GREEN AVIATION RESEARCH & DEVELOPMENT NETWORK

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in  Green Aviation Research & Development Network (GARDN)
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The last federal budget highlighted the innovation agenda as a top high in Canada for the next few years; $950 million have been reserved for the development of five superclusters by 2022 targeting the acceleration of innovation and business growth, especially of clean technology industries. Furthermore, over $2 billion have been specifically allocated to the development of clean technology research and development. These measures have been well acclaimed by AIAC, and follow AIAC’s recommendations for the advancement of the Canadian aerospace industry.

GARDN as an entity has been following the direction set by the federal government regarding clean technologies, and is more than ever eager to continue its work in reducing the environmental nuisance of aircrafts. The development of technologies resulting from GARDN research projects will serve a higher purpose and benefit Canadian businesses, communities, families and individuals.

This past year, GARDN has achieved steady progress moving its projects forward. GARDN is involved with all tiers of the green aviation sector together, and supports members and participants of its network. GARDN also aims to sensitize the government, and all stakeholders of the importance of R&D and integration of resulting technologies in the next generation of aircrafts.

The 4th round launched in December 2016 had many high-quality proposals but only four could be funded. Thus, the importance of a continued investment and financing of green aviation projects to not only continue to support existing ones, and to allow others promising R&D projects to be considered.

With GARDN’s work and results serving as a precursor for the next generation engines and aircrafts for a greener aviation, I wish to acknowledge the support of the Government of Canada and Business-Led Networks of Centres of Excellence Program for making this possible. We are proud of our work and hope to see the current trend and program continue in the future through the Innovation agenda. As the government seeks to boost innovation in Canada, national research networks like GARDN and CARIC have an important role to play. We are global leaders when it comes to bringing R&D stakeholders together to create a robust innovation environment, and we can contribute our expertise towards the growth of a new culture of innovation in Canada. This is a tremendous opportunity for our industry, and we look forward to a strong future for sustainable, clean innovation in Canada.

Finally, I would like to extend my appreciation to all the members of GARDN’s network for your devotion in developing innovative green technology and processes for the aerospace sector.
MESSAGE FROM THE EXECUTIVE DIRECTOR

It’s with great pleasure that I present you with GARDN’s annual report for the year 2016-2017 which was marked by the selection of four new projects. Our network is now even stronger and bigger with the addition of new members and contributors from the Western and Central Canada such as Boeing Canada, Composites Innovation Center, Convergent Manufacturing Technologies. The large number of project proposals received gave us confidence that significant work and research is underway to meet ICAO standards and to make the Canadian aerospace greener.

GARDN’s involvement to many international and national conferences organizing committees has contributed to showcase the work accomplished so far. GARDN has also been solicited by the federal government in relation to the development of the following strategies:

- Canada’s transition to a low carbon economy
- Sustainable development strategy
- Clean technologies strategy
- Innovation Strategy

GARDN organized two very insightful integration workshops which brought together project leaders and participants, and helped integrate even more GARDN members in the aerospace supply chain. Some of the workshop topics include the presentation of ATI’s (UK) aerospace road map, a presentation on the European REACH regulations and the proposition for Canada’s next green aviation program.

The future is even greener with the new federal budget which put a high priority on innovation and clean technology R&D. The year ahead of GARDN will be full of challenges such as the proposal of an Environmental assessment of the GARDN research portfolio. Furthermore, GARDN is working intensively with CARIC and other aerospace organizations in the context of the supercluster initiative, and the Strategic Innovation Funds.

I would like to express my gratitude and thanks to all the project leaders, participants, stakeholders and to my team for their work, contribution and passion to the GARDN program.

Sylvain Cofsky
Executive Director
The Green Aviation Research and Development Network (GARDN) is a non-profit organization created in 2009 with funding from the Business-Led Network of Centres of Excellence (BL-NCE) of the federal government and Canadian aerospace industry. GARDN’s mission is to help support and increase Canada’s competitiveness in the aerospace industry — by reducing the environmental footprint of the next generation of aircraft, engines and avionics systems developed in the country.

Following the first round of financing terminated in 2014, GARDN was granted more financing for a second round of five years until 2019. The new round, GARDN II, has kept the focus on the ongoing development of technology and procedures for a MORE CLEAN, QUIET, SUSTAINABLE aviation to achieve the environmental objectives of the global aerospace industry. Both programs, GARDN I and GARDN II, have jointly generated close to $70 million in research and development projects facilitating:

- Creativity and innovation in the development of greener aviation technology
- Collaboration between different-sized companies in the supply chain
- Investment in research institutions to train qualified personnel
- Life cycle of business projects and services factored into the environmental impact

ABOUT BL-NCE

The Business-Led Network of Centres of Excellence (BL-NCE) innovation in the private sector, responding to real-world challenges with the right expertise. These extensive networks of cooperative research increase private sector investment’s in Canadian research and accelerate the transformation of laboratory ideas into vital solutions for the private sector.
GARDN II

HIGHLIGHTS & ACHIEVEMENTS

2016

JULY
Strategic retreat in Montréal gathering board and network members to discuss the future of GARDN.

NOVEMBER
Third integration workshop that drew close to 50 participants, and three parallel sessions on GARDN’s research themes: clean, quiet and sustainable.
Presentation of the impact of the European REACH regulation on the aerospace sector by EcoMundo, a team of scientific experts from France specializing in chemical substances and their regulation.
Presentation by Dr. Simon Weeks, Chief Technology Officer of the Aerospace Technology Institute (ATI), about the current road mapping approach in the United Kingdom.
GARDN has been appointed ‘partner taking action’ to the clean energy component by the Government of Canada’s new federal Sustainable Development Strategy initiative.

DECEMBER
GARDN adds four R&D projects to its portfolio. Three are extensions and one is a new research project led by Boeing Canada.

2017

FEBRUARY 2017
Participation to ConvergX in Calgary
Participation to the Biojet Fuel Symposium in Vancouver

MARCH
Presentation by GARDN to the Standing Senate Committee on Energy, the Environment and Natural Resources relative to the survey of the cost ordinary Canadians and businesses will face by transitioning to a low carbon economy.

APRIL
GARDN attended the “Aircraft Noise and Emissions Reduction (ASCENT)” session in Washington D.C.
GARDN implicated in the organizing committee of the “Aircraft Noise and Emissions Reduction” (ANERS) conference, animated a panel on the international research network collaboration and another one on sustainable aviation.

MAY
Canadian Aeronautics and Space Institute (CASI) AERO 2017 conference: many GARDN research projects were showcased. GARDN shared its expertise during the panel on Collaboration and funding opportunities.

JUNE
Paris Airshow: GARDN shared a stand with CARIC visited by Ministers Bains, Garneau and Champagne.
Participation to Movin’On, organized by Michelin in Montréal.
GARDN projects featured at the UTIAS National Colloquium on Sustainable Aviation (Toronto)
The GARDN II program supports green aerospace research and development projects since 2014. Today, GARDN funds 20 COLLABORATIVE RESEARCH PROJECTS for a total value of more than 20 M$. The results of GARDN’s efforts not only directly meet the needs of the industry, but also achieve the environmental objectives of the government and ICAO.

The GARDN network counts close to 50 members working for a greener aviation:

- **27 companies** of which **17** are SMEs
- **20 research institutions**
- **9 R&D projects conducted by SMEs**
- **246 researchers**
- **5 international organizations**
- **57 developed prototypes**
- **5 ready-to-market technologies**
- **45 filed patent applications**
OBJECTIVE
Invest in a design system for lowering non-volatile Particulate Matter (nvPM). nvPM has been determined to be a potential source for greenhouse gas. Investing in nvPM reduction will not only benefit the environment, but also will help P&WC remain competitive in a market that is now demanding for cleaner (lower emissions) aircraft engine exhaust.

OBJECTIVE
Optimize the vertical and horizontal path of the aircraft within the Flight Management System by taking into account the Required Time of Arrival, the wind grids and meteorological conditions.

The main motivation of the project is to reduce overall carbon emissions and flight costs.

OBJECTIVE
A continuation of prior work, the GARDN II project involves the development of a novel aircraft concept which is designed to satisfy various performance and stability and control (S&C) requirements.

This aircraft concept will then be tested in a wind tunnel test campaign to validate the S&C characteristics. Various alternative designs will be tested in addition to the baseline configuration.
SUBSTAINABLE

QC-21
Greening the Aerospace Supply Chain

OBJECTIVE
Define a supply chain management framework to provide industrials with the capacity to prioritize eco-responsible purchasing actions, define technologies’ green specifications and efficiently treat environmental information.

The acquired knowledge will offer a collaboration model fully adapted to the Canadian aerospace sector, facilitating ecodesign across the supply chain.

QUIET

PWC-22
Noise Reduction for Next Generation Regional Turboprop

OBJECTIVE
Leverage new technologies, develop new design methodology, and mature concepts in support of a low-noise large regional turboprop aircraft meeting stringent noise requirements.

The technology advancement to TRL6 of noise reduction concepts is a must for the development of a new large environmentally-friendly turboprop aircraft.

QUIET

BA-22
Airframe Noise Reduction for Business and Commercial Aircraft

OBJECTIVE
Reduce noise impact of aircraft operations in the vicinity of airports by leveraging new technologies, developing new design methodology and maturing concepts in support of a low-noise business and commercial aircraft.

The project will lay groundwork to help reducing the adverse effects of the expected large increase in aircraft traffic volumes in Canada and elsewhere in the next decades.
OBJECTIVE
Investigate novel air vehicle configurations, advanced propulsion systems, and noise reduction techniques to enable cleaner and quieter UAV operations and air transportation. This includes the development of a hybrid gas/electric propulsion system that will allow advanced technologies such as distributed propulsion. The technology will be demonstrated using Nebula’s existing VTOL fixed wing UAV air frame.

The research will develop an analysis of lightweight and flexible wings and unique energy harvesting methods on the flexible wing structures and the testing of physical prototypes.

OBJECTIVE
Reducing the fuel burn and corresponding CO2 emissions of small commercial turboprop aircraft (19 or less seats) during the cruise flight phase using a software application installed on stand-alone Electronic Flight Bag (EFB) device.

The main motivation for developing an EFB-based solution stems from the need to achieve an average improvement in fuel efficiency of 1.5% per year per industry target.

OBJECTIVE
Ensure that constituent technology components for an aerospace-grade Integrated Electric Propulsion System (IEPS) are commercially available, operationally viable, meet Certification Authority requirements, and are through-life supportable in a cost effective way.

This project will give involved business entities a jump on a key emerging branch of aerospace technical capability.
OBJECTIVE
Validate the performance of additive manufacturing (AM) process for aerospace non-structural parts, the use of standard post-manufacturing processes required and evaluate the certification of aerospace parts produced by AM.

At the end of the project, the performance of parts made by AM will be compared to certifiable machined parts used as reference.

OBJECTIVE
Advance the development and production of biojet fuels in Canada from sustainable biomass feedstocks.

The project will assess the potential of producing biojet from Canada’s considerable forest residue resources, using the experience of Canada’s established forest products sector and the pellet sector.

OBJECTIVE
Demonstrate the operational feasibility of biojet fuels in the domestic jet fuel supply system, catalyze the development of the domestic biojet sector by using HEFA biojet, validate CND biojet supply chain elements, and generate hands-on experience with biojet handling and integration to develop best practices in a Canadian context. CBSCI blending activities will occur at Montreal-Trudeau International Airport (YUL).
OBJECTIVE

Focus on validating new findings in terms of axial compressor design strategies to maintain nominal performance and stall margins. The objective of the proposed research is to validate the findings from research experimentally on a real compressor design in a representative environment to validate the predicted design improvements through testing of original designs versus a newly proposed design based on the desensitization strategies.

OBJECTIVE

Invest in a design system for lowering nvPM. Non-volatile particulate matter has been determined to be a potential source for GHG and detrimental to human health. Investing in nvPM reduction would not only benefit the environment, but help P&W remain competitive in a market that is now demanding cleaner (lower emissions) engines on aircraft.

OBJECTIVE

Enhance the T33 emissions instrumentation by the addition of a CPC 3776 ultra-fine aerosol sensor and denuder to differentiate between volatile and non-volatile particles, and then undertake jet emissions and contrail measurement flights.

OBJECTIVE

Demonstrate that electric propulsion is feasible and viable to support glider launch operations with multiple flights per hour with quick battery replacement in-between flights, develop the Canadian expertise in electric propulsion for general aviation-sized aircraft, and increase awareness for green aviation through a project that is “accessible” to Canadian citizens.
**4TH ROUND PROJECTS**

**CLEAN**

**SRS-22**

Turboprop Flight Advisory Systems Enhancements, Testing and Engine Model Development

**OBJECTIVE**

The objectives of this project are to enhance and extend the capabilities of an iPad-based Flight Advisory System (FAS), to perform ground and flight testing to confirm the benefits of up to 10% in fuel burn and CO2 emissions reductions in small commercial turboprop aircraft (19 or less seats) and to determine whether an engine model can be employed to define more efficient flight trajectories. Research and development activities will investigate the means to increase the utility of the FAS over a wider range of flight conditions and aircraft types, thereby delivering greater economic benefits to turboprop operators while further reducing the impact of the aircraft type on the environment.

**QUIET**

**BA-23**

Experimental Validation of Innovative Environmentally Friendly Aircraft Configurations – Extension for Noise measurements

**OBJECTIVE**

The proposed project is an extension to a currently ongoing GARDN II program “Experimental Validation of Innovative Environmentally Friendly Aircraft Configurations”, which aims at maturing an unconventional aircraft configuration using wind tunnel testing. The unconventional aircraft under study has shown potential to significantly reduce greenhouse gas emissions but also has an inherent potential for community noise reductions.

**DURABLE**

**BC-21**

Reuse of Uncured Aerospace Preimpregnated Composite Materials in Commercial Applications

**OBJECTIVE**

This project will further the knowledge, experience and capability to reuse of uncured aerospace grade pre-impregnated (prepreg) materials for the Canadian Aerospace industry. The outcome will be further “greening” of the aerospace composite supply chain through:

- reduction of the volume of landfilled, incinerated or acid/solvent reclaimed prepreg waste
- redirection of prepreg waste into value-added commercial products demanding high quality fibres and high performance epoxy matrix systems
- industry development and growth through the creation of a new “reclaimed prepreg” material supplier(s)
- development of new regional commercial opportunities, and
- cost avoidance through the reduction of uncured prepreg scrap disposal costs.

**CLEAN • QUIET**

**CMC-22**

Flight Management Performance Optimization III

**OBJECTIVE**

The main environmental benefits of the research projects presented below are to reduce the overall carbon emissions, the flight costs and noise through the enhancement of the Flight Management System (FMS) capabilities and the vast deployment of the FMS across many aircraft platforms. As for the second project, the enhancement of the FMS capabilities allows fuel and noise reductions.
CLEAN
QUIET
SUSTAINABLE

BLUE-SKY THINKING
FOR A GREEN AEROSPACE FUTURE.
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* This post is up for reelection
** Replaces Benny Pang as a committee member