

MANITOBA AEROSPACE TECHNOLOGY ROAD MAP

2017 SUMMARY

INTRODUCTION

Canada is a world leader in aerospace design, manufacturing, maintenance repair and overhaul (MRO), and space systems. Western Canada is a significant contributor to Canada's aerospace industry, with Manitoba being the largest component of the West's aerospace industry, and the third largest aerospace centre in Canada.

To maintain a leadership position in manufacturing and MR&O, and share in the rising market demand for new aircraft, space systems and aircraft servicing over the next 20 years, Manitoba companies must be increasingly successful in the fiercely competitive global supply chain. In an industry driven by technology and innovation, this means identifying and developing key technologies that will provide a sustainable, long-term competitive advantage.

In industries such as aerospace, in which R&D is a costly, long-term undertaking, collaborative approaches often yield better results for both participants and the economy. Therefore, as we grow our capabilities and investments in R&D, we need to encourage collaboration and support for regional, national and international efforts.

A Technology Road Map (TRM) provides a framework of the key technologies built on consensus of the participants. In 2013 Manitoba's aerospace community first met to consider and propose a series of Technology Thrusts for the industry. The resulting 2014 Technology Thrust Reports and Manitoba Aerospace Technology Road Map provided clear direction for our technology development programs.

To maintain relevance, the Manitoba Aerospace Research & Technology Committee (MARTC) has undertaken the review and refresh of the TRM. In just over two years there have been sufficient changes in Advanced Manufacturing (formerly Advanced Machining), Robotics and Automation, Composites, and Testing & Certification to warrant updates. In addition, the number of advances in Unmanned Aerial Vehicles warrants a dedicated Thrust Area.

MARTC greatly appreciates the vision and hard work of the original contributors to the TRM and will endeavour to continue to provide clear direction and facilitate collaboration in our technology development programs.



Mathew Shewfelt
MARTC Chair

Boeing Canada — Winnipeg

MARTC Members:

Loren Hendrickson Deputy Chair <i>CARIC</i>	Alfonz Koncan Secretariat <i>EnviroTREC</i>	Gene Manchur <i>Composites Innovation Centre</i>
Bob Hastings <i>WestCaRD</i>	John Bagan <i>Magellan Aerospace</i>	Shane Zakaluk <i>Cadorath</i>
Chad Kaatz <i>StandardAero</i>	Myron Semegen <i>Industrial Technology Centre</i>	Oyedele Ola <i>Red River College</i>
Doug Thomson <i>University of Manitoba</i>	Martin Petrak <i>Precision ADM</i>	David Simpson <i>EnviroTREC</i>
John McCutcheon <i>Corner Aerospace</i>	Jeff Thomas <i>Argus Industries</i>	



MANITOBA TECHNOLOGY ROAD MAP PROCESS

An industry-led steering committee was established to lead the TRM project and identify the major technology thrust areas critical to the long-term competitiveness of Manitoba's aerospace industry.

Six strategic thrust areas were identified and a Thrust Area Working Group (TAWG) was established to undertake a detailed review of the future needs and opportunities in each area. Over 50 technical experts from across the aerospace community participated in the six TAWGS, identifying 25 key technologies.

31 KEY TECHNOLOGIES:

- Inspection
- Adaptive Machining
- Additive Manufacturing
- Machining Strategies
- Nanotechnologies
- Joining (Metallics)
- Post Processing (Metallics)
- Robotic Applications
- Robot Integrated Sensing
- Robot Communications
- Robot Software Systems
- Robot Safety Systems
- Out-Of-Autoclave (Composites)
- Mid Temp (Composites)
- Resin Infusion (Composites)
- Pre-Forms (Composites)
- Hybrid Processing (Composites)
- Automated Fabrication (Composites)
- Automated Inspection (Composites)
- Enhanced Technical Instructions and Analysis
- Simulation Platform for Complex Interconnected Systems
- Modeling of New and Emerging Composite Materials
- Emerging Tests (Gas Turbine Engines)
- Specialized Instrumentation (Gas Turbine Engines)
- Gas Turbine Testing Simulator
- Space Autonomy
- Autonomy (UAVs)
- Robustness and Safety (UAVs)
- Certification (UAVs)
- Sensors (UAVs)
- Data Collection (UAVs)

External resources, including environmental scans prepared by National Research Council (NRC) Knowledge Management as well as NRC subject matter experts, supported the TAWGs to ensure a broad understanding of the national and international state of development of the key technologies before formulating a Manitoba-centric Critical Technology Report for each one.

Collectively, these 25 Critical Technology Reports represent Manitoba's Aerospace Technology Road Map, providing a clear direction for our technology development programs.



THRUST AREA 1 – ADVANCED MANUFACTURING

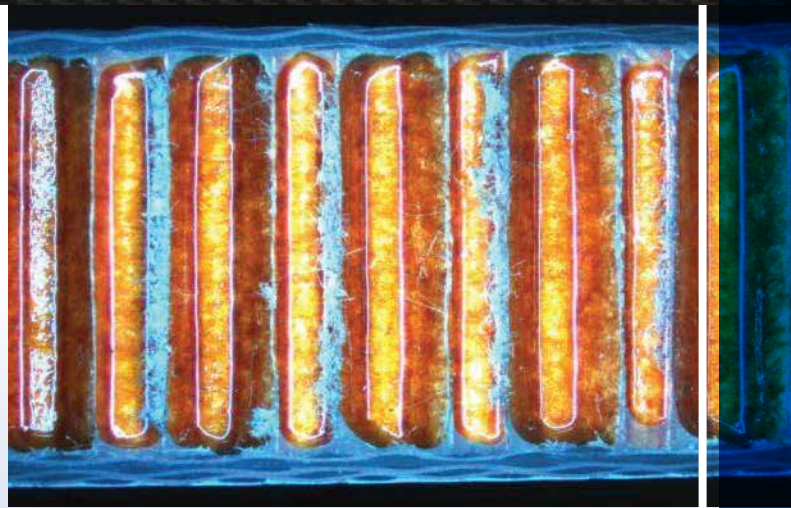
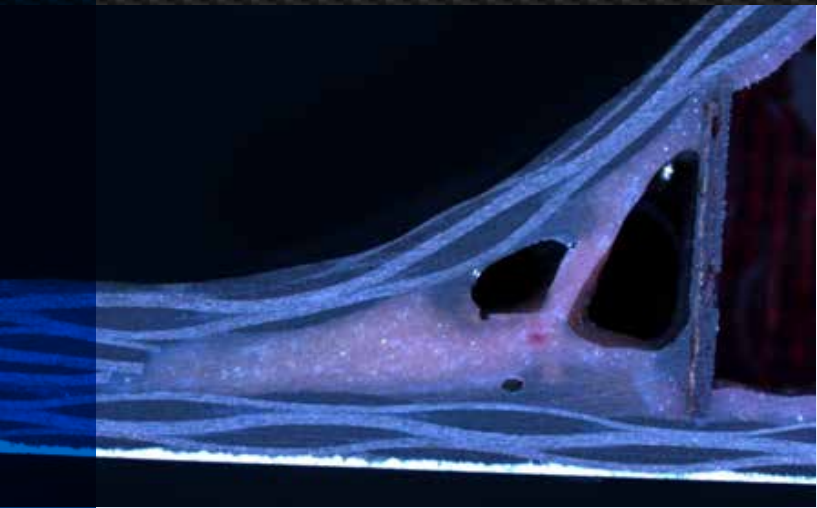


- **Inspection** – the use of 3D scanning and automation to provide accurate, rapid, dimensional and non-destructive inspection, especially for “hard to inspect” aerospace applications.
- **Adaptive Machining** – the use of advanced 3D surfacing technologies to blend machined surface features seamlessly into the contours of existing aerospace parts
- **Additive Manufacturing** – the use of “3D printing” technologies to create near net or net shape complex metallic or polymer parts with good material characteristics.
- **Machining Strategies** – the development of advanced machining technologies to extend the range of aerospace component machining capabilities.
- **Nanotechnology** – the development of coatings, sensors and reinforcements at the nano scale level to drive new opportunities in the aerospace materials and manufacturing sector.
- **Joining** – the advancement of fusion processes in the manufacturing and repair of aerospace structures to maximize material and dimensional properties.
- **Post Processing** – the use of peening, heat, chemical and Hot Isostatic Pressing (Hipping) treatments to improve material properties of aerospace materials.

THRUST AREA 2 - ROBOTICS AND AUTOMATION

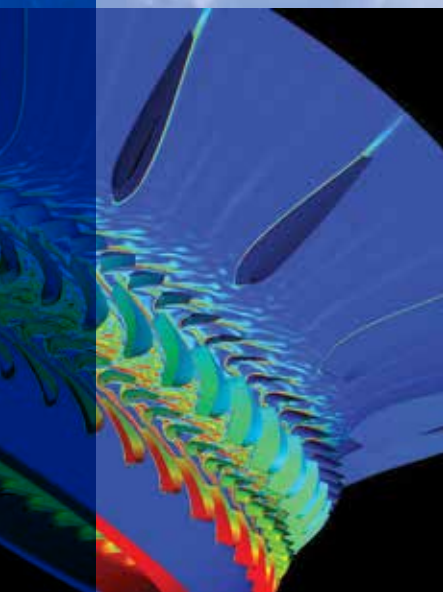
- **Robotic Applications** – the use of robotic machines, control systems, and information technologies to optimize productivity, quality and ergonomics in aerospace manufacturing.
- **Robot Integrated Sensing** – this includes Vision, Force Feedback, Sonar, Lasers and anything that assists with feature identification, spatial positioning and validation.
- **Robot Communications** – the use of information to support robot associated activities including the Industrial Internet of Things, Machine to Machine Protocols and Analytics.
- **Robot Software Systems** – the systems and tools required to support robotic activity including environmental awareness, real-time/live Simulation, machine learning (AI) and OS.
- **Robot Safety Systems** – the development and use of systems (regulatory or other) to protect collaborative humans from harm, as well as product and environment from damage.





THRUST AREA 3 – COMPOSITES

- **Out-Of-Autoclave** – improves on traditional prepreg composite manufacturing approaches by allowing aerospace parts to be cured at reduced pressures, eliminating the need and constraints of an autoclave cure.
- **Mid Temperature** – the use of Bismaleimide (BMI) and new polyimide resins that allow conventional epoxy resin composites processing, with improved temperature capability (350 – 600F) but dramatically reduced costs compared to earlier generations of these class of materials.
- **Resin Infusion** – the development of technologies whereby dry fibres are impregnated with a liquid resin in-situ, enabling efficiencies in the manufacture of near net shape composite products. Includes SQRTM and its variants where traditional prepregs are processed at the same time as preforms and resin infused to create a product.
- **3D Pre-Forms** – the use of technologies to weave, stitch, or braid dry fibres into a reinforcement to enable resin infusion with improved “through the thickness” strength.
- **Hybrid Processing** – entails multi-material co-process and co-cured forms cured in a single stage.
- **Automated Fabrication** – the use of “right sized”, tailored automated technologies to laminate, reticulate, drape form, and/or consolidate composite prepreg materials, to optimize productivity, quality and ergonomics.
- **Automated Inspection** – covers both the pre-cure (FOD, ply number and orientation) and post-cure environments (NDI and dimensional) for composites fabrication to improve quality and flow.



THRUST AREA 4 – SIMULATION MODELLING AND ANALYSIS

- **Enhanced Technical Instructions and Analysis** – The development of enhanced training technologies for aerospace manufacturing and maintenance technicians, including Virtual Reality (VR) training, will reduce the cost and time for training, and improve the level of competency.
- **Simulation Platform for Complex Interconnected Systems** – The development of sophisticated simulation technologies that facilitate the integration of various subsystem/subcomponent simulations into a broader, enhanced system-level simulation for the entire platform as a single integrated unit.
- **Modelling of New and Emerging Composite Materials** – New and sophisticated software and simulation tools will be needed to support the introduction of advanced materials and new composites for next generation aerospace designs.

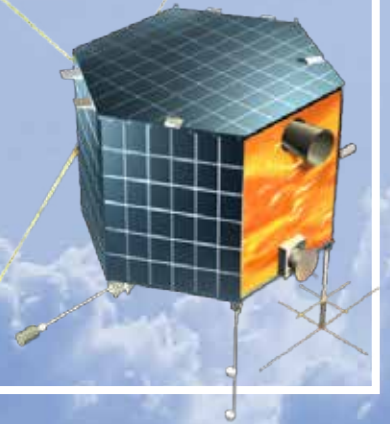


THRUST AREA 5 – TESTING AND CERTIFICATION

- **Emerging Tests** – the development of new engine test capabilities at Winnipeg and Thompson test facilities to perform water, hail, ice crystal, and volcanic ash ingestion tests.
- **Specialized Instrumentation** – the custom design of specialized gas turbine engine instrumentation to support enhanced test capabilities at Manitoba's certification and production test facilities.
- **Gas Turbine Testing Simulator** – to proceed with the development of a gas turbine engine test simulator to facilitate training of test technicians and engineers under normal and emergency situations.

THRUST AREA 6 – SPACE AND ROCKET SYSTEMS

- **Space Autonomy** – the development of improved autonomous spacecraft systems to reliably and effectively monitor inputs from various sensors, determine the state of the system, detect errors or failures, implement isolation or recovery actions, and predict future states.



THRUST AREA 7 – UNMANNED AERIAL VEHICLES

- **Autonomy** – the capability of operating independently and to be able to interface with other UAV's without the support of an operator.
- **Robustness and Safety** – in addition to human safety, the ability to sustain minimal damage due to loss of power (e.g. autorotation) or loss of signal (e.g. autonomy).
- **Certification** – the development and compliance to a regulatory environment in this rapidly changing field.
- **Sensors** – unique sensors are required (e.g. without GPS) and “light weighting” required compared to traditional aerospace sensors given payload limitations.
- **Data Collection** – this involves collection and processing of data in both onboard and streaming applications and also from multiple sources.



THE RESULTS

The TRM process identified 31 key technologies in seven areas.

The key technologies are shared across and beyond the aerospace industry in Manitoba, and are consistent with those identified by the national Technology and Innovation Committee operating under the direction of the Aerospace Industries Association of Canada (AIAC). Many of the technologies identified are universally applicable to both manufacturing and maintenance, repair and overhaul (MRO) applications.

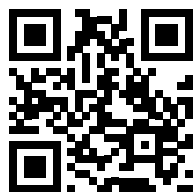
The efforts required to develop many of the technologies will require collaborative approaches, both to create the required critical mass of knowledge and facilities and to share the risks and costs. The Manitoba aerospace community will need to increase its capacity to undertake collaborative research projects, including collaboration beyond Manitoba's borders.

Drawing upon existing collaborative research programs across Canada and elsewhere, Manitoba will need to establish strategies and mechanisms to pursue collaborative research and development. Both funding models and coordination/ leadership models will be required.

The resulting Technology Thrust Reports and Manitoba Aerospace Technology Road Map provide clear direction for our technology development programs.

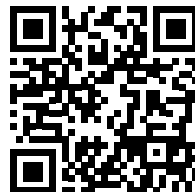
The entirety of the Manitoba Aerospace Technology Roadmap reports are available through the Manitoba Aerospace Inc., EnviroTREC and WestCaRD websites:

**Manitoba
Aerospace Inc.**



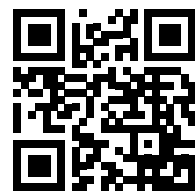
www.mbaerospace.ca

EnviroTREC



www.envirotrec.ca/projects

WestCaRD



www.westcard.ca



THRUST AREA WORKING GROUPS

ADVANCED MANUFACTURING

Chair — Martin Petrak, Precision ADM, Chief Executive Officer

Deputy Chair — Alfonz Koncan, EnviroTREC, Director of Business Development and Government Relations

Members:

- Subramaniam Balakrishnan, University of Manitoba, Professor
- Elliott Foster, Magellan Aerospace, Team Leader Quality Control
- Keith Jephcote, StandardAero, Manager, Process Engineering
- Chris Godin, Boeing Canada, Operations Equipment Engineering
- Dale Kellington, Precision ADM, GM / VP Business Development
- Bill Noakes, RRC, Chair: Mechanical, Manufacturing and Communication
- Richard Scarle, StandardAero, Specialist, Process
- Leo Sousa, Cormer Aerospace, President
- Hong Yu, NRC-IRAP, Industrial Technology Advisor

ROBOTICS AND AUTOMATION

Chair — Serge Boulet, Magellan Aerospace, Manufacturing Technology Engineering

Deputy Chair — Myron Semegen, ITC, Manager, Advanced Technologies

Members:

- Subramaniam Balakrishnan, University of Manitoba, Professor
- David Boonstra, Boeing Canada, Boeing Research & Technology
- Fred Doern, Red River College, Research Chair
- Brendan Guyot, Phantom Motion, President
- Iraj Mantegh, NRC, Research Officer
- Shawn Schaerer, Schaerer Innovations Inc, CEO

COMPOSITES

Chair — Kevin Robbins, Boeing Canada, Boeing Research & Technology

Deputy Chair — Gene Manchur, CIC, VP, Aerospace, Materials and Processes

Members:

- John Bagan, Magellan Aerospace, Senior Manager, Business Development
- Raghavan Jayaraman, University of Manitoba, Associate Professor – Mechanical Engineering
- Andrew Johnston, NRC, Group Leader
- Chris Marek, Red River College, Instructor – Composites Manufacturing

SIMULATION MODELLING AND ANALYSIS

Chair — Doug Roberge, StandardAero, Senior Airworthiness Engineer

Deputy Chair — Ken Webb

Members:

- Steve Crouch, CIC, Principal Engineer, Aerospace EIT
- Ray Woodason, StandardAero, Director, Performance Engineering
- Brent Jones, Magellan Aerospace, Mechanical Engineering, Space Systems
- Hartley Waldman, Boeing Canada
- Michael Thomlinson, ITC, Engineering Manager
- Franco De Luca, B/E Aerospace, Design and Stress Manager
- Nick Bellinger, NRC, Group Leader

TESTING AND CERTIFICATION

Chair — Bob Hastings, WestCaRD, Chief Executive Officer

Deputy Chair — Alfonz Koncan, EnviroTREC, Director of Business Development and Government Relations

Members:

- Kathryn Atamanchuk, University of Manitoba, EIR
- Trevor Cornell, ITC, Chief Operating Officer
- Fred Doern, Red River College, Research Chair
- Kevin Luellman, IDERS Inc, Sr. Business Development Manager
- Jim MacLeod, NRC, Group Leader
- Brent Ostermann, StandardAero, Director – Engineering
- Troy Ramnath, MDS Aerotest, General Manager
- Doug Thomson, University of Manitoba, Professor & Associate Dean – Computer Engineering

SPACE AND ROCKET SYSTEMS

Chair — Diane Kotelko, Magellan Aerospace, Space Systems Engineer

Deputy Chair — Wendell Wiebe, Manitoba Aerospace Inc., CEO

Members:

- Igor Telichev, University of Manitoba, Assistant Professor
- Howard Loewen, MicroPilot, President
- David Bertin, Red River College, Research Technologist
- Sylvie Beland, NRC, Director R&D Structures Materials and Manufacturing

UNMANNED AERIAL VEHICLES

Chair — Martin Petrak, Precision ADM, Chief Executive Officer

Deputy Chair — Alfonz Koncan, EnviroTREC, Director of Business Development and Government Relations

Members:

- Leon Hanlan, Altus Geomatics Limited Partnership
- Howard Loewen, Micropilot, President
- Shawn Schaerer, Schaerer Innovations Inc, CEO
- Nariman Sepehri, University of Manitoba, Professor & Associate Dean – Mechanical Engineering
- Hong Yu, NRC-IRAP, Industrial Technology Advisor

