# WHITE PAPER “AÉRO TALENTS”

## *Propelling the talents of aerospace towards Industry 4.0*

***Prepared by Aéro Montréal***
***Québec’s Aerospace Cluster***

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AÉRO MONTRÉAL
Québec's Aerospace Cluster

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## Aéro Montréal's Human Resources Working Group

The mandate of this working group is to plan, coordinate and carry out a concerted action plan to address major issues of succession and manpower in Québec's aerospace sector. The Québec aerospace sector is known internationally for its highly specialized workforce. In Québec, one in 96 people work in the sector, while in Greater Montréal it is one in 52[1].

*The masculine generic used refers to both the masculine and feminine genders and is used in this document for conciseness purposes only.*

[1] Source: CAMAQ (camaq.org). 2016 Industry Data

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## SECTION 1 – MESSAGE FROM THE CO-CHAIRS

The transition to 4.0 in an industry where innovation is fundamental poses many challenges for our companies, SMEs and OEMs alike, especially in terms of ensuring a strong labour pool and next generation of workers with increasingly specialized skills.

Even today, we do not know what workers in Industry 4.0 will truly be facing. What we do know, however, is that the industry has had 22 years of growth in the last 32 years, representing an annualized growth of 2.24%. If we project this trend for the next decade, more than 10,500 new jobs will be created and a total of nearly 39,000 vacancies will need to be filled in aerospace.[2]

To achieve this goal, our partners on the ground have a range of issues to consider: the adaptability of production to new technologies; funding access for companies and educational institutions to invest in equipment at the cutting-edge of technology; training aligned with the real needs of companies; awareness programs for young people in science and technology; the acquisition of new skills; knowledge transfer and a more efficient management of resources.

Propelling the talents of aerospace towards the future is one of Aéro Montréal's top priorities. That's why the Aero Talents Forum 2016 brought together in one place representatives of companies, government agencies and all levels of the education and research community. The goal was to create new synergies and adapt better targeted and enhanced training programs for the benefit of the actual and new generation of workforce.

This White Paper has been prepared accordingly. In addition to summarizing the event, we wanted to deepen reflection. While providing an overview of the programs and initiatives of Québec aerospace cluster partners, we make recommendations to enable our companies and our local talents to take advantage of existing and future levers so that they can be even more competitive on the international stage.

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[2] Source: "Recensement des emplois au 1er janvier 2015 et prévisions du nombre d'emplois au 1er janvier 2016 et au 1er janvier 2017 – Industrie aérospatiale au Québec," CAMAQ, March 2016.

## SECTION 2 – EXECUTIVE SUMMARY

Québec's aerospace cluster is recognized worldwide as fertile ground for excellence, competitiveness and innovation. It is one of the engines of growth and prosperity for Québec. With the advent of Industry 4.0, the entire Québec aerospace ecosystem is being challenged to increase efforts to take advantage of the benefits associated with the transition to the digital era: workforce; companies; educational institutions; cooperation and mobilization organizations and networks; and governments.

There is a clear consensus on the need to act quickly, especially since we have all the necessary assets in Québec, and particularly in the Greater Montréal area, to articulate a vision and a concerted action plan enabling our companies to enter the 4.0 movement by deploying the necessary resources: human, financial and material. For the workforce, both today's and tomorrow's, educational institutions at all levels are ready to deploy and adapt training and curricula that will enable them to acquire the new skills required.

However, basic steps must be taken, starting with a clear understanding of the concept of "Industry 4.0" in Québec aerospace. The digital revolution is bringing its share of challenges in terms of education and skills that must be acquired by workers and the next generation to meet the needs of companies. All aerospace players must be able to drive their efforts in a common and coordinated direction.

This White Paper sets out four key recommendations for achieving these goals.

**Summary of recommendations**

- **Recommendation 1**
  **Demystify and clarify the concept of "Industry 4.0".**
  Understanding, awareness and integration of the concept of "Industry 4.0" form the foundation of work for all players in Québec aerospace. The work carried out as part of the development of this White Paper clearly shows that not everyone is on the same level when it comes to understanding its concept, details, challenges and benefits. We need to promote communication and awareness initiatives in different formats that are tailored to target audiences.

- **Recommendation 2**
  **Define a shared vision of education at all levels and in a concerted way to guide the entire aerospace ecosystem towards Industry 4.0.**
  The priority is to develop a common vision that will guide the efforts of all the players in aerospace. This vision will facilitate the development of common strategies that will translate into action. In view of 4.0, an integrated approach will ensure a more relevant, agile and adaptable alignment between the needs of companies and workforce training.

- **Recommendation 3**

  **With the implementation of Industry 4.0 in aerospace, establish a gradual approach to analyse the business needs of companies, especially SMEs, and support them in developing a strategy.**

  Measures in the Québec Aerospace Strategy should serve as a lever to ensure SMEs have access to multidisciplinary, digital intervention squads to perform a diagnostic, establish priorities and develop a strategic plan. Similarly, the move of the aerospace industry towards 4.0, from the perspective of SMEs, should ensure that they have access to financing for the acquisition of specialized equipment and an additional specialized labour pool to meet their current and future needs.

- **Recommendation 4**

  **Develop a culture of knowledge sharing and succession focused on the emergence of a new generation of 4.0 workers.**

  Faced with an aging workforce, numerous retirements and the increasingly massive arrival of a new generation of workers accustomed to new technologies, we will need to intensify efforts and activities promoting careers in aerospace, especially among women and immigrants, and develop a culture of succession within companies.

## SECTION 3 – SUMMARY OF THE AERO TALENTS FORUM, APRIL 29, 2016

The first edition of the Aero Talents Forum, organized by Aéro Montréal in collaboration with CAMAQ and Emploi-Québec de l'Ile-de-Montréal, was held at the Palais des Congrès de Montréal. Completing the activities of International Aerospace Week held from April 25 to 29, 2016, the Forum was a tremendous success, bringing together over 100 participants, 19 speakers and 17 exhibitors. The event also hosted Dominique Anglade, Québec's Minister of Economy, Science and Innovation and Minister responsible for the Digital Strategy.

The objective of the Aero Talents Forum was primarily to help SMEs by setting up three clinics to address the following issues:

**1. Training programs**
**2. Company internships**
**3. Funding for training**

Company leaders and representatives who attended the event could speak directly with experts from the education and research communities to share their reality and see how they can support their needs. An SME guide was developed for them. It includes the names and contact information for resources to help them as well as detailed examples of training courses that have been developed and can be adapted to their needs for the development of their talents.

The one-day event took place from 8 a.m. to 4:30 p.m. In addition to the three clinics, presentations and testimonials, participants took part in the luncheon hosted by the Board of Trade of Metropolitan Montreal featuring guest speaker Marc Parent, President and Chief Executive Officer of CAE. The event ended with a networking cocktail from 3:30 p.m. to 4:30 p.m.

In her opening remarks, Minister Dominique Anglade underlined the importance of Québec's aerospace sector for the economy and the interest the Québec government has in its development. The Forum was held a few weeks before the unveiling of the Québec Aerospace Strategy 2016-2026 and the announcement of $500 million over five years to support innovative manufacturing[3]. The minister outlined support opportunities that will benefit aerospace companies at the dawn of the digital revolution. She recalled the three pillars of the Québec government's economic action plan that will support aerospace in its journey to Industry 4.0:

[3] **"Redefining the horizon: the Québec Aerospace Strategy 2016-2026"** was unveiled on May 30 by Premier Philippe Couillard and Dominique Anglade, Québec's Minister of Economy, Science and Innovation and Minister responsible for the Digital Strategy, at the École nationale d'aérotechnique (ÉNA) in Longueuil.

**1. Innovative manufacturing**

The Québec aerospace industry has an extraordinary innovation capacity that makes the industry a model of internationally renowned excellence.

- $1 billion is invested annually in R&D, or 70% of the Canadian total.
- Innovation involves more than 13,000 engineers and scientists in the aerospace sector.
- The aerospace industry is the No. 1 R&D leader in Québec's manufacturing sector.
- Bombardier, Pratt & Whitney Canada and CAE are among the largest investors in R&D in Canada.

**2. Exports**

Montréal is one of the three world capitals in aerospace, along with Seattle and Toulouse. The industry ranks first in Québec exports. Many of the aerospace companies are among the world's top 100.

The industry is healthy as evidenced by the following:

- It had sales of $15.5 billion in 2015
- More than 40,000 highly skilled workers are in high value-added jobs for the economy.
- 80% of Québec's aerospace production is exported.

**3. Entrepreneurship**

The Québec aerospace industry forms a true ecosystem composed of three groups of companies with close links:

- 4 OEMS: Bombardier, Pratt & Whitney Canada, CAE and Bell Helicopter Textron
- 10 equipment manufacturers
- An extensive network of 177 specialized and experienced suppliers, mainly composed of SMEs.

## DAY AGENDA

### Welcome remarks

- **Suzanne M. Benoît**, President, Aéro Montréal
- **Kevin P. Smith,** Chair, Human Resources Working Group, Aéro Montréal, Honorary Chair, 2016 Aero Talents Forum, Vice President, Human Resources and Communications, Pratt & Whitney Canada
- **Nathalie Paré,** Executive Director, Comité sectoriel de main-d'œuvre en aérospatiale du Québec (CAMAQ)
- **Hélène V. Gagnon,** Chair of Aéro Montréal and Vice President, Public Affairs and Global Communications, CAE

### Forum Opening Remarks

- **Dominique Anglade**, Québec Minister of Economy, Science and Innovation and Minister responsible for the Digital Strategy

## Clinic "Training offer"

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|---|---|
| SME testimonial | **Marie Sampaio**, Director, Human Resources, Sonaca |
| "Industry 4.0: training needs" | **Hany Moustapha**, Professor and Director, AÉROÉTS, Senior Research Fellow, Pratt & Whitney Canada |
| *Professional training*<br>"Montréal training experts: a winning team at your service!" | **Annie Morin**, Coordinator, Services aux entreprises, ÉMAM<br>**Frédéric Berthézène**, Consultant, Services aux entreprises, ÉMAM |
| *College Training*<br>"Services for companies and continuing education" | **Nancy Perron**, Training advisor, Services aux entreprises, ÉNA |
| *University training*<br>Concordia University - Concordia Institute of Aerospace Design & Innovation (CIADI) | **Nadia F. Bhuiyan**, Professor, Mechanical and Industrial Engineering, Director, Training, Concordia Institute of Aerospace Design & Innovation |
| *University training*<br>"Continuous training in the aeronautical sector" | **Sylvie Carmel**, Marketing and Communications advisor, École Polytechnique |

## Clinic "Company internships"

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|---|---|
| SME testimonial | **Victor Calamote**, Vice-President, NSE AUTOMATECH |
| Testimonial of 3 students | Vocational training: **Fabien Mira**, ÉMAM<br>College training: **Jean-François Trottier**, Aerospace engineering technique, ÉNA<br>University training: **Samar Rad**, Concordia University |
| *Vocational training* | **Mario Cardin**, Head of internships, ÉMAM |
| *College training* | **Catherine Beaudry**, Educational advisor, Alternance travail-études et placement internship |
| *University training*<br>"A Model of University – Industry Collaboration for Students Training" | **Dominique Sauvé**, Director, Montréal Aerospace Institutes (MAI) |

## Luncheon conference: "Innovation at the heart of our growth strategy"

- **Marc Parent,** President and Chief Executive Officer, CAE

## Clinic "Training financing"

| | |
|---|---|
| SME testimonial | **Anne-Renée Meloche**, Vice-President, Human Resources, Groupe Meloche |
| Emploi Québec | **Manon Berthelette**, Advisor, Centre des services aux entreprises |
| CAMAQ<br>"Ton 1er emploi en aérospatiale – Programme de subvention salariale" (Your first job in aerospace – wage subsidy program) | **Nathalie Paré**, Executive Director |
| MITACS<br>"Establish partnerships between the university, industry and the world to stimulate innovation in Canada" | **Jean-Philippe Valois**, Director of Business Development |
| ÉNA<br>"Crédit d'adaptation technologique" and "Le Centre technologique en aérospatiale" | **Geneviève Dalcourt**, Educational advisor, Services aux entreprises |
| NSERC<br>"Experience Awards" | **Hélène Fortier**, Communication and promotion advisor |

## HR networking session

- The day ended at 3:30 p.m. with a networking event that enabled participants to continue discussions initiated throughout the day.

## SECTION 4 – THE CONTEXT

With the advent of the fourth industrial revolution in aerospace, this White Paper of the Aero Talents Forum 2016 aims to identify the needs that must be met so that companies can transition to the concept of the factory of the future. This document is part of ongoing training activities, reports and White Papers that have been prepared in the last six years, and is designed to focus on future challenges related to Industry 4.0[4].

Québec's aerospace cluster is recognized worldwide as fertile ground for excellence, competitiveness and innovation. It is one of the engines of growth and prosperity for Québec.

One of the top three global aerospace capitals, along with Seattle and Toulouse, the Greater Montréal region includes most of the company centres of excellence in Canada. It is home to the Consortium for Research and Innovation in Aerospace in Québec (CRIAQ), organizations ensuring mobilization and cooperation within the sector, including Aéro Montréal and the Comité sectoriel de main-d'oeuvre en aérospatiale du Québec (CAMAQ). It also has quality educational institutions that provide high-level training in high school, college, university and graduate studies. Indeed, it is home to the École nationale d'aérotechnique (ÉNA), the École des métiers de l'aérospatiale de Montréal (ÉMAM), the Montréal Aerospace Institutes (MAI), to which are attached the six universities active in aerospace research, and more than 10 renowned public and parapublic research centres. Organizations such as the Centre technologique en aérospatiale (CTA) and the Technology Center in Aerospace Manufacturing of the National Research Council Canada, support innovation within SMEs. Prestigious international organizations in the field of aviation are headquartered in Montréal: The International Civil Aviation Organization (ICAO), the International Air Transport Association (IATA), and the International Federation of Air Line Pilots' Associations.

As demonstrated, Québec aerospace is a vast ecosystem that brings together all the key players needed to enable the industry to benefit from the digital revolution. Québec has all the necessary assets to position itself well in this area since Industry 4.0 involves workers and companies, educational institutions and governments, who can adjust or improve the education curriculum currently offered in high schools, colleges and universities.

However, the concept of "Industry 4.0," its impact in terms of organizational transformation, and its benefits in terms of production costs and competitiveness internationally, does not seem clear enough for many companies, especially SMEs. Whether the concept of "Industry 4.0" itself, the issue of access to funding related to the acquisition of advanced generation equipment, automation technology, etc., or the response to workers' concerns about employment prospects and the acquisition of new skills outside their traditional field of training, Québec aerospace SMEs are wondering how to initiate a digital migration.

[4] Editor's note: The 2009 AéroFormation Summit (on training of engineers and specialists in universities), 2010 (on-the-job training), and 2013 (on the development of a world-class workforce – held as part of the 2013 Aerospace Innovation Forum). Two White Papers were produced following the 2009 and 2013 AéroFormation Summits. Note also the Summit on aerospace training in companies organized in 2010 by the Institut de formation aérospatiale (IFA) in collaboration with Aéro Montréal, entitled "Towards a sharing of courses and best practices in the aerospace industry" which resulted in a report produced in 2011. Aéro Montréal's Human Resources Working Group also produced a White Paper in 2013, "La situation est sérieuse... Il est temps d'agir!" with 26 recommendations to address the growing challenges of the industry in the development of its human capital.

Yet there are many opportunities and the needs are becoming urgent to promote the transition to Industry 4.0. Do current training and financial support programs adequately address the future needs of companies? Are we able to identify the new skills required by future workers? Are there ways to enhance the promotion and awareness of the concrete impacts and benefits of the digital revolution? What are the challenges and the socio-demographic trends that will, over the next few years, help to transform the aerospace industry towards Industry 4.0? How can we benefit from the levers of the Québec aerospace strategy to enable all stakeholders to play a leading role in the transition to Industry 4.0?

This White Paper attempts to answer these questions by outlining solutions that are being implemented in the Québec aerospace industry and proposing recommendations to accentuate the move towards Industry 4.0.

### 4.1 What is "Industry 4.0"?

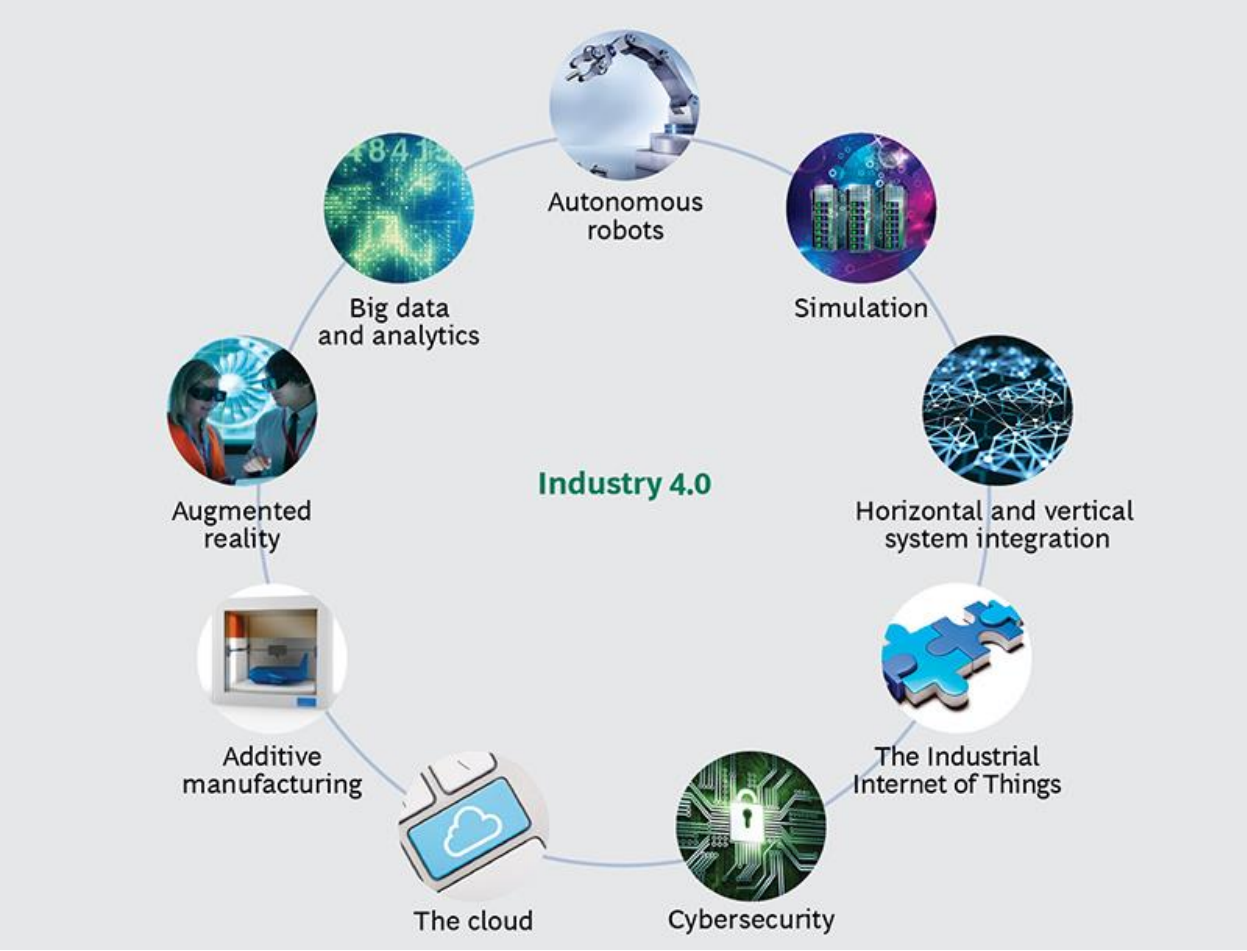
"Industry 4.0" is a simplified term for a "cyber-physical system of production" whose concept was introduced in Germany in 2005 to describe the fourth current revolution in the manufacturing industry. Industry 1.0 (1784) was characterized by mechanical production and steam power; Industry 2.0 (1870) by electric power, mass production and the first assembly line; Industry 3.0 (1969) by electronics, information communications technology, and automation.

Industry 4.0 is characterized, in turn, by automation and digitization, asset knowledge, optimization and management, data reliability, accuracy, variability, sharing and security, tracking parts from cradle to grave: the "digital thread," data analytics and Artificial Intelligence (AI). Big data are the "raw materials" of Industry 4.0. It is the transformation from physics to digital: the "digital twin," carbon to silicone, clusters to cloud computing, deterministic to probabilistic design and experimental to analytical certification[5].

New technologies shown in the following figure[6], are radically transforming industrial production and leading companies to define a different vision. Each of these technologies are fundamental concepts[7] of Industry 4.0. Each requires resources and specific skills sets.

[5] Source: "Aerospace 4.0." an integrated program of research, education and training created by AÉROÉTS. Author: Hany Moustapha, Professor and Director, AÉROÉTS, École de technologie supérieure, Senior Research Fellow, Pratt & Whitney Canada, July 2016.
[6] Source: www.bcgperspectives.com/Images/Industry_40_ex01_large_tcm80-185174.jpg.
[7] NB: Consult the lexicon for definitions of these concepts.

**Figure 1: Technologies that are transforming industrial production in Industry 4.0[8]**




Studies published by Deloitte (2014 and 2015)[9] highlight the four challenges and solutions for Industry 4.0 digital transformation: the **vertical networking** of smart production systems, logistics and services; the **horizontal integration** of business partners and customers across the globe; **through-engineering** throughout the entire product life cycle; and acceleration through **exponential technologies**.

The Deloitte report listed the five advanced technologies driving disruptive innovation: **Artificial Intelligence, advanced robotics**, **networks** (internet of things, data, services and people), **advanced manufacturing** (3D printers), and **collaborative connected platforms** (cloud computing and crowdsourcing). According to Deloitte, global CEOs pointed to **talent, cost competitiveness** and **workforce productivity** as the top three drivers of manufacturing competitiveness.

Over the past decade, several well-funded initiatives have been pursued for the implementation of Industry 4.0: Germany Smart Factory (2005) and its Industry 4.0 Demonstrator, Siemens Digital Factory

[8] Source: bcgperspectives.com/content/articles/engineered_products_project_business_industry_40_future_productivity_growth_manufacturing_industries.

[9] Source: www2.deloitte.com/content/dam/Deloitte/ch/Documents/manufacturing/ch-en-manufacturing-industry-4-0-24102014.pdf.

(2012), GE Brilliant Factory (2014), EU Factory of the Future (2013) and USA National Network of Manufacturing Innovation NNMI (2013)[10].

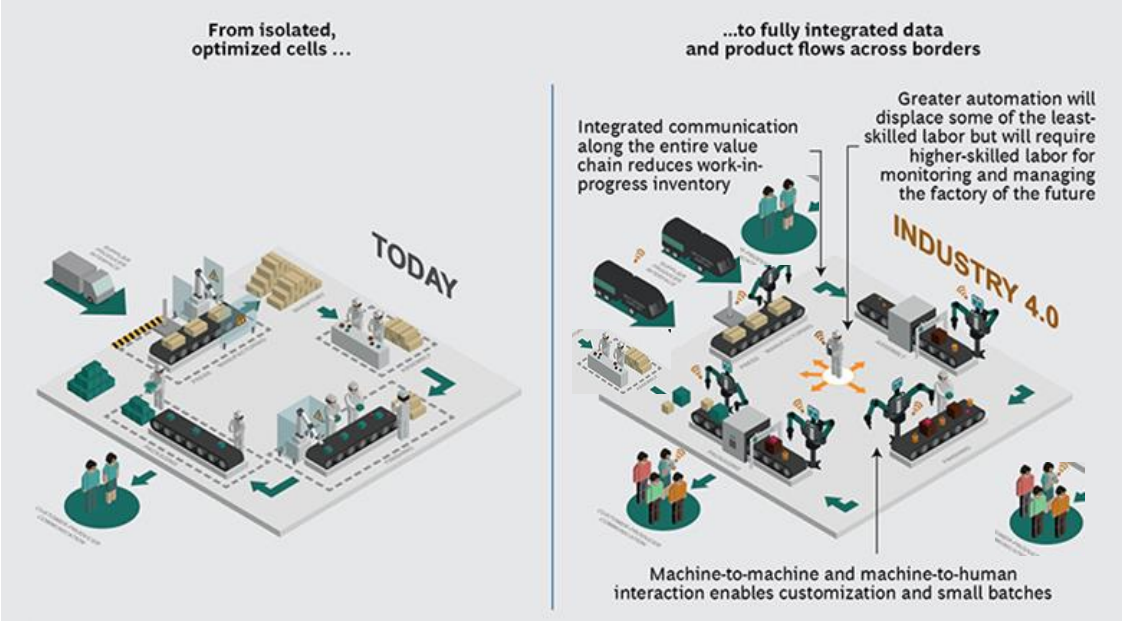
In Canada, it is worth mentioning that Pratt & Whitney Canada (P&WC) identified these needs back in 2000 when they defined their vision for a "Digital Virtual Enterprise" integrating all aspects of design, manufacturing, supply chain, customer service, etc. In 2012, P&WC started their ICEMAN (Intelligent Cells Manufacturing) program, and in 2014 their Advanced Manufacturing Center (AMC) and Enterprise Product Life Management (EPLM) programs[11].

During Aéro Montréal's last Aerospace Innovation Forum (April 2016), participants in the session on Industry 4.0 unanimously agreed that it is not only about a factory but rather the total enterprise: digital-smart-virtual design, factory and supply chain[12].

Industry 4.0 will drive a big change in tomorrow's workforce as highlighted by the Boston Consulting Groups (BCG)[13] 2015 report. Despite the greater use of robotics and computerization, there will be a net increase in jobs. Focus will be on retraining the workforce, revamping organization models, strategic recruiting and workforce planning. These transformations bring benefits in innovation, productivity and quality. However, they confront companies with new challenges in terms of design and manufacturing processes as well as changes in the labour market[14]. The following figure[15] illustrates the transformations that lead to the digital revolution in traditional manufacturing processes in the factory.

[10] Source: "Aerospace 4.0.", an integrated program of research, education and training created by AÉROÉTS. Author: Hany Moustapha, Professor and Director, AÉROÉTS, École de technologie supérieure, Senior Research Fellow, Pratt & Whitney Canada, July 2016.
[11] Source: idem.
[12] Source: idem.
[13] Source: www.bcgperspectives.com/content/articles/engineered_products_project_business_industry_40_future_productivity_growth_manufacturing_industries/.
[14] Source: "**The Future of Jobs Report – Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution: Part 1: Preparing for the Workforce of the Fourth Industrial Revolution,"** World Economic Forum, January 2016.
[15] Source: www.bcgperspectives.com/content/articles/engineered_products_project_business_industry_40_future_productivity_growth_manufacturing_industries/?chapter=2#chapter2.

**Figure 2: Industry 4.0 transforms traditional interactions related to manufacturing[16]**




The Québec aerospace industry has 41,060 highly skilled workers working in 191 companies[17]. More than 80,000 professionals work in aerospace in Canada, including thousands of engineers, technicians and skilled workers in the manufacture and support of a wide variety of products.

As with any revolution that has marked the industrial sector until now, the labour and skills needed in Industry 4.0 will continue to become clearer in the years to come. While we can identify some worker profiles and skills, others remain to be defined based on companies' future needs.

To these technical skills will be added the need to acquire transversal skills (such as "soft skills"), both for managers and workers. Human resources are at the heart of the fourth industrial revolution and continue to play a critical role in adapting to changes that are affecting daily work life. Transversal skills are acquired through personal and professional experiences and are often transferable from one job or task to another. These varied experiences facilitate learning and adapting to change and the acquisition of self-confidence towards oneself and towards others, especially when it comes to teamwork[18]. Examples include: organizational skills and the ability to plan, prioritize, reason and analyze different scenarios and problem solving; the operation of software; management skills; communication and supervision, etc.

These new data will help to raise educational and training programs to a higher level and ensure a better alignment between companies and their workforce needs.

[16] Source: bcgperspectives.com/content/articles/engineered_products_project_business_industry_40_future_productivity_growth_manufacturing_industries. Figure adapted by Aéro Montréal.
[17] Source: Innovation, Science and Economic Development Canada, 2015.
[18] Source: www.centrefora.on.ca/sites/default/files/documents/Ressources/Competences/PDF/Guide_final.pdf.

## Recommendation 1
## Demystify and clarify the concept of "Industry 4.0."

**Understanding, awareness and integration of the concept of "Industry 4.0" form the foundation of work for all players in Québec aerospace.**

- The work carried out as part of the development of this White Paper clearly shows that not everyone is on the same level when it comes to understanding its concept, details, challenges and benefits.
- To determine the degree of knowledge, maturity and implementation of the concept of "Industry 4.0," a survey could be conducted with companies, trainers and teachers, and workers.
- We also need to promote communication and awareness initiatives, training activities, seminars, workshops involving companies and the educational and research sector, company visits for students, the dissemination of success stories, etc.
- To achieve this, we would need to use the levers and synergies of the Québec aerospace ecosystem: OEMs, SMEs, suppliers, mobilization and collaboration organizations and networks, the education system (high school, college, university, graduate), funding and support programs, government programs, etc.

### 4.2 Study programs: train workers and the next generation to develop skills of the future

The aerospace industry is booming on a global scale and its needs in terms of the development of world-class human capital reflect this more than ever. Greater Montréal is recognized as a high-level training centre in many technical and scientific fields due to the presence of a network of universities, technical colleges and vocational schools that are recognized internationally, and its high ratio of graduate students per capita[19].

The development and recruitment of skilled labour is a major lever that will allow Québec's aerospace industry to create more collective and individual wealth. According to the Montréal Board of Trade, there is a direct link between productivity and diplomas in science, technology, engineering and mathematics (STEM). Education is one of the most important investments for individuals, society and companies. It also brings social progress, innovation and greater harmony within society[20].

#### *4.2.1 High School, college and university training*

The Aero Talents Forum 2016 underscored achievements in terms of the establishment of training structures, the development of specialized content, and the implementation of customized training methods through coaching and mentoring. However, there are still major challenges to be met with regards to the growth of the industry, global competition and technological acceleration that characterizes Industry 4.0.

[19] Source: "**Pour une main-d'œuvre de classe mondiale**." White Paper of the 3rd AéroFormation Summit 2013 organized by Aéro Montréal in partnership with the Conseil emploi métropole (CEM) and Emploi-Québec, December 2013.
[20] Source: "**Un monde en mutation – Soyons prêts pour les emplois de demain!"**. Information document on skills of the future produced by the Board of Trade of Metropolitan Montreal, 2016.

Education systems need to respond to the needs of Industry 4.0, provide broader skill sets and close the gap in Information and Communications Technology (ICT) skills. The Boston Consulting Group report highlighted the following 10 effects of Industry 4.0 on the workforce:

1. Big-data-driven quality control: algorithms based on historical data identify quality issues and reduce product failures;
2. Robot-assisted production: flexible humanoid robots perform other operations such as assembly and packaging;
3. Self-driven logistics vehicles: fully automated transportation systems navigate intelligently within the factory;
4. Production line simulation: novel software enables assembly line simulation and optimization;
5. Smart supply network: monitoring of an entire supply network allows for better supply decisions;
6. Predictive maintenance: remote monitoring of equipment permits repair prior to breakdown;
7. Machines as a service: manufacturers sell a service, including maintenance, rather than a machine;
8. Self-organizing production: automatically coordinated machines optimize their utilization and output;
9. Additive manufacturing of complex parts: 3D printers create complex parts in one step, making assembly redundant;
10. Augmented work, maintenance and service: fourth dimension facilitates operating guidance, remote assistance and documentation.

We can say today that there will be a need for **Industrial Data Scientists** with strong manufacturing and production knowledge, ICT and AI skills, user interface design, advanced analytics, root-cause-analysis skills and statistical programming. In addition, there will be a need for **Robot Coordinators** to oversee robots and respond to malfunction and emergency maintenance tasks. Embedded E-Learning tools[21] to be used in real world situations and ICT skills need to be integrated in all technicians, engineering and business curricula. Engineers in systems integration, programmers and software experts, technicians in 3D printing are just a few examples of the trades already in demand[22].

Although we can identify certain types of skills, others are sure to appear in the coming years to meet the needs of Industry 4.0 companies. As noted in the first part of the White Paper, Industry 4.0 calls on all aerospace players. It is hoped that the industry will make a concerted and continuous effort to take stock of the skills that will be needed to ensure the alignment of employment and training at all levels of education - secondary, college and university.

Québec's aerospace community, supported by a strategy and government policy, has already launched various training initiatives at the university, college, secondary and primary levels to tackle the digital transformation.

[21] Source: "Aerospace 4.0." an integrated program of research, education and training created by AÉROÉTS. Author: Hany Moustapha, Professor and Director, AÉROÉTS, École de technologie supérieure, Senior Research Fellow, Pratt & Whitney Canada, July 2016.
[22] Source: "**Adéquation formation-emploi – Constat du secteur de l'aérospatial"**. Document produced by the CAMAQ and Aéro Montréal, April 2015.

## Overview of actions undertaken

1. **"Aerospace 4.0"**
   Created by AÉROÉTS in 2016, "Aerospace 4.0" is an integrated program of research, education and training designed to meet the needs of Industry 4.0 in the aerospace sector. This program includes an R&D component and an education and training component.

   **1.1 Research and development component**
   This component brings together several institutions and research centres to carry out research and development structuring projects on the technologies of Industry 4.0 for the aerospace sector. This initiative will focus on the entire company to foster a "smart digital company." This transformation will affect all operational units within a company that touch the "product value chain": marketing, engineering design, development testing, manufacturing, supply chain, support, customer service centre, etc. The new projects envisaged and/or under discussion between industrial and institutional partners address topics such as integrated systems modeling and simulation, smart supply chains, multidisciplinary optimization of the plant, precision and collaborative robotics, additive manufacturing, machining modeling and simulation, etc.

   **1.2 Educational and training component**
   This component mobilizes AÉROÉTS's resources to develop various continuing, short-term education sessions that will prepare aerospace workers with the new skills required by Industry 4.0. These courses could be provided to skilled workers, technicians, engineers and professionals through **AéroFormation.**

2. "**AéroFormation**" is a consortium created in 2013 between École des métiers de l'aerospatiale de Montréal (ÉMAM), École nationale d'aerotechnique (ÉNA), and the Centre for Aerospace Professional Education (CAPE - ÉTS and McGill University ) in partnership with Aéro Montréal, the Comité sectoriel de main-d'œuvre en aérospatiale (CAMAQ) and Emploi-Québec de l'Île-de-Montréal. **AéroFormation**'s goal is to develop various continuing and short-term training courses to prepare skilled workers, technicians and engineers with the new skills required by industry 4.0.

3. **Montréal Aerospace Institutes (MAI)**
   Established in 2001, the Montréal Aerospace Institutes aims to better prepare undergraduates through industrial projects, company internships, mentoring, training courses, industrial visits, internships abroad, etc. Every year about 300 students are chosen from Concordia University, ÉTS, Polytechnique, McGill, Sherbrooke and Laval. Most of the graduates are hired by member companies of MAI. As part of its new mission, the MAI aims to double the number of students in five years, expand access to SMEs, and act as an academic spokesperson for aerospace education and training.

4. Establishment of **aerospace bridges among educational institutions**
   Aéro Montréal's Human Resources Working Group is very active in enhancing the skills and expertise of the workforce by building bridges among educational institutions to provide a broader perspective to young people. To promote educational bridges among educational institutions and encourage them to raise awareness about them with students, the HR Working Group has implemented concrete actions with the contribution of its partners.

4.1. Establishment of three aerospace bridges

4.1.1 The DES – DEP diploma in aerospace mechanical assembly and testing of École des métiers de l'aérospatiale de Montréal (ÉMAM) towards the maintenance program of École nationale d'aérotechnique (ÉNA).

4.1.2 2.1.2 Aerospace engineering techniques of École nationale d'aérotechnique (ÉNA) towards the aeronautical engineering program of Concordia University.

4.1.3 2.1.3 The DEC – BAC diploma in avionics technique of École nationale d'aérotechnique (ÉNA) to the bachelor's program in electrical engineering (aerotechnical) at Polytechnique Montréal.

**5. SME Directory – Aero Talents Summit 2016**

So that SMEs can have a better idea of training solutions tailored to their business reality and needs, a guide to SMEs was developed as part of the Aero Talents Summit 2016. The document aims to better equip SMEs with available programs in continuing education, internships and training funding.

**6. Mapping of players and aerospace training programs**

Aéro Montréal's Human Resources Working Group and CAMAQ have developed a mapping of players and training programs that are available in aerospace. The mapping shows the ecosystem of all the available levers in aerospace.

### *4.2.2 Promotion of sciences, technologies and aerospace among young people*

To meet the challenges of the actual and future workforce in aerospace, Aéro Montréal has implemented several projects focusing on young people and the next generation. “Passion from Within” and “Passion for Flight” are designed to develop a passion for aerospace at an early age among students at the upper primary and secondary levels.

Many other initiatives exist to create and sustain the interest of young people in scientific careers.

## Overview of actions undertaken

1. Implementation of the **Passion for Flight** program which aims to spark young people’s interest in aerospace and contribute to student retention.
    - 1.1 This project has two components: **Passion from Within** (for Grades 5-6 students) and **Passion for Flight Challenge** (for Grades 7-8 students). This program was initiated by Bombardier in 2014 and deployed by Aéro Montréal in 2015 in the form of various projects.
    - 1.2 This project aims to introduce over 5,000 students from 100 schools to the world of science, technology, engineering and mathematics (“STEM”) and the aerospace sector.
    - 1.3 This project features an aerospace competition bringing together more than 450 students as part of the Ligue d’improvisation en science et technologies (“LIST”), under the aegis of the Marguerite-Bourgeoys School Board.
    - 1.4 It includes a classroom workshop using a 3D application (developed by CRÉO) on the forces applied to a plane.

2. **Creation and launch of the Aéro2 program**
   A unique school training program in Québec for students from Grades 7 to 11 at Louis Riel High School in Montréal. The program started in September 2016 with its first group of students from Grade 7. It was designed and implemented by major partners in the aerospace and career search worlds for young people: the École des métiers de l’aérospatiale de Montréal (ÉMAM), the Comité sectoriel de main-d’œuvre en aérospatiale du Québec (CAMAQ), and Lockheed Martin Commercial Engine Solutions, a company that specializes in the repair of aircraft engines for commercial airlines.

3. **Launch of the Aero Portal (aeroportail.ca)**
   This digital ecosystem is designed to enable young people aged 16 to 25 years to obtain, through a simple, centralized and dynamic platform, all the information on the sector. Besides the website, it integrates a Facebook page, a Twitter page and a YouTube channel.

4. **AéroPortail: Vitrine 2016 event, February 11, 2016** (**aeromontreal.ca/aeroportail-vitrines-2016**)
   Nearly 3,000 young graduates and professionals looking for new challenges and aerospace industry members converged on the Montréal Science Centre for the first major aerospace employment event and presentation in Québec. The event was organized by Aéro Montréal in partnership with Emploi Québec – Ile de Montréal.

5. **Annual participation in the Eurêka! Festival**
   Aéro Montréal has been a partner of Eureka! for over seven years. The event aims to promote science and technology among young people and the public. The festival annually attracts about 100,000 people, including 5,000 young people.

6. **Annual participation in the Salon des métiers de l'aérospatiale**
   Organized by CAMAQ, Aéro Montréal participates in the Salon des métiers de l'aérospatiale in the Laurentides, Laval and Lanaudière regions.

7. **Expo-Sciences**
   Aéro Montréal participates in Expo-Sciences through an Aero Portal booth.

## Recommendation 2

## Define a shared vision of education at all levels and in a concerted way to guide the entire aerospace ecosystem towards Industry 4.0.

**The priority is to develop a common vision that will guide the efforts of all the players in aerospace. This vision will facilitate the development of common strategies that will translate into action. In view of 4.0, an integrated approach will ensure a more relevant, agile and adaptable alignment between the needs of companies and workforce training.**

- **Make representations to the relevant ministries (Québec Education Department, Emploi Québec, etc.) so that educational programs in aerospace change and adapt more quickly.**
  - It should no longer take five to 10 years to change a training program, as is currently the case.
  - Promote the development and financing of services to companies and continuing education to accelerate the integration of new job functions and technologies.

- **Redefine the curriculum of high schools, colleges and universities to incorporate a "4.0 Program" into basic training through the "AéroFormation 4.0."**
  - Integrate continuous training in robotics, advanced manufacturing and new technologies.
  - Encourage the presence of teachers in companies, and company involvement in the teaching curriculum.
  - Develop and integrate a transversal skills development program for workers in the industry.
  - Further develop the establishment of bridges among educational institutions with a view to 4.0.

- **Review the elementary school academic curriculum to initiate young students even earlier on their journey to science, digital technology (programming), robotics and aerospace.**
  - Promote and expand Aéro Montréal's "Passion for Flight" program to all primary and secondary educational institutions in Québec.
  - By letting young people know earlier in their career journey what kind of jobs will be in demand in the coming years, we can stimulate their interest in labour market needs.

- **Develop a "4.0 Skills Guide" through concerted and continuous consultation with aerospace companies, with the participation of educational institutions of all levels, research centres, the aerospace cluster and its partners.**
  - This initiative will allow for an analysis of current and future critical skills, and to adapt high school, college and university programs to company needs.
  - The approach could be based on the "industrial commissions"[23] model set up by CAMAQ whereby companies and educational institutions are invited each year to assess current training and identify new needs, with a view of making representations to the Québec Ministry of Education.
  - This initiative aims to encourage aerospace companies to more rapidly define their "4.0 workforce" needs.
  - In pursuing this initiative on a continuous basis, aerospace will benefit from a strategic monitoring of changing skills requirements and be able to better equip companies and the workforce accordingly.

- **Expand access to scholarships for high school, college and university (undergraduate) training in the workplace and for SMEs, as well as to funds for internships, continuing education and professional development in companies.**
  - Build on the university graduate scholarship model to redefine and implement an internship model that is fully harmonized with the needs of companies and the workforce.
  - Consider the possibility of adapting the German dual model in Québec, with a pilot project under the aegis of Aéro Montréal in collaboration with the CAMAQ. This would combine work experience and classroom training and leverage features of the university education system and vocational training in Germany[24] to take advantage of the best practices that could be adapted to the reality of Québec.

- **Bring the industry closer to training centres by promoting and financing mobile training opportunities for skilled workers and technicians.**
  - Prioritize initiatives already in place by players from academia[25] to expand access to mobile teams of trainers that are dedicated, available at all times, and travel onsite to companies to provide training on request.
  - The mobile training program would meet the needs of SMEs who do not have the means to free up several workers at the same time to join a program or train outside of the workplace.
  - It will enable many SMEs in a region, for example, to delegate one or two workers for specific training given in a nearby location.
  - The mobile trainers could go to companies on a set scheduled (rotation) to provide the required training and could at any time delay the planned training to another date if a production emergency occurs at the customer's.
  - Targeted companies could subscribe to this service for a financial contribution and thus demonstrate their commitment to the project and ensure its sustainability.

[23] Source: "**Adéquation formation-emploi – Constat du secteur de l'aérospatial"**. Document produced by CAMAQ and Aéro Montréal, April 2015.
[24] Source: cdeacf.ca/actualite/2014/09/12/etude-modele-dual-allemand-caracteristiques-evolutions.
[25] Source: " **Stratégie aérospatiale québécoise : présentation conjointe de l'École nationale d'aérotechnique (ÉNA) et de l'École des métiers de l'aérospatiale de Montréal (ÉMAM)"**. 2016

- **Repeat events that bring together companies, students and aerospace workers to enhance career opportunities in aerospace.**
  - Take advantage of these opportunities to sensitize participants to "Industry 4.0."

### 4.3 Supporting SMEs in moving towards Industry 4.0

Industry 4.0 offers many benefits to companies: business opportunities in new markets, the development of new competitive and innovative products to improve their service offering, and optimization of the production chain. Ultimately, Industry 4.0 will transform not only industrial processes but also all administrative services that revolve around the plant to support its activities. However, not all companies, especially SMEs, are at the same stage. Some have already integrated automation and robotics, while others continue their traditional production methods.

The Québec Aerospace Strategy 2016-2026, developed through the mobilization and consultation of stakeholders from the industry, was unveiled in May 2016. It confirms recognition of this key sector and is supporting its growth by furthering the implementation of major investment projects and ensuring the presence of a qualified new generation of workers. SME development is at the heart of the approach: the strategy will promote the transition to Industry 4.0, boost exports and foster innovation in companies[26].

**The Québec Aerospace Strategy 2016-2026 focuses on four drivers to leverage the existing strengths of Québec and development opportunities arising from the current and future transformations taking place internationally.**
**1. Strengthen and diversify the industry's structure.**
**2. Support industry growth: promote projects and invest in the workforce.**
**3. Mentoring SMEs in their development.**
**4. Focus on innovation.**

As part of this strategy, the Government of Québec committed to three initiatives to help aerospace SMEs successfully complete their journey to Industry 4.0 and develop an innovative manufacturing sector[27].

1. **Sponsorship and mentoring of SMEs towards Industry 4.0**
   1.1. A contribution of $9.5 million over five years from the Ministry of Economy, Science and Innovation, plus a matching contribution by the private sector, will support the new approach to improve the competitiveness of SMEs: the MACH FAB 4.0 approach based on the MACH Initiative of Aéro Montréal.
      1.1.1. The MACH FAB 4.0 Initiative will support 50 aerospace SMEs in their transition to the digital company of the future.

[26] Source: Message of the Minister of Economy, Science and Innovation, Dominique Anglade. "**Redefining the horizon: the Québec Aerospace Strategy 2016-2026**". Produced by the Government of Québec, May 2016.
[27] Source: " **Redefining the horizon: the Québec Aerospace Strategy 2016-2026"** Produced by the Government of Québec, May 2016, Pp. 40-42.

2. **Specialized digital intervention squads**
   2.1. The Ministry of Economy, Science and Innovation will develop specialized, multidisciplinary digital intervention squads.
      2.1.1. These squads will support SMEs, including aerospace, in performing a diagnostic and developing a strategic plan.
      2.1.2. A budget of $4 million over the next five years is earmarked for this measure.

3. **Support for investments to transition to Industry 4.0**
   3.1. The Ministry of Economy, Science and Innovation will provide targeted financial support to SMEs having performed a diagnostic and prepared a strategic plan through MACH FAB 4.0 or with the support of intervention from specialized digital squads.
      3.1.1. The financial support will especially apply to the acquisition of equipment and software required to implement digital transformation projects and improve competitiveness. These measures will help to develop an innovative manufacturing sector.

## Overview of actions undertaken

1. Launched in 2011, Aéro Montréal's **MACH Initiative** aims to support, over the long term, the strategic growth of the aerospace sector.
   1.1 To date, the MACH Initiative has four active cohorts composed of 47 suppliers and 28 local and international sponsors.
   1.2 More than $13 million in direct and indirect investments and in-kind contributions have supported 465 projects (completed or underway).
   1.3 In a sign that the initiative is earning the attention of the aerospace industry outside Québec, The Wallonia MACH Initiative was launched by the Skywin competitive cluster in Wallonia.
   1.4 The MACH Canada Initiative, based on Aéro Montréal's model, is being led in collaboration with the Aerospace Industries Association of Canada (AIAC), and discussions are ongoing.

2. **MACH FAB 4.0**
   This partnership program between Aéro Montréal, École de technologie supérieure (ÉTS), the CEFRIO and STIQ, aims to equip Québec aerospace SMEs with processes, software, projects and training programs that will enable them to automate and digitize their facilities.

3. Implementation of Phase 2 of the **CEFRIO's SME 2.0** pilot project
   The SME 2.0 project was established to enhance the productivity and competitiveness of Québec SMEs through digitalization. Mandated by the MEIE[28] for the realization of this major project, CEFRIO supported, from 2012 to 2015, 30 companies in the aerospace and fashion and clothing industries in their digital transition. To achieve their digital strategy, these companies will have invested over $10 million in their projects. The second phase continues from 2015 to 2018[29].

[28] Ministry of Economy, Science and Innovation of Québec (MESI), formerly the Ministry of Economic Development, Innovation and Export Trade of Québec (MEIE).
[29] Source: cefrio.qc.ca/projets-recherches-enquetes/numerique-entreprise/pme-20/.

## Recommendation 3

**With the implementation of Industry 4.0 in aerospace, establish a gradual approach to analyse the business needs of companies, especially SMEs, and support them in developing a strategy.**

- **Understand, communicate and use the measures of the Québec Aerospace Strategy to implement actions related to supporting and financing companies transitioning to Industry 4.0.**
  - Adopt a gradual approach by ensuring SMEs have access to multidisciplinary, digital intervention squads to perform a diagnostic, establish priorities and develop a strategic plan.
  - Improve access for companies, especially SMEs, to an additional specialized labour pool to meet their current and future needs related to 4.0, through increased funding dedicated to these needs.
  - Ensure investment support for the acquisition of equipment, software, etc., to carry out projects related to the digital transformation, innovation and improved competitiveness.
  - Increase MACH FAB 4.0 program funding to expand access for SMEs and to enable Aéro Montréal, through its Human Resources Working Group, and the Comité sectoriel de main-d'œuvre en aérospatiale du Québec (CAMAQ), to draw on the contribution of all ecosystem players (École des métiers de l'aérospatiale, École nationale d'aérotechnique, Centre technologique en aérospatiale, Montréal Aerospace Institutes, etc.). This will ensure alignment between workforce training and new business needs.

### 4.4 The influence of socio-demographic factors on aerospace in the era of 4.0

#### *4.4.1 The challenge of rising retirements*

With the aging of the workforce, the transfer and management of knowledge is an essential step for companies seeking to adapt to changes in the labour market by better matching their needs and the skills of workers. Over the next five to 10 years, massive departures through the retirement of experienced employees - the baby boomers - will accelerate. This is applying increased pressure on the industrial sector and the labour market.

According to Emploi-Québec, from 2015 to 2019, 321,600 jobs will need to be filled in the Montréal metropolitan area, of which 70% (224,900) will be due to expected replacement of retirees. In Québec, retirements will affect some skill levels more than others. From 2015 to 2024, over a third of managers will need to be replaced, as well as 30% of professional positions (usually requiring a university education). During this same period, a third of the vacated positions will be filled by technical-level workers (usually requiring college or secondary professional education)[30].

[30] Sources: "**Un monde en mutation – Soyons prêts pour les emplois de demain!"** Information document on future skills produced by the Board of Trade of Metropolitan Montréal, 2016; "**Le marché du travail et l'emploi par industrie au Québec, perspectives à moyen (2015-2019) et à long terme (2015-2024)"**, Emploi-Québec, 2016.

In an economy where the mastering, practice and enhancement of expert knowledge are a key strategic capability - even more so in the era of digital transformation – this "brain drain" into retirement poses a risk to the competitiveness and sustainability of Québec companies[31]. The challenge of ensuring the transfer of knowledge will add to the skilled labour shortage.

The White Paper by Aéro Montréal's Human Resources Working group in 2013 included recommendations to address this issue, based on a strategic, economic and social urgency:

7. Conduct an inventory of knowledge and critical skills.
8. Conduct an inventory of best practices in knowledge transfer.
9. Establish a government policy for financing knowledge transfer programs.
10. Ensure the transfer of critical knowhow to educational institutions.
11. Involve the community in academic achievement projects.

## Actions taken

1. **"Inventory of critical skills in aerospace**," 2014[32]
   The "Inventory of critical skills in aerospace" is an initiative of the Human Resources Working Group of the Aéro Montréal cluster, produced by the Institut de formation aérospatiale (IFA) with the financial support of Emploi-Québec de l'Ile-de-Montréal.

   The document provides an overview of important skills required for interventions that have a significant impact on the development of the workforce in Québec aerospace. This initiative targets mainly SMEs since they are generally less well equipped than large companies to meet the challenges of human capital. But it also targets integrators, equipment manufacturers and maintenance, repair and overhaul (MRO) companies.

   It presents a detailed portrait of the most critical skills for machinists, assemblers, technicians, methods agents, scientific staff and supervisors. In addition, the paper identifies transversal skills deemed most critical by the companies interviewed, based on the MACH framework of excellence, namely:

   a. Performs quality control at the workstation.
   b. Works in a team.
   c. Communicates appropriately and effectively.
   d. Manages change.
   e. Knows and understands existing norms, laws and regulations.
   f. Manages documentation.
   g. Manages risk.
   h. Planner.
   i. Learns following experiences.
   j. Is aware of human factors.

[31] Source: Mosaic HEC Montréal, "Héritage: Retaining Critical Expertise" conference, May 24, 2016.
[32] Source: "**Inventaire des compétences critiques en aérospatiale."** Report published by Aéro Montréal with the participation of the Institut de formation aérospatiale (IFA) and Emploi-Québec de l'Île-de-Montréal, August 2014.

2. Development of a **Guide on knowledge transfer for SME managers**[33]
   Produced by CAMAQ in 2014, the Guide to knowledge transfer presents the key elements of knowledge transfer and provides managers with tools to identify and protect critical jobs within their company. CAMAQ also organized workshops on this theme.

3. **The Héritage Project – Intergenerational transfer of critical skills**
   Sponsored by Aéro Montréal and Emploi Québec, and bringing together several industrial partners of the Montréal aerospace cluster, including Bombardier, Pratt & Whitney Canada, Héroux-Devtek, Hutchinson, JMJ and CAMAQ, this research project led by the Mosaic cluster at HEC Montréal aimed to gain an overview of the current situation of Québec organizations and propose recommendations to reposition knowledge management within current strategic concerns.

   3.1 "**Héritage: retaining critical expertise"** conference, May 24, 2016
   A symposium on knowledge transfer in the context of generational change was held on Tuesday, May 24, 2016 at HEC Montréal. The goal was to share the results of the outstanding cooperation that has been developed around the Héritage project as well as to share knowledge management practices that exist throughout the world. This conference allowed for an in-depth analysis of the progress being made in Québec. It also examined existing best practices to provide Québec organizations with practical tools to face this new strategic challenge. More than 200 representatives and leaders from business, academia and governments attended.

   3.2 Launch of the **Knowledge Transfer Portal** by the end of 2016
   Now in its third year, the Héritage project is moving into high gear with the development of an innovative platform for knowledge management for Québec employees. The Knowledge Transfer Portal, which will be launched in the second half 2016, aims to help workers to position themselves in relation to their intergenerational knowledge transfer responsibilities.

### *4.4.2 The place of women and immigrants in the aerospace employment market*

From 2013 to 2022 in Québec, the workforce will be mainly composed of young people, with a greater representation of women and immigrants.

Industry 4.0 is expected to have an impact on the gap in employment rates between men and women. Generation Y women will gain a greater presence in the labour market than women of the previous generation. They will increasingly take on what had been traditionally male-dominated jobs. Moreover, in the Montréal area, international immigration will be the main driver of population growth by 2031[34].

It should be emphasized that members of Generation Y were born with the advent of the Internet, which is a knowledge and socializing tool for them. They have seen rapid technological changes and are entering the job market with critical expertise and an ability to adapt to changes driven by Industry 4.0.

[33] Source: camaq.org/_fichiers/171_588.pdf.
[34] Source: **"Un monde en mutation – Soyons prêts pour les emplois de demain!"** Information document on future skills produced by the Board of Trade of Metropolitan Montréal, 2016.

In the coming years, this new generation[35] will continue to rise in the hierarchy to hold decision-making jobs.

This changing demographic landscape will encourage employers to redefine the planning of their human capital to create a new balance. Flexible work schedules and evaluation processes based on results rather than attendance, as well as a better professional integration of immigrants, are among the options that could be envisaged[36] to foster increased representation and a greater interest of this pool of workers in aerospace jobs.

## Overview of actions undertaken

1. **Promotion of aerospace-related professions among women**
   Together with its partners, Aéro Montréal has contributed to targeting professions in which women are likely to show an interest and publicizing them. In addition, efforts have been made to attract women from other sectors of activities who may have transferable skills, and to publicize success stories of women working in the sector.

   1.1 **Aero Training Summit** 2013
   - 1.1.1 Holding of a panel discussion dedicated to promoting aerospace professions among women.

   1.2 **Women in Aerospace (WIA)** events
   - 1.2.1 As part of the Aero Talents Forum 2016, Aéro Montréal partnered with Women in Aerospace (WIA) to organize a "speed mentoring" activity. This put 30 university students interested in knowing a bit more about career opportunities in the aerospace industry in contact with professional women from the sector.
   - 1.2.2 Organization of a *Lunch & Learn* of Women in Aerospace in March 2014.
   - 1.2.3 Québec women in aerospace golf tournament in September 2014.

   1.3 **Journée des femmes de l'air** – Les filles découvrent l'aviation (Girls discovering aviation)
   - 1.3.1 Aéro Montréal and CAMAQ have taken part in three editions of this annual event since 2014.

   1.4 Testimonials of **women on the Aero Portal**
   - 1.4.1 Posting of video clips on the Aero Portal site.

   1.5 "**Exceptional women – four inspiring journeys"**
   - 1.5.1 To mark International Women's Day, March 9, 2016, four inspiring women in the fields of management and aerospace came to talk about their journeys and provide advice to people who want to follow in their footsteps. The event was held at the École nationale d'aérotechnique (ENA).

[35] Source: Statistics Canada (statcan.gc.ca/census-recensement/2011/as-sa/98-311-x/98-311-x2011003_2-fra.cfm). Generation Y is the generation of baby boomer children, born between 1972 and 1992. According to the 2011 census, it represents 27% of the total Canadian population.

[36] Source: "**The Future of Jobs Report – Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution: Part 1 – Women and Word in the Fourth Industrial Revolution"** World Economic Forum, January 2016.

## Recommendation 4

**Develop a culture of knowledge sharing and succession focused on the emergence of a new generation of 4.0 workers.**

- **Increase efforts and activities to promote careers in aerospace among women and immigrants, through networking events, workshops, conferences in educational institutions, the sharing of success stories, etc.**
- **Ensure that workers have skills profiles and development plans.**
- **Develop a culture of succession in companies.**
- **Promote the Knowledge Transfer Portal in the aerospace industry.**

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- "**Adéquation formation-emploi – Constat du secteur de l'aérospatial"**. Document produced by the CAMAQ and Aéro Montréal, April 2015.
- "**Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries"**. Boston Consulting Group, avril 2015. (https://www.bcgperspectives.com/content/articles/engineered_products_project_business_industry_40_future_productivity_growth_manufacturing_industries/?chapter=2#chapter2).
- "**Inventaire des compétences critiques en aérospatiale"**. Report published by Aéro Montréal with the participation of the Institut de formation aérospatiale (IFA) and Emploi-Québec de l'Île-de-Montréal, August 2014.
- "**Industry 4.0 – Challenges and solutions for the digital transformation and use of exponential technologies"**. Study produced by Deloitte, August 2014.
- "**Le modèle dual allemand : caractéristiques et évolutions de l'apprentissage en Allemagne"**. Study produced by the Centre de documentation sur l'éducation des adultes et la condition féminine (CDEACF), September 2014 (cdeacf.ca/actualite/2014/09/12/etude-modele-dual-allemand-caracteristiques-evolutions).
- "**La situation est sérieuse… il est temps d'agir!"**. White Paper produced by Aéro Montréal's Human Resources Working Group, April 2013.
- "**Pour une main-d'œuvre de classe mondiale"**. White Paper of the 3rd AéroFormation Summit 2013 organized by Aéro Montréal in partnership with the Conseil emploi métropole (CEM) and Emploi-Québec, December 2013.
- "**Offre de formation et adéquation formation-emploi – Secteur de l'aérospatiale"**. Produced by the Conseil emploi métropole (CEM), 2013.
- "**Diagnostic des besoins en main-d'œuvre – Secteur de l'aérospatiale"**. Produced by the Conseil emploi métropole (CEM), 2012.
- "**Vers un partage des cours et des meilleures pratiques dans l'industrie aérospatiale"**. Final report of the Summit on aerospace training in businesses, November 2010.
- Simard Stéphane, "**Génération Y – Attirer, motiver et conserver les jeunes talents"**, Viséo Solutions, 2007, 202 pages.

## LEXICON

- **Aéro Montréal** (**aeroMontréal.ca**): Quebec's aerospace cluster, is a strategic think tank created in 2006 that groups all the major decision makers in Quebec's aerospace sector, including companies, educational and research institutions, associations and unions. Its mission is to mobilize industry players around common goals and concerted actions to increase the cohesion and optimize competitiveness of Quebec's aerospace cluster.
- **AÉROÉTS (aeroets.etsmtl.ca)**: In collaboration with the Departments and Services concerned, the AÉROÉTS group represents, promotes and integrates ÉTS's teaching and research activities in the aerospace field.
- **AI:** Artificial Intelligence
- **BCG (bcg.com)**: Boston Consulting Group
- **CAMAQ** (**camaq.org**): Comité sectoriel de main-d'œuvre en aérospatiale du Québec
- **CAPE – Université McGill et ÉTS**: Centre for Aerospace Professional Education / Centre aérospatial de conseillèreperfectionnement
- **CCMM (ccmm.qc.ca)**: Chamber of Commerce of Metropolitan Montreal
- **CEFRIO (cefrio.qc.ca)**: Centre facilitating research and innovation in organizations with information and communication technology (ICT). It has specialized in the use and adoption of digital technology since its inception in 1987. In collaboration with its network of associate researchers and members, CEFRIO pool knowledge to develop new practices that address today's social challenges.
- **CEM (emploi-metropole.org)**: Conseil emploi métropole
- **CIADI (concordia.ca/encs/aerospace.html**): Concordia Institute of Aerospace Design & Innovation
- **CMM:** Communauté métropolitaine de Montréal
- **CRIAQ (criaq.aero)**: Consortium for Aerospace Research and Innovation in Québec (CRIAQ)
- **CRSNG/NSERC (nserc-crsng.gc.ca)**: Natural Sciences and Engineering Research Council of Canada
- **CTA (cegepmontpetit.ca/cta)**: Centre technologique en aérospatiale
- **ÉMAM** (**ecole-metiers-aerospatiale.csdm.ca**): École des métiers de l'aérospatiale
- **ÉNA (cegepmontpetit.ca/ecole-nationale-d-aerotechnique)** : École nationale d'aérotechnique
- **EPLM** : Enterprise Product Life Cycle Management
- **ÉTS (etsmtl.ca)** : École de technologie supérieure
- **IATA (iata.org)** : International Air Transport Association
- **ICAO (icao.int)** : International Civil Aviation Organization
- **ICEMAN** : « Intelligent Cells Manufacturing »
- **ICT** : Information and Communication Technologies
- **MAI (mai-aero.ca)** : Montréal Aerospace Institutes
- **MITACS (mitacs.ca)**: Mathematics of Information Technology and Complex Systems. A national not-for-profit research and training organization that funds research and training.
- **STIQ (stiq.com)**: Sous-traitance industrielle Québec. Founded in 1987, STIQ is a multi-industry association of Quebec-based manufacturers whose mission is to improve the competitiveness of manufacturing supply chains in order to promote the development of our economy.

# APPENDICES

## *Appendix 1 – List of members of Aéro Montréal's Human Resources Working Group*

- **Kevin P. Smith,** Chair, Human Resources Working Group of Aéro Montréal, Vice President, Human Resources and Communications, Pratt & Whitney Canada
- **Marie-Pier Allard**, Senior Business Partner, Competency Development, Bell Helicopter Textron Canada
- **Frances Arthur**, Leader, Talent Acquisition, CAE
- **Sylvie Bourassa**, Executive Director, Government Relations, Concordia University
- **Élise Bourgeois**, Director, Human Resources, Pratt & Whitney Canada
- **Jacques Cabana**, President & CEO, FDC Composites
- **Aude Clotteau**, Director of Continuing Education and Business Services, École nationale d'aérotechnique (ÉNA)
- **Louis-Marie Dussault**, Associate Director, Studies, École nationale d'aérotechnique (ÉNA)
- **Solange Fresneau**, Director of Corporate Affairs and Administration, PCM TechFab
- **Dominique Gérin-Lajoie** Director, Human Resources Expertise Centre, Bell Helicopter Textron Canada
- **Mario Héroux**, Director, École des métiers de l'aérospatiale de Montréal (ÉMAM)
- **Nancy Jobidon**, Department Head, Talent Acquisition, Human Resources, Bombardier
- **Hany Moustapha**, Professor and Director, AÉROÉTS, Senior Research Fellow, Pratt & Whitney Canada
- **Geneviève Nantel**, Human Resources Senior Advisor and organization Development, STELIA Aerospace
- **Nathalie Paré**, Executive Director, Comité sectoriel de main d'œuvre en aérospatiale du Québec (CAMAQ)
- **Claude Picard**, Director, Work Organization and Training, Pratt & Whitney Canada
- **Merling Sapene**, Director, Change Management and Business Analyst, Center of Excellence, Bombardier Aerospace

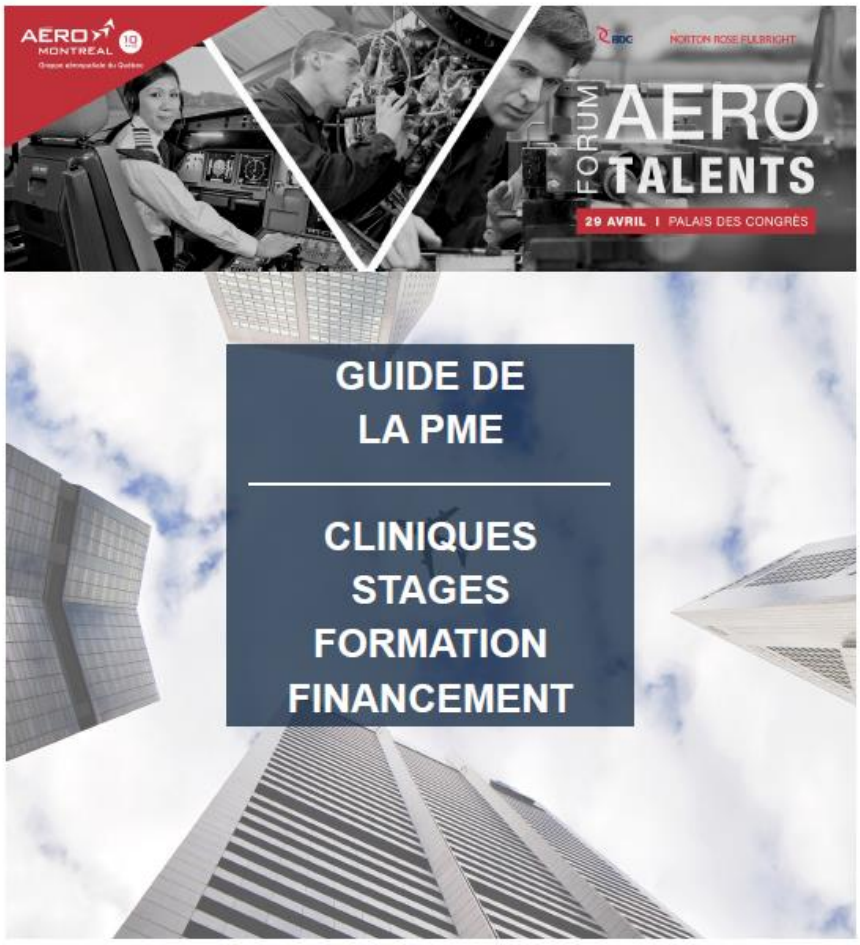
**Observers:**

- **Réjean Charbonneau**, Director, Direction régionale adjointe à la prestation de services aux clientèles, Emploi-Québec de l'Île-de-Montréal
- **Donald H. Violette**, Advisor (Partners and Strategy), Direction régionale adjointe à la prestation de services aux clientèles, Emploi-Québec de l'île-de-Montréal

## *Appendix 2 – Aéro Talents Forum SMEs Guide*

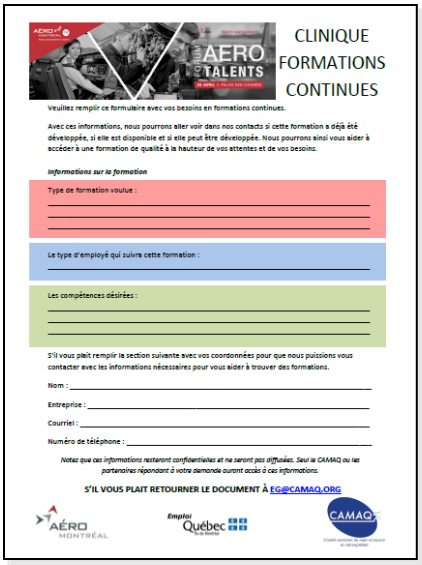
The SMEs Guide can be downloaded here:

https://www.aeroMontreal.ca/aero-talents-pme-2016.html?details=1



## *Appendix 3 – Forms regarding business's needs, distributed during the Aéro Talents Forum*

These forms can be downloaded under this link: https://www.aeromontreal.ca/formulaires-besoins



CLINIQUE FORMATIONS CONTINUES

Veuillez remplir ce formulaire avec vos besoins en formations continues.

Avec ces informations, nous pourrons aller voir dans nos contacts si cette formation a déjà été développée, si elle est disponible et si elle peut être développée. Nous pourrons ainsi vous aider à accéder à une formation de qualité à la hauteur de vos attentes et de vos besoins.

*Informations sur la formation*

Type de formation voulue :

Le type d'employé qui suivra cette formation :

Les compétences désirées :

S'il vous plait remplir la section suivante avec vos coordonnées pour que nous puissions vous contacter avec les informations nécessaires pour vous aider à trouver des formations.

Nom :

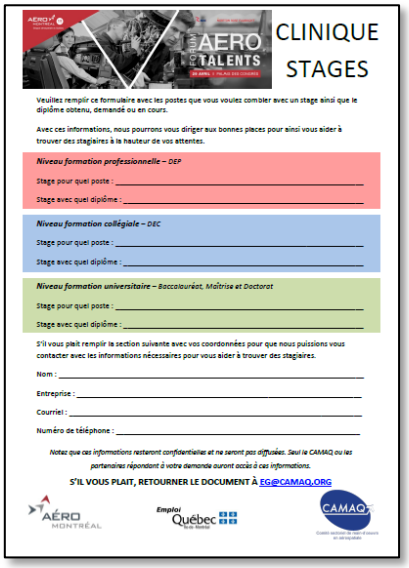
Entreprise :

Courriel :

Numéro de téléphone :

*Notez que ces informations resteront confidentielles et ne seront pas diffusées. Seul le CAMAQ ou les partenaires répondant à votre demande auront accès à ces informations.*

S'IL VOUS PLAIT RETOURNER LE DOCUMENT À EG@CAMAQ.ORG



CLINIQUE STAGES

Veuillez remplir ce formulaire avec les postes que vous voulez combler avec un stage ainsi que le diplôme obtenu, demandé ou en cours.

Avec ces informations, nous pourrons vous diriger aux bonnes places pour ainsi vous aider à trouver des stagiaires à la hauteur de vos attentes.

*Niveau formation professionnelle – DEP*

Stage pour quel poste :

Stage avec quel diplôme :

*Niveau formation collégiale – DEC*

Stage pour quel poste :

Stage avec quel diplôme :

*Niveau formation universitaire – Baccalauréat, Maîtrise et Doctorat*

Stage pour quel poste :

Stage avec quel diplôme :

S'il vous plait remplir la section suivante avec vos coordonnées pour que nous puissions vous contacter avec les informations nécessaires pour vous aider à trouver des stagiaires.

Nom :

Entreprise :

Courriel :

Numéro de téléphone :

*Notez que ces informations resteront confidentielles et ne seront pas diffusées. Seul le CAMAQ ou les partenaires répondant à votre demande auront accès à ces informations.*

S'IL VOUS PLAIT, RETOURNER LE DOCUMENT À EG@CAMAQ.ORG

CLINIQUE FINANCEMENT

Veuillez remplir ce formulaire avec vos besoins en financement.

Avec ces informations, nous vous redirigerons vers le/les bonnes ressources afin de vous aider à trouver le financement à la hauteur de vos projets.

*Informations sur le projet à financer*

Court descriptif du projet :

Organisme avec lequel j'aimerais un suivi (Coches) :

MITAC ☐ Emploi-Québec ☐ CTA ☐ CAMAQ ☐ Autres : _____

Date de début de projet espéré :

S'il vous plait remplir la section suivante avec vos coordonnées pour que nous puissions vous contacter avec les informations nécessaires pour vous aider à trouver du financement.

Nom :

Entreprise :

Courriel :

Numéro de téléphone :

*Notez que ces informations resteront confidentielles et ne seront pas diffusées. Seul le CAMAQ ou les partenaires répondant à votre demande auront accès à ces informations.*

S'IL VOUS PLAIT RETOURNER LE FORMULAIRE À EG@CAMAQ.ORG

## *Appendix 4 – Mapping of players and aerospace training programs*

The mapping will soon be available under the websites of CAMAQ (www.camaq.org/) and Aéro Montréal (www.aeroMontreal.ca)