

# CRIAQ and CARIC: An Innovation Journey - Insights on How to Build Successful Research and Development Collaborations in Aerospace: The Case of the Quebec and Canadian Ecosystems

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**Abstract.** The Consortium for Research and Innovation in Aerospace in Quebec (CRIAQ) and the Consortium for Aerospace Research and Innovation in Canada (CARIC) are organizations whose missions are to facilitate collaboration of researchers from the aerospace industry, academia and research centres, and to launch initiatives whose primary purpose is to promote responsive, impactful R&D. This letter presents the distinctive characteristics of these models and their impact on Quebec and Canada's aerospace innovation culture.

**Keywords.** Innovation, Aerospace industry, Industrial research, Technology transfer.

## 1 Introduction

The Consortium for Research and Innovation in Aerospace in Quebec (CRIAQ) and the Consortium for Aerospace Research and Innovation in Canada (CARIC) are organizations, respectively in Quebec and Canada, which develop and stimulate collaborations between industry specialists and academic researchers in aerospace research and development projects. The two organizations work in synergy to offer their members competitive financial leverage and a rich collaborative ecosystem for all parties. Highly focused on aerospace industry challenges, CRIAQ and CARIC support industrial and academic teams from project ideas to completion. Overall, the projects and activities of CRIAQ and CARIC strengthen the technological foundation for tomorrow's aerospace innovations in Quebec and Canada.

Today, the two consortiums have 107 members<sup>1</sup>, out of which 73 are industrial members and 34 are research organizations. Since CRIAQ's inception 13 years ago and CARIC's two years ago, their members have launched 132 research projects<sup>2</sup>, representing \$132 million in collaborative R&D investments in Canada. The consortiums also support international projects with France, India, Sweden, Austria, China and Germany, and are currently establishing collaborative agreements with Hamburg, Japan and Belgium. These initiatives position Canadian companies on the

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<sup>1</sup> As of May 2016

<sup>2</sup> 74 completed projects and 58 ongoing projects

international scene and enrich Canada's university expertise. More than 1,200 students work or have worked on CRIAQ and CARIC projects, including over 120 post-doctorates, 300 PhDs and 400 Masters students.

There is no doubt that CRIAQ and CARIC are models of success<sup>3</sup>. But what explains this success? What factors and distinctive elements of these models make them true benchmarks of collaborative open innovation? For, beyond the numbers and the statistics, there is a story rich in lessons. Although we can claim to have told it many times, it is possible that we did not say all there is to say. Accordingly, this letter will focus on CRIAQ and CARIC's models of success. The main elements of these models will be presented to highlight their principal characteristics — an interesting and original addition to the existing literature on innovation project management. This letter will conclude with a discussion on the future orientations of both consortiums.

### 1.1 Takeoff of an innovation culture

**Portrait of Quebec's aerospace industry.** Quebec's aerospace industry provides over 40,000 jobs at 190 businesses, including about 15 general contractors, integrators and equipment manufacturers. Exports represent over 80% of the \$15.5 billion in aerospace sales. The Greater Montreal Region is at the heart of this ecosystem, and alone accounts for over 70% of all Canadian aerospace R&D<sup>4</sup>. This area includes two of the 10 largest investors in R&D in Canada<sup>5</sup>, namely Bombardier and Pratt & Whitney Canada. In turn, the Canadian aerospace industry generates 180,000 jobs and \$1.8 billion is allocated to R&D in this sector<sup>6</sup>.

A tightly link dynamic exists between industries in the Quebec aerospace industry. Three tiers of companies represent the entire production chain, from conception based on client requirements to the production of specialized parts. In addition to this vertical supply chain structure, many other companies have specialized horizontally in niche markets. The broad spectrum of expertise needed to build an aircraft creates a dynamic of complementary expertise rather than direct competition between the companies. Indeed, the expertise of the four original equipment manufacturers (OEMs) in Quebec complements each other. Bombardier Aerospace integrates and assembles aircraft components, Bell Helicopter manufactures helicopters, Pratt & Whitney Canada specializes in engines and CAE supplies flight simulators and comprehensive pilot training solutions. This strength of the Quebec aerospace sector has been put to good use by CRIAQ and CARIC projects.

**CRIAQ's early days.** CRIAQ was officially launched in 2003. From the start, the Consortium had the support of the sector's major OEMs and key universities with engineering programs. To stimulate further collaboration between companies and

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<sup>3</sup>See Guedda, Chiraz. "Les dynamiques de collaboration entre les partenaires de la grappe aéronautique québécoise : le cas des projets du CRIAQ", Université du Québec à Montréal, 2015

<sup>4</sup>Stratégie québécoise de l'aérospatiale, Réinventer l'horizon 2016-2026, available online : [https://www.economie.gouv.qc.ca/fileadmin/contenu/documents\\_soutien/strategies/strategie\\_aerospatiale/strategie\\_aerospatiale.pdf](https://www.economie.gouv.qc.ca/fileadmin/contenu/documents_soutien/strategies/strategie_aerospatiale/strategie_aerospatiale.pdf)

<sup>5</sup><http://www.researchinfosource.com/pdf/CIL%20Top%20100%20corp%20R%26D%20Spenders%202015.pdf>

<sup>6</sup>AIAC, The State of the Canadian Aerospace Industry, 2015 report, available online: <http://aiac.ca/wp-content/uploads/2015/11/The-State-of-the-Canadian-Aerospace-Industry-2015-Report.pdf>

research centres, and between companies themselves, the Board of Directors instituted the “2+2” model from the very beginning. All projects had to include at least two industrial partners and two research partners. With this policy, the idea was to force companies and research organizations to collaborate. As mentioned by Blum, collaboration between businesses and universities has long existed in the aerospace industry. What’s unique about the CRIAQ model is two-fold: institutionalizing this collaboration and, above all, forcing companies and universities to collaborate<sup>7</sup>.

It is worth noting that, with Montreal’s industrial structure, organizations can profit from this rule in two ways: (1) OEMs are not natural competitors, which encourages “co-development” when it comes to generic technology and processes on “low technology readiness level” projects; and (2) the presence of small and medium-sized companies (SMEs) in the whole supply chain leads to compelling multi-party research collaborations that create ties with future suppliers.

## 1.2 First project implementation

**Research Forums.** To both foster relationships between aerospace companies and research organizations and identify research projects, CRIAQ initiated the Research Forum model<sup>8</sup>. Research Forums, held every two years, can be seen as a platform for the dissemination of project ideas to the entire Quebec, Canadian and abroad aerospace community-seeking partners. These Forums, organized by the CRIAQ team, are actually a large gathering of the R&D community whose primary objective is to present research project ideas and identify potential partners for them. Over the years, these Forums have become a true benchmark in the field<sup>9</sup> and a concrete example of the open innovation concept. Here’s a glance at the key success factors of these Forums:

- *Projects are presented by industrial partners.* The presentation by industrial partners ensures that the projects are part of their internal technology roadmap and are therefore financially supported.
- *Project ideas are presented in two-three minutes in plenary session at the Forum.* The presentation to all Forum participants maximizes the idea’s exposure and the time limit is enough to present project objectives, a brief description and the necessary industry and academic expertise sought.
- *Forums are open events.* Members and non-members of the Consortium can meet and talk freely throughout the Forum. No confidentiality agreement is necessary for this event. This encourages cross-fertilization and access to interdisciplinary projects. Many projects benefit from expertise that had not been considered initially.
- *All participants can show interest in the projects.* Interest in any project idea is collected on the spot. Afterwards, a project launch process<sup>10</sup> is led by the CRIAQ

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<sup>7</sup> Blum, Guillaume, "L'émergence des connaissances dans le secteur québécois de l'aéronautique : une étude de l'innovation conduite par le concept d'avion vert", Université du Québec à Montréal, 2014, p.341

<sup>8</sup> See website for the latest CRIAQ Research Forum: <http://criaq.aero/forum2016/?lang=en>

<sup>9</sup> 2014 CRIAQ Forum: 1,300 participants, including 10 international delegations, 2016 CRIAQ Forum: 730 participants, including 8 international delegations.

<sup>10</sup> [http://criaq.aero/forum2016/wp-content/uploads/2016/04/processus\\_projets\\_intl\\_EN.pdf](http://criaq.aero/forum2016/wp-content/uploads/2016/04/processus_projets_intl_EN.pdf)

team to formalize the project teams.

Over the years, these Forums have become special moments for the entire ecosystem, going far beyond Quebec's borders with the participation of many international delegations. Without a doubt, this is a significant achievement for the Consortium — both its presentation format and open approach are a testimony to the innovation culture that CRIAQ promotes in the aerospace ecosystem.

### 1.3 Consolidation through formalization

To properly manage the increase in the Consortium's activities, including membership, project numbers and services, CRIAQ's internal structure and practices had to change. Based on its first five years of experience, CRIAQ has adopted a series of practices and measures designed to provide greater support to its growth strategy. Here are a few examples.

**Legal Committee.** CRIAQ is involved in the entire project launch process, from supporting teams during grant applications to dealing with intellectual property agreements. CRIAQ team soon realized that the average signing lead-times for multi-party intellectual property agreements were too long. Because CRIAQ projects involve at least four partners, often six or seven, each agreement must be reviewed and commented on by the legal department of every organization involved in the project. CRIAQ's team then had the idea to create a legal committee with legal representatives of industrial partners and members of university research offices and research centres. This committee's mandate was to create a generic agreement template that could be applied to all "low technology readiness level" projects. A generic agreement was created and is compulsory for all low-TRL research projects funded by CRIAQ. The model grants exclusive, royalty-free licenses to industries in their aerospace-related fields of use. The legal committee meets twice a year to review occasional modification requests made by members and resolve agreements-related conflicts. The many advantages of this generic template agreement include the following:

- Pre-approved agreement by the corporate legal departments since they are always identical, reducing revision time
- R&D project portfolio review made easier for companies as IP allocation rules are known in advance. This makes it easier to identify projects submitted to CRIAQ and those kept in-house.
- All partners start on an equal footing, making sure that SMEs do not feel they're at a disadvantage versus large companies<sup>11</sup>.

Creating this committee has resulted in lower barriers to signing agreements, ensuring that the lawyers for OEMs and university research offices meet in person to review common issues.

**Project design structure.** Since its inception, CRIAQ has aimed to simplify multilateral project management for its partners. Over time, the team has developed tools to control internal procedures, manage their standardization and, more recently, monitor the project launch process.

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<sup>11</sup> Blum, Guillaume, "L'émergence des connaissances dans le secteur québécois de l'aéronautique : une étude de l'innovation conduite par le concept d'avion vert", Université du Québec à Montréal, 2014, p. 340

For “low technology readiness level” projects, proposals are traditionally drafted by the academic team based on objectives defined by the industrial partners. In CRIAQ’s early days, the structure of project proposals could vary greatly. To help CRIAQ scientific committee evaluate the proposals and prevent any confusion about future expectations on deliverables, CRIAQ suggested including a Work Breakdown Structure (WBS) in the research proposal, which has been used in the industry and has proven to be very effective for collaborative R&D projects.

To carry out a WBS, the project is broken down into ever-smaller work units that are easy to manage. One of the benefits of this approach is that it provides a graphical representation of the project structure, with the number of levels based on the project’s complexity. In CRIAQ’s case, two realms had to be considered: industrial and academic. Also, projects are divided as in work units with associated deliverables. For each deliverable, a manager is appointed. Then, these deliverables are each broken down into specific tasks. At this point, structuring converges with educational logic as each task is linked to a specific student research element. During the project kickoff meeting, CRIAQ uses and presents the same structure as a monitoring tool of the project. Implementing these tools, initially considered additional work by some project partners, is now quickly and routinely done. And today, they are fully adopted and lend CRIAQ credibility as a genuine advisor and facilitator — in addition to its funding role.

**Online Portal.** In pursuing its efforts to create greater synergy within its ecosystem and foster discussion between various stakeholders, CRIAQ has developed an online collaborative platform. Its purpose is to simplify contact during each collaborative project planning stage and promote a number activities to the ecosystem.

The Aero-Collaboration portal<sup>12</sup> offers both a public and private space. The public space allows users to sign up for CRIAQ events, gives them special access to projects in the planning stage and permits them to show their interest in participating in a collaborative research project. It also enables users to suggest project ideas and exchange information directly with community members. The private space gives users access to the CRIAQ member directory and a collaborative research infrastructure inventory (reserved for CRIAQ members). It also allows users to take part in discussions on on-going projects.

The introduction of these procedures has enabled CRIAQ to support projects from Financing Rounds 4, 5 and on. This has led to a significant increase in activity — from 13 projects financed in Round 3 to 29 in Round 4 and 25 in Round 5. These successes demonstrate the Consortium’s impressive achievements and serve as a stepping stone to expand its activities across Canada.

## 2 CARIC: A national network

### 2.1 Creation of CARIC

In late 2012, the federal government conducted an aerospace review of all policies and programs related to the aerospace industry to develop a federal policy framework to maximize the competitiveness of this sector. As part of the review process, various

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<sup>12</sup> Available at : <https://aero-collaboration.org/connexion>

industry-led working groups were assembled, composed of industry representatives, academic and research institutions, unions and federal government officials (as observers). One of these working groups looked specifically at technology development, demonstration, and commercialization. This work led to an aerospace review report, known as the Emerson Report<sup>13</sup>. One of the key recommendations of this report was the creation of a national collaborative aerospace network, which led to the creation of CARIC, the Consortium for Aerospace Research and Innovation in Canada.

## 2.2 Frontiers to Overcome

Although the Emerson Report focused on CRIAQ as a model to deploy on a pan-Canadian scale, it did not provide the path to follow. In fact, there were many *frontiers* to overcome before launching a national network.

The first *frontier*: the territorial challenge. To successfully roll out across the country, CARIC relies on provincial ecosystems and their communities. Through signed framework agreements with local aerospace associations in various regions and the appointment of Regional Directors close to key aerospace players in their territory, CARIC has set the stage for a successful launch in Canada by adapting to the local landscape.

The second *frontier*: from a manufacturing base to services and multi-sectoral industries. The development of interprovincial projects has already exceeded expectations but CARIC must now maintain its efforts to ensure the involvement and integration of the entire aerospace value chain across Canada, even where industry density is lower and of a different nature or the collaborative research culture is less developed.

CARIC goes even further by crossing a third *frontier* — supporting industry during the technology transfer from the research environment to the industrial world. CARIC helps to achieve this by directly funding companies during the joint R&D projects, in the form of direct contributions. This allows technologies and processes developed at lower technology readiness levels to *be transplanted* into businesses and take root. The research side of it remains but the bulk of the project work is done in an industrial setting. CARIC's programs therefore offer funding and support for activities that take these projects from the world of research to the industrial realm.

## 2.3 Solid Foundation

As we have seen, setting up a national network has had its share of challenges. To launch the Consortium's activities quickly on a solid foundation, a series of strategic and operational decisions were taken to make the rapid launch possible and build awareness of the Consortium on a national level. This included the following:

**A flexible structure.** The Consortium's governance structure includes representation from Canadian regions renowned for their aerospace innovation capabilities and a mix of industry, universities, colleges and research centres. Moreover, the CRIAQ and CARIC Boards of Directors have opted for an integrated approach to operating the two

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<sup>13</sup> <http://aerospacereview.ca/eic/site/060.nsf/eng/home>

networks to maximize benefits for their members, both in terms of funding and program access.

From a team standpoint, the overall CRIAQ team has been involved in helping roll out CARIC's activities quickly and is still involved in running it today. In addition, many tools (such as the online project platform and database) and costs were shared. CARIC's acknowledgement of CRIAQ membership has also allowed CRIAQ members to take advantage of many benefits, including the following:

- Access to a wider network of partners
- Access to additional funding from CARIC for collaborative projects and dedicated industry financing
- Pan-Canadian coverage for the organization and its research activities

**Established co-funding mechanisms.** Building on CRIAQ's credentials and long history in structuring projects funded by multiple sources, working collaborations were easily established between CARIC and other funding bodies in Canada, such as the Natural Sciences and Engineering Research Council of Canada (NSERC) and Mitacs, a not-for-profit organization designing and delivering research and training programs in Canada. Beyond the co-funding of projects, CARIC has regular interactions with these organizations to optimize submission, review and reporting processes. It is in this context that CARIC and Mitacs recently harmonized their processes, reducing turn-time and leading to faster project implementation.

**Joint confidentiality agreements and intellectual property guidelines.** CRIAQ's generic project agreement mentioned earlier has been adapted to include CARIC and is now used for all "low technology readiness" research projects. This has led to faster sign-offs on the first projects involving CARIC members. Moreover, an 'umbrella' confidentiality agreement, common to both organizations, has been developed to foster an open exchange of ideas by all CRIAQ and CARIC members and discussions on future collaborations.

**Quebec's regional CARIC office managed by CRIAQ.** CARIC has five regional directors based in Halifax, Montreal, Toronto, Winnipeg and Vancouver to maintain a presence in local ecosystems. CARIC has relied on service contracts with various aerospace associations or groups in each Canadian region to deliver the services of these regional directors. In the Quebec region, CARIC's regional director is also CRIAQ's Vice-President, Business Development and International. Once again, this maximizes synergy.

#### 2.4 First successes

Building upon a proven model, CARIC's first projects were rapidly set up. Financing for 27 multi-partner collaborative projects, valued at \$36M, in the first two years of operation demonstrates the value of the network. Due to this coverage and recognition as a key player in Canadian aerospace R&D, CARIC has been named by the European Commission as the official contact for co-development international research projects. This initiative, known as CANNAPÉ, has led to the first coordinated aerospace project call between Canada and the European Union. This coordinated project call has allowed key players in industry and academia to expand their collaborative network. CARIC and the Natural Sciences and Engineering Research Council of Canada (NSERC),

along with the European Commission, announced the launch of three collaborative research projects<sup>14</sup> in February 2016. These research projects are the result of sustained discussion between Canadian and European experts. They will require the close collaboration of 30 partners: half from Canada and the other half from Europe (from eight different countries, including France, the United Kingdom, Poland, Germany, Italy, Sweden, Spain and the Netherlands).

It should be noted that, two years after its launch, CARIC has 50 members who were not CRIAQ members. Finally, out of the first 23 projects launched, 13 projects include partners outside Quebec and 12 have partners from two provinces or more.

### 3 CRIAQ and CARIC: Beyond the horizon

As shown by their numerous achievements, CRIAQ and CARIC have undoubtedly played different roles in establishing a culture of research and innovation in the Quebec and Canadian aerospace sectors: as facilitators definitely but also as intermediaries between large and small businesses, intermediaries between industry and universities, educational catalysts for students and *lieux de rencontre*<sup>15</sup>. The 132 projects launched since 2003 represent a high level of expertise in terms of collaborative project development, financing and management. Given their track record, they help enrich and develop know-how on state-of-the art technology and create a collaborative dynamic that so many industry players are seeking. Benefitting from the support of industry and both the Quebec and Canadian aerospace communities, CRIAQ and CARIC now have new challenges to face, outlined as follows:

- *Leadership in research program development.* CRIAQ and CARIC must now assume a greater leadership role in the development of technological priorities in aerospace. Their involvement in defining the aerospace community's research program will be part of CRIAQ and CARIC's role in future years.
- *SMEs.* SMEs require greater assistance with their technological development projects. What's more, these SMEs must develop a leadership position when it comes to managing innovation projects and migrate from a 'build-to-print' model to a 'design, build and integrate' model. CRIAQ and CARIC aim to develop specific programs for SMEs.
- *International.* More and more, a consolidated approach, combining innovation and the integration of global supply chains, is the model that will give SMEs access to the commercial outlets they need for their innovations<sup>16</sup>. To this end, CRIAQ and CARIC must stimulate international collaborative R&D by forging

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<sup>14</sup> CARIC and NSERC, together with the European Commission, launches three collaborative research projects on crucial research areas for the aerospace sector

<http://www.newswire.ca/fr/news-releases/caric-and-nserc-together-with-the-european-commission-launches-three-collaborative-research-projects-on-crucial-research-areas-for-the-aerospace-sector-567341941.html>

<sup>15</sup> Blum, Guillaume, «L'émergence des connaissances dans le secteur québécois de l'aéronautique: une étude de l'innovation conduite par le concept d'avion vert », Université du Québec à Montréal, 2014.

<sup>16</sup> As discussed in Strengthening Symbiosis: International Business Innovation, Conference Board of Canada, [http://www.conferenceboard.ca/press/newsrelease/16-05-12/thinking\\_globally\\_could\\_improve\\_canada\\_s\\_innovation\\_performance.aspx](http://www.conferenceboard.ca/press/newsrelease/16-05-12/thinking_globally_could_improve_canada_s_innovation_performance.aspx)



ties with international companies and research institutions.

- *Cross-sectoral and value chain*. CARIC has successfully helped boost aerospace R&D activity in Canadian provinces. Nevertheless, each Canadian region possesses a unique culture and the local industry structure is different than Quebec's own one. Thinking outside existing norms is central to initiating R&D projects in these different environments. A key success factor for CARIC is its solid understanding of regional ecosystems. To generate stronger interest in these regions, greater visibility must be given to initial research collaborations and project results.

In light of the issues discussed here, it can be concluded that, through their rich histories, CRIAQ and CARIC have shown us that the strength of these groups undoubtedly comes from the collaborative culture that they have fostered between industry and universities. It is a culture based on trust, openness and transparency. Far beyond policies, procedures and systems, even beyond funding, these models prove that the real artisans who make the projects work, who make the entire structure work, are the people who participate, who give their time and who believe in it. And perhaps the most valuable lesson of all is that, by gradually introducing a collaborative culture in the Quebec and Canadian aerospace sectors, they created sustainable change within business practices, questioned preconceived ideas and successfully introduced a collaborative research model that has become the norm within the Canadian aerospace ecosystem.

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