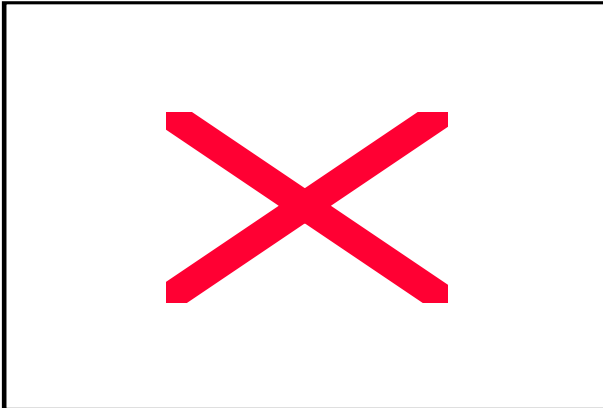


***Bombardier  
Global Express XRS***

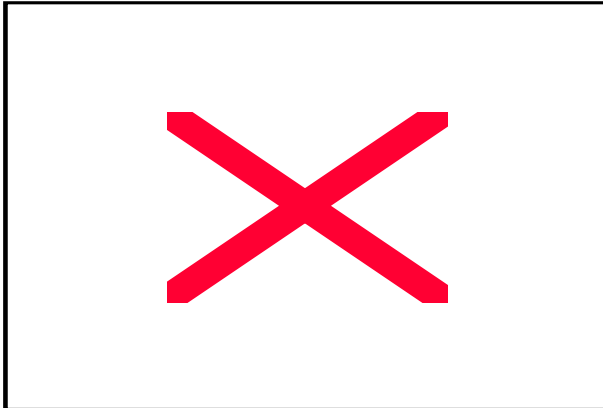
# Bombardier Commercial Aircraft



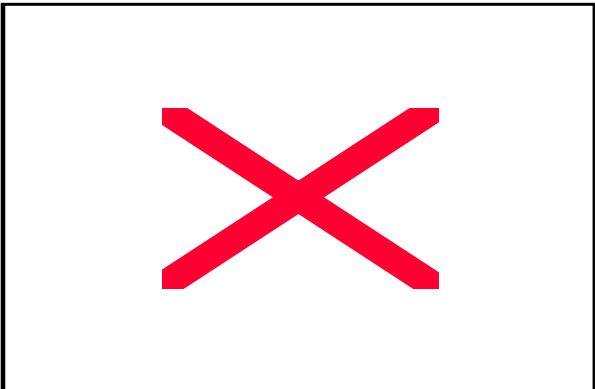
*Bombardier Q100/200*



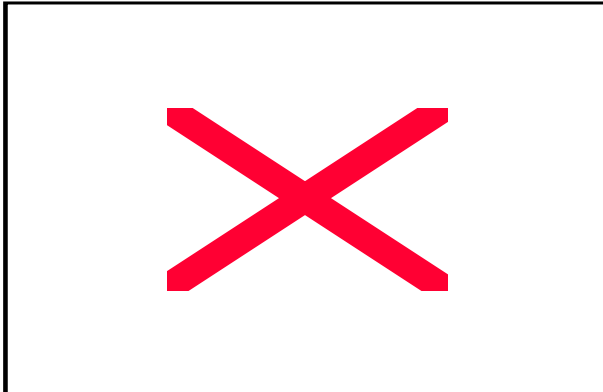
*Bombardier Q300*



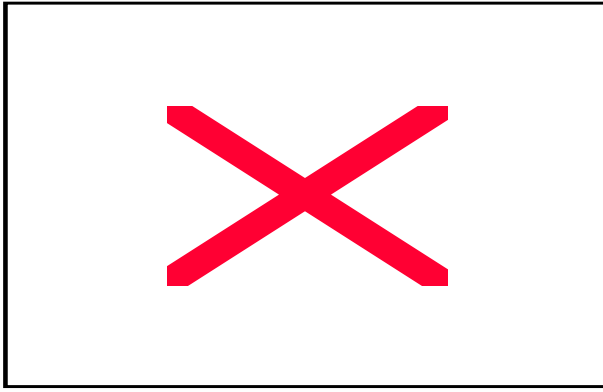
*Bombardier Q400*



*Bombardier CRJ200*



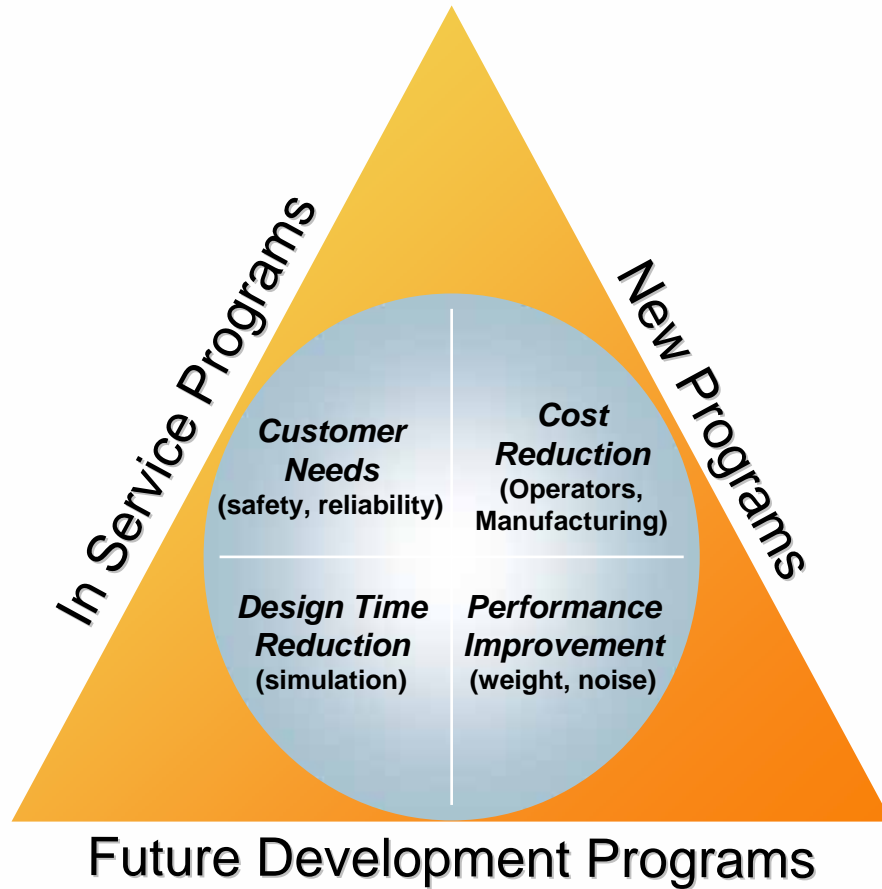
*Bombardier CRJ700*



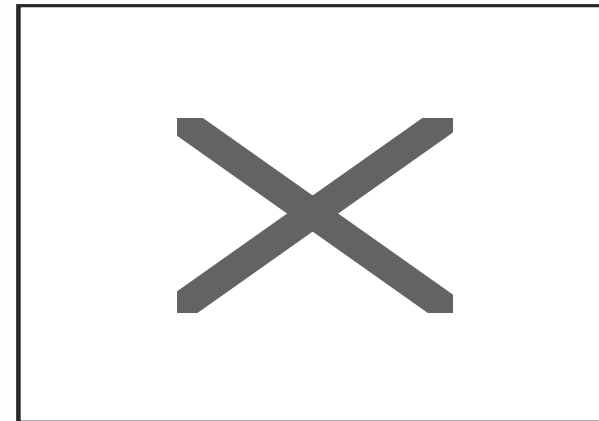
*Bombardier CRJ900*

# R&D Program Objectives

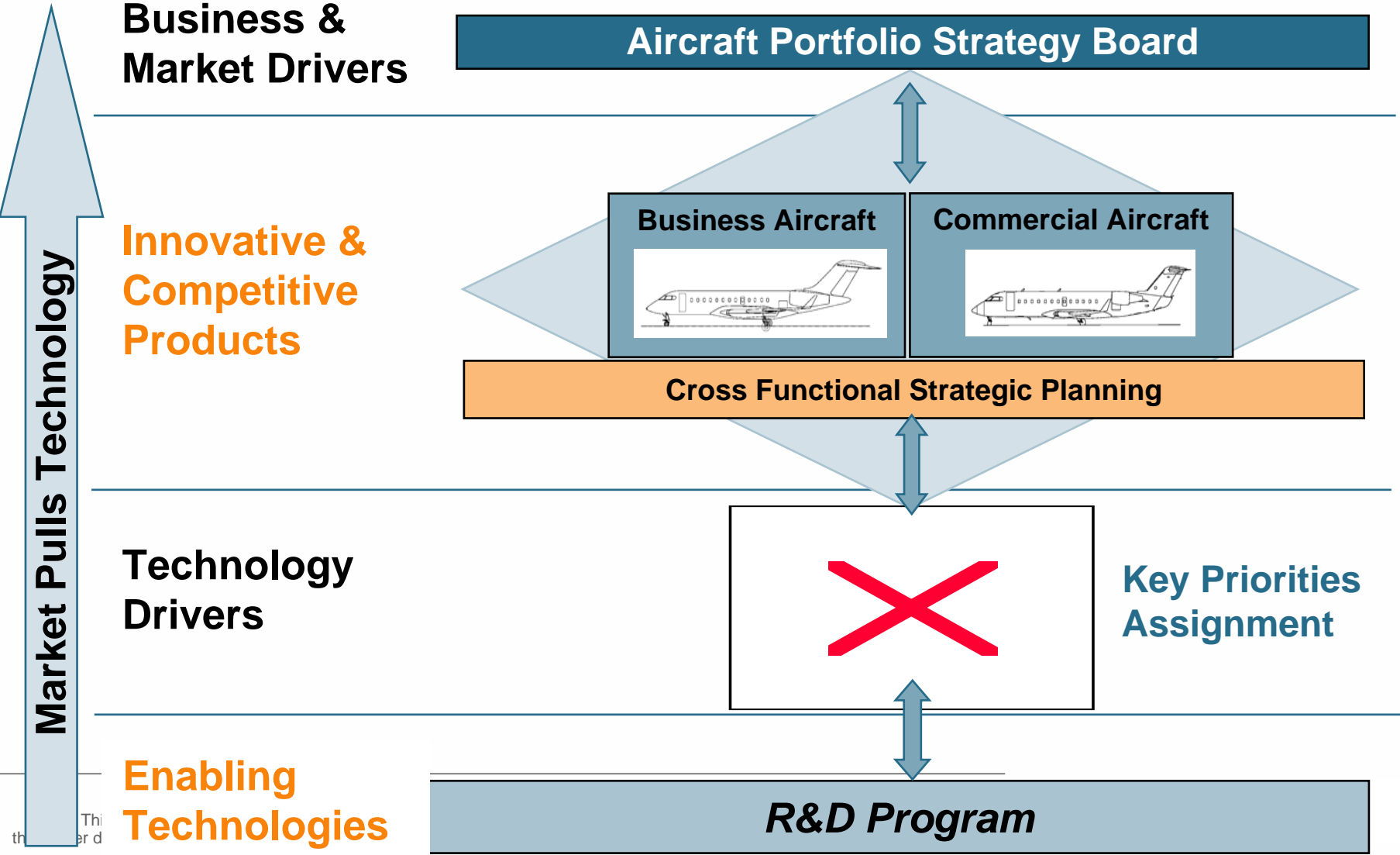
- **Develop cost-effective and competitive technologies for sustaining, new and future programs.**



**Technology Innovation Drives Productivity and Growth**

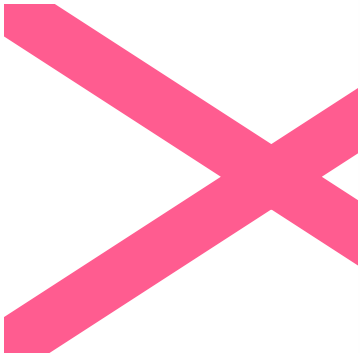
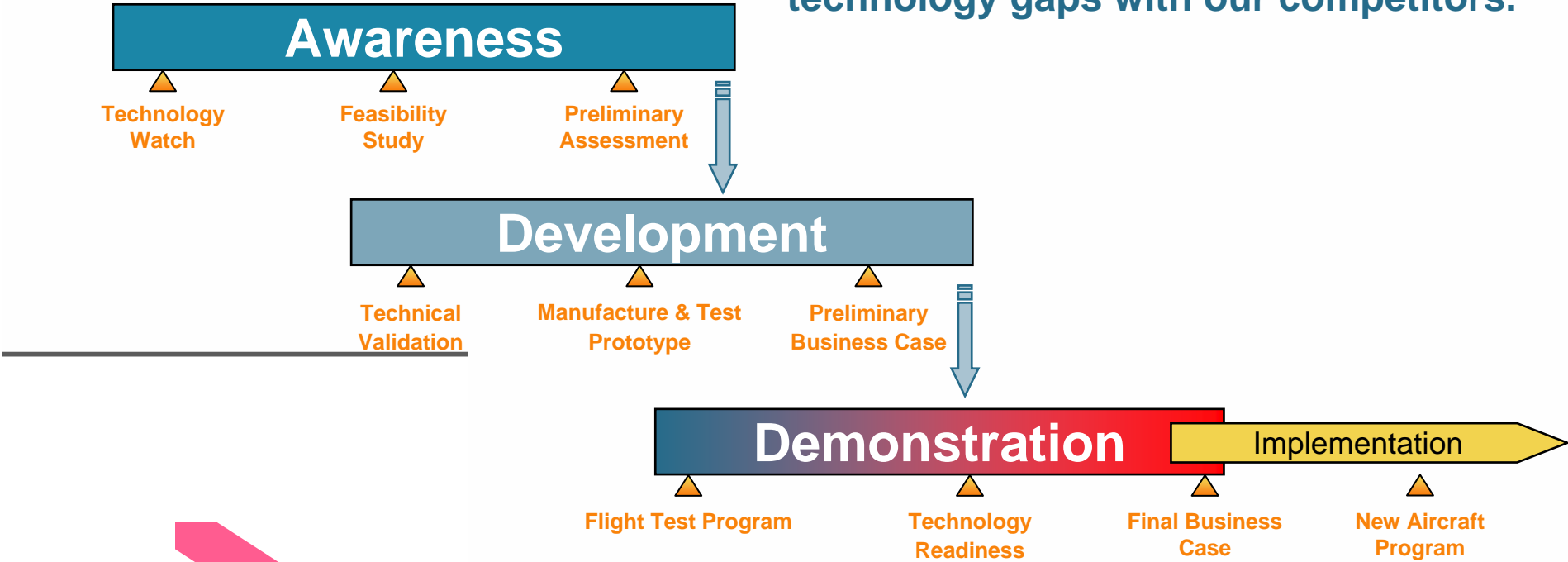


# R&D Program is “Pulled” by the Aircraft Platform Needs



# R&D Program Key Milestones

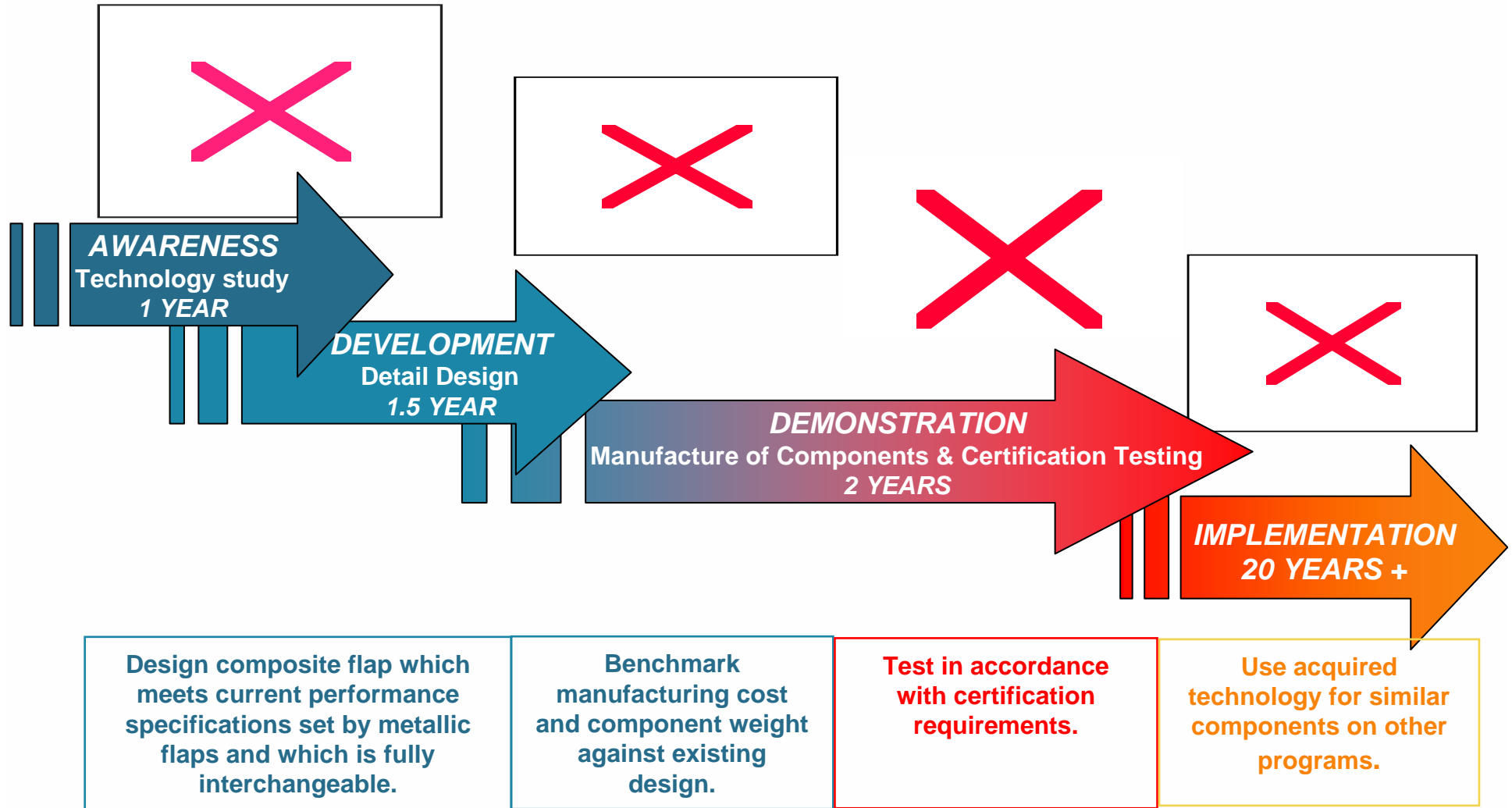
Keep abreast of any perceived technology gaps with our competitors.



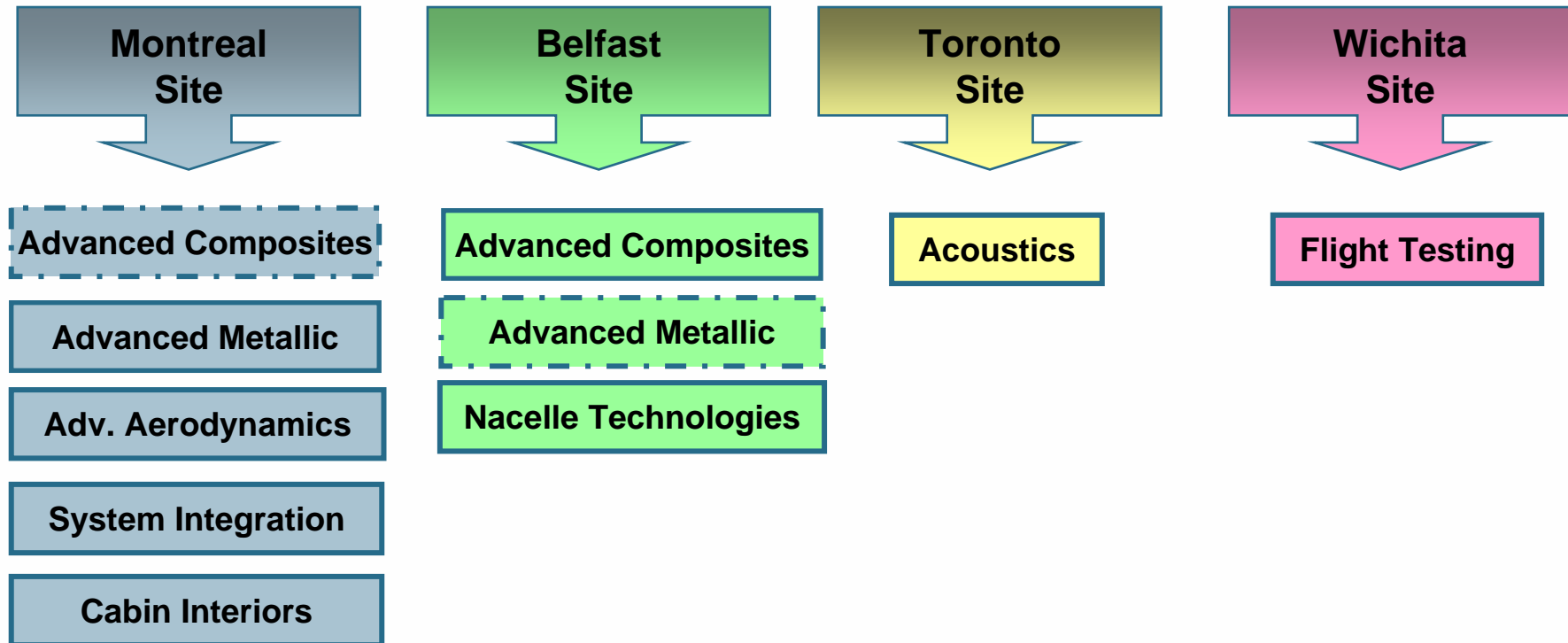
Ensure new technologies are implemented into the Business Units at minimal cost and risk to the program.

# R&D Program Demonstrator Programs

Example: Design, build and certify a Resin Transfer Molding (RTM) composite flap at Belfast, UK.

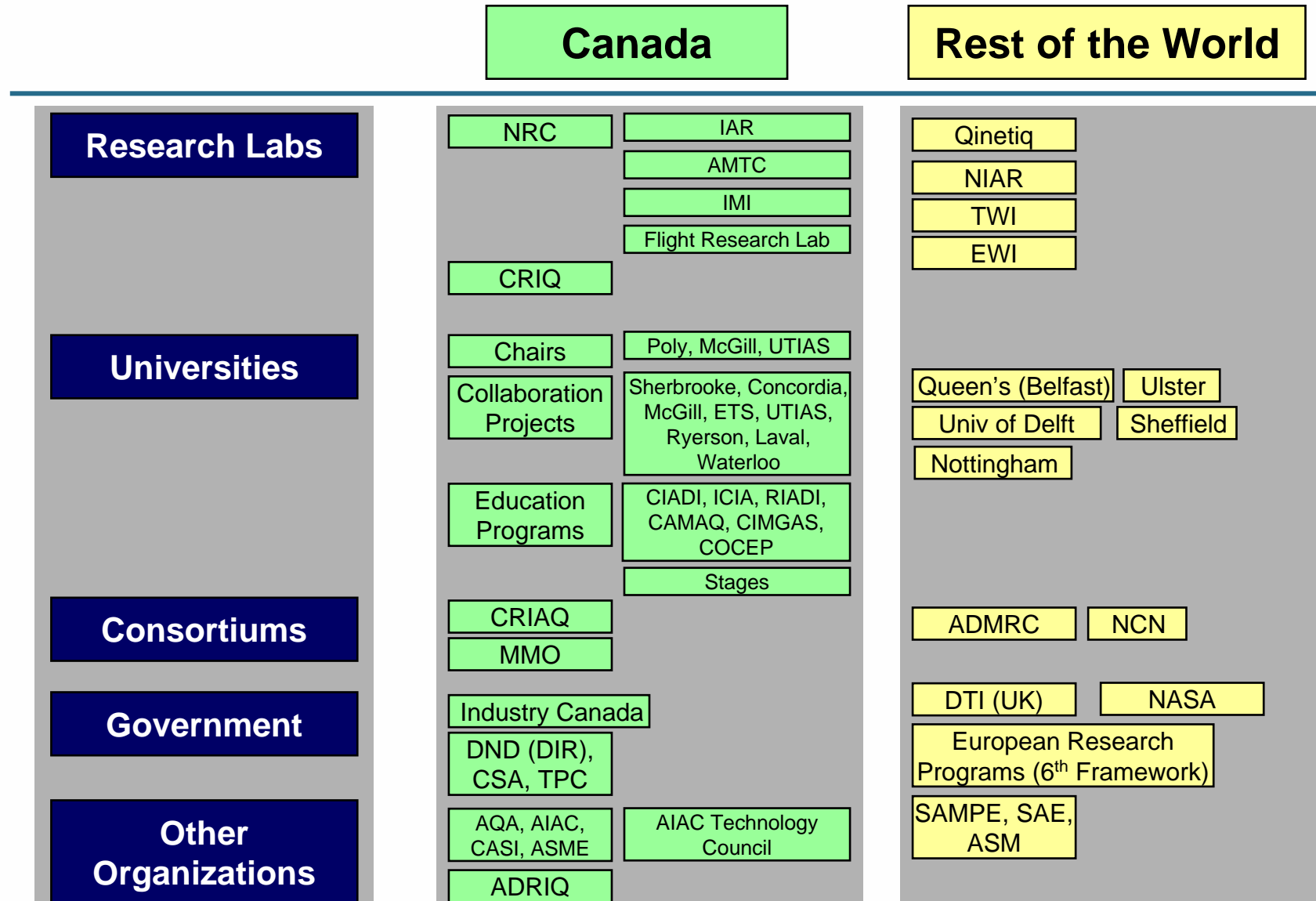


# Bombardier R&D Center of Expertise



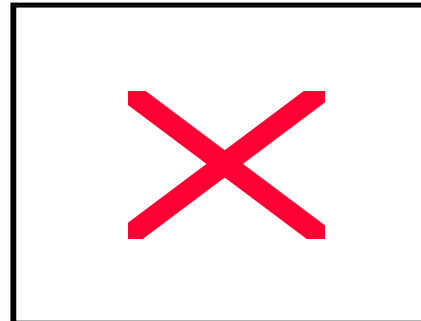
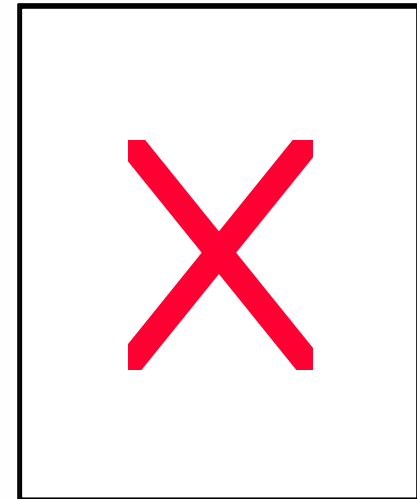
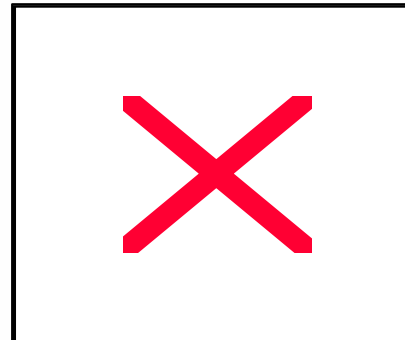
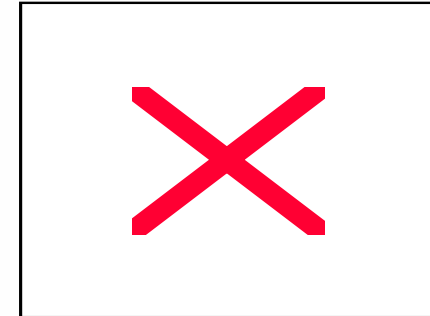
- **Bombardier’s R&D Program is coordinated by a Corporate entity that represents all Manufacturing Sites**
- **Each site is responsible for R&D supporting Design and Manufacturing at that location**

# Some Examples of R&D Program Interactions



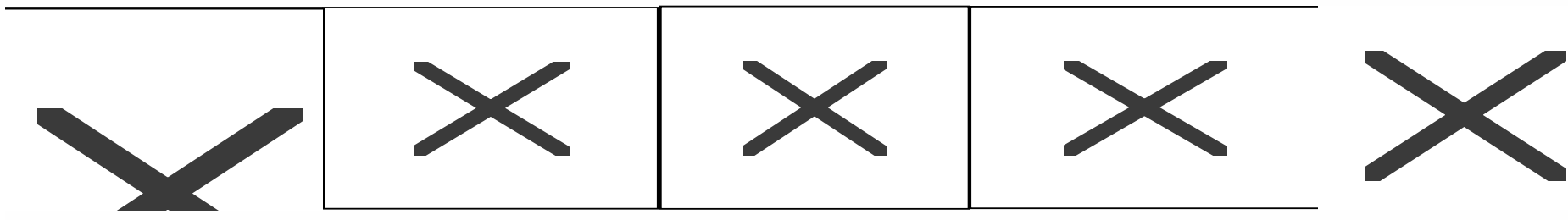
## Bombardier has made a substantial investment at Belfast

- Bombardier has invested €1.8bn at Belfast
- Belfast is a world-class centre of excellence for design and manufacture of fuselages, engine nacelles, and processes such as advanced composites (including RTI/RTM)
- Belfast expertise developed through FP3, 4, 5, 6 ensures advanced technologies exploited in Europe for Bombardier and other manufacturers
- Belfast currently involved in ALCAS, TANGO, VITAL, SILENCER, COMPROME: positioning for FP7
- Key to local Northern Ireland economy
  - largest manufacturer with 5,300 employees
  - consistently profitable
  - largest skills training programme



# Conclusion

- **Canada is a major player all aspects of the Aerospace Industry Research and Development Activities**
- **The R&D Program at Bombardier:**
  - Establishes a well-balanced strategy fully integrated into a structured product development process.
  - Ensures new technology is demonstrated and implemented into the various Manufacturing sites.
  - Promotes partnerships with industry leaders, universities and governments.



# Bombardier Aerospace R&D Initiatives



Fassi Kafyeke  
Aerodays 2006, Vienna  
June 20<sup>th</sup>, 2006

**BOMBARDIER**