NATIONAL RESEARCH COUNCIL CANADA

De-Risking Innovation

Wajid Ali Chishty
NRC-Aerospace

16 May 2013

National Research Council Canada | Conseil national de recherches Canada

Canada

NRC

Vision:

To be the most effective research and technology organization in the world, stimulating sustainable domestic prosperity.

Mission:

Working with clients and partners, we provide innovation support, strategic research, scientific and technical services to develop and deploy solutions to meet Canada's current and future industrial and societal needs.

Nationwide presence

- 2012-13 budget: $774M
- Over **4,000** employees and 650 volunteer and independent visitors
- 3 Divisions and 13 business units
- Multi-disciplinary expertise and broad array of services and support for industry
- Infrastructure support of over half-a-billion dollars

Strategic role

- Focused in areas where we should rather than where we could
- Bridge gaps between early stage R&D and technology deployment
- Aligned with the needs of the Canadian innovation system
- De-risk innovation in Canada

4 Business lines (1/2)

Strategic R&D

- Mission-oriented research and technology development
- High impacts for Canada
- Focused on long term sustainment

Technical Services

- NRC helps clients solve immediate problems
- Shorter term focus on client needs based largely on fee-for-service

4 Business lines (2/2)

Management of National S&T Infrastructure

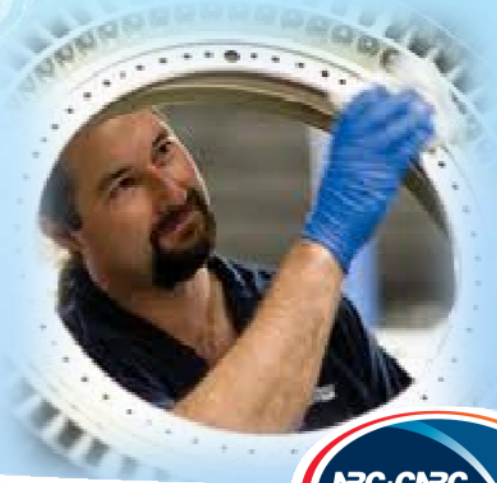
- Ensure that Canada's large, unique engineering and scientific facilities are kept at world standards
- Help Canadian and international clients make the most of specialized scientific infrastructure.

Industrial Research Assistant Program (IRAP)

- Innovation support for SMEs
- An important client portal into NRC capabilities and services

Green, growing and global

- Environmentally responsible aviation is an aerospace industry priority
- Aerospace is significant contributor to Canadian economy, directly adding CAD$ 11.3B to GDP and providing 87,000 direct jobs
- Aerospace is Canada's most export-intensive (74%) and trade-diverse manufacturing sector
- Investment in R&D of CAD$ 2B
- Investment in capital of CAD$ 1.4B



A promising future for aerospace in Canada

- Aerospace recognized as important industry in Canada
- Government of Canada working with industry and provinces to address Aerospace Review recommendations
- Technology demonstrators emerging as important priority
- Typical demonstrations in mid-to-high TRL
- Consortia may be formed for lower-to-mid TRL technologies

NRC Aerospace

- Advancing aerospace R&TD in aerodynamics, flight research, gas turbines, structures and materials and manufacturing

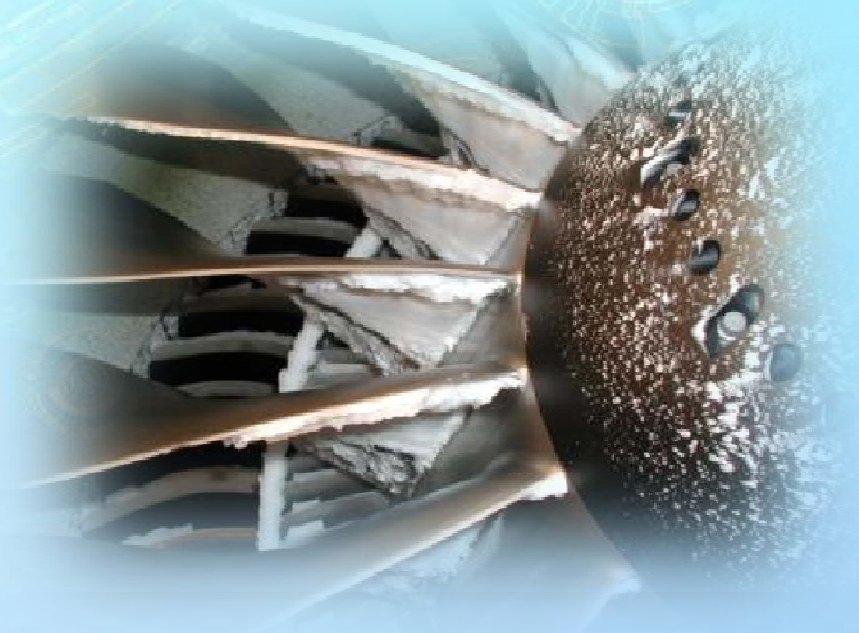
- R&TD programs, national infrastructure, strategic alliances focus on:
  - cabin and cockpit technology
  - aircraft icing threat mitigation
  - high TRL technology and process development
  - air defence technologies
  - UAS civil certification and applications
  - future aircraft systems development

Research focus:
Cabin and cockpit comfort

- Developing technologies that improve comfort while travelling in aircraft
- Global integration of lighting, acoustics, vibration, thermal and air quality
- Optimizing aircrew performance in challenging work environments
- Reducing design cycle time for cabin and avionics technology

Research focus:
Reducing aviation icing risks

- Advancing technologies, processes and facilities to reduce costs of developing and qualifying icing products
- Demonstrating, de-risking and certifying new technologies to detect, characterize and mitigate icing threats



Research focus: Aeronautical technology and process development

- Reducing costs of advancing technological readiness of aeronautical products from initial prototype to certified product
- Working with Transport Canada to streamline regulatory processes while ensuring safety

Research focus: Aerospace defence systems

- Developing and demonstrating technologies to reduce the environmental footprint and cost of operation for DND
- Collaborating with industry on strategic R&D in the area of sustainment
- Transferring military technologies to the commercial aerospace sector

Research focus:
Civil unmanned aircraft systems

- Addressing technology gaps that are impeding the civilian adoption of UAS
- Working with regulators to develop a safe and commercially viable regulatory framework for UAS operation in Canada
- Enabling technology demonstrations

Research focus: Aeronautics for the 21st Century

- Enabling reduction in cost of aircraft ownership
- Developing and advancing critical aerospace technologies and processes
- Increasing the content of Canadian products on current and future platforms
- Securing Canada's position in supporting the next generation of efficient, cost-effective and environmentally friendly aircraft
- Fostering development of technology validation platforms and ITD centric consortia

Example 1: “Seed-to-sky” research, development & demonstration

Project on jet aircraft flight powered by 100% unblended renewable fuel

AGRISOMA

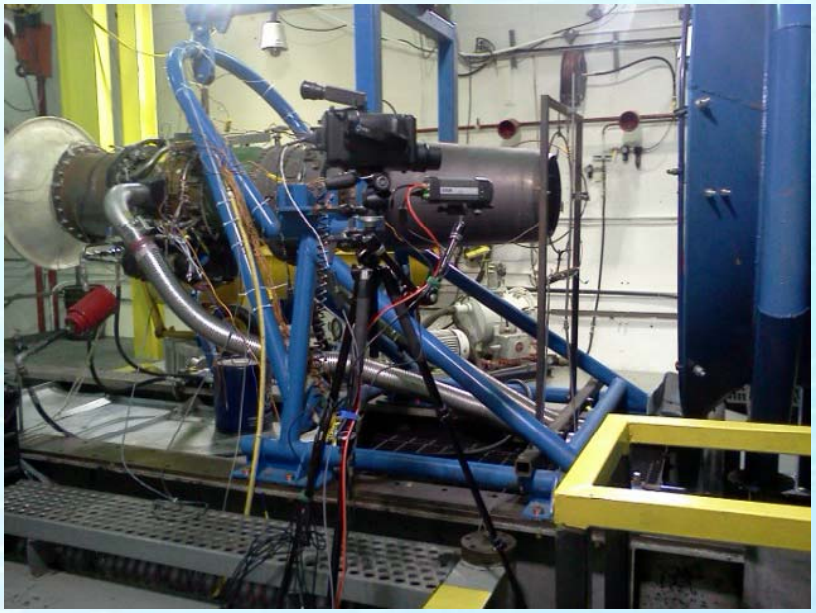
ARA

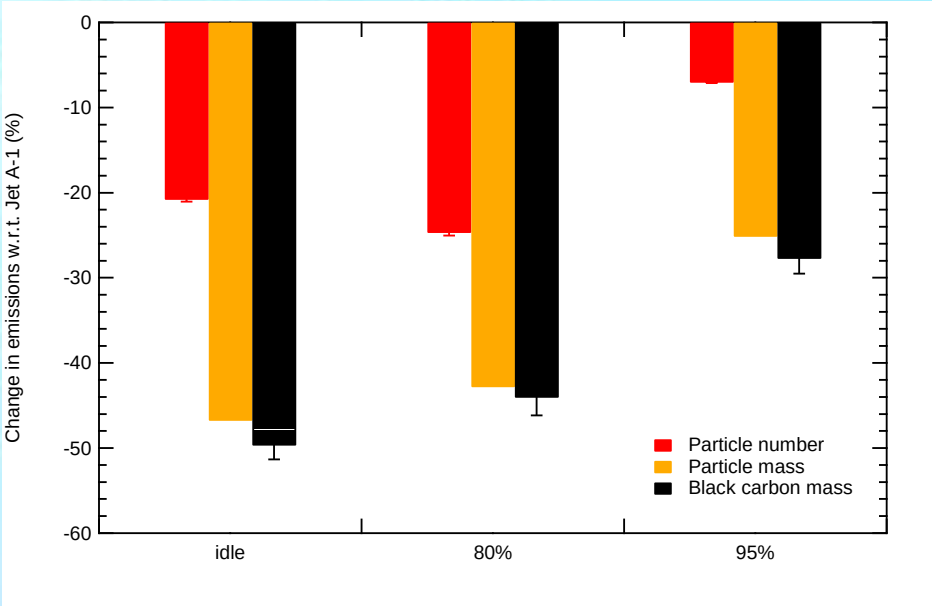
GARDN

Transport Canada

NRC·CNRC

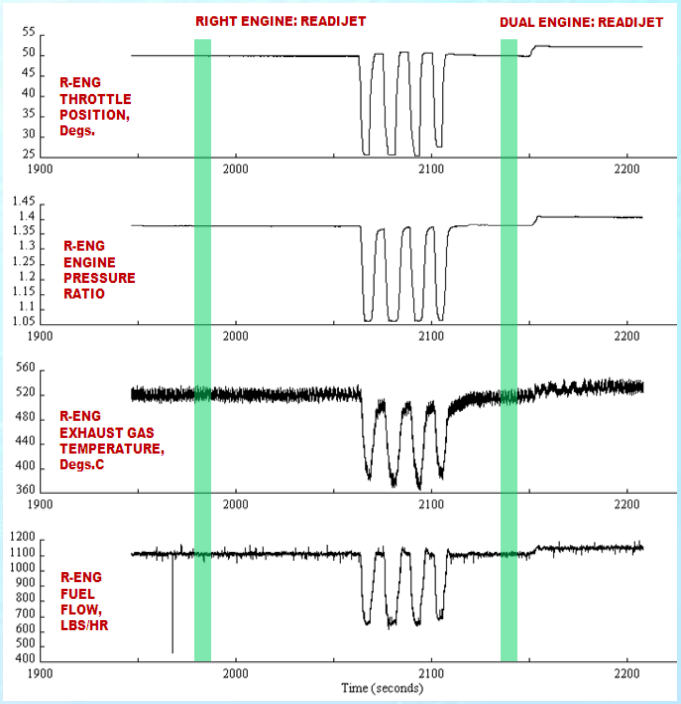
Results – Static engine test

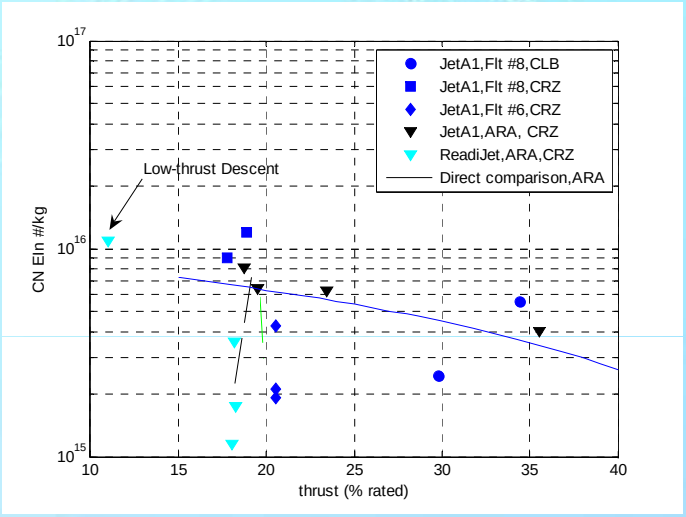


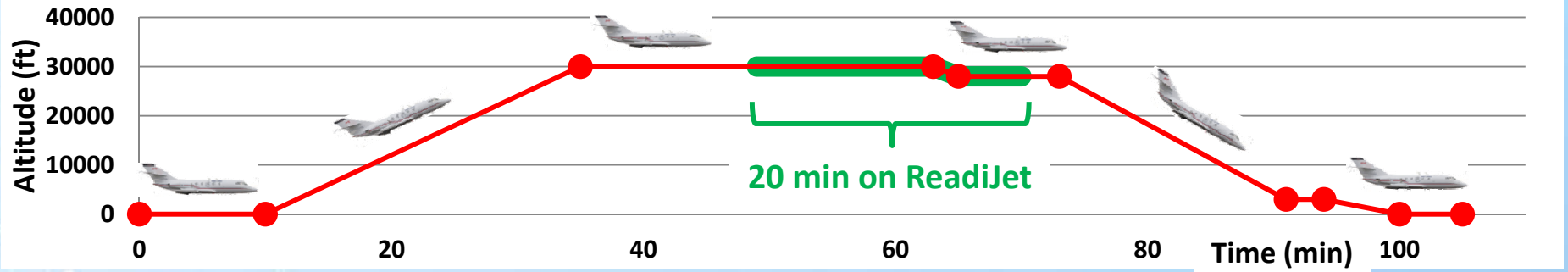


- No significant difference in engine performance noted during steady state and transient operation with Jet A1 or ReadiJet fuels
- Significant reduction in particle number (up to 25%) and black carbon (up to 49%) using ReadiJet relative to Jet A1 operation

Results – Flight test



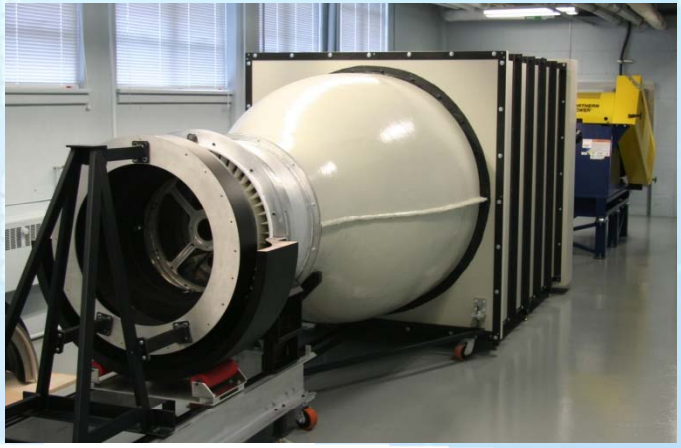


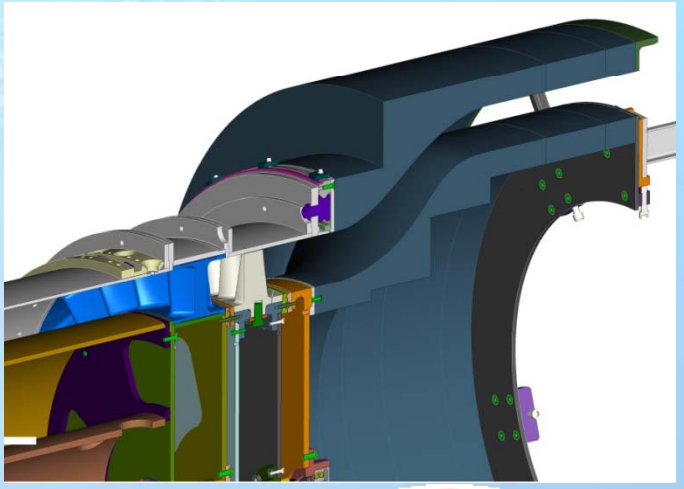


Example 2: Engine weight reduction technology development

Single-stage Subsonic Turbine Rig

- Detailed flowfield measurements
- High-pressure stage performance testing
- Evaluate effects of tip clearance and purge flow
- Optimize downstream inter-turbine ducts including the low-pressure turbine vanes

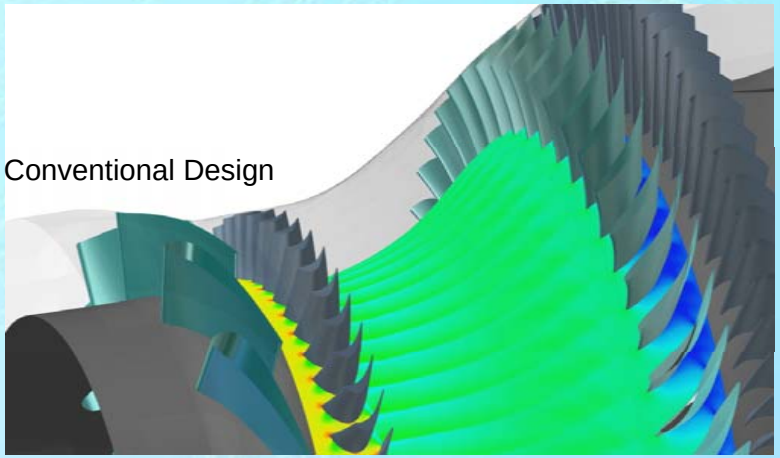




Results – Inter turbine ducts

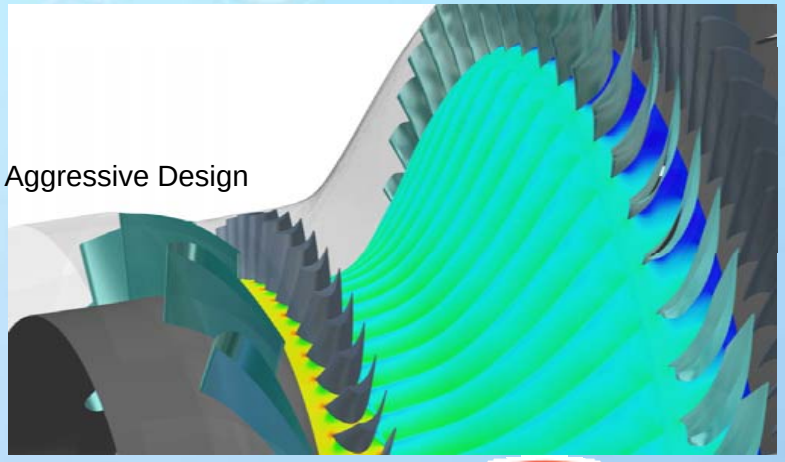
Accomplishments

- Reduced length by 30%
- Increased radial offset by 20%
- Increased area ratio by 25%
- Minimal performance penalty



Benefits

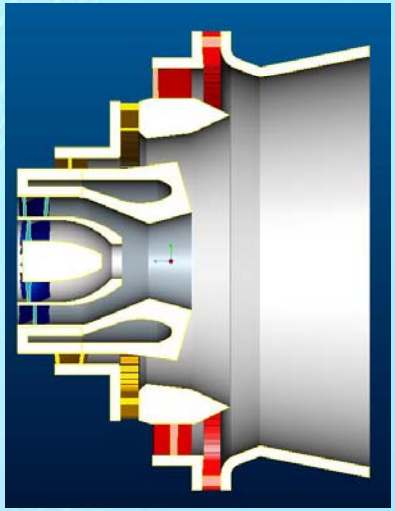
- Reduced weight of engine hot-section
- Reduced LPT stage count
- Reduced manufacturing costs
- Improved overall fuel consumption
- Reduced engine noise



Example 3: Advanced low emissions burner technology development & validation

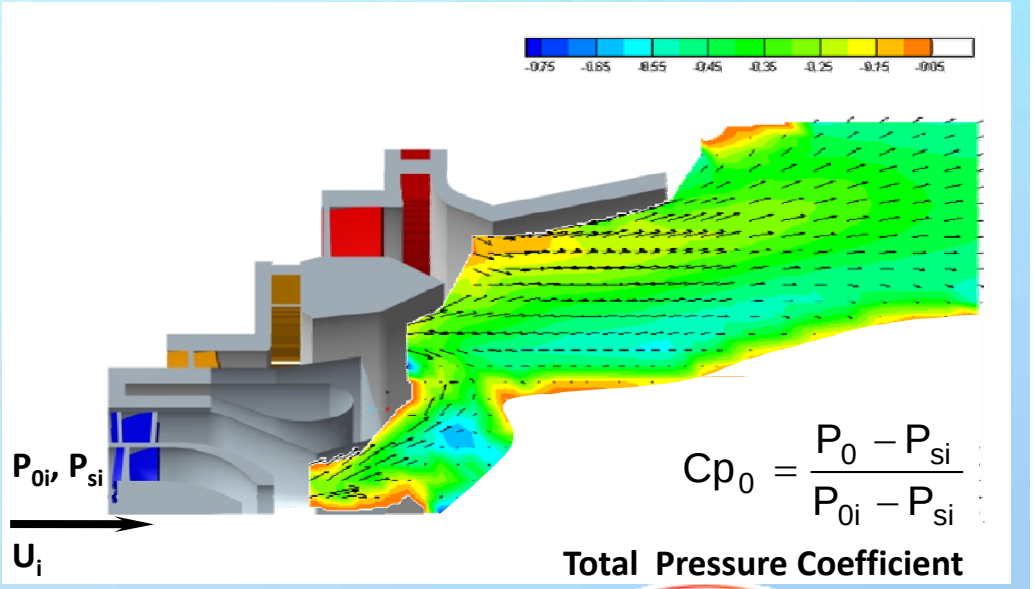
- Facilities to support the development of burner under realistic gas turbine operating conditions (air compression and temperature conditioning, optically accessible combustion rig, flow diagnostics)
- Spray and mixing characterization
- Single burner combustor evaluation (followed by combustor sector) under realistic operating conditions
- Integrated group of aerodynamics and combustion experts

Preliminary results



Benefits

- Low emission combustor with adequate combustor noise attenuation control.
- LTO NOx reduction by 75% (Re: CAEP 6 limit) without compromising other emissions
- Simplified fuel injection
- Improved operability



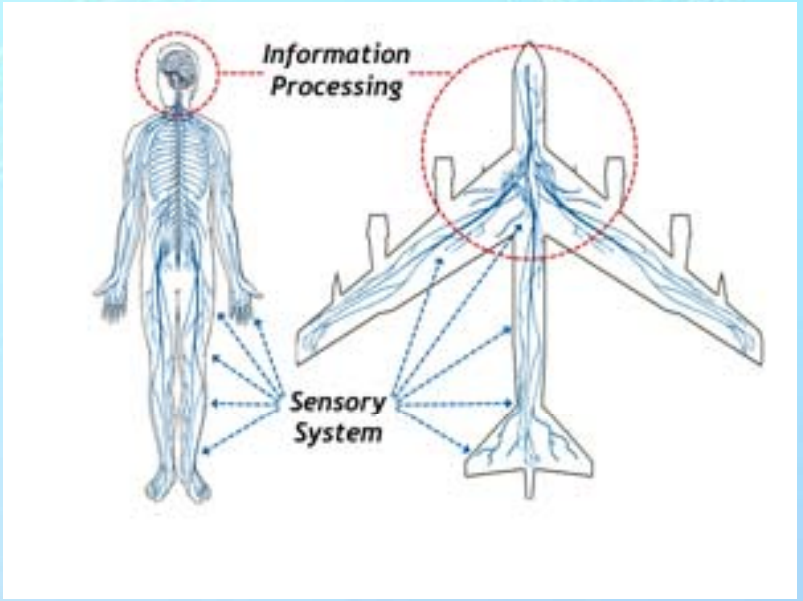
Example 4: Structural health M management – characterization of Guided Wave Propagation in aircraft structures

Objective

Improve safety and reduce aircraft maintenance costs by SHM techniques

Challenges being addressed

- Identification of structural features which impact the interaction of waves with defects
- Simulate representative defects
- Develop methodologies for assessing wave interaction with defects



BOMBARDIER

UNIVERSITÉ DE SHERBROOKE

McGill

L3 MAS

ÉTS Le génie pour l'industrie

NRC·CNRC

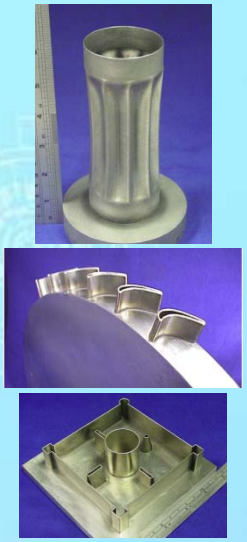
Example 5: Additive Laser Manufacturing

Processing Expertise

- Structural design of components
- ALM of Mg, Al, Ti, steels, Ni superalloys
- 9 ALM systems
- Composite manufacture, cold spray, EBPVD, machining
- Process develop/optimize and manufacture components
- Tailoring of material composition

Accuracy
Performance

Robotic laser additive manufacturing facility at NRC

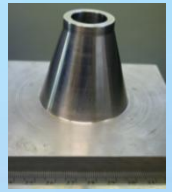


Parts fabricated at NRC

Structural Testing Facility at NRC

Product Manufacturing and Certification

- Flight Testing at NRC
- Certification



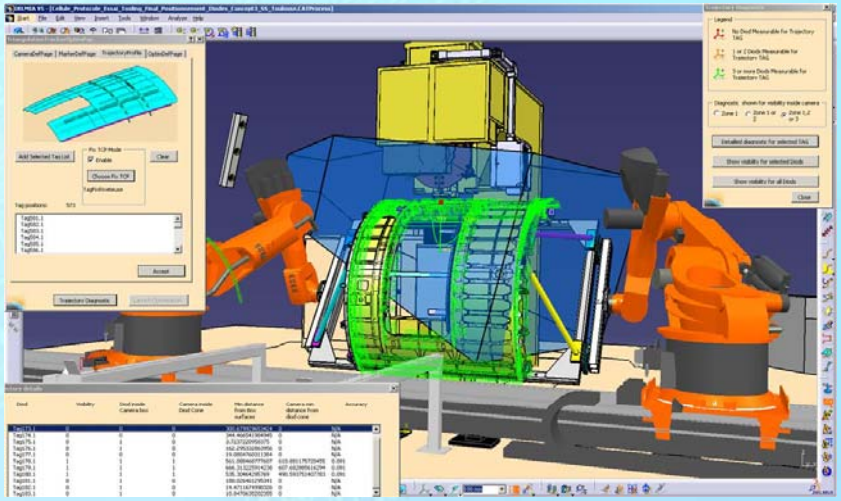
ALM at NRC

Performance Evaluation

- Residual stress measurement (x-ray, neutrons)
- Non-Destructive Inspection (x-ray, phase array, eddy current, laser ultrasound)
- Additive manufacturing build - integrity evaluation
- Room and elevated temperature static and dynamic testing (full-scale)
- FEM of process (LS-Dyna, Deform)

Example 6: Robotized aerostructures assembly

- Completed a $1.2M, 4-year robotized assembly of aerostrucutures collaboration project with Bombardier.
- Implemented a fully robotized riveting system from concept design with high accuracy and quality of performance suitable for aerospace production.
- The system is currently fully operational for production at Plant 1.



Re-cap: NRC's approach to business

- Assist Canadian industry by:
  - working on research projects that respond to strategic R&D priorities and Canada's economic prosperity
  - opening doors to world-class infrastructure, technical expertise and people
  - developing national and international networks to ensure timely access to emerging research, technologies and markets
- Bridge gap between inventions and commercialization
- Encourage more business investment in R&TD
- De-risk innovation

Thank you