BRITISH COLUMBIA AEROSPACE INDUSTRY
SECTOR LABOUR MARKET PARTNERSHIP

PHASE 2 | LABOUR MARKET INFORMATION

FINAL REPORT – APRIL 2018

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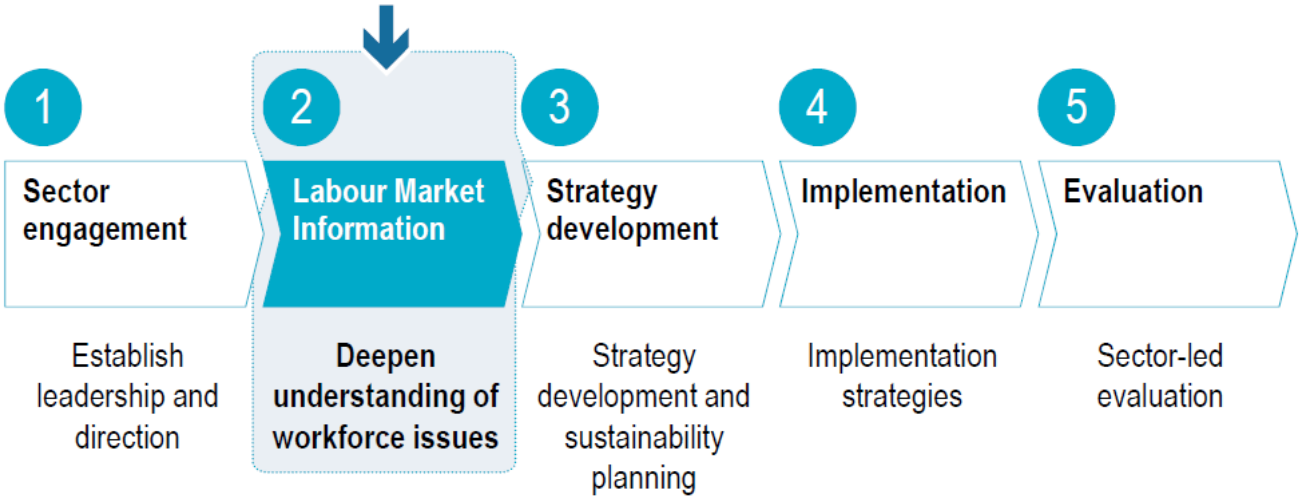
EXECUTIVE SUMMARY

Purpose of the Study

The BC Ministry of Advanced Education, Skills & Training administers the Sector Labour Market Partnerships (LMP) Program, which supports sectors in BC to conduct labour market research, develop labour market strategies, and pilot innovative programs to address the workforce development challenges that they face. Under the Sector LMP Program, funding can be provided for five distinct phases of labour market strategy development and implementation. The Aerospace Industries Association of Canada (AIAC Pacific) was approved for funding to complete Phase 1 and Phase 2 of the process. Phase 1 of the process was completed in November 2016 and this project focuses on Phase 2.

The Five Phases of Labour Market Strategy Development and Implementation



The objective of Phase 1 was to engage industry, recruit industry leaders for a Sector Governance Committee, and obtain preliminary input regarding aerospace labour market issues within BC, as well as advice and guidance for the subsequent phases. The methodology included two dedicated Engagement Sessions (Surrey and Kelowna). The purpose of Phase 2 research is to provide data that will be useful in developing an effective labour market strategy in Phase 3, by augmenting existing labour market information (LMI) available through the Government of BC's Labour Market Outlook and other available sources with primary research. Phase 2 focused on five research questions:

1. What is the current size and composition of the BC aerospace industry workforce?
2. How is the sector forecast to grow and expand?
3. Which occupations/skills are most in demand – current and anticipated – and which shortages present the greatest challenges/threats to the industry?
4. What are the critical impediments to attracting and retaining in-demand skills and occupations?
5. To what extent is the educational sector in BC fulfilling the education, training and skills development needs of the industry?

Method of Study

Key elements of the project involved:

- A series of meetings and communications with the Governance Committee to discuss the objectives of the study, the proposed approach and instruments, and results of the field research. The members also provided feedback on the key project outputs.
- Reviewing labour market information related to the aerospace industry in BC available from the Government of BC, the federal government, and other sources.
- Developing an analytical framework, detailed methodology report, and research tools.
- Developing a database of about 200 employers believed to be active in the BC aerospace sector. During the process of the study, some of the employers that are no longer operating or indicated that they are not active in aerospace were removed from the database while some additional companies were added.
- Inviting all 200 employers to participate in the survey. We regularly followed-up with target companies by email and telephone. In total, 104 employers in the aerospace sector in BC participated. The questionnaire was lengthy and detailed (the average response time was over 48 minutes).
- Conducting telephone and personal interviews with 20 subject matter experts including representatives from major employers, educational and training institutions, associations, government and other experts.
- Conducted three roundtables sessions, in Surrey, Kelowna and Nanaimo, involving over 40 participants.

Major Findings and Conclusions

The major findings and conclusions arising from the review are as follows:

1. The 200 organizations active in the BC aerospace industry employ an estimated 8,924 people, with a majority working in manufacturing and MRO operations.

Phase 1 of the BC Aerospace Sector LMP defined the industry as including five sub-sectors: Advanced Manufacturing; Aviation Training; Maintenance, Repair & Overhaul/In-Service Support (MRO/ISS); Research and Development; and Space and Remote Sensing. This definition excludes major carriers, such as Air Canada and WestJet, with operations in BC.[1]

Employers reported revenues from an average of 1.6 sectors. The sectors that were most commonly identified by the 104 employers were manufacturing (identified by 37 employers who employed 3,853 people) and MRO/ISS (identified by 42 employers who employed 3,123). There is considerable overlap between these two sectors with about one-half of the manufacturers (18 of 37) also generating revenues from MRO/ISS.

2. BC aerospace features a highly diverse group of companies, which is reflected in a wide range of occupations within the industry.

Employers report that almost half (47%) of their workforce is involved in production. Other leading functions included administration (12%), senior management (6%), logistics (6%) and sales and service (5%). The survey, secondary data and roundtables indicate that industry employment is

1 Carriers are not normally defined as part of the aerospace industry and were not included in the definition for this study. However, Canada's major carriers are significant employers of pilots and maintenance workers. As of their 2016 Annual Report, Air Canada employed 26,200 FTEs and WestJet employed 9,988 FTEs in total. Specific data is not available on their level of employment in British Columbia. Maintenance costs account for about 6% of Air Canada total annual expenses and 5% of WestJet's annual expenses.

relatively evenly divided between positions that require:

- *Aerospace-specific education, training or certifications*. This includes positions such as pilots (which account for about 8% of industry employment), aerospace engineers (4%), and shop positions such as aircraft maintenance engineers (maintenance, structural and avionics AMEs account for about 18% of reported employment) as well as other technicians. The industry, as defined for this study, employs the majority of aerospace engineers in BC, a significant percentage of AMEs, and a smaller percentage of the pilots. Some AMEs and many pilots work outside the industry, for employers such as the major carriers.

- *More general education or experience*. BC aerospace accounts for only a small percentage of the senior managers, IT professionals, admin, logistics, sales and customer service staff, machinists and technicians employed in BC.

As such, the aerospace sector is not the primary driver of demand for most of the occupations it employs. In addition to competing with other aerospace companies for pilots, aerospace engineers and AMEs, the industry also competes directly for workers with employers in other sectors as well as in other related industry sectors such as the major carriers.

Employers identified 51% of their employees as possessing education or professional certifications which are either required or important for their positions. Commonly identified qualifications included pilot (rotary or fixed; 9%), AME – Maintenance (e.g., M1 or M2 or Aircraft Maintenance Technician: 9%), AME – Structural (e.g., Category S or Aircraft Structural Technician) (6%), and AME – Avionics (3%).

3. The aerospace industry is undergoing a period of unprecedented change and the ability of BC employers to respond and evolve to these changing industry conditions will have a major impact on the future growth of the industry.

Significant changes are occurring with the introduction of more stringent specifications, advanced materials (such as carbon fiber composites, hybrid alloys, and special coatings), additive manufacturing, 3D printing, and Industry 4.0. The industry is also striving to balance cyber security and ultra connectivity. At the same time, changes are occurring with respect to the regional distribution of the industry, industry consolidation and the structure of the supply chains.

The rate of change tends to be higher in the space and remote sensing sector and, to a lesser extent, in the manufacturing sector than the MRO sector. Nevertheless, the MRO industry will need to evolve significantly over the next decade in response to growing demand, changes in regional distribution and fleet mix, and the introduction new technology in areas such as diagnostics, digitization, automation, data analytics and ultra-connectivity. At the same time, the industry must continue to service legacy aircraft.

4. Most employers are very optimistic about the potential for further growth.

Employment in the BC aerospace industry has been increasing over the past five years as a result of both growth in the size of existing employers and the continuing establishment of new businesses. Most organizations expect that employment will continue to increase, projecting growth of between 0.7% and 8.3% annually with the most likely figure being 4.4% annually over the next five years.

The positive outlook for growth was attributed largely to the strength of the aerospace industry

internationally. There is increasing demand for air travel as both the world urban population and the size of the global middle class increases. The in-service commercial airline fleet is forecast to grow from nearly 25,000 aircraft at the beginning of 2017 to over 35,000 by 2027. By 2027, 58% of the fleet will be new-generation aircraft (designed and built after 2000). Demand for MRO services, for commercial airlines, is projected to growth at the rate of 3.8% annually from 2017 to 2027.

The BC industry has a strong base of capabilities on which the industry can grow, particularly with respect to MRO and selected areas within manufacturing as well as space and remote sensing. The region can also benefit from its proximity to the rapidly growing airline market in Asia Pacific and China as well as to Boeing's operations in Washington State. The rate of growth will also be impacted by the extent to which the aerospace cluster is a priority for development by the federal and provincial government. Some concern was expressed that other regions (e.g. Ontario and Quebec) were receiving more significant support for development than is British Columbia.

5. **Availability of qualified or skilled personnel is the factor most commonly identified as impacting the ability of the industry to achieve its full potential for growth.**

Of the employers surveyed, 37% identified the availability of qualified or skilled personnel as the most important factor while 69% identified it as one of the three major factors. Other factors that were commonly identified included the cyclical nature of the aerospace industry and increasing competition. While recognizing these issues, most employers believe that they would, at most, serve as a drag on growth but that the industry will continue to grow.

6. **When discussing key shortages, employers focus primarily on the challenges in attracting, developing and retaining pilots, AMEs, and aerospace engineers, as well as the growing need for employees with the skills needed to work with emerging technologies and advanced materials. Larger employers also identified shortages in areas such as senior management and sales.**

The shortage of pilots is not limited to British Columbia; significant pilot shortages have been reported across Canada, in the United States and internationally. Factors that exacerbate the shortage in BC include the rate of new pilot hires by the major carriers (strong demand has meant that major carriers are hiring less experienced pilots than in the past, shortening the time spent with smaller employers), the high cost of pilot training combined with the inadequacy of available student loans, and a shortage of instructors because of the strong demand for pilots. Conditions could also be impacted by new federal regulations around pilot fatigue, which could increase the demand for pilots. Over the longer-term, demand will also be impacted by technological change (which may reduce requirements for pilots).

Aircraft maintenance engineers are a core occupation for MRO operations. The industry faces significant challenges regarding the aging of the existing workforce, recruitment of new participants, the length and front-end loaded nature of the AME training which makes it more difficult for industry to respond to short-term changes in demand, the need for onsite training and experience, and declining industry margins which have impacted the wages paid, not just in BC but across the industry. Technician shortages are projected in most regions; by 2027, it is forecasted that US demand for maintenance technicians will exceed supply by 9%.

Although the number of aerospace engineers in BC is relatively small (about 300), engineers play a significant role in the development of the industry particularly in the space, remote sensing and manufacturing segments. The importance of aerospace engineers will further increase over time

with the introduction of new generation aircraft, increasing rates of automation and continuing adoption of new technologies, products and processes. The lack of an aerospace engineering program in BC puts the provincial industry at a disadvantage related to the development and adoption of new technology, products and processes. While BC produces other types of engineers, there are no bridging programs in place to give those engineers a grounding in aerospace. The ability to attract recent graduates or established aerospace engineers from other regions is constrained by the strong demand for those workers and factors such as the high cost of housing in BC.

Employers highlighted challenges in accessing the skills required to work with emerging technologies and advanced materials. Employers need to both attract new workers with the types of new skills sets required (e.g. software engineering, systems architecture, advanced data analytics, robotics, mechatronics, artificial intelligence, digitalization, materials development, and advanced materials) and facilitate access to training that will enable existing workers to upgrade, update and build on their existing skill sets. In the absence of industry-wide programs, upgrading has been the responsibility of individual employers.

7. Given its aging workforce, the industry will need to significantly improve its performance in attracting and retaining workers (particularly millennials and under-represented groups such as women, Indigenous people and recent immigrants) as well as upgrading the skills needed to meet changing requirements.

The major themes that came out of the roundtables, interviews and survey regarding critical impediments to attracting and retaining in-demand occupations included:

- ***Strong competition for workers.*** The December 2017 unemployment rate of 4.6% in BC was the lowest on record. Given tight labour market conditions, it has been common for employers to hire workers away from other employers in the industry. Employers estimated that over one-quarter of their new hires were working with another industry employer at the time they were hired, while one-third were working in BC but outside of the aerospace industry. Similarly, about 30% of the employers identified strong competition for workers from other employers as a major factor contributing to employee turnover within their organization.

- ***Aging of the existing workforce.*** Cyclical downturns in the industry have contributed to periodic losses of younger workers in the industry, resulting in a workforce which is, on average, significantly older than the workforce in BC overall. Forty percent of the BC workforce was aged 45 to 64 in 2017 as compared to 61% of aircraft assemblers and inspectors, 50% of aircraft mechanics and inspectors, 48% of pilots, and 44% of aircraft instrument, electrical and avionics mechanics, techs and inspectors. Forty-six percent of employers identified aging of the workforce as contributing to their difficulties in attracting good candidates with the required skills.

- ***Low awareness or negative perceptions of the industry.*** Even though much of the industry remains on the leading-edge technologically, it does not have the same allure it once did. Other industries, such as Information and Communications Technology (ICT) have tended to displace older industries, including aerospace, as the place to work. As a heavily regulated industry, aerospace is perceived as a difficult industry to enter. It tends to be highly cyclical, which increases employment risk particularly for recent labour market entrants, and much of the industry is not visible or well understood by prospective entrants.

- ***Limited success in attracting and retaining millennials.*** By 2020, millennials (people born between 1980 and 2000) will account for about one-half of the workforce in North America. Roundtable participants noted that the BC aerospace industry has not been providing millennials with the types of opportunities and support they are looking for in their careers. Research indicates that millennials tend to be less loyal to their employers and much more willing to consider changes in employers and careers than previous generations. The dissatisfaction of millennials with their current employment situation is found primarily in their desire for further development, limited opportunities to make use of the skills they have, lower tolerance for rigid corporate structures and inflexible approaches to work, and misalignment of their personal values with those of the organization. Some employers have been much more successful than others in implementing strategies to attract and retain millennials.

- ***Limited use of economic immigration and temporary worker programs.*** Some other countries, such as Australia, have used their immigration and temporary foreign worker programs more effectively to ease labour shortages in the industry. BC employers reported employing only 27 Temporary Foreign Workers and 88 workers who had immigrated to Canada in the past five years. The industry has not been active in promoting use of the programs or demonstrating that shortages exist in key occupations such as pilots, AMEs, and aerospace engineers.

- ***Low levels of gender diversity*****.** Occupations in the BC aerospace industry are very much male-dominated and efforts to date to attract more women have not been very successful. Amongst the companies surveyed, women made up only about 20% of the workforce. The percentage is much lower amongst aerospace specific occupations, ranging from a high of 10% amongst mechanical engineering technologists and technicians as well as 10% of mechanical assemblers and inspectors to 7% of pilots, 5% of avionics mechanics, technicians and inspectors, 4% of aerospace engineers, and 3% of aircraft assemblers and 3% of aircraft mechanics.

- **C*onstraints to attracting workers from other regions*****.** Factors identified as constraining the ability of BC aerospace employers to attract workers from other regions include the high cost of living (particularly housing in the Lower Mainland); location (e.g. distance from family); availability of suitable employment for spouses; cyclical nature of the industry; prevalence of similar skills shortages in other regions; and the extent to which the wages may be sufficient to attract workers.

- ***Ability to retain workers during economic downturns.*** The industry needs to be more effective in working together to retain workers (e.g. by providing an easier path through which workers laid off at one employer can transfer to another employer).

- ***Ability to respond to changing technologies*****.** Employers highlighted the importance of becoming more effective in attracting workers with highly developed skill sets, often in areas (e.g. big data analytics, automation and robotics, and advanced materials) which were not previously required; attracting workers with the capability to learn about new technologies, products, and processes on an on-going basis; investing in upgrading programs at the industry level rather than just at the employer level; developing and testing new training models, and developing strategies to share scarce employees (e.g. those with highly specialized skills).

- ***Absence of a coordinated labour market and industry development strategy.*** Representatives identified the need for greater coordination between industry, government and universities/colleges on broad strategic initiatives in areas such as attracting, developing and retaining skilled people; joint marketing; investments in research, development and innovation; strengthening the supply chain, improving and streamlining the regulatory environment, supporting technology adoption, and making more effective use of available programming.

8. Employers generally consider the existing education and training programs to be effective in providing basic education and skills training as well as in facilitating journeyperson credentials and Transport Canada certifications.

The absence of an aerospace engineering program in BC was identified by employers and other key informants as a significant factor constraining further development of the industry. Employers also identified a variety of opportunities for improvement, focusing on the need for:

- **Targeted training**: It was suggested that education and training programs could do more to increase job-readiness by providing more opportunities for practical hands-on experience, particularly in the workplace, and putting more emphasis on soft skills and applied training.

- **Up-to-date curricula and technology**: Given the pace of technological change, it is increasingly difficult for educators and trainers to keep their curriculum and technology up-to-date. Training will need to increasingly incorporate new technology, simulators (including virtual and augmented reality), computer skills and advanced materials.

- **New training models**. It is an appropriate time to review new potential models given the rate of change in the industry, the fact that the ITA programs are under review, and changes being considered to the Transport Canada regulations and certifications. Suggestions focused on getting students into the workplace and onto the shop floor earlier in the process, better enabling students to enter right into industry from high school, developing strategies to reduce the cycle times for training, streamlining the regulatory environment to focus more on outcomes than on process, and expanding distance education options as a means to increase access to training for both new market entrants and for upgrading purposes.

- **Better promotion of education and training programs.** It was suggested that industry needs to get much more involved in promoting aerospace as a potential career, particularly by building relationships with the K-12 education system.

- **Stronger linkages between industry and educators.** While some employers have been involved in serving on advisory committees, providing feedback on curriculum and hosting interns or coop students, many others have not been very involved. There is also a need for increased coordination and communication across institutions, regions and sectors.

- **Expansion of training for international students.** Further promoting programs to international students was identified as an important vehicle through which the education and training sector in BC can be expanded.

- **Upgrading programs.** It will be important for industry and educators to work together to identify common needs across employers with respect to training and, where possible, develop joint or common programs which can benefit multiple employers in the industry.

- **Increased access to financial assistance for students as well as government funding for training**. Employers and educators highlighted the rising cost of training, particularly related to advanced technology and applied sciences. Concerns were expressed about the ability of institutions to provide sufficient compensation to instructors to retain them.

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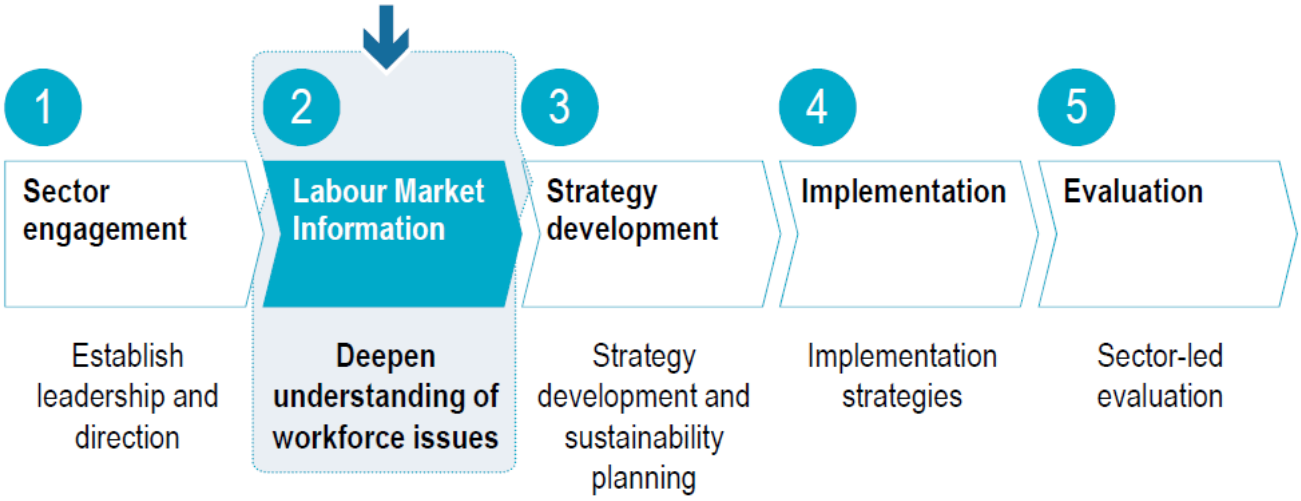
1. Introduction

1.1 The Sector Labour Market Partnerships (LMP) Program

The Aerospace Industries Association of Canada (AIAC Pacific) has entered into an agreement with the Province of British Columbia, Ministry of Advanced Education, Skills & Training to conduct a Phase 2 Sector Labour Market Partnerships (LMP) Program project focusing on the BC aerospace industry. The Sector LMP Program provides funding for partnership-led projects that address broader sector and regional labour market and human resource issues within British Columbia's diverse economy. Labour market issues are generally defined as a current or anticipated imbalance between the labour market and the supply, skills and experience of workers.

Under the Sector LMP Program, funding can be provided for five phases of labour market strategy development and implementation. Phase 1 of the process was completed for the aerospace industry in November 2016, and this project focuses on Phase 2.

The Five Phases of Labour Market Strategy Development and Implementation



The objective of Phase 1 was to engage industry, recruit industry leaders for a Sector Governance Committee, and obtain preliminary input regarding aerospace labour market issues within BC, as well as advice and guidance for the subsequent phases. The methodology included two dedicated Engagement Sessions (Surrey and Kelowna), two consortium/committee discussions, three individual meetings, six telephone interviews, one presentation, and a general industry survey with 22 respondents.

The purpose of Phase 2 research is to compile the data needed to develop an effective labour market strategy in Phase 3 by augmenting existing labour market information (LMI) available through the Government of BC's Labour Market Outlook and other available sources with primary research.

1.2. Purpose of the Phase 2 Study

The Phase 2 study will use primary and secondary data research to:

- Develop a profile of the existing and projected future labour market;

- Validate existing data and, where necessary, adapt it to better reflect the characteristics of the sector;
- Assess the potential impact of international aerospace trends, technological trends and evolving business models on the future demand and supply for workers, including changing requirements in terms of occupational mix and needed skills;
- Identify labour and skills shortages; and
- Analyze key labour market issues.

It will also examine the characteristics, strengths and challenges associated with the existing labour force development ecosystem (e.g., training and education program, worker attraction and retention programs, linkages between industry and educators, experiential learning programs, economic immigration and temporary foreign worker programs, etc.).

More specifically, the research is expected to answer the following questions:

1. What is the current size and composition of the BC aerospace industry workforce?

2. How is the sector forecast to grow and expand?

3. Which occupations/skills are most in demand – current and anticipated – and which shortages present the greatest challenges/threats to the industry?

4. What are the critical impediments to attracting and retaining in-demand skills and occupations?

5. To what extent is the educational sector in BC fulfilling the education, training and skills development needs of the industry?

1.3 Methodology

We have undertaken this project in three stages: 1. Development of the Methodology Report; 2. Field Research; and 3. Analysis and Reporting.

Development of the Methodology Report

To develop the methodology report, we:

- Conducted an initial meeting with the Governance Committee established for the BC Aerospace Sector LMP project. During the meeting, we reviewed our proposed methodology to ensure that the purpose, scope, objectives and approach for the assignment were clearly understood. We also obtained input from the Committee regarding some of the key issues facing the sector, the proposed methodology, and the definition of sectors and key occupations.

- Reviewed and assessed the available labour market information. We reviewed the information related to the aerospace industry in BC available from the Government of BC, the federal government, and other sources. For example, we reviewed data on:

    - The aerospace industry in BC from various sources including Industry Canada, a KPMG/AIAC Pacific study (*Economic Impact Analysis and Capabilities Study of the BC Aerospace Industry*), the Conference Board of Canada, BC Stats, the BC 2017 to 2027 Labour Market Outlook – Industry Profiles and profiles developed by the BC Ministry of International Trade and Responsible for Asia Pacific, as well as and Innovation, Science and Economic Development

Canada.
- The targeted NOCs from sources including the ten-year Labour Market Outlook for British Columbia, the federal Labour Force Survey, occupational profiles prepared by WorkBC and Welcome BC, the Canadian Occupational Projection System (COPS) and the *2015 Report on the Aviation and Aerospace Industry Labour Market Information Survey and Interviews* (the Canadian Council of Aviation & Aerospace);
- Education programs in BC including dashboard reports on student outcomes and apprenticeships (http://outcomes.bcstats.gov.bc.ca/Default/Home.aspx);
- Workers arriving under the Temporary Foreign Worker Program, the Federal Skilled Worker Program, and the Provincial Nominee Program as reported by IRCC and the Government of BC (http://www.cic.gc.ca/english/resources/statistics/index.asp); and
- Data obtained from WorkSafeBC on the size of companies (i.e., payroll data) in the industry obtained through a Freedom of Information Request.

- Developed an analytical framework. The analytical framework stipulated how the information collected from employer surveys, key informants, roundtables and secondary data sources will be used to address each of the research questions.

We then prepared a methodology report which defined the project objectives, study methodology, activities, intended deliverables and timelines, presented the analytical framework, proposed a schedule for meetings with the Governance Committee, and defined the target groups for the employer survey, interviews and roundtables. We also prepared the research tools that were used in the study.

Field Research

In implementing the field research, we:

- **Developed of a database of employers active in the BC aerospace sector.** The scope of the study focused primarily on the MRO, manufacturing and space and remote sensing sectors. It did not include the major carriers.

  The initial population list was compiled by AIAC Pacific and is believed to include most employers active in the sector. During the process of the study, some of the employers that are no longer operating or indicated that they are not active in aerospace were removed from the database, while some additional companies were added. All organizations were targeted in the survey, with a emphasis placed on the larger employers. To identify the largest employers, we obtained input from AIAC Pacific, made an information request for Payroll Data to WorkSafeBC, and noted leading employers identified in the literature.

- **Conducted a survey of 104 employers active in the aerospace sector in BC.** In total, approximately 200 employers believed to be active in the aerospace industry were contacted (this figure may be overstated in that one cannot assume that, just because the invitation did not bounce back, the email was necessarily received and viewed by the target recipient). The invitations provided target employers with a link to an online questionnaire and described other options for completing the survey questionnaire, including by telephone with a representative of GGI. We regularly followed-up with target companies by email and telephone.

  Of the employers contacted, 104 completed the survey as indicated in the table below.

Response to the Survey to Date

Status		
Response	**Number**	**Percent**
Completed	104	52%
Refused or Unsubscribed	52	26%
Did Not Respond	44	22%
Employers in the Database	**200**	**100%**

Not all employers answered all questions. As a result, the number of respondents may vary somewhat by question. The number of respondents is clearly identified for each question. The questionnaire was lengthy and detailed (average response time was over 48 minutes amongst those who completed the questionnaire). At a confidence level of 95%, the sample of 104 employers who completed or substantially completed the survey achieves a margin of error of about ±6.7%. Questions for which the confidence interval is more than ±10% are noted. A detailed description of the employers surveyed is included in Chapter 3.

- **Conducted telephone and personal interviews with a sample of 20 subject matter experts and major employers.** A population list was developed of 25 representatives believed to be familiar with human resources in the aerospace sector. The subject matter experts who were interviewed included one representative from an industry association, 4 consultants working in the industry and 10 representatives from educational and training institutions, and 5 major employers.

- **Conducted three roundtable sessions (Surrey, Kelowna and Nanaimo) involving over 40 participants.** To set up the roundtable, we distributed invitations to a group of target representatives and followed up by telephone to encourage participation. In advance of the session, we distributed a short discussion paper (in the form of PowerPoint presentation) to the participants. At the session, we facilitated a group discussion regarding the outlook for the BC aerospace industry (e.g. key economic factors and trends that will affect labour demand; occupations and skills that will be most in demand; and shortages which will present the greatest challenges/threats to the industry) as well as the key issues that need to be addressed by the strategy (e.g., constraints to attracting, developing and retaining in-demand skills and occupations as well as the extent to which the educational sector in BC is fulfilling the education, training and skills development needs of the industry).

Analysis and Reporting

We then summarized the major into an interim report, a draft report and a final report. The results were also presented to the Governance Committee. Each of the research questions is directly addressed in Chapter 4. A confidence interval has been calculated for the projection of industry employment in Chapter 4.

1.4. Structure of the Report

Chapter 2 provides an overview of the aerospace industry internationally, in Canada and more specifically in BC. Chapter 3 presents the results of the employer survey, as well as secondary data on the characteristics of the labour market for the aerospace industry in BC. Chapter 4 used the major findings of the research, including the roundtables and interviews, to address each of the research questions outlined in Section 1.2. A summary of the major findings and preliminary conclusions is provided in the Executive Summary.

2. Overview of the Aerospace Industry

This chapter provides an overview of the aerospace industry internationally, in Canada and in BC, as well as key industry trends (provincial, national and international) based on an initial literature review.

2.1 The International Aerospace Industry

The aerospace industry can be defined as companies engaged in the production, maintenance and modification of spacecraft and commercial, military, and private aircraft (and does not include companies involved in airline operations). As defined by Thomson Reuters, the industry includes manufacturers of military equipment, such as tanks and related vehicles, bombs, missiles, associated navigational and guidance systems, artillery, ammunition and related weaponry.

Manufacturing

The table below summarizes financial performance of the top 100 companies as of December 31, 2016, most of which are manufacturers.

Characteristics of the Largest 100 Global Companies

Top 100 Global companies	2015	2016
Revenue US$ billion	$658.7	$674.4
Profit US$ billion	$69.5	$70
Core operating margin	10.5%	10.4%
Number of A&D employees	1,939,614	1,917,643
Book-to-bill ratio	1.34 times	1.16 times

Source: 2017 Global Aerospace and Defense Sector Financial Performance Study, Deloitte, 2017

US-based companies accounted for a majority of the revenues for the global Aerospace & Defence (A&D) sector (60%), followed by European headquartered companies (31%). Companies domiciled in Canada, Brazil, Japan, China, Australia and other countries shared the balance of 9%. The top 100 manufacturers included four Canadian companies: Bombardier, CAE Inc., MacDonald, Dettwiler and Associates (MDA), and Magellan Aerospace. Revenues of the top 20 global A&D companies accounted for nearly one third (74%) of global A&D sector revenues in 2016, reflecting continued sector concentration.[2] The table below shows the breakdown between commercial aerospace and the defence subsector.

Size of the Commercial and Defence Subsectors

Top 100 Companies	Commercial Aerospace			Defence Subsector		
	2015	2016	% change	2015	2016	% change
Revenues (US$ billion)	$314.7	$323.1	2.7%	$344.1	$351.3	2.1%
Core operating earnings (US$ billion)	$31.8	$29.6	-7.0%	$37.4	$40.2	7.6%
Operating Margin	10.1%	9.1%	-9.4%	10.9%	11.5%	5.3%

Source: *2017 Global Aerospace and Defense Sector Financial Performance Study*, Deloitte, 2017.

2 *2017 Global Aerospace and Defense Sector Financial Performance Study*, Deloitte, 2017.

Revenues of the commercial aerospace subsector accounted for 47% of total A&D revenues and 42% of industry earnings in 2016. Revenues for the original equipment manufacturers (OEM) segment increased by 0.9% in 2016. Boeing experienced a revenue decline of 1.6%, while Airbus Group reported stronger growth of 3.3%. Tier 2 and Tier 3 suppliers generated significantly stronger revenue growth of 7.6% and 7.7% respectively. Revenue growth for the aerostructures segment lagged and was significantly lower at 0.5% percent compared to the global A&D growth while the Tier 1, electronics, propulsion and services segments experienced moderate revenue growth in 2016 and outpaced global A&D sector growth.

Deloitte forecasted that the A&D industry would experience revenue growth of about 2% percent in 2017. With military spending in the US on a renewed growth trajectory, most of this revenue growth is coming from the defence subsector. Deloitte's forecast was based on a median of 2017 analyst estimates of top 20 pure play A&D companies, accessed from Bloomberg.[3] These pure play A&D companies include Boeing, Airbus, Lockheed Martin, General Dynamics, BAE Systems, Northrop Grumman, Raytheon, Safran, Leonardo Finmeccanica, Thales, L-3 Communication, Textron, Huntington Ingalls Industries, Spirit AeroSystems, Zodiac Aerospace, Rockwell Collins, Harris Corp., MTU Aero Engines, Dassault Aviation, and Orbital ATK.

Deloitte estimated that commercial aerospace subsector revenues would likely remain flat. Passenger travel demand increased more than five times from 1981 to 2016. However, a 47% decrease in CPI adjusted airfares since 1990 combined with low fuel costs and a surplus of secondhand aircraft have delayed decisions to upgrade airline fleets, leading to a slowdown in demand for twin-aisle aircraft. Other trends influencing the market include new aircraft production programs, especially from China and Russia, and growing consolidation by part family (components, aero-structures, electronics, interiors, etc.). This latter trend is driven by an increased focus on gaining economies of scale as the effects of continued demand for lower airfares filters through the value chain.

Regarding the longer-term outlook, the global aerospace market is expected to grow to $352.5 billion by 2023. The major drivers for growth in the global aerospace market will be the high replacement rate, change in technologies, increased aircraft size, and an increase in the high net-worth population.[4]

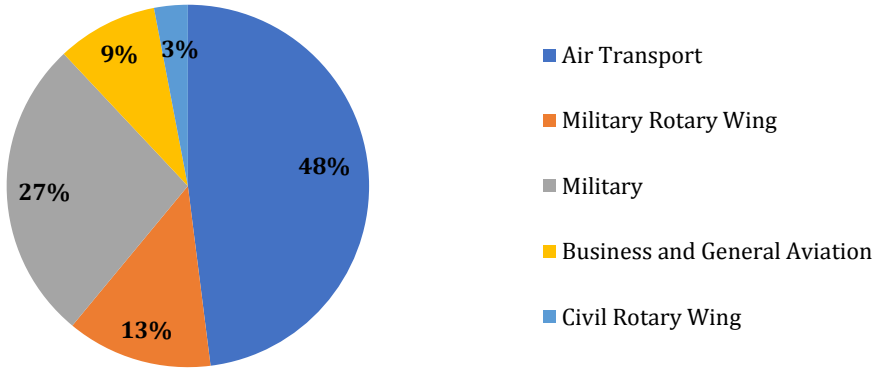
Maintenance, Repair and Overhaul (MRO)

Separate data is available on the MRO sector. Commercial aircraft MRO is a mature and well-established sector. There are multiple players ranging from those offering a complete range of services and hangar or workshop facilities, to small repair companies for specific components. The competitive landscape has shifted significantly in recent years, with fewer airlines providing in-house maintenance and an increase in the numbers of OEMs present in the market. Changing customer demands, as well as fleet expansion and renewal, is also changing how MRO services are sourced and delivered. Bombardier is among the world's top 15 MRO companies.[5]

In 2015 the global MRO market was worth US$135 billion, equivalent to about 75% of the value of current production aircraft (US$180.3 billion)[6]. The market is detailed by segment in the chart below.

3 *2017 Global Aerospace and Defense Sector Outlook*, Deloitte, 2017.
4 *Growth Opportunities in the Global Aerospace Market.* Lucintel. http://www.lucintel.com/aerospace-market-2033.aspx
5 *Commercial Aircraft Maintenance, Repair & Overhaul (MRO) Market Report 2016-2026: Leading Companies Analysis, Contracts & Forecasts for Heavy Airframe Maintenance, Engine MRO, Component MRO & Line Maintenance*, Visiongain.
6 *MRO Industry Outlook*, Presentation by Kevin Michaels, ICF International, MRO Conference, April 28, 2016, Montreal, Canada.

2015 MRO SPENDING US$135 billion



Source: *MRO Industry Outlook, Presentation by Kevin Michaels, ICF International, MRO Conference, April 28, 2016, Montreal, Canada.*

Oliver Wyman estimates that commercial airline MRO growth over the coming decade will show a healthy 3.8% compound annual growth rate (CAGR), growing from the current demand of $75.6 billion to $84.9 billion by 2022, to just over $109 billion by 2027.[7]

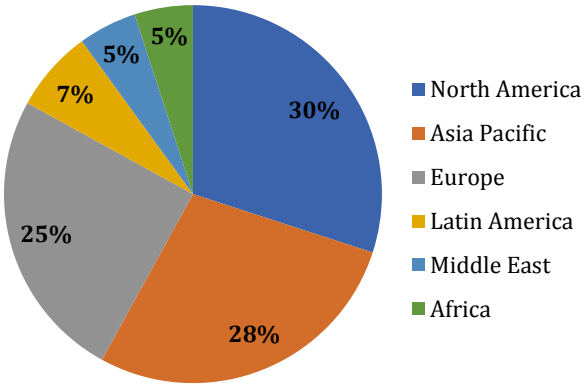
Record high profitability (US$ 35.6 billion) was achieved for the global airline industry in 2016. The in-service commercial airline fleet is forecast to grow from nearly 25,000 aircraft at the beginning of 2017 to over 35,000 by 2027. However, net fleet growth by world region is likely to be uneven. Oliver Wyman predicts that major growth will be driven by Asia, especially China and India, which will nearly double in-service fleet and related MRO demand. Asia will overtake North America as the largest region, with almost 40% of the global fleet. North America, which will experience little absolute growth other than fleet upgrading over the decade, is predicted to drop to third place by 2027 behind Asia and Europe. Historically, Africa and other developing nations acquired most of their fleets through migrations of older aircraft from mature regions such as North America and Western Europe. That trend appears to be changing as new aircraft orders have become the dominant source of growth.

ICF also predicts that the combination of strong air travel demand and the need to replace ageing aircraft will drive fleet growth globally. However, ICF predicts that North America's share of the global fleet will fall to 25% in 2026 from 30% in 2016.[8] Asia and the Middle East will likely see compound annual growth rates of 4.8% and 5% respectively from 2016 to 2026, compared to North America's 1.3%. This may present a challenge for the Asia Pacific region in building the infrastructure and new facilities as well as training a workforce to keep up with the rapidly rising MRO demand.

In 2016, the Asia Pacific region accounted for 30% of global MRO demand of US$67.6 billion, followed by North America (27%), Europe (26%), Middle East (8%), Latin American (7%), and Africa (5%). [9]

7 Global Fleet & MRO Market Forecast Summary, 2017-2027, Oliver Wyman, 2017.
8 MRO Market Update and Industry Trends, Presentation by Jonathan M. Berger, ICF, MRO Latin America Conference, January 25-26, 2017, Cancun, Mexico.
9 MRO Market Update and Industry Trends, Presentation by Jonathan M. Berger, ICF, MRO Latin America Conference, January 25-26, 2017, Cancun, Mexico.

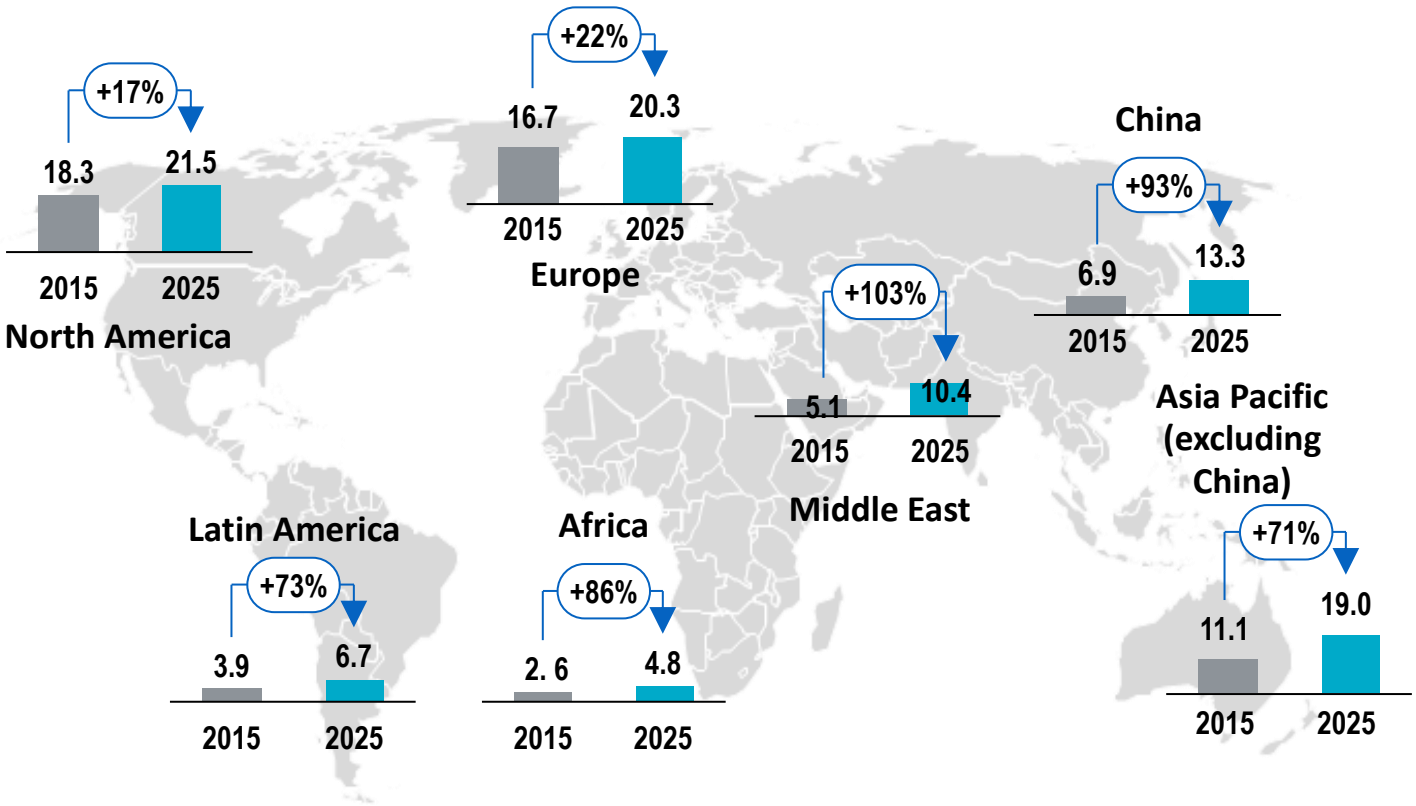
Regional Distribution of the 2016 Global Commercial Air Transport Fleet (27,957 Aircraft)



Source: *MRO Market Update and Industry Trends, Presentation by Jonathan M. Berger, ICF, MRO Latin America Conference, January 25-26, 2017, Cancun, Mexico.*

The chart below outlines the projected growth in the MRO market by region, highlighting the relatively lower rates of growth projected in the North America and Europe.

Projected Growth in the MRO Market By Region, 2015 to 2025



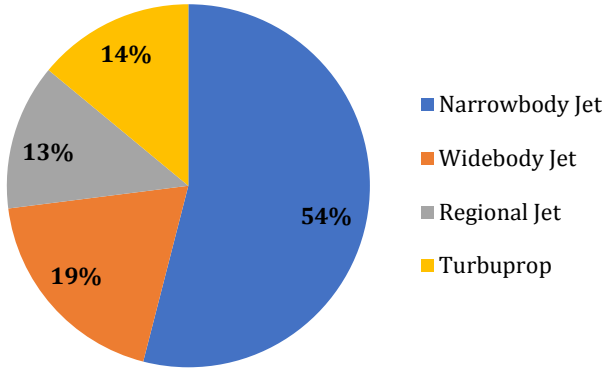
Source: ICF, Roland Berger

Oliver Wyman forecast a change in fleet mix over the following decade with narrow-body aircraft growing faster than the other classes. The shares of regional jets and turboprop fleets are likely to decline, while that

of wide-body aircraft will hold steady.

The chart below shows the current global commercial air transport fleet by type of aircraft. By 2027, the shifts will result in a narrow-body share of 65%, wide-body share of 21%, leaving a combined 14% share for the smaller regional jet and turboprop fleet. Canadian MRO demand may be affected by the Canadian regional jet (CRJ) order book which has fallen dramatically. Rapid removal of the CRJ, making up more than 40% of all regional jet removals, is forecast over the next ten years.

Overview of the 2016 Global Commercial Air Transport Fleet (27,957 Aircraft)



Source: *MRO Market Update and Industry Trends, Presentation by Jonathan M. Berger, ICF, MRO Latin America Conference, January 25-26, 2017, Cancun, Mexico.*

In 2016, commercial air transport global MRO demand was estimated at US$67.6 billion with engines accounting for 40% of this, followed by components at 22%. The line maintenance segment accounted for 17% followed by the airframe segment (14%), and modifications (8%). The global MRO market is expected to grow by 4.1% per annum to over US$100 billion by 2026 according to Oliver Wyman. Engine and component MRO markets are likely to remain the largest segments, accounting for 41% and 22% respectively. The modifications market is anticipated to see the strongest growth, driven by modifications to aircraft cabin interiors (lie-flat seats, premium economy, wi-fi, on-board connectivity, and "Cabin Densification"). In-flight entertainment systems are expected to account for a large share of the interior MRO market, undergoing the most frequent changes to cater to luxury preferences. Due to the decreasing life cycles of electronic products, cabin entertainment retrofitting every two years as a part of regular aircraft maintenance operation has become a major trend among new market entrants, offering continuous revenue for the MRO market.

Other trends affecting the MRO sector include:

- ICF predicts that, in the next decade, the fleet of new generation aircraft fleet will grow by approximately 530% to nearly 19,000 aircraft globally, and by around 400% in North America. Over the next decade, MRO spending on new technology Airbus A350 & Boeing 787 aircraft will double every three years. New technology aircraft will challenge traditional MRO strategies. Oliver Wyman suggests that, from an airframe MRO perspective, providers must be able to handle the new composite and metal matrix materials dominant in the newest-generation aircraft, such as the 787 and A350. The newer technology includes much more sophisticated avionics and systems that are able to interface with health monitoring systems, designed to recognize pending system or component failures. "Big data" capture and processing will require new strategies. Component MROs will need the capital to acquire testing equipment and licenses to access OEM manuals and data for these new parts. Line maintenance providers will experience challenges related to training and use

of the new aircraft health monitoring systems, fault isolation systems, and software configuration protocols.

- Increasing fuel costs, a strong US dollar, and increasing US interest rates are all having an impact on the MRO sector. Major airlines, including Air Canada and WestJet, are increasingly driven by Return on Net Assets and are trying to minimize maintenance expenditures. The strong US dollar has had an impact on aftermarket results from some regions including Canada. Air Canada's 2015 maintenance cost increased US$95 million from 2014 mainly due to unfavourable currency impact of US$108 million.

- The availability of Used and Serviceable Material (USM) has grown with aircraft retirements in recent years. ICF forecasts USM to grow to US$6.3 billion by 2024 (5.5% annually). Engine USM is expected to be the main driver of growth with anticipated annual growth of 5.9% over the next decade. Low fuel prices, if sustained for multiple years, could reduce partouts and the projected growth of USM.

- Oliver Wyman suggests that the rapidly growing airline market in Asia Pacific and China may present an opportunity for North American MRO companies. Operators around the world are currently sending nearly 30% of wide-body heavy airframe maintenance needs to Asia. Eventually there may be a tipping point when capacity growth within Asia falls short of regional MRO demand combined with that of foreign operators, particularly those in North American and Western European regions. Operators may be driven to other markets for MRO services, presenting opportunities in North America, Western Europe and Latin America. MROs could target wide-body work currently performed by Asia-based MROs with the introduction of new capacity and the development of the necessary technical skills. As regional labour rates move toward global parity, MROs that invest in new wide-body capabilities might be well positioned to capture market share from operators that get squeezed out of the Asia market. The repatriating of wide-body heavy maintenance work will create some revenue growth in otherwise stagnant MRO markets in North America and Western Europe; a global focus is needed to meet the growing demand being generated in Asia.

2.2. Characteristics of the Aerospace Industry in Canada[10]

The Canadian aerospace industry directly generated $27.7 billion in revenues and employed over 87,000 people in 2016. Including its induced and indirect impacts, the industry supports about 208,000 jobs in Canada. The direct contribution of the aerospace industry to Canadian GDP was estimated at $12.9 billion in 2016.[11] Manufacturing contributed approximately 70% of revenues and GDP while MRO contributed 30%. MRO is more labour intensive than manufacturing, and requires more employee training, licensing and qualifications. MRO accounts for 64% of aerospace employment.

From 2011 to 2015, the Canadian industry enjoyed something of a boom with revenues growing by almost 29% (6.6% average growth per year). However, between 2015 and 2016, both revenues and jobs fell by 7% and 2% respectively, with the decline observed only in manufacturing (MRO showed small increases). In 2015, Quebec accounted for over half of all Canadian aerospace manufacturing employment (55%), as well as 18% of MRO employment. Ontario accounted for around one–quarter of the aerospace workforce, both for manufacturing and MRO. Western Canada accounted for 44% of aerospace MRO employment and 36% of aerospace manufacturing employment. Western Canadian aerospace manufacturing includes

10 The aerospace industry includes both civil and defence activities (i.e., defence aerospace manufacturing and MRO). Within the aerospace industry, there is a small overlap with space systems manufacturing (besides manufacturing, the space industry also includes satellite operations, value-added applications and space-based broadcasting).
11 Data in this and the subsequent paragraphs is from the *State of Canada's Aerospace Industry 2017 Repor*t; Innovation, Science and Economic Development Canada (ISED) & The Aerospace Industries Association of Canada (AIAC Pacific).

establishments such as Boeing Canada Winnipeg, the largest Canadian Boeing site and the largest aerospace composite manufacturer in the country. The site produces nearly 1,000 end item composite parts and assemblies for Boeing Commercial Airplanes, specifically for the 737, 747, 767, 777 and 787 airplane models.

More than 60% of Canadian aerospace product exports are supply chain related. Canada's share of supply chain exports increased by more than 20% over the past 15 years. These products include components such as aero-engines (53%), avionics (16%), landing gear (13%) and other aerospace parts (18%). Finished products like airplanes, rotorcraft and spacecraft account for 35% of exports; simulators account for the remaining 4%. In a global comparison, Canada ranked in the top three in terms of civil airplanes, helicopters, engines and civil flight simulators. Canada is ranked first in the world for turboprop and helicopter engine production. It is ranked #2 globally in business aircraft production and #3 in regional aircraft production.

The aerospace manufacturing industry is responsible for the largest share of R&D in the Canadian manufacturing sector, generating 29% of overall Canadian manufacturing R&D in 2016 ($1.64 billion). Almost all of this (97.6%) was spent on aerospace manufacturing. It was six times as R&D intensive as the manufacturing industry average in 2016. Process innovation was more prevalent than product innovation among Canadian aerospace manufacturers.

The aerospace industry contributed 208,000 jobs to the Canadian economy and close to $28 billion in GDP, including indirect impacts of suppliers ($8.5 billion) and induced impacts of consumer spending by associated employees ($6.4 billion) in 2016. This includes the direct economic impact from enterprises for which aerospace is the main activity (87,000 jobs); the indirect impact of suppliers to the aerospace industry (70,600 jobs); and the induced economic impact of consumer spending by associated employees (estimated at 49,000 jobs).

Global aerospace companies which have Canadian offices include Aerolia, Bell Helicopter, GE, Pratt & Whitney, Rolls-Royce, Airbus Helicopters, L3, MHI, General Dynamics, Boeing (AeroInfo Systems) and StandardAero.

Canada currently ranks second in the world for the production of business aircraft, behind the US. Bombardier, Pratt & Whitney Canada, Bell Helicopter Textron Canada, CAE and Viking Air Ltd are a few of the major players in the business aircraft manufacturing sector in Canada. A separate impact analysis of business aviation in Canada suggests that the direct impact is 22,300 FTEs of employment (2,330 in BC), $1.8 billion in wages, $2.9 billion in GDP, and $6.8 billion in economic output. The annual total impact including indirect and induced impact includes 43,200 FTE employees, $3 billion in wages, $5.1 billion in GDP, and $10.7 billion in economic output.[12]

Business aircraft include helicopters, turbine-powered turboprops and turbojets. Although the worldwide fleet includes ultra-long-range business jets capable of flying 20 or more passengers nonstop between distant international business centers such as Toronto and Tokyo, the vast majority of business aircraft seat six passengers in a cabin and fly average trips of less than 1,000 miles. The number of registered aircraft in Canada currently totals over 36,000, of which it is estimated that approximately 1,900 are business aviation aircraft, including both fixed wing (76%) and rotor aircraft (24%). These aircraft are spread across Canada, with the majority based in Québec, Alberta, British Columbia and Ontario. According to the Teal Group's forecasted Canadian production based on aircraft value, business jet aircraft will represent an estimated 56% of all aircraft production in 2023, a decline from 65% in 2015. The main growth sector will be in single aisle large jets in 2023. Bombardier is expected to be responsible for over 90% of all aircraft production in Canada

12 *Economic Impact of Business Aviation Operations and Business Aircraft Manufacturing in Canada,* prepared for the Canadian Business Aviation Association (CBAA); sponsored by Bombardier Business Aircraft, Pratt & Whitney Canada and CAE; prepared by InterVISTAS Consulting Inc., 8 September 2016.

by 2023.

In recent years, new manufacturers from China, Japan, and Russia have been competing to enter the regional aircraft manufacturing market, challenging the traditional dominance of Bombardier and the Brazilian aerospace company, Embraer.

PricewaterhouseCoopers 2017 Aerospace Manufacturing Attractiveness Rankings, released in August 2017, ranked Canada as fifth globally behind the United States, Switzerland, United Kingdom and Australia. The United States consistently places first because of the industry's scale and the support it receives from the strong economy, air transportation infrastructure and active defence posture.[13] Canada ranks eighth globally for its industry and labour force, thirteenth for its infrastructure and geopolitical risk, seventeenth for tax policy, twenty-fourth for cost, and twenty-sixth for economy. Thirty-three metrics were combined into these seven categories to provide an overall ranking.

2.3. Characteristics of the Aerospace Industry in BC

Economic Impact of the Sector in BC

According to KPMG's 2015 profile, the BC's aerospace industry encompassed approximately 160 firms, directly generated revenues of $2.4 billion annually, employed 8,348 people, and contributed $1.3 billion in value-added output (GDP).[14] BC is home to the third largest aerospace industry in the country (by revenues, GDP and employment), behind Quebec and Ontario. In Western Canada, the BC aerospace industry is comparable in size to the aerospace industries of Manitoba, Alberta and Saskatchewan combined. BC makes up 11% of the Canadian aerospace industry's revenues and contributes 12% of the total Canadian aerospace GDP. Proportional to its share of Canadian revenues and GDP, the BC aerospace industry employs 12% of the total Canadian aerospace workforce. Including indirect and induced impacts, the total impact of the industry is estimated by KPMG to be $2.9 to $3.5 billion in GDP contribution and 14,300 to 19,800 jobs sustained in BC.

There is a clear distinction in the composition of the aerospace industries in the eastern and western parts of Canada. In Quebec and Ontario, the manufacturing sector accounts for more than 70% of the GDP and 60% of employment. In BC (and more generally, in the western provinces), the majority of output and employment is in the MRO-ISS Service Sector. In BC, the breakdown between manufacturing and the MRO-ISS Service Sector to aerospace GDP was 44% and 56% respectively in 2011.

Components of the Value Chain

The industry in BC is active in segments across the value chain, with the greatest numbers of companies being involved in aircraft component manufacturing, MRO-ISS service, and supporting services segments. An overview of each segment is provided in the table below.

13 Aerospace Manufacturing Attractiveness Rankings, PricewaterhouseCoopers, August 2017. http://www.pwc.com/us/en/industrial-products/publications/assets/pwc-aerospace-manufacturing-attractiveness-rankings-2017.pdf

14 *Economic Impact Analysis and Capabilities Study of the BC Aerospace Industry*, prepared for AIAC Pacific by KPMG, August 2015.

Components of the Value Chain in British Columbia

Segment	Characteristics
Pre-assembly	• Consists of firms that produce products which facilitate production of aircraft components such as tooling, consumables and test equipment. • 16 companies in BC. • 7 reported revenues in excess of $20 million per year. • Of the 16 players, 13 companies reported tooling capabilities (such as assembly fixturing design and fabrication, and layup and bonding jigs) and 10 reported build to print capabilities (manufacturing based on customer supplied engineering and fabrication methods). • Examples of firms include Advanced Integration Technology Canada, Anotek Anodizing, Pyrotek, Wesgar Aerospace, Metal Action Machining, Ebco Industries, Zum Hingst Technologies, Versaform Canada Corporation, Straightline Precision Industries Inc., Redline CNC and Kodiak Aerospace.
Aircraft Component Manufacturing	• Focuses on creating products that are specifically designed and manufactured to be installed on production aircraft (produce or transform physical goods including the structure of the aircraft, avionics and electronics, and propulsion systems among other components). • 50 companies in BC. • Vast majority are small, with only 7 firms reporting revenues over $20 million per year. • Firms are most commonly involved in the structure (27 companies), systems & components (16 firms), composites and plastics (12 firms), and processing (11 firms) segments rather than propulsion (3 firms) or avionics (7 firms). • Examples of firms include AEM (Anodyne Electronics Manufacturing), Jupiter Avionics, Maxcraft Avionics, AVM Solutions, Skytrac Systems, Latitude Technologies, ASCO Aerospace Canada, Avcorp Industries, and International Water-Guard.
Final Assembly	• Includes aircraft manufacturers that aggregate the components of the aircraft into an operational aircraft. • One BC company (Viking Air) is active in the fixed wing segment.
Supporting Services	• Includes firms that provide supporting services within the aerospace industry, such as pilot and technician training and education, airport equipment, business services and others • 33 companies in BC. • 8 reported revenues in excess of $20 million per year. • Particular strengths in education and training (17 firms), followed by business services (14 firms), flight simulation (9 firms), and ground support equipment (9 firms). • Examples of firms involved in education, training, simulation and other services included Chinook Helicopters, Coastal Pacific Aviation, Convergent Manufacturing Technologies, Coulson Aviation, HNZ TopFlight, KF Aerospace, Montair Aviation, NGRAIN, Pacific Sky Aviation, Pelesys Learning Systems, Platinum Aerospace, and RaceRocks 3D.
MRO-ISS Service	• Includes firms that provide ongoing support over the in-service life of the aircraft, including maintenance, repairs and overhaul. • The segment also includes In-Service Support (ISS), which includes value-added activities such as project management, engineering services, integrated logistics support, modifications, airworthiness and lifecycle management. • 34 companies in BC, of which 9 reported revenues in excess of $20 million per year (4 of which reported revenue above $100 million). • Particular strength in line and component maintenance (25 firms reported capabilities such as avionics testing and repair, flight control, fuel systems, interior finishing, landing gear, rotor blade, and life support equipment). • Although 22 firms reported heavy maintenance capabilities, many of them are small (at least 10 with revenues under $5 million per year). • Examples of firms include Cascade Aerospace (one of two C-130J heavy overhaul facilities

Segment	Characteristics
	in the world), KF Aerospace (WestJet's structural maintenance contractor). CHC Helicopter and Heli-One (a leading helicopter maintenance service company), Alpine Aerotech, AVM Solutions (Kelowna), Maxcraft Avionics Ltd, MTU Maintenance Canada, and Vector Aerospace.
Space	• Includes firms that manufacture space vehicles, satellites and telecommunication systems, earth observation, space and system engineering services and data and application development. • BC has an OEM in the space segment (MDA). • BC's space sector generated $237 million in revenues in 2012. • BC also has firms with capabilities that align well with the Earth Observation segment, which is a significant growth sector for the Canadian space industry.

Source: *Economic Impact Analysis and Capabilities Study of the BC Aerospace Industry, Prepared for AIAC Pacific, August 2015, KPMG.*

An analysis of BC capabilities by OEM finds that Boeing and Airbus are strongly represented, particularly in the MRO-ISS and Aircraft Component Manufacturing segments. A significant number of BC firms in component manufacturing and supporting services delivery also reported serving Lockheed Martin and Viking. On the other hand, Bombardier had less representation across all value chain activities relative to other OEMs considered. While BC is home to two OEMs currently in production (Viking Air in the fixed-wing segment and MDA in the space segment), it lacks large-scale Tier 1 integration capabilities[15]. BC aerospace manufacturing firms, especially those located in the Lower Mainland, are well placed geographically to serve Boeing final assembly line operations in Washington State, possibly even as just-in-time (JIT) component inventory suppliers for Boeing's final assembly lines.

Government Involvement in the Industry

The Government of BC has identified the aerospace industry as a priority for development. Towards that end, in 2013 the provincial government committed funding of $5 million over five years for AIAC Pacific to work with the industry to develop a more unified aerospace industry cluster, attract investment and accelerate the growth of the industry in BC. AIAC Pacific was tasked to work with the provincial government to:

- Increase collaboration among BC aerospace industry partners;
- Enhance market access and expand international trade opportunities;
- Develop a globally competitive supply chain to expand access to global markets;
- Improve the BC aerospace industry's research and development capabilities;
- Access BC's fair share of federal program, procurement, and research funding; and
- Leverage provincial training programs and opportunities to strengthen the advanced manufacturing skills base.

The sector has also been identified as a priority for development by various municipalities in BC including:

- Abbotsford: In August 2016, the Abbotsford International Airport (YXX) in conjunction with industry partners, launched an Aerospace & Technology Cluster, a web-based platform to assist the local Abbotsford aerospace industry promote its capabilities to the global marketplace. Participating

15 Tiers relate to a company's position in the supply chain. Tier 1 companies provide air frames, components, and other final parts (e.g. avionics systems, engines, aircraft interiors, landing gears, actuators, and other complex components and assemblies) directly to the original equipment manufacturer (OEM). Tier 2 suppliers may create many of the same types of parts as Tier 1,but deliver them to Tier 1 rather than OEMs. In turn, they rely on Tier 3 suppliers to supply them with parts and materials.

organizations demonstrate the strategic viability of the YXX locale, establishing it as a regional hub for advanced technology R&D and the commercialization of new technologies that service Western Canada and support the Aerospace corridor of the Pacific Northwest. The participating organizations are dedicated to four areas of intervention; Service Support and Engineering, Flight Operations and Training, Technology and Research Development, and Consulting Services and Industry Associations. The YXX business model is based on an onsite growing aerospace (fixed/rotary wing) community, investors ready to custom build facilities, and fixed and rotary-wing schools on site. YXX processes approximately 500,000 passengers annually and hosts the following events: the Aerospace, Defence & Security Expo (ADSE), the Canadian Business Aviation Association Convention and Exhibition, The Abbotsford International Airshow, and Girls Fly Too Events.

- Pitt Meadows developed a targeted aerospace strategy which includes initiatives to extend a runway at its airport.[16] The Pitt Meadows Regional Airport is home to approximately 60 aerospace businesses and organizations which provide a range of different products and services. This includes 10 firms offering aircraft parts and services, seven air taxi/charter service providers, and seven flight training schools and institutions, among other services. Unique among the (Lower Mainland) airports examined is that Pitt Meadows Regional also has several aerial photography services firm on-site. It has identified two potential and emerging gaps which could support Pitt Meadows Airport, in particular: cost increases at YVR and shrinking amount of industrial land in the Lower Mainland.

- Chilliwack: Chilliwack has also developed an Aviation Strategy. The Chilliwack Municipal airport encompasses 130 acres and contains an air terminal building designed to accommodate aircraft handling no more than 19 passengers. The Airport is home to approximately 75 private and commercial aircraft, which includes both fixed wing and helicopters. There are over 20 businesses at the airport including: flight training schools, charter companies (both fixed wing and helicopter), aircraft paint and maintenance shops as well as other aviation related businesses.[17] The two factors which could support Chilliwack were the same as those identified for Pitt Meadows (cost increases at YVR and shrinking amount of industrial land in the Lower Mainland). Chilliwack has identified its attractiveness as a community and its cost advantages are its strongest selling point.

In addition to these Lower Mainland municipalities, the Okanagan is also positioning itself as a growing aerospace cluster with several major companies serving aviation and defence markets globally, a growing base of companies, and R&D capabilities including the Composite Research Network and Survive and Thrive Applied Research Centre.

Since the mid-1970s, the Government of Canada has pursued the use of industrial benefits as part of the federal procurement contracts that are exempt from international trade agreements. Under this approach, firms bidding on government defence and security contracts are evaluated on the basis of the economic benefits of their proposals to Canada, as well as price and quality (technical merit). The most recent policy, the Industrial and Technological Benefits (ITB) Policy, requires companies awarded procurement contracts undertake business activity in Canada equal to the value of the contract. The ITB applies to all eligible defence procurements over $100 million and eligible Canadian Coast Guard procurements over $100 million (for which the National Security Exception applies). In addition, eligible defence procurements with contract values between $20 million and $100 million are reviewed for the use of Value Propositions.

Between 2011 and 2015, the IRB Policy (the predecessor to the ITB) resulted in $1.75 billion being invested

16 *Pitt Meadows Targeted Aerospace Strategy,* Prepared for Pitt Meadows Economic Development Corporation by InterVISTAS Consulting Inc., April 2011.
17 *Chilliwack Aviation & Aerospace Sector Strategy*, Prepared for Chilliwack Economic Partners Corporation by InterVISTAS Consulting Inc., 20 February 2012.

in 375 small and medium-sized enterprises (SME). As of January 2017, the portfolio of current IRB and ITB obligations included 82 projects representing $32.3 billion in obligations, of which $19.1 million had been met, $9.4 million was in progress, and $3.8 billion was yet to be identified (e.g., which represent future work opportunities). Approximately 30 companies or groups of affiliated companies serve as the prime contractors for these projects. While many prime contractors are associated or affiliated with foreign multinationals, some are non-affiliated Canadian firms. The ITB is intended to generate a range of economic benefits for Canada including:

- Long-term sustainability and growth of our defence sector (e.g., companies establish or grow their presence in Canada)
- Growth of prime contractors and suppliers, including small and medium-sized enterprises in all regions of the country (e.g., increased participation in supply chains)
- Enhanced innovation through R&D undertaken by companies and post-secondary institutions
- Increased export potential (e.g., increased supplier exports as well as exporting the procured product from Canada)
- Creation of high-quality jobs for Canadians
- Attraction of foreign direct investment

These investments helped embed these SMEs into supply chains with long-term growth opportunities.

BC's aerospace industry was given a boost in December 2016 with the announcement that 19 Wing Comox had been chosen as the location for the training centre for the Fixed Wing Search and Rescue Replacement Project. The replacement project is a federal initiative to replace the aging planes currently being used in search and rescue operations and to integrate to a single nationwide fleet. As part of the contract, Airbus will provide 16 of the planes and has partnered with Newfoundland-based PAL Aerospace for maintenance and support services. The initial contract for 11 years is valued at $2.4 billion. Should the federal government choose to exercise an option to extend the maintenance and support services for an additional 15 years, the contract value would increase to $4.7 billion.[18]

A new defence policy has the potential to provide additional support for Canadian aerospace innovation and industrial capability. On June 7, 2017, the Minister of National Defence announced the government's new defence policy. The policy sets a path forward for Canada's security and armed forces for the next twenty years, including a significant long-term increase to the defence budget, a focus on supporting innovation in Canada's defence sector and an acknowledgement of the strategic importance of space-related capabilities to Canada's long-term sovereignty and security.

2.4 Key Trends That May Affect the Sector

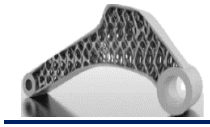
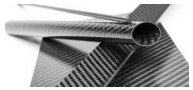
Overview of Key Trends

Roland Berger and others identified a variety of megatrends which will impact on the future labour market for the aerospace industry over the next 5, 10 and twenty years. These trends as well as expected impact and timing are outlined in the table on the following page.

18New SAR training centre will have significant economic impact on Comox Valley, Comox Valley Record, December 8, 2016. http://www.comoxvalleyrecord.com/news/new-sar-training-centre-will-have-significant-economic-impact-to-comox-valley/

Key Market Trends That Will Impact the Aerospace Industry As Well As BC

Trends	Description	Impact	Timing
Shift of Market to Asia 	• Market for large commercial and regional aircraft is increasingly shifting to Asia-Pacific and in particular China • Customers (airlines/leasing firms) are putting offset/local content obligations on Western aircraft OEMs • New OEMs for LCA[2)] and regional aircraft emerge in China (e.g. Comac)		Now
Flattening of production rates 	• OEMs for LCA have in the recent years continuously increased their production rate to all-time highs • Currently increase for A320 neo as well as B737 max program have been announced to 60 aircraft/ month (and beyond) • However production/ industrial system at OEMs as well as suppliers come to its limit • Order inflow at OEMs is currently drying • Result will be a flattening of production rates and increased cost reduction actions triggered by OEMS		After 2020
Personal air mobility & cargo drones 	• UAVs have in the recent years become increasingly important for a wide range of civil (agriculture, maintenance of infrastructure) as well as military (e.g. surveillance) applications • Latest trends within the UAV segment are drones for passenger transport (e.g. Dubai) as well as for (heavy) cargo transport		After 2020
Electrical propulsion 	• There are two broad movements underlying the aircraft electrification trend: More Electric Aircraft and Electric Propulsion • A lot of R&T is ongoing within the field of electrical propulsion – However major applications will not be on the market before 2025 due to battery technology • The developments in electrically propelled aircrafts is pushed by startups challenging the current industry structure in commercial aerospace		After 2025
Automation/ Industry 4.0 	• New automation solutions/ industry 4.0 increase flexibility and reduce costs/ improve speed of production • Automation mostly already performed on part level • In the last years big process for automation of assembly but potential still remains • Automation solutions are driven by the equipment producers • Artificial intelligence will allow to optimize overhead costs, e.g. via RPA		Now

Trends	Description	Impact	Timing
Resin Transfer Modelling / IInfusion 	• Major drawback on current CFRP production process is the high double investment into Automated Fibre Placement (AFP) machines as well as Autoclaves • Alternative technology is dry fibre lay-up of textiles into preforms before infusion of liquid resin with Out of Autoclave (OoA) curing (and avoiding thus investment into autoclaves) – this is known as resin transfer molding (RTM) • This technology is still in its final stages of development for serial application in the aerospace industry, however a intermediate step is Resin Transfer Infusion (RTI) as a hybrid of Resin Transfer Moulding (RTM) and autoclave processing		After 2020/2025
AM and High Deposition Rate 	• Additive manufacturing/ 3D printing is on the verge of taking off driven by market forces and greater technical maturity but issues with certification still remain • Within aerostructures in the short- to mid-term major applications will be for spare parts (ease obsolescence management) as well as rapid prototyping • Intermediate step is High Deposition Rate which is additive manufacturing and machining afterwards – Allows to replace current forgings (which are quite expensive with high margins for the supplier firms)		After 2020
Stabilization of use of composites 	• Use of composites (and in particular CFRP1) has increased over the last decades, in particular with launch of B787 and A350 • Composites and in particular CFRP has advantages (e.g. strength, reduced part count) but suffers also (e.g. high cost of tooling and CAPEX, difficult to repair) compared to metallic , which leads to stabilization of mix of composites/ CFRP vs. metallic at current levels for future •		After 2020/2025
Use of Thermo-plastics 	• Thermoplastic composites are different to thermosetting materials, such as e.g. • Thermoplastics have great impact resistance compared to thermosets (e.g. CFRP) • Parts are heated to soften it and then brought (e.g. press) into their final form • Parts can also be reheated to be brought into a new form/ as part of recycling • Complex structures can be assembled via welding (e.g. leading edge A380) • Thermoplastics allow to reduce cost for maintenance and repair (e.g. structure can be heated and brought back to the initial form after an impact)		After 2020/2025

Source: Market Reports, Siemens, and Roland Berger

Potential Implications for Further Competitiveness - MRO

The total MRO market is expected to become increasingly concentrated within a handful of aircraft platforms (A320x, B737x), which could favor large players and fleet management new business models. The global fleet will experience a transition to new aircrafts with composite/hybrid aero structures, advanced avionics requiring interfaced with health monitoring technology requiring significant adaptation from the MRO players (specifically in the field of data analytics). Line and component maintenance MRO providers will be facing similar challenges: access to OEM testing equipment and training as well as capabilities to properly use health monitoring data.

MRO activities in BC are focused primarily on narrow body aircraft, turboprops and regional jets. The outlook for growth in the narrow body segment is positive while prospects in turboprop and regional jet segments are more limited given that few new programs are coming and the introduction of new technologies (e.g. hybrids, composites, and advanced avionics) in these segments will remain limited. Future competitiveness will be dependent in part on the ability of BC players to capture and retain narrow body business, reduce costs (possibly through consolidation or other means) and develop new business models (fleet management). Consequently, the province will require not only engineers, AMEs and technicians but also highly skilled professionals able to deal with business development consolidation issues and shape new business models.

MRO for military aircrafts will remain well-oriented as aircraft usage is systematically extended (e.g. with the C-130). BC players will need to compete effectively against operations in emerging countries (for simple maintenance work) and even on ex-USAF bases.

Potential Implications for Further Competitiveness - Manufacturers

The aerostructure global market is expected to grow at a rate of 4.2% annually to 2020 and then remain relatively stable until 2025. BC suppliers may be impacted by insourcing (a movement amongst OEMs of producing more their own components, reversing a trend of recent years) and increased rates of OEM (e.g. Airbus, Boeing, and engine manufacturers) production which impact the full value chain. Boeing existing aero structure strategy is to outsource doors, cockpit, nacelle and wiring while using a combination of insourcing and outsourcing for other components (e.g. wings, fuselage, empennage).

Due to the proximity of Boeing ecosystem and also some history with Boeing Tier 1 suppliers, the future competitiveness of BC manufacturers will be dependent, in part on the ability to meet Boeing requirements as well as the requirements of other OEMs (e.g. delivery schedules, production flexibility, focus company concept, role of thermoplastics in the design of new programs, etc.)

3. Summary of Findings from the Employer Survey

This chapter summarizes the major findings from the employer survey regarding the characteristics of the labour market in BC, recent and projected growth in employment, labour and skills shortages, and planned and recommended actions to address shortages.

3.1 Employers by Sector

Definition of Sectors for the Study

The Phase 1 component of the BC Aerospace Sector LMP program recommended that this Phase 2 study should focus on five sub-sectors: Advanced Manufacturing; Aviation Training; Maintenance, Repair & Overhaul/In-Service Support (MRO/ISS); Research and Development; and Space and Remote Sensing. A further definition of these sectors is provided in the table below.

Definition of the Sub-sectors for Phase 2

Sub-sector	Description	Related NAICS Codes
Advanced Manufacturing	Involves the use of innovative ideas and technology to improve products or processes for manufacturing aircraft structures, components and systems	• 336410 - Aerospace Product and Parts Manufacturing • 332710 - Machine Shops • 332810 - Coating, engraving, cold and heat treating and allied activities
Aviation Training	Encompasses fixed and rotary wing pilot training – in military, general commercial and niche markets such as mountain, bush, firefighting, and seaplanes – as well as aircraft maintenance and air traffic control training	• 481215 - Non-Scheduled Specialty Flying Services • 611510 - Technical and trade school
In-Service Support/ Maintenance, Repair & Overhaul (MRO/ISS)	Consists of the ongoing service, upgrading and retrofit of in-service aircraft. The ISS service sector encompasses additional value-added activities such as project management, engineering services, integrated logistics support, modifications, airworthiness and lifecycle management	• 488190 - Other Support Activities for Air Transportation • 541330 - Engineering Services
Research and Development	Involves developing new innovations/technologies and bringing them to market – often through collaborative partnerships between academic institutions and industry. Aerospace research and development is considered critical to the long-term success of the industry	• 336410 - Aerospace Product and Parts Manufacturing • 541360 - Geophysical surveying and mapping services • 541370 - Surveying and Mapping (except Geophysical) Services • 541330 - Engineering services • 334220 -Radio and television broadcasting and wireless communications equipment manufacturing
Space and Remote Sensing	Includes firms involved in the design, development and manufacturing of space vehicles, satellites and telecommunication systems; earth observation; space and system engineering services; and data and application development	• 541710 - Research and development in the physical, engineering and life sciences

The scope of the survey did not include major carriers or any regional carriers who are not involved in one of the sectors outlined above.

Sectors Reported by Employers

A total of 104 aerospace employers participated in the survey. The employers were asked to identify the areas in which their operations are most involved. As indicated, the areas that were more commonly identified as sources of revenue were maintenance, repair & overhaul, sale of aircraft, aircraft structures, and research and development activities.

Participation by Sector

Question: Does your organization generate revenues from (select all that apply):

Sectors	Number	Percentage
Employers Responding	**104**	**100%**
The sale of aircraft, aircraft structures, components and/or systems manufactured by your company?	37	36%
Aviation training (e.g., fixed and rotary wing pilot training, aircraft maintenance or air traffic control training)?	15	14%
Maintenance, Repair & Overhaul (MRO) and/or In-Service Support (ISS) services?	42	40%
Research and development activities?	20	19%
Space and remote sensing?	6	6%
Other aerospace related activities?	47	45%

Some examples of other sectors specified by employers as generating revenues include operations/logistics (e.g., air cargo operations, flight operations, charter); data/IT (e.g., data analytics, training systems); the sale or leasing of aircraft, aircraft components and/or systems not manufactured by their company (e.g., distribution/third party supplier of manufactured parts, aircraft leasing, facilities rentals); and engineering-related activities (e.g., ADO/engineering).

Some of the employers are involved in more than one sector. For example, 18 organizations reported generating revenues from both manufacturing and MRO/ISS services. Most of the companies reporting R&D activities were involved in either manufacturing or space and remote sensing.

Reliance on the Aerospace Sector

The employers were also asked to specify the percentage of their firm's revenue from operations in BC based upon the above sources of revenue. Almost half (46%) of employers indicated that 100% of their revenues are generated by aerospace related activities.

Reliance on Aerospace as a Percentage of Revenues

Question: What percentage of your firm's revenues from operations in BC are generated from the products and services listed above?

Percent From Aerospace	Number	Percentage
Less than 10%	15	14%
11%-25%	10	10%
26%-50%	7	7%
51%-75%	8	8%
76%-99%	12	12%

Percent From Aerospace	Number	Percentage
All (100%)	48	46%
Not Noted	4	4%
Employers Responding	**104**	**100.0%**
Average	71%	
Weighted by Number of Employees	76%	

Years in Operation

Most of the businesses are long-established. A majority (69%) have been operating more than 10 years, including 41% operating in BC for more than 20 years. However, 15% were established in the past five years.

Number of Years in Operation

Question: How long has your organization been operating in BC?

Response	Number	Percentage
Fewer than 5 years	16	15%
5 to 9 years	13	13%
10 to 14 years	14	14%
15 to 20 years	15	14%
Over 20 years	43	41%
Not Noted	3	3%
Employers Responding	**104**	**100%**

The more recently established organizations reported revenues from a variety of sub-sectors in the industry, of which manufacturing and space & remote sensing were identified most frequently.

3.2. Number of People Employed

In administering the survey, emphasis was placed on encouraging the participation of larger employers. We asked the employers surveyed to specify the number of employees the organization currently has in BC. The aggregate number of employees was calculated by adding up the number of employees specified by all 104 employers. These numbers were then placed into the categories below.

In total, the 104 employers who were surveyed employed 6,204 people, which is equal to an average of about 60 employees per organization. However, over one-half of the organizations responding employed 15 or fewer employees as indicated in the table below.

Number of People Currently Employed

Question: How many people does your organization employ in BC?

Number of People	Number	Percentage
1 to 10	39	38%
11-15	16	15%
16 to 30	23	22%

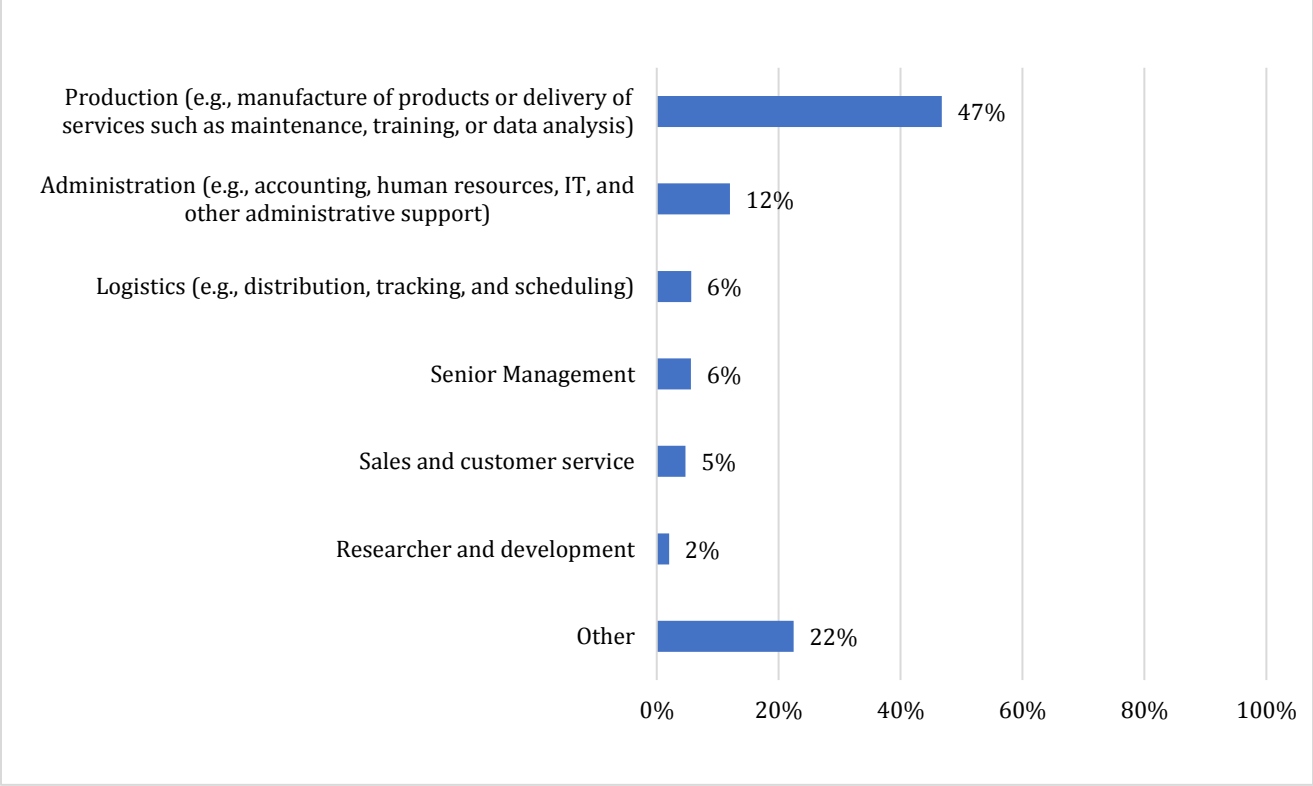
Number of People	Number	Percentage
31 to 50	7	7%
51-100	5	5%
101-150	3	3%
151-250	4	4%
Over 250	7	7%
Employers Responding	**104**	**100.0%**
Average Employees Per Employer	60	
Aggregate Employment	6,204	

3.3 Employment by Functional Area

When asked to identify the functional areas of their workers, 97 employers provided a breakdown of their current number of employees by functional area. In aggregate, they indicated that almost half (47%) of their workforce was involved in production followed by administration (12%), senior management (6%), logistics (6%) and sales and services (5%).

Employees by Functional Area (n=97)

Question: If you were to allocate these staff by function, approximately how many employees would you have in each of the following functional areas?



The other category included a wide variety of other types of positions ranging from flight operations to non-aerospace related operations.

3.4 Employment in Selected Positions

The Phase 1 component of the Sector LMP program recommended that this Phase 2 study focus on a series of specific occupations and identified the National Occupations Classification (NOC) codes which should be included. Subsequent to completion of the Phase 1 Engagement Report, the Governance Committee, and separately the BC Aviation Council, identified a need to broaden the scope of the Phase 2 study to include pilot demand. For each occupation identified in Phase 1 as well as pilots, the following table summarizes available secondary data on the related NOC codes; the sub-sectors to which the occupations relate; the number of people estimated to be employed in those occupations in 2017; and the number projected to be employed in 2027 as per the BC Labour Market Outlook, 2017-27

The table also separates the occupations into two groups: those occupations which tend to be aerospace (or at least aviation specific) and those which are common to other sectors.

- According to the BC Labour Market Outlook, 2017 to 2027, the demand for workers in aerospace specific occupations (i.e., those occupations mostly limited to the aerospace industry) is projected to increase from 12,775 in 2017 to 13,997 in 2027 (an overall increase of 9.6% which is equal to 0.9% annually). The number of workers in these occupations is significantly higher than the number reported in Economic Impact Analysis and Capabilities Study of the BC Aerospace Industry prepared for AIAC Pacific (2015) as being employed in the industry (8,348), reflecting the fact that a significant percentage of the people employed in these occupations are working for organizations which are not defined as part of the industry (e.g. major carriers and regional airlines).

- The demand for workers in occupations shared with other sectors (i.e. most of the workers in those occupations do not work in the aerospace industry) is projected to increase from 55,424 in 2017 to 66,424 in 2027 (an increase of 19.8% overall or 1.8% annually, largely due to the high rate of growth projected for IT related occupations). The vast majority of workers in these occupations are employed in industries other than aerospace.

Overview of the Identified Occupations

Occupation	NOCs	Employment		Sectors					
		2017	*2027*	*ISS/ MRO*	*Adv. Man*	*Aviation Training*	*Space & RS*	*R&D*	*Other*
Aerospace Specific Occupations (Mostly Limited to the Aerospace and Aviation Industries)									
Aerospace engineers/ Aircraft Maintenance Engineers (AMEs)/ Structures AMEs	2146 Aerospace engineers	303	356	•	•				
	2232 Mechanical engineering technologists and technicians	1,836	2,070						
	7315 Aircraft mechanics & aircraft inspectors	3,578	4,221						
Turbines	9526 Mechanical assemblers & inspectors	731	773			•			
Assemblers (aircraft)	9521 Aircraft assemblers and inspectors	193	211						•
Aviation instructors/ trainers	2271 Air pilots, flight engineers & instructors	4,389	5,293			•			
Pilots						•			
Avionics technicians (certified)	2244 Aircraft instrument, electrical and avionics mechanics, techs & inspectors	1,379	1,621	•					•
Total, Aerospace Specific Occupations									
Occupations That Are Shared With Other Sectors (Extend Outside of the Aerospace)									
CNC Machinists/ Machinists	7231 Machinists, machining & tooling insp.	4,088	4,331	•	•				•
	9417 Machining tool operators	336	341						

Occupation	NOCs	Employment		Sectors					
		2017	*2027*	*ISS/ MRO*	*Adv. Man*	*Aviation Training*	*Space & RS*	*R&D*	*Other*
Composite structure technicians	2211 Chemical technologists techs	2,941	3,324	•	•				
Data analysts (space and remote sensing)	2172 Database analysts & admin	1,517	1,820				•		
	2147 Computer engineers	2,990	3,750						
	2255 Techs in geomatics and meteorology	1,224	1,414						
Design/software technicians	2173 Software engineers and designers	9,159	12,084	•	•	•	•	•	•
Heat treat personnel	9411 Machine operators/processing	697	701						•
	9415 Inspectors and testers	178	206						
IT professionals	2171 Info systems analysts & consultants	17,240	21,986	•	•	•	•	•	•
	0213 Computer/IS managers	6,941	8,645						
Labourers (mechanically inclined)	9619 Other labourers in processing, manufacturing and utilities	5,062	5,407	•	•	•	•	•	•
NDT – non-destructive testing	2261 Non-destructive testers and inspection technicians	827	933	•	•				•
Painters	9536 Painters, coaters and metal finishing	1,643	1,746	•					•
Total, Occupations Shared with Other Sectors									

Sources: Economic Impact Analysis and Capabilities Study of the BC Aerospace Industry; BC Labour Market Outlook, 2017-27.

A brief profile of the characteristics of workers in aerospace specific occupations, using secondary data, is provided in the following table, highlighting the range in terms of wages, gender, age and required education.

Characteristics of the Aerospace Specific Occupations

NOC	Emp-loyed	Hourly Wage Range			% Male	% 45-64 yrs	General Education Requirements
		Low	Median	High			
2146 Aerospace engineers	300	$17.75	$37.16	$52.73	96%	39%	Bachelor's degree in aerospace engineering or related engineering discipline, such as mechanical engineering or engineering physics. A master's degree or doctorate in a related engineering discipline may be required.
2232 Mechanical engineering technologists and technicians	1,840	$19.00	$29.72	$50.00	90%	40%	While not restricted by legislation, agencies and employers may require professional certification provided by the Applied Science Technologists and Technicians of British Columbia (ASTTBC).
2244 Aircraft instrument, electrical and avionics mechanics, techs & inspectors	1,380	$23.54	$34.23	$44.04	95%	44%	Completion of Transport Canada approved college diploma program and certification generally required. Programs vary in length from 29 weeks for Aircraft Mechanical Component Technicians to 48-week diploma program for Aircraft Maintenance Engineer Category E (Avionics)
2271 Air pilots, flight engineers & instructors	4,390	$22.94	$48.08	$60.10	93%	48%	• Pilots require graduation from a certified flying or aviation school and a commercial or air transport pilot license as well as additional licences or endorsements to fly different types of aircraft • Requires Transport Canada ratings and endorsements to provide instruction on different types of aircraft. • Flight engineers require a flight engineer license issued by Transport Canada.
7315 Aircraft mechanics & aircraft inspectors	3,580	$20.90	$36.00	$47.20	97%	50%	College diploma in aircraft maintenance or completion of four-year apprenticeship program is usually required.
9521 Aircraft assemblers and inspectors	190	Median hourly wage $23.29			97%	61%	Completion of a college or other program in aviation or aeronautical technology, with emphasis on aircraft manufacturing, may be required.

NOC	Emp-loyed	Hourly Wage Range			% Male	% 45-64 yrs	General Education Requirements
		Low	Median	High			
9526 Mechanical assemblers & inspectors	730	$12.61	$19.98	$33.07	90%	48%	--

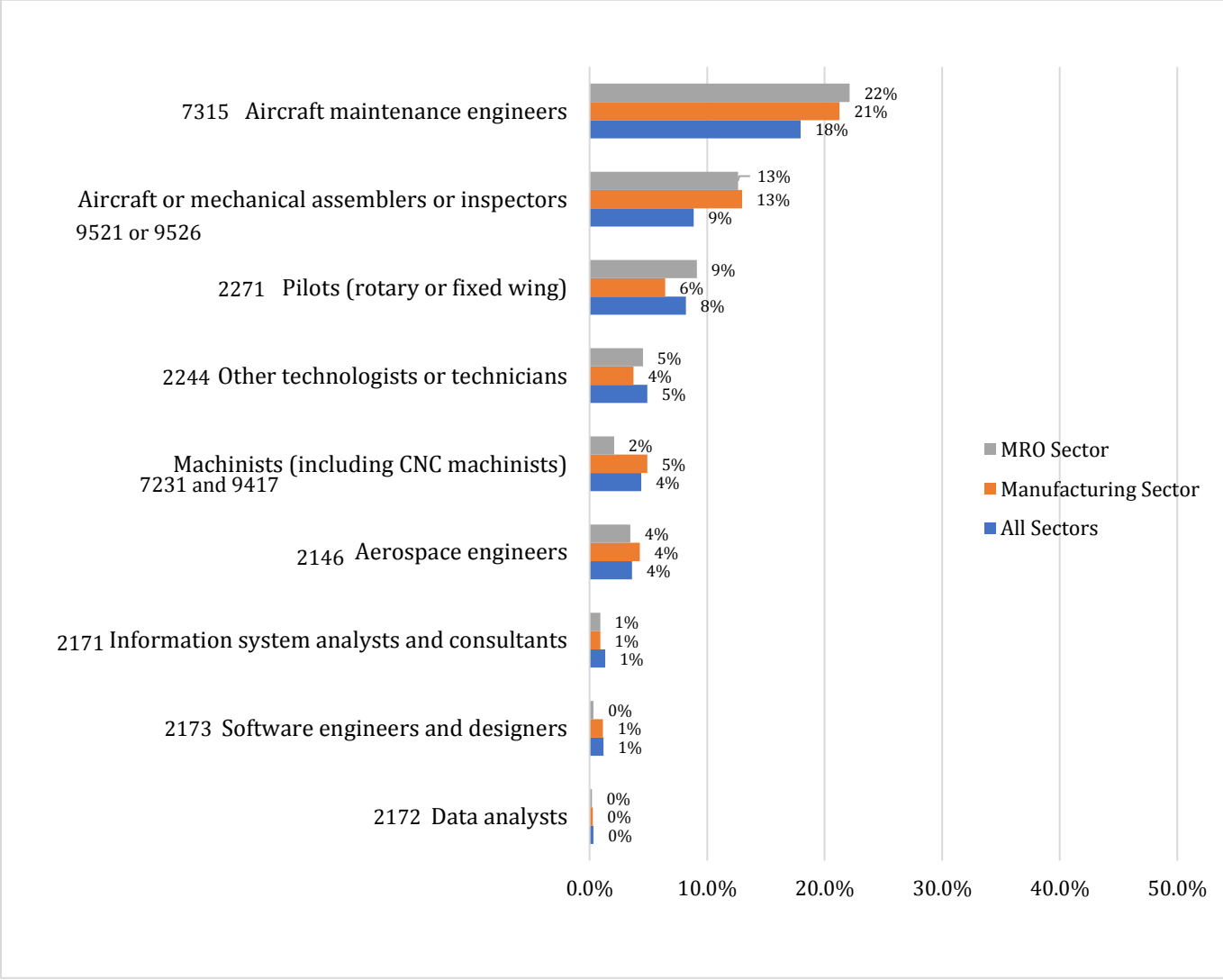
Source: BC Labour Market Outlook, 2017-27; 2016 Job Bank Wage Report; WorkBC profile.

Employees by Position Amongst the Employers Surveyed

The 86 organizations that provided a breakdown of employees by position employed over 5,000 workers, of which 18% are aircraft maintenance engineers, 9% are aircraft or mechanical assemblers or inspectors, and 8% are pilots (rotary or fixed wing). The chart below also illustrates the breakdown of employment by position for the 37 employers involved in manufacturing and 42 involved in MRO/ISS.

Employees by Position (n=86)

How many, if any, people do you have employed in the following positions?

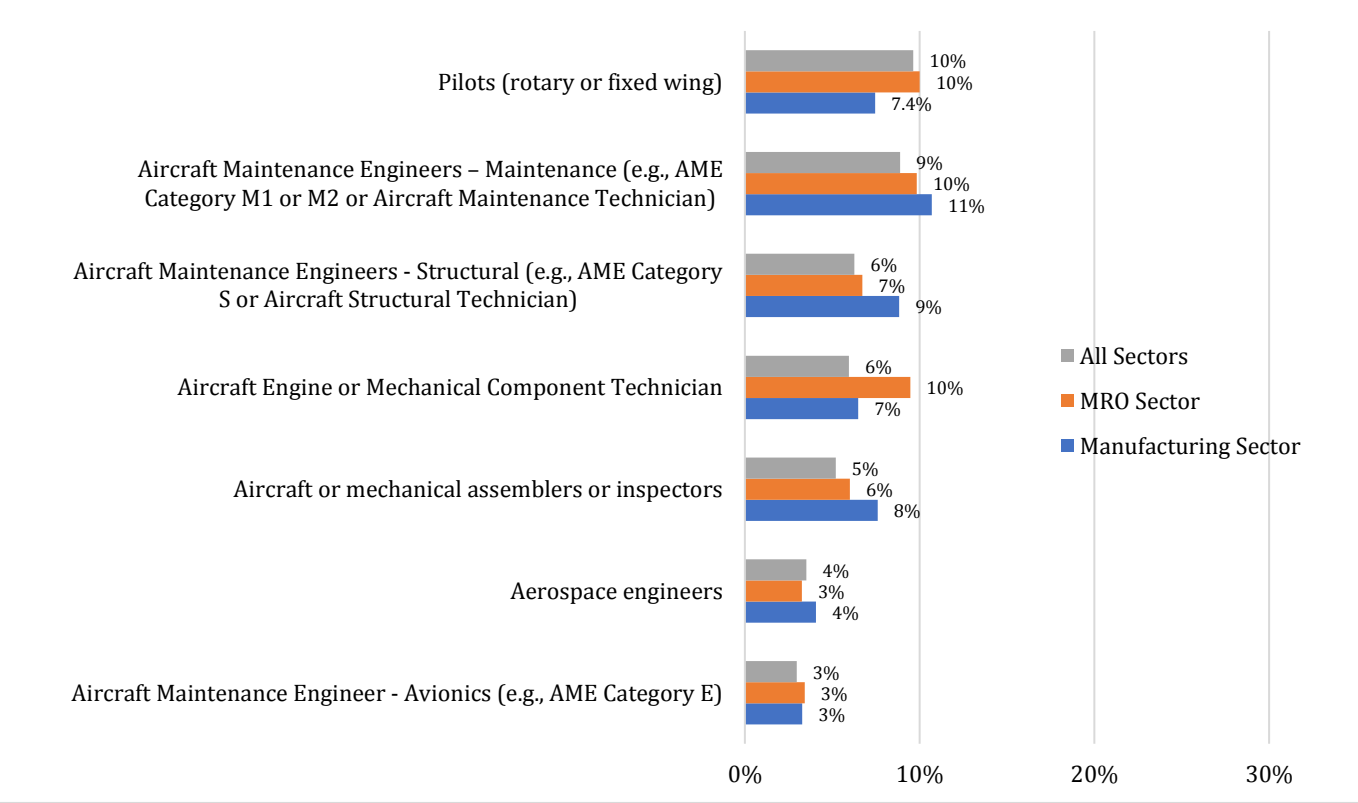


Credentials and Education

Fifty-eight employers identified having at least some employees who possess education or professional certifications which are either required or important for their positions. The most common credentials included pilot (rotary or fixed; accounting for 10% of total industry employment), aircraft maintenance engineers – maintenance (e.g., AME Category M1 or M2 or Aircraft Maintenance Technician; 9%), and Aircraft Maintenance Engineers – Structural (e.g., AME Category S or Aircraft Structural Technician; 6%).

Credentials and Education (n=86)

Question: How many, if any, employees do you currently have employed who have the certifications or education listed below?



Factors Contributing to Changes in the Workforce Composition

Employers were also asked if there have been any significant changes to their operations in BC over the past five years that significantly affected the relative composition of their workforce. Of the 85 employers that were operating five years ago, 28 identified significant changes including:

- The need for more highly skilled workers (e.g., more training, hiring of different skill sets) because of the adoption of new technologies, processes and/or materials (identified by 9 employers);
- The need for employees to have a broader range of skills because of growth in the nature or range of services they offer (8 employers);
- An increasing need to invest regularly in skills upgrading as operations advance (3 employers);
- The impact of growth on the need for additional hiring and staff (3 employers);

- An economic downturn in their business reduced their staffing requirements in BC (3 employers);
- They are making greater use of co-op students as a means to attract new workers and augment existing resources (3 employers);
- They are investing more significantly in research and product development, which requires greater engineering and technical expertise (1 employer); and
- Regulatory changes have impacted their staffing requirements (1 employer).

3.5 Characteristics of Employees

Aerospace employers were asked various questions about the characteristics of their workers in order to develop an up-to-date profile of the existing workforce. Ninety-seven of the 104 employers surveyed, representing 84% of the reported employment, provided a breakdown of the characteristics of their employees. The following table identifies how many employers answered each question and, for each characteristic, compares the number of workers reported with the selected characteristic to the aggregate workers employed by the responding companies.

According to the employers surveyed, 34% of their employees are members of a union (9 employers reported that they are unionized, all but one of which have over 100 employees). In terms of qualifications, 5% are enrolled in apprenticeships or pursing AME licenses, 12% have Transport Canada certifications, and 13% are journeypersons. Women account for less than one-fifth (19%) of the workforce, and 20% of workers are 55 years or older. Taken together, the employers reported only 27 Temporary Foreign Workers and 88 workers have immigrated to Canada in the past five years.

Characteristics of Employees (n=97)

Question: Of your employees, approximately how many are:

Characteristics	All Sectors		
	Employers reporting any employees in this category	Employees reported in this category	Percentage of total people employed
Total Employment	97	5,183	100%
Members of a union?*	9	1,642	32%
55 years or older?	71	955	18%
Female?	85	918	18%
Journeypersons?	33	634	12%
Persons with Transport Canada certifications?	44	592	11%
Enrolled in apprenticeships or pursing AME licenses?	28	240	5%
People who have immigrated to Canada in the past five years?	32	88	2%
Temporary foreign workers (working in Canada with a temporary work visa?)	15	27	1%

*Note: Because of the small sample size of employers in these sub-groups, the results should not be considered statistically significant (at a margin of error over of about ±10% at a confidence level of 95%)

Recognizing that numerous companies are involved in both sectors, the composition of the workforce did not vary significantly between the two major sectors, manufacturing and MRO. A slightly higher percentage of the workforce of employers identifying as manufacturers were unionized (32% vs 25%) while a slightly higher percentage of the workforce of employers identifying as MROs possessed MRO certifications (15% vs 10%).

3.6 Recent Growth in Employment

Employment Growth over the Past Five Years

Of the companies surveyed, 44% of companies reported that the number of people they employ has increased over the past 5 years, 16% reported employment has stayed the same, 15% reported employment has declined and 15% were not operating five years ago.

Growth in Employment over the Past Five Years

Question: Is the number of workers employed by your organization today:

Response	Number	Percentage
Higher than it was five years ago?	46	44%
The same as it was five years ago?	17	16%
Less than it was five years ago?	16	15%
Not operating Five Years Ago	16	15%
Don't Know/Not Sure	9	9%
Employers Responding	**104**	**100%**

Seventy-nine of the 88 companies operating five years ago were able to provide an estimate of the growth in employment over the past five years (i.e., they reported their current level of employment and level five years ago). As indicated, on average, these companies have grown from an average of 67 employees to 73 employees over the past five years.

Growth in Employment over the Past Five Years

	Five Years Ago		Currently	
Number of People By Size of Employer	**Number**	**Percentage**	**Number**	**Percentage**
1 to 10 Employees	199	4%	148	3%
11 to 15	124	2%	176	3%
16 to 30	352	7%	436	8%
31 to 50	114	2%	269	5%
51 to 100	386	7%	229	4%
101 to 150	405	8%	260	5%
151 to 250	204	4%	767	13%
Over 250	3,509	66%	3,471	60%
Employers Responding	**79**		**79**	
Number of Employees on Average	67		73	
Aggregate Employment	5,293		5,756	

Sixty percent of the people are employed in organizations with over 250 employees, down somewhat from 66% five years ago. The percentage of employees working for employers with 151 to 251 employees has increased from 4% to 13% because one larger employer (previously with over 250 employees) declined in size while two employers that previously had between 101 and 150 employees increased in size.

Factors Contributing to Employment Growth

When asked about the factors that contributed to their employment growth, the 46 employers reporting growth most commonly indicated that they have increased the volume of existing goods or services being delivered (80%) and/or have expanded the range of products or services they produce (73%). Twenty percent attributed the growth, at least in part, to vertically integrating their operations.

Conversely, of the 16 employers who reported declining employment, the most commonly identified factor was a decrease in the volume of goods produced or services delivered (38%). One-quarter reported improvements in productivity that decreased the number of workers needed to produce the same volume, as well as outsourcing some of the functions or production.

3.7. Recent Hiring

Hiring Over the Past 12 Months

Employers were asked to identify how many new workers they hired over the past year. The ninety-one employers that were able to provide data reported hiring 742 employers. These employers currently employ 5,175 people, which means they, on average, hired 14 new workers for every 100 current employees.

Number of Hires over the Past 12 Months

Question: Over the past 12 months, approximately how many new employees did you hire to fill new positions or to replace staff members who left?

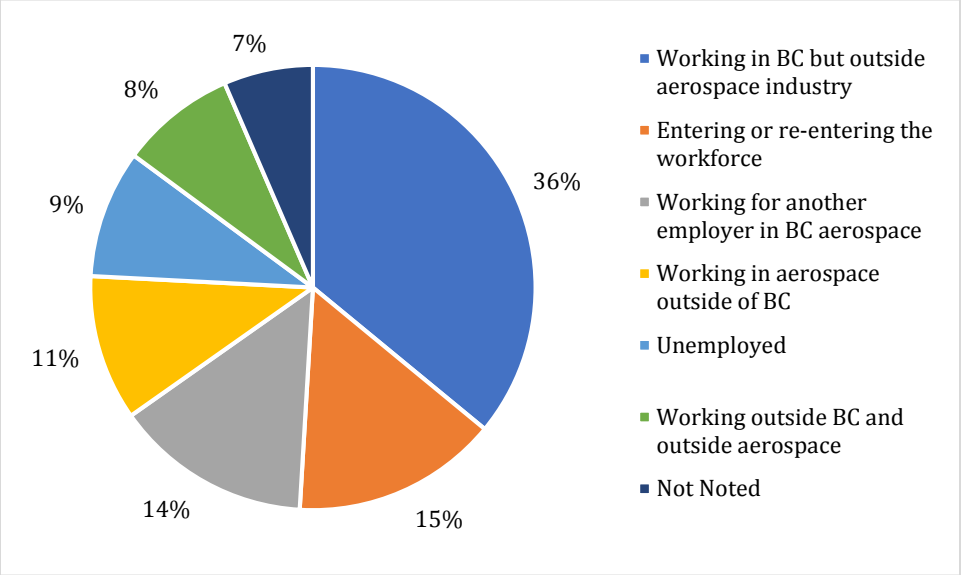
Number of People	Number
Number of Employers Reporting New Hires	91
Number of People Hired	742
Current Number of Employees Amongst Companies Reporting Hirings	5,175
Number Hired Per 100 Current Employees	14

Source of New Employees

Prior to the hiring, new employees were most commonly working for an aerospace employer outside of BC or working for an employer in BC but outside of the aerospace industry.

Source of New Employees
(n=91)

Question: Of these new employees that you hired, how many do you estimate were:



AMEs, Pilots and Engineers were commonly already working in the industry, while managers, admin, production, techs and data/IT were most commonly working in another sector.

Employers who have hired from outside the province were asked to specify for which positions they would be most likely to hire. Engineers (23% or 11 out of 48 employers) were specified as the most likely positions, followed by pilots (17%) and AMEs (13%), as shown in the table below.

Positions Most Likely to Hire from Outside BC

Question: For what positions were you most likely to hire from outside of BC?

Position	N	%
Total Respondents Hiring from Outside BC	**48**	**100%**
Engineers	11	23%
Pilots	8	17%
AMEs	6	13%
Technicians	4	8%
Administration/Management	4	8%
Machinists	3	6%
Aerospace Engineers	3	6%
Data/IT	3	6%
Apprentices	3	6%
Testers	3	6%
Tradespeople	2	4%
Consultants/Contractors	1	2%
Research and Development	1	2%
Any	1	2%

Position	N	%
None	6	13%

*Note: Because of the small sample size of employers in these sub-groups, the results should not be considered statistically significant (a margin of error over of about ±10% at a confidence level of 95%)

Employers who have hired from outside the industry were asked to specify for which positions they would be most likely to hire. Of the 60 employers that responded, 22% indicated that they would be most likely to hire administrative or management positions (e.g., administration, HR, senior management positions). As shown in the table below, production (13%), technicians (10%; e.g., mapping technologists, composite technical), and data/IT (10%) were also specified.

Positions Most Likely to Hire from Outside of the Aerospace Industry

Question: For what positions were you most likely to hire from outside of the aerospace industry?

Position	N	%
Respondents Hiring Outside of the Aerospace Industry	**60**	**100%**
Administration/Management	13	22%
Production	8	13%
Technicians	6	10%
Data/IT	6	10%
Machinists	5	8%
Engineers	4	7%
Most/Any	4	7%
Tradespeople	4	7%
Sales	3	5%
Contractors/Consultants	2	3%
Testers	1	2%
Research and Development	1	2%
None	1	2%

*Note: Because of the small sample size of employers in these sub-groups, the results should not be considered statistically significant (a margin of error over of about ±10% at a confidence level of 95%)

3.8. Employee Turnover

Level of Staff Turnover

The level of staff turnover (defined as the number of people employed in the past year who no longer work for the organization divided by the maximum number employed at any one time) varies across the firms. Of the employers that responded, almost half (45 or 43%) experienced a staff turnover rate of 0% to 5%. The simple average rate was 8.8%.

Level of Staff Turnover

Question: What was your organization's rate of staff turnover in BC last year (i.e., the number of employees who left your employment/company, were laid off, or terminated divided by the maximum number of people employed at any one time)?

Response	Number	Percentage
0% to 2%	35	34%
3% to 5%	10	10%

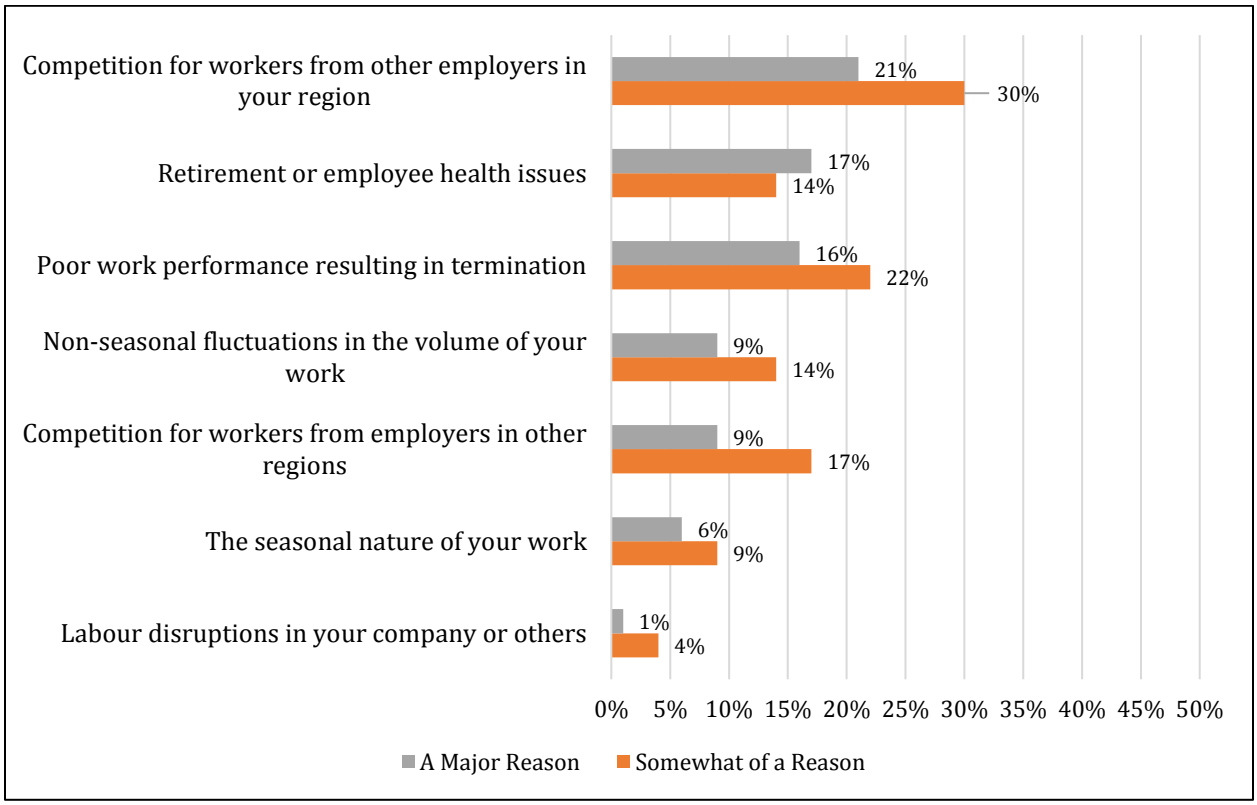
Response	Number	Percentage
6% to 10%	13	13%
11% to 15%	8	8%
16% to 20%	13	13%
21% to 30%	7	7%
31% to 40%	1	1%
Over 40%	1	1%
Not Sure	3	3%
Other (please specify)	0	0%
Not Noted	13	13%
Employers Responding	**104**	**100%**
Simple Average	**8.8**	
Weighted Average	**9.0**	

Factors Contributing to Turnover

The employers most commonly identified the major factors contributing to staff turnover to be competition for workers from other employers in their region (identified by 21% of employers), retirement or employee health issues (17%), poor work performance resulting in termination (16%), non-seasonal fluctuations in the volume of the work (9%), competition for workers from other employers in the region (9%), the seasonal nature of their work (6%) and labour disruptions in their company or others (1%).

Factors Contributing to Staff Turnover (n=70)

Question: Over the past year, to what extent did the following factors contribute to the level of staff turnover?



3.9 Projected Growth in Employment

Each employer was asked to estimate a range in terms of the number of people that they will employ in five years and also provide an estimate of the most likely number. The employers which have been operating for at least five years, on average, projected employment growth of 4.0% per year (based on the most likely estimates). Aggregate estimates of future growth ranged from a low of 0.5% annually to a high of 7.6%.

Most organizations are very optimistic about the potential for further employment growth, on average projecting that employment will increase by 4.4% annually over the next five years. Aggregate estimates of future growth ranged from a low of 0.7% annually to a high of 8.3% annually.

Estimates Regarding the Number of People to be Employed by the Organization in Five Years

Question: How many people will you employ in five years? Please provide a range in terms of lowest and highest expected numbers as well as your estimate of the most likely number.

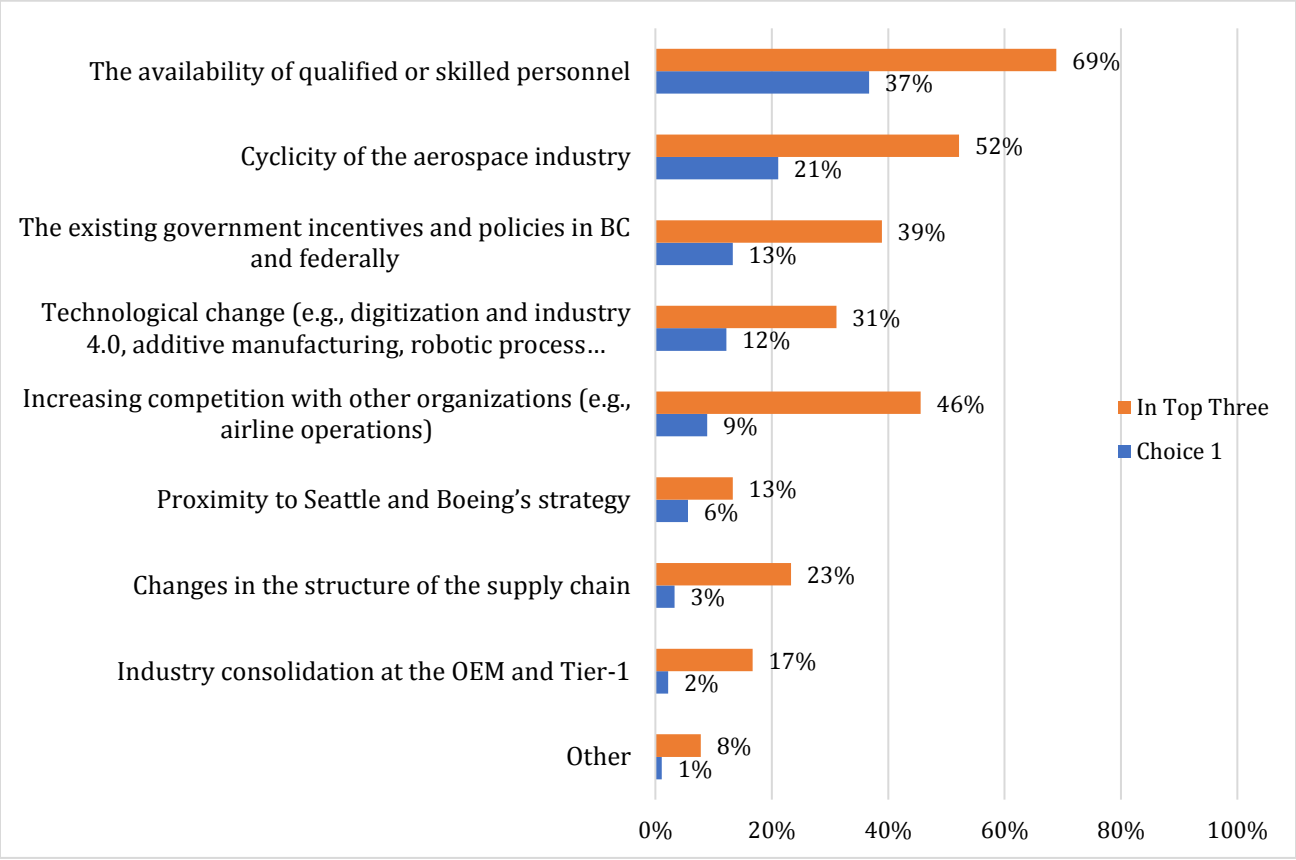
Most Likely Number of Employees in Five Years	Low		High		Most likely	
	Number	Percentage	Number	Percentage	Number	Percentage
1 to 10	258	5%	112	1%	161	2%
11-15	143	3%	171	2%	206	3%
16 to 30	544	10%	690	9%	573	9%
31 to 50	321	6%	765	10%	645	10%
51-100	355	6%	725	9%	357	5%
101-150	260	5%	115	1%	240	4%
151-250	560	10%	580	7%	855	13%
Over 250	3,030	55%	4,740	60%	3,545	54%
Total Employers Providing Estimates	**100**		**100**		**100**	
Projected Number in 5 Years	5,471		7,898		6,582	
Average Per Employer	54.7		78.9		65.8	
Current Employment Amongst the 100 Firms	5,295		5,295		5,295	
Projected Annual Growth	0.7%		8.3%		4.4%	

Ranking of Factors Affecting Future Growth

Employers were also asked to indicate up to three of the major factors that would drive future employment in the sector. The availability of qualified or skilled personnel was the most commonly identified factor (37%) identified it as the most important factor, and 69% identified qualified or skilled personnel as one of the top three factors.

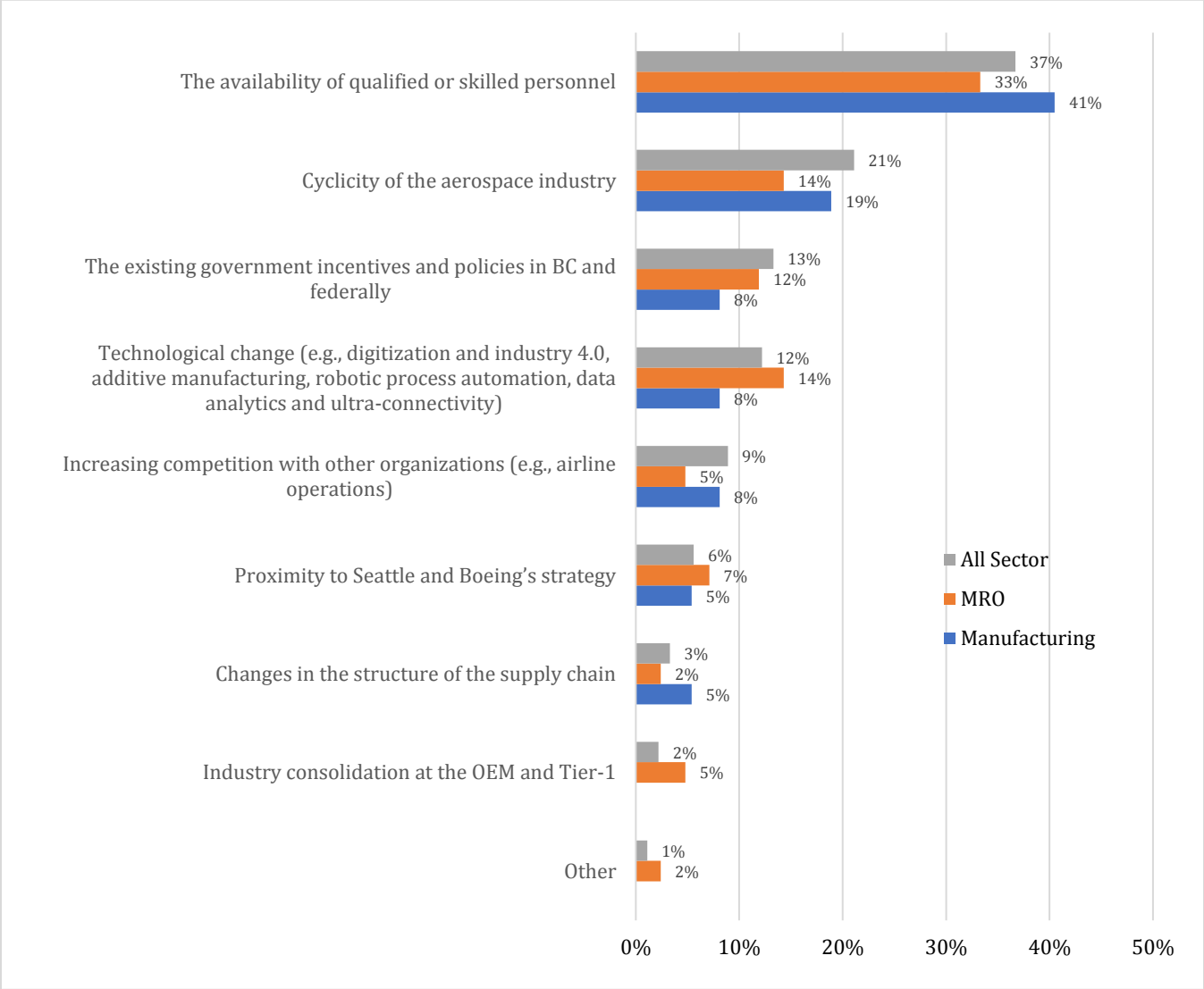
Factors Impacting Growth in Employment over the Next Three to Five Years (n=90)

Question: Which, if any, of the following broader industry developments do you think are most likely to have an impact on the number of employees that your organization will have in BC three to five years from today (please rank at least 3 factors)?



The following table compares the factors identified by employers in the MRO sector to those in the manufacturing sector.

Number One Factor Affecting Future Employment Across Sectors (n=90)



Impact of Federal and Provincial Government Incentives and Policies

When employers were asked about the how existing provincial and federal government incentives and policies will impact their operations, the most common responses included (the number of employers identifying each impact are in the parentheses):

- Current incentives have little to no impact on their operations (identified by 29 employers);
- They are not familiar enough with existing incentives and policies to comment (13 employers);
- Existing tax/SRED credits, grants and sources of government funding are critical to their operations (8 employers);
- Existing policies and incentives, particularly the ITB Policy, have a positive impact for their operations (e.g., help to increase business, helps move forward into certified markets, reduces risk in product development. regulations primary driver for clean tech) (6 employers);
- Existing Transport Canada regulations and/or proposed changes to those regulations negatively impact on their operations (3 employers);

- Existing taxes create challenges for their operations (3 employers); and
- Concerns about NAFTA and how the existing negotiations will turn out, while recognizing there is a need to update the regulations and cross-border policies (2 employers).

Other Factors

Some of the themes which came out of the survey in terms of factors affecting future growth included:

- Other regions, particularly Quebec and to a lesser extent Ontario, receive more significant support from their governments.
- The pressure for increased productivity and cost savings is increasing, causing companies to give greater consideration to options such as offshoring, automation, and vertical integration for larger cost savings.
- Competition is increasing. Globalization of the supply chain both increases inter-dependence and impacts on the competitive environment. Regionally, Asia is becoming a more significant player.
- The emergence of new technologies is still in a relatively early stage but is beginning to have a significant impact on the industry (e.g., digitization, industry 4.0, 3D printing and additive manufacturing, robotic process automation, data analytics and ultra-connectivity). Factors such as difficulties in technology adoptions and access to advanced materials may impact on the rate of growth.
- Future growth will be dependent on the rate of cluster development in the region and how well local industry responds to pressures for more efficient supply chain
- Factors such as the cost of living and doing business on the West Coast as well as oil prices could impact on the rate of growth

3.10 Labour and Skills Shortages

Expected Difficulties Filling Positions

Employers were asked whether they are planning to hire workers during the next three to five years and, if so, they anticipate it will be difficult to find good candidates. Ninety-five companies reported that they are planning to hire new workers, of which 63 (66%) expect that it will be very challenging to find workers for at least of their positions.

The positions which were expected to be the most difficult to fill included senior management (22%) and production managers or supervisors (14%) followed by aerospace engineers, pilots (rotary or fixed wing) and machinists (15%). The following table outlines the employer intentions to hire for each occupational category, and the anticipated difficulty in recruiting candidates with the right skills.

Expected Difficulties in Filling Positions

Question: If you are expecting to hire people to fill any of the following positions over the three to five years, how challenging do you anticipate it will be to find candidates with the skills and experience you need?

NOCs and Job Classifications	Not Planning to Hire	Not at all Challenging	Somewhat Challenging	Very Challenging	Not Noted	Total
	%	%	%	%	%	%
Administration (accounting, human resources, IT, and other administration)	27%	41%	25%	1%	5%	100%
0016 Senior Management	48%	7%	21%	22%	1%	100%
6221 ales and customer service	27%	18%	38%	7%	9%	100%
2271 Pilots (rotary or fixed wing)	57%	6%	5%	15%	17%	100%
2232 Other technologists or technicians	44%	10%	26%	7%	13%	100%
1215 Logistics (Distribution, tracking and scheduling)	41%	23%	22%	1%	13%	100%
Production managers or supervisors	31%	11%	34%	14%	12%	100%
7315 Aircraft maintenance engineer	44%	4%	19%	12%	21%	100%
2173 Software engineers and designers	54%	6%	13%	11%	17%	100%
7315 Aircraft engine or mechanical component technician	55%	5%	13%	5%	22%	100%
2146 Aerospace engineers	39%	6%	8%	14%	30%	100%
2171 Information system analysts and consultants	56%	8%	16%	1%	19%	100%
7231 Machinists (including CNC machinists)	43%	12%	12%	15%	19%	100%
2261 Non-destructive testing professionals	55%	7%	10%	5%	23%	100%
9536 Paint and finishers	54%	11%	11%	3%	22%	100%
2172 Data analysts	55%	5%	14%	1%	24%	100%
Total Respondents Indicating Plans to Hire	**95**					

Most Difficult Positions to Fill

The employers that anticipated difficulty finding appropriate candidates with the needed skills in the next three to five years were asked to identify the positions for which they anticipate it will be most difficult to find candidates with the necessary skills. The full list of occupations identified by surveyed employers is provided in the following table.

Most Difficult Positions to Fill

Question: Please specify the position(s) that you anticipate it will be most difficult to find appropriate candidates with the needed skills (specify up to 3 positions)

Position	N	%
Total Respondents Specifying Positions	**67**	**100%**
Management (e.g., project manager, production management, general manager)	21	31%
Engineers (e.g., program engineer, stress engineer, manufacturing engineer)	19	28%
AMEs	16	24%
Pilots	16	24%

Position	N	%
Tradespeople (e.g., welders, painters, fabricators)	13	19%
Sales (e.g., business strategist, sales, technical sales, marketing expert)	12	17%
Machinists (e.g., CNC machinist, manual machinist)	11	16%
Data/IT (e.g., analysts, CAD/CAM programmers, developers)	10	15%
Technicians (e.g., anodizing technicians, technicians	9	13%
Aerospace Engineers	8	11%
Designers/Drafters	6	9%
Testers (e.g., NDT, quality control)	6	9%
Production (e.g., supply chain, assembly technician, production staff)	6	9%
Mechanics (e.g., engine overhaul and repair tech, GTE mechanic, turbine engine technician)	3	5%
Logistics (e.g., shipping and receiving, logistics)	3	5%
Air Traffic Controllers	1	2%
Technical Writers	1	2%
Auditors	1	2%

*Note: Because of the small sample size of employers by position, the results should not be considered statistically significant (a margin of error over of about ±10% at a confidence level of 95%)

Factors Contributing to Difficulties

When the employers identified one or more positions as most difficult to fill, they were given a list of potential factors that could contribute to the difficulties associated with these positions and asked to identify which factors were relevant to their situation. The list of factors and the percentage of employers experiencing hiring difficulties who identified each is provided below.

- There are few applicants with the experience required (85%)
- There are few applicants with the education, training, or certifications required (82%)
- The available education and training does not make the workers job ready (58%)
- There is strong competition for these workers from other aerospace companies in our region (58%)
- There is limited interest in the sector or occupations amongst youth (55%)
- The education and/or experience of applicants does not transfer well to our type of operation (51%)
- There is strong competition for these workers from companies outside the aerospace industry (51%)
- Many of the skilled workers in this position are nearing retirement (49%)
- It is difficult to attract qualified applicants to our region from other areas (in BC, Canada, or internationally) (48%)

Factors commonly identified as constraining access to workers by position are summarized in the table on the following page.

Factors Attributed to Difficulties in Attracting Qualified Candidates

Question: To which (if any) of the following factors would you attribute your difficulties in attracting qualified candidates?

Employers Identifying Position As Difficult to Fill (N)		Not Job Ready	Experience	Graduates Credentials	Transferability	Sector Competition	Competition Other Sectors	Attraction	Aging	Youth Interest
		%	%	%	%	%	%	%	%	%
Management	21									
Engineers	19									
AMEs	16									
Pilots	16									
Tradespeople	13									
Sales	12									
Machinists	11									
Data/IT	10									
Technicians	9									
Production	6									
Aerospace Eng.	8									
Testers	6									

Legend: Percent of employers Identifying — Over 40% | 21-40% | 5-20% | 0%

*Note: Because of the small sample size of employers in these sub-groups, the results should not be considered statistically significant (a margin of error over of about ±10% at a confidence level of 95%)

Approximately half of the employers (51%) indicated that the education and experience do not transfer well to their operation. When asked to explain the issues, the most common responses were:

- Their operations require job specific or specialized skills (e.g. working with specific types of technology or aircraft) which the applicants would not have specifically been trained for or gained experience in the past (20 employers);
- The applicants, most often recent graduates, are simply not job ready (i.e. they do not have enough shop floor experience; they have underdeveloped manual, technical or soft skills, etc.) (18 employers);
- The applicants may have some of the skills that are needed but will need to develop a broader range of skills, gain more experience, be more versatile, and or be exposed to more facets of industry before they will be productive or able to meet the job requirements (6 employers); and
- The education programs are not providing enough real experience – there is a need for more applied skills training and increased co-op programs and on the shop floor training (4 employers).

Forty-eight percent identified difficulties in attracting qualified applicants to our region as a key factor. When asked to elaborate on the difficulties, the employers most commonly identified the:

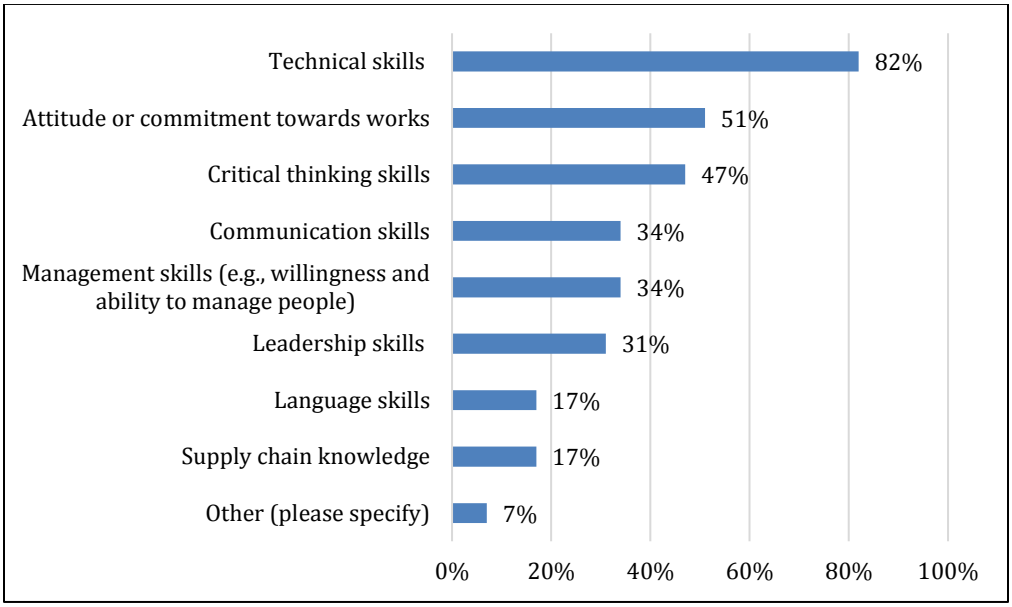
- High cost of living and more specifically housing, particularly in the Lower Mainland (identified by 32 employers);
- Location of the business, in terms of being in a smaller community and/or being a long distance from where the prospective applicants have grown up (9 employers);
- High level of competition for qualified candidates from employers in other regions (7 employers);
- The more limited numbers of aerospace employers in BC. Prospective employees perceive a higher level of risk associated with moving because there are few options if the first job does not work out (5 employers);
- Difficulties in creating awareness of the opportunity amongst possible candidates and finding qualified candidates (5 employers);
- High level of compensation that would need to be paid to entice to workers to move to BC (4 employers);
- Difficult nature of work (e.g., labour intensive, harsh environment) (3 employers); and
- Potential issues associated with finding work for spouses (2 employers).

Challenges Related to Applicant Skills

The types of skills shortages most commonly identified included technical skills, attitude, and critical thinking skills.

Challenges in Attracting Appropriate Candidates (n=90)

In terms of types of skills, would you say that the challenges in attracting appropriate candidates are most commonly in the areas of (select all that apply):



3.11 Participation in Education and Training

Involvement with Educators and Trainers

Employers in the aerospace sector are active with respect to education and training. Of the 89 employers that responded to questions about their involvement in education and training, 49% of companies hosted interns or coop students, 48% delivered group training seminars on site, 36% provided funding for multi-day technical training, 27% participated in program advisory or curriculum development committees, and 26% offered a formal mentoring program for newer workers.

Involvement in Training and Education

Question: We would like to find out about the involvement of your company with respect to training and education. Over the past year, has your company (select all that apply):

Response	Number	Percentage
Employers Responding	**89**	**100%**
Participated in a program advisory or curriculum development committee?	24	27%
Hosted interns or coop students?	44	49%
Provided funding for multi-day technical training taken by employees from outside sources?	32	36%
Offered a formal mentoring program for newer workers?	23	26%
Delivered group training seminars to your employees on site?	43	48%

However, educators reported a relatively weak relationship with industry and a shortage of coop/apprenticeship opportunities.

Expenditures on Training

On average, companies invested about 5% of revenues in training, education and professional development.

Expenditures on Training

Question: Over the past year, what percent of your revenues did your organization spend on employee training in BC?

Training Expenditures	Respondents	
	Number	%
Less than 1%	0	0%
1% to 3%	33	32%
Over 3% to 5%	21	21%
Over 5% to 10%	5	5%
Over 10%	7	7%
No employees to be trained	8	8%
Not noted/difficult to measure	30	28%
Employers Responding	**104**	**100%**
Simple Average	**5%**	

3.12 Actions to Address Skill or Labour Shortages

When asked which strategies or actions their organization was most likely to undertake in response to the current or projected skills shortages, employers most commonly cited expanding the amount of internal or informal training or mentoring provided to employees (66%), increasing their investment in formal or external training (48%), outsourcing certain functions or work (38%), increasing the wages and benefits paid to make the positions more attractive to candidates (38%) and hiring new or recent immigrants with the required skills (34%).

Likely Actions in Response to Skills Shortages

Which, if any, of the following strategies or actions is your organization most likely to undertake in response to these skills shortages? (select all that apply)

Strategies/Actions	Number	Percentage
Employers Responding	**89**	**100%**
Expand the amount of internal or informal training or mentoring provided to employees	59	66%
Increase our investment in formal or external training	43	48%
Outsource certain functions or work	34	38%
Increase the wages or benefits you pay to make positions more attractive to candidates	34	38%
Hire new or recent immigrants with the required skills	30	34%
More aggressively promote our job openings	27	30%
Increase our investment in equipment or technology to reduce labour requirements	24	27%

Strategies/Actions	Number	Percentage
Slow our rate of business growth	18	20%
Increase the amount of overtime worked by our employees	14	16%
Hire temporary foreign workers with the required skills	15	17%
Reduce our job requirements (in terms of education, experience, or certifications)	11	12%
Move certain functions or work to other regions within our organization	10	11%
Introduce or expand job sharing programs	4	5%

4.0 Major Findings Regarding Research Questions

This chapter draws from the findings of the roundtables, key informant interviews, literature review, and employer survey to address each of the research questions which were outlined in Chapter 1.

Question 1: What is the current size and composition of the BC aerospace industry workforce?

The major findings of the review regarding the current size and composition of the workforce in the aerospace industry are as follows:

The 200 aerospace organizations active in BC employ an estimated 8,924 people.

These projections exclude the major carriers, such Air Canada and WestJet, which have operations in BC. In developing an estimate of the total number of employees, we first refined a population list of employers in the sector. The population list was provided by AIAC Pacific, with some additions and deletions made based on input received during the course of the study. As noted in Chapter 1, the final population list included 200 companies.

For the purpose of projecting employment, the population list was divided into four categories:

- 104 employers who reported their level of employment in the survey. In total, 104 companies reported employment totalling 6,204.
- 31 employers who did not respond to the survey but for which we were able to obtain payroll data through a Freedom of Information Request with WorkSafeBC. WorkSafeBC provided us with payroll data on medium and larger employers (i.e. payroll of over $500,000) but suppressed the data for smaller employers. Amongst the 35 companies that were surveyed for which we obtained payroll data, the average payroll (from WorkSafeBC) per employee (as reported in the survey) was equal to $66,183. To estimate the number of people employed by organizations for which we had payroll data but were not surveyed, we divided the total payroll reported by them to WorkSafeBC by $66,183 (the standard deviation provides of a margin of error of ±19% at a 95% confidence)
- 6 employers which were not surveyed and not included in the WorkSafeBC but for which we obtained information from a secondary source (e.g. website or directory)
- 59 other small employers for which WorkSafeBC did not provide payroll data. For these employers, we assumed there were an average of 11 employees per organization, which is equal to the average number of employees per organization which were surveyed but for which WorkSafeBC suppressed the payroll data (the standard deviation provides of a margin of error of ±18% at a 95% confidence).

As indicated in the table below, the employers which were surveyed account for 52% of the estimated number of companies and 70% of the projected total employment in the industry. Most of the projected employment (92%) was confirmed through the survey and/or the WorkSafeBC data. Using the confidence intervals associated with each of the categories, the overall level of confidence associated with the projection is equal to ±5.5%, 19 times out of 20.

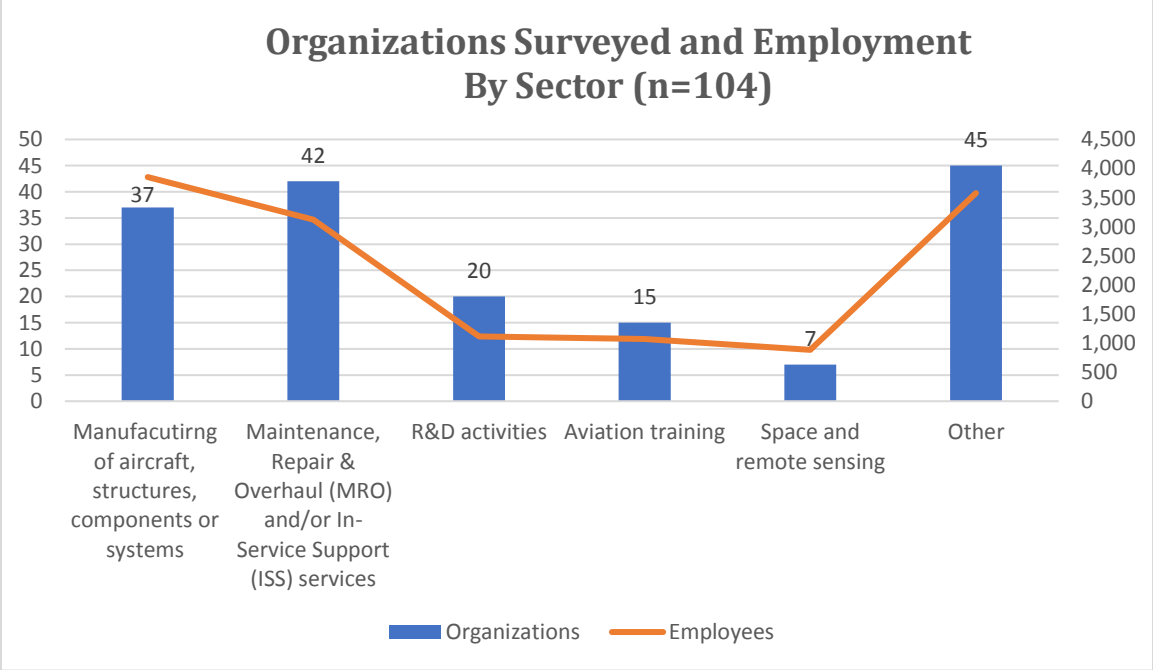
Projected Current Number of Employees in the BC Aerospace Industry

Categories	Employers	Percent	Employment	Percent
Data Reported By Employers in the Survey				
Surveyed Employers	104	52%	6,204	70%
Estimates for Employers That Did Not Participate				
Based on WorkSafeBC Figures	31	16%	1,951	22%
Secondary Sources	6	3%	120	1%
Projected Employment	59	29%	649	7%
Sub-total	96	48%	2,720	30%
Projected Total Employers and Employment	200	100%	8,924	100%

The manufacturing and the MRO/ISS segments account for the majority of employment in the BC aerospace industry.

Phase 1 of the BC Aerospace Sector LMP project defined five sub-sectors and the employers were asked whether they generated revenues from these sectors. On average, the employers indicated that they generated revenues from an average of 1.6 sectors. The industry in BC is active in segments across the value chain, with the greatest numbers of companies being involved in Aircraft Component Manufacturing, MRO-ISS Service, and Supporting Services segments.

As indicated in the table below, the sectors that were most commonly identified were manufacturing (identified by 37 employers) and MRO/ISS (identified by 42 employers). The aggregate number of employees reported by the 37 manufacturers of aircraft, structures, components and or systems totalled 3,853, while the level of employment reported by the MRO/ISS sector totalled 3,123.



Source: *Employer Survey. Note that employers can be active in more than one sector.*

There is overlap between the various sectors. About one-half of the manufacturers (18 of 37) also reported generating revenues from MRO/ISS. A majority of those who reported R&D activities were involved in space

& remote sensing and/or manufacturing. The other category included a wide variety of other types of operations of which the most prevalent were information technologies including hardware and/or software (10 employers), flight or cargo services (8 employers), machining, tooling or equipment treatment (6 employers), manufacturers of other types of equipment (5 employers), airport operations (3 employers), contracting agencies for staff (3 employers), distributors (2 employers), leasing (2 employers), and other professional services (4 employers related to consulting, engineering, environmental testing, training, or other aviation-related services).

BC aerospace consists of a highly diverse group of companies, which is reflected in a wide range of occupations within the industry. In general, the BC aerospace industry (as defined for the purposes of this study) does not account for the majority of the demand for workers in these occupations.

The results of the survey, analysis of secondary data and roundtables indicate that:

- The industry employs people in a wide variety of positions, most of which do not involve formal education or training that is targeted specifically at the aerospace industry. For example, some of the positions that were commonly identified in the industry survey included senior management, IT professionals, administration staff, logistics, sales and customer services, research and development, and various production positions such as machinists and technicians. The industry accounts for a small percentage of the total employment in BC in these occupations.

- The employers included in the scope of the study are not the only employers of workers in BC who have a formal education or training related to aerospace. More specifically, the scope of the survey did not include the major carriers who are also a significant employer of aerospace workers, such as pilots.

To illustrate this, the following table compares data obtained from the survey (extrapolated based on the 8,924 employees estimated to be employed by the 200 employers within the study scope) with occupational data obtained from the BC Labour Market Outlook. As indicated, the projections indicate that the BC aerospace industry accounts for most of the employment of aerospace engineers and aircraft or mechanical assemblers or inspectors in BC, about one-half of the AMEs, and relatively smaller percentages of other technologists or technicians, machinists (including CNC machinists), information system analysts and consultants, software engineers and designers, and data analysts.

Extent to Which the BC Aerospace Sector Employs Workers in the Target Occupations

Positions	Percent of Employees	Projected Number	Employed in BC	% in the Industry
Total Projected Employment	100%	8,924	--	--
Aircraft maintenance engineers (7315)	17.9%	1,597	3,578	45%
Aircraft or mechanical assemblers or inspectors (9521 and 9526)	8.9%	794	924	86%
Pilots (rotary or fixed wing) (2271)	8.2%	732	4,389	17%
Other technologists or technicians (2244) Mechanical engineering technologists and technicians (2232)	4.9%	437	3,215	14%
Machinists (including CNC machinists) (7231 and 9417)	4.4%	393	4,088	10%
Aerospace Engineers (2146)	3.6%	321	303	106%

Positions	Percent of Employees	Projected Number	Employed in BC	% in the Industry
Information system analysts and consultants (2171)	1.3%	116	17,240	1%
Software engineers and designers (2173)	1.2%	107	9,159	1%
Data analysts (2172)	0.3%	27	1,517	2%

Sources: Employer Survey and BC Labour Market Outlook, 2017-27.

Two implications of this analysis are that:

- The aerospace sector, as it was defined for this study, is not the primary driver of demand for training and education in BC in most of these occupations; and
- The industry has to compete directly for workers with employers in other sectors as well as in other related industries sectors such as the major carriers. This point was reinforced in the roundtables and will be further discussed under Question 4.

It should also be noted that BC's share of the national total of workers varies significantly across these occupations. For example, whereas BC accounts for over 20% of the AMEs (there are about 16,000 aerospace maintenance engineers in Canada) and 14% of pilots (there are over 30,000 pilots in Canada), BC accounts for less than 1% of NOC 7315 (which includes aerospace engineers).

Question 2: How is the industry forecast to grow and expand?

The major findings of the review regarding the outlook for the industry are as follows:

Employment in the BC aerospace industry has been increasing as a result of both growth in existing employers and the continuing establishment of new businesses.

The results of the survey indicate that:

- 84% of employers were operating five years ago. On average, these organizations indicated that their number of employees has increased from 67.0 people to 72.9 over the past five years (equal to an average annual growth 1.7%). The growth was driven primarily from an increase in the volume of goods or services being delivered (identified by 80% of employers with increased employment), followed by having broadened or changed the range of products or services provided (73%) and vertically integrated operations (20%).

- 16% of the companies indicated that they have been established in the past five years. On average, these new companies reported having 18 employees. The organizations reported revenues from a variety of sub-sectors in the industry, of which manufacturing and space were identified most frequently.

Most organizations project that employment growth will continue. Employers are projecting that employment will increase between 0.7% and 8.3% annually with the most likely figure average being 4.4% annually over the next five years.

Each employer was asked to estimate a range in terms of the specific number of people (a low estimate and a high estimate) that they expect to employ in five years and also provide an estimate of the most likely number. The employers which have been operating for at least five years, on average, projected employment growth of 4.0% per year (based on the most likely estimates). Aggregate estimates of future growth ranged

from 0.5% annually at the low end to 7.6% at the upper end.

Under the low, most likely and high growth estimates provided by all the employers, employment would increase to 9,241 and 13,295 over the next five years, with the most likely figures providing for an estimate of 11,068.

Potential Future Level of Employment Based on Employer Projections

Employer Projections		Employment in 2022	Employment in 2027
Current Employment	8,924	--	--
Low Estimate	0.7%	9,241	9,569
High Estimate	8.3%	13,295	19,808
Employer Most Likely	4.4%	11,068	13,727

The positive outlook for growth was attributed largely to the strength of the aerospace industry overall, as well as some competitive strengths on which the BC industry can build.

The outlook for the industry internationally is generally positive. Demand for aerospace related products and services is driven by a variety of inter-related factors such as:

- Increasing demand for air travel as both the world urban population and the size of the global middle class increases.
- Projected growth in the size of the fleets. The in-service commercial airline fleet is forecast to grow from nearly 25,000 aircraft at the beginning of 2017 to over 35,000 by 2027.
- The demand for new generation aircraft. ICF predicts that in the next decade, the fleet of new generation aircraft fleet will grow by approximately 530% to nearly 19,000 aircraft globally, and by around 400% in North America. By 2027, 58% of the fleet will be new-generation aircraft (designed and built after 2000).19

The demand for MRO services, for commercial airlines, is projected to grow at a rate of 3.8% annually from 2017 to 2027.[20] The BC industry has a strong base of capabilities on which the industry can grow, particularly with respect to MRO and selected areas within manufacturing, as well as space and remote sensing. The region can also benefit from its proximity to the rapidly growing airline market in Asia Pacific and China, as well as to Boeing's operations in Washington State.

The rate of growth will also be impacted by the extent to which the aerospace cluster is identified as a priority for development by the federal and provincial government. As noted in Chapter 2, government has a history of providing some support to the industry. Participants in the roundtables stressed the importance of continuing government support for the region with respect to marketing the capabilities of the industry, investments and incentives for research and development, support for commercializing new technology, products and services, further development of supply chains, support for cluster development, assistance in capturing the benefits under the Industrial and Technological Policy, and assistance in addressing

19 MRO Market Update and Industry Trends, Presentation by Jonathan M. Berger, ICF, MRO Latin America Conference, January 25-26, 2017, Cancun, Mexico.

20 Oliver Wyman, 2017 – 2027 Fleet & MRO Forecast, http://www.oliverwyman.com/our-expertise/insights/2017/feb/2017-2027-fleet-mro-forecast.html

constraints to development in areas such as access to skilled workers, regulations and trade issues. Some concern was expressed in the roundtables and interviews that other regions (e.g., Ontario and Quebec) in Canada were receiving more significant support for development than is British Columbia,

The ability of employers to respond and evolve to changing industry conditions will have a major impact on the future growth of the industry. While the nature and structure of the aerospace industry is undergoing significant change, it was also stressed that some elements of the industry change relatively slowly because of long operating lives of legacy aircraft.

The aerospace industry is undergoing a period of unprecedented change in areas with respect to:

- The introduction of advanced materials (such as carbon fiber composites, hybrid alloys, and special coatings), additive manufacturing, 3D printing, and Industry 4.0. Significant advancements are being made in terms of corrosion resistance, strength, hardness, material usage, fuel-efficiency and speed to market. Digitization is impacting on business models and leading to the development of new products and services. The industry is dealing with the challenge of balancing cyber security and ultra-connectivity.

- The regional distribution of the industry (e.g., expansion of manufacturing capacity in regions such as China, Japan, and Russia).

- The supply chain. The manufacturing sector has been moving from a vertical integration model to more of a component assembly model. This model requires changes to manufacturing and the capabilities of the supply chain (e.g., level of collaboration, use of common business data structures, and quality assurance). There is also ongoing consolidation in manufacturing by part family (components, aero-structures, electronics, interiors, etc.) which is driven by an increased focus on gaining economies of scale as the effects of continued demand for lower airfares go through the value chain. Globalization of the supply chain has also led to the creation of large MRO hubs across the world.

- Emphasis on cost containment and productivity. Strategies such as robotic process automation, offshoring, increased consolidation and economies of scale, and further supply chain integration are being used to achieve cost savings.

- Increasing use of more stringent specifications from purchasers of the products and services.

The general perception in the roundtables was that the rate of change tends to be much higher in the space and remote sensing sector and, to a somewhat lesser extent, in the manufacturing sector than in the MRO sector. Nevertheless, the MRO industry will need to evolve significantly over the next decade in response to growing demand, change in regional distribution and fleet mix, and the introduction of new technology in areas such as diagnostics, digitization, automation, data analytics and ultra-connectivity. At the same time, the industry must continue to service legacy aircraft.

The availability of qualified or skilled personnel was the factor most commonly identified as impacting on the ability of the industry to achieve its full potential for growth.

Of the employers surveyed, 37% identified the availability of qualified or skilled personnel as the most important factor while 69% identified it as one of the three many factors. Other factors that were commonly cited included the cyclical nature of the aerospace industry (i.e., the potential for an economic downturn in the next five years, which was identified by 21% of employers) and increasing competition with other

organizations (identified by 9% of employers). While recognizing these issues, most employers participating in the roundtables believed that they would, at most, serve as a drag on growth but that the industry would still continue to grow.

Question 3: Which occupations and skills are most in demand (current and anticipated)? Which shortages present the greatest challenges or threats to the industry?

The major findings of the review regarding the occupations and skills that are most in demand as well as the shortages which present the greatest challenges or threats to the industry, are as follows:

Reflecting the broad diversity of the industry, the companies identified a wide variety of occupations as being in demand and challenging to fill.

Of the companies that were surveyed, 56% identified one or more positions as being very challenging to fill. Occupations which were perceived to be the most difficult to recruit included senior management (22%), production managers or supervisors (14%), as well as aerospace engineers, pilots (rotary or fixed wing) and machinists (including CNC machinists) (15%). The following table outlines the employer intentions to hire for each occupational category, and the anticipated difficulty in recruiting candidates with the right skills.

When discussing major threats and challenges, the roundtable discussions focused most heavily on the four areas: the challenges in attracting, developing and retaining pilots, AMEs, and aerospace engineers as well as the growing need for employees with the skills required to work with emerging technologies and advanced materials.

Pilots

The shortage of pilots is not limited to British Columbia. Rather, pilot shortages have been reported across Canada, in the United States and internationally. A report by the Canadian Council for Aviation and Aerospace (CCAA) indicates that Canada needs to produce 300 pilots per year to meet increasing demand and replace retiring pilots (approximately 1,000 pilots are trained each year in Canada, including foreign students who may not stay and work in Canada after graduation). Furthermore, the CCAA report concludes there could be a shortage of 6,000 pilots in Canada by 2036. [21] The Boeing Pilot Outlook predicts a need for 117,000 new pilots in North America and 637,000 worldwide between 2017 and 2036 alone.[22] Australia has recently eased its working visa requirements to facilitate the attraction of foreign pilots.[23] A variety of factors were identified in the roundtables as contributing to the shortage in BC, including:

- The rate of new pilot hires by the major carriers. Even when they are able to match or offer superior salaries in the short-term, other employers have difficulties competing against the major carriers because of the benefits they can offer (e.g. air travel) and expectations of greater income, job security (based on seniority) and opportunities for advancement over the longer-term. The strong demand

21 CBC News, Who's going to fly the plane? Pilot shortage could get worse for regional carriers, http://www.cbc.ca/news/business/pilot-shortage-bearskin-air-georgian-super-t-1.4451976
22 Boeing Pilot Outlook 2017, http://www.boeing.com/commercial/market/pilot-technician-outlook/2017-pilot-outlook/
23 The Guardian, Pilot shortage: Australia to relax visa laws to attract foreign flyers, https://www.theguardian.com/australia-news/2017/dec/28/pilot-shortage-australia-to-relax-visa-laws-to-attract-foreign-flyers

from the major carriers has meant that, over time, they are hiring less experienced pilots than they did in the past. It was suggested that, in the 1990s, pilots may have needed more than 5,000 flying hours before they would be considered by a major carrier. Recent job postings at WestJet Encore required only 1,000 hours. Pilots often gain experience with smaller employers, schools and regional carriers before moving on. The implication of the major carriers hiring pilots with less experience is that they now stay with the smaller employers for much shorter periods of time than they did in the past. For example, one employer participating in the roundtable indicated that the length of time they can typically retain a new pilot has declined from three years to about one year.

- The high six-figure cost of pilot training combined with the limited level of student loans and grants available from government. It was noted that in some other jurisdictions, such as Alberta, student pilots have much greater access to student loans and other support than those in BC.
- A shortage of instructors, as a result of the strong demand for pilots. In the past, serving as an instructor was a common way through which pilots gained further flight experience.

Demand could also be impacted by new federal regulations around pilot fatigue, which could increase the demand for pilots. Over the longer-term, the demand could also be impacted by technological change which may reduce requirements for pilot (i.e., few pilots per plane and, over time, the introduction of pilotless planes).

AMEs

Aircraft maintenance engineers are a core occupation for MRO operations. Roundtable participants identified a variety of challenges associated with recruiting, developing and retaining AMEs including:

- The aging of the existing workforce. As of 2015, 61% of aircraft assemblers and inspectors and 50% of aircraft mechanics and inspectors were between the ages of 45 and 64.[24] According to the Transport Canada licensing department, 46 per cent of aircraft mechanics are between the ages of 50 and 79 years old.[25] As the workforce ages, it has also become more difficult for employers to fill senior positions with Transport Canada approved staff members.

- Difficulties in recruiting new participants into AME programs. Factors which were identified as contributing to these difficulties include the low profile of the occupation (in comparison to other occupations, including many other trades, few youth have an understanding of what an AME is or does – one roundtable participant referred to it as an "invisible occupation") and strong competition from other trades. It was noted that schools have to promote the AME courses aggressively to fill the classes, while some other programs - such as electrical - have waiting lists. It was also suggested that few youth today grow up working on engines or other equipment and therefore tend to develop less interest, aptitude and skills which are relevant to occupations such as AME.

- The cycle time in terms of the length of the training, combined with front-end loaded nature of the training, which makes it more difficult for the industry with respect to responding to short-term changes in demand.

- The importance of onsite training and experience. Becoming certified is just the first step in the process of becoming a productive worker. Employers must invest in training AMEs related to the aircraft on which they focus, the nature of their operation, and the employee's specific roles and

24 BC Labour Market Outlook 2017-27
25 Global News, Canada faces impending shortage of aircraft mechanics and pilots, https://globalnews.ca/news/3111765/canada-faces-impending-shortage-of-aircraft-mechanics-and-pilots/

responsibilities. It was noted in the roundtables that it can take an AME 10 years to become fully productive. As the industry grows and experienced workers retire, it is becoming more and more difficult to find experienced workers in each of the AME classifications (M1, M2, S and E).

- Strong price competition and the emphasis of carriers on reducing costs has resulted in tighter margins, which impacts on the wages paid not just in BC but across the industry (MRO operations must complete globally). Major carriers may push for year-over-year reductions in costs and some are pursuing vertical integration strategies, as an option to outsourcing, to achieve further cost savings. In a recent Oliver Wyman industry survey, 51% of airlines and MRO industry executives identified wages and benefits as an issue for the MRO sector. The Aviation Technician Education Council (ATEC) estimates that 30% of those who finish an aviation maintenance training course end up accepting employment in another industry.[26] Participants in the roundtables also provided examples where AME workers were motivated by wage and other workplace issues to move on to other occupations, trades and industries.

Technician shortages are projected throughout most regions. According to Boeing, between 2017 and 2036, the Asia Pacific region will require 256,000 new technicians, North America will require 118,000, and Europe will require 111,000.[27] By 2027, it is forecasted that US demand for maintenance technicians will exceed supply by 9%.

Aerospace Engineers

Although the number of aerospace engineers in BC is relatively small compared to pilots and MRO technicians, the engineers play a significant role in the development of the industry particularly in the space and manufacturing segments. The Labour Force Survey indicates that there are about 300 aerospace engineers in BC. [28] It was noted during the roundtables that the importance of aerospace engineers to the industry will increase over time with the continued introduction of new generation aircraft, increasing rates of automation and the continuing adoption of new technologies, products and processes such as the Internet of Things/ultra-connectivity, additive manufacturing, 3D printing, and Industry 4.0.

The lack of an aerospace engineering program in BC puts the provincial industry at a disadvantage related to the development and adoption of new products and processes. While the province produces other types of engineers, there are no bridging programs in place to give those engineers a grounding in the aerospace industry. The ability of the local employers to attract recent graduates or established aerospace engineers from other regions is constrained by the strong demand for those workers and factors such as the high cost of housing in BC. In one of the roundtables, an employer indicated that they had been recruiting for anaeronautics engineer for three months and had only one qualified applicant; even then, they were unable to provide a strong enough offer to entice the person to move up from the United States. Some preliminary discussions have been held with the University of Victoria about establishing an aeronautical engineering program there.

Skills Required to Work with Emerging Technologies and Advanced Materials

Employers also highlighted the challenges associated with ensuring they will have access to the skills required to work with emerging technologies and advanced materials. The impact of these new technologies

26 Oliver Wyman, MRO Survey 2017: When Growth Outpaces Capacity, http://www.oliverwyman.com/our-expertise/insights/2017/apr/mro-survey-2017.html
27 Boeing Technician Outlook: 2017 – 2036, http://www.boeing.com/commercial/market/pilot-technician-outlook/2017-technician-outlook/#/quick-facts
28 BC Labour Market Outlook 2017-27

will be more immediate in the manufacturing and space segments. However, even in the MRO segment, the industry will be impacted by developments such as further introduction of technologically advanced diagnostics, composite material repair and manufacture, collection and reporting of data for advanced analytics, big data, and predictive maintenance; and advanced avionics and electrical systems. At the same time, the MRO segment will also continue to need workers who are experienced in working with less digitally sophisticated technology and legacy airplanes.

Employers recognized challenges associated with both:

1. Attracting new workers with the types of skills sets required. Employers highlighted the importance of competing effectively against other industries in attracting skills in areas such programming, software engineering, systems architecture, advanced data analytics, robotics, mechatronics, artificial intelligence, digitalization, materials development, and advanced materials.

2. Facilitating access to training that will enable existing workers to upgrade, update and build on their existing skill sets. In the absence of industry-wide upgrading programs, this training has been the responsibility of individual employers. Larger employers, such as the Vancouver Airport Authority, are in a better position to monitor technology changes and prepare to reskill and retool their workforce in response to technological advances. When asked which strategies or actions their organization was most likely to undertake in response to the current or projected skills shortages, employers surveyed most commonly cited expanding the amount of internal or informal training or mentoring provided to employees and increasing their investment in formal or external training.

Technical skills were the type of skills most commonly identified by the employers as being in short supply.

Eighty-two percent of employers identified shortages in terms of technical skills. Other commonly identified skills areas where shortages exist included attitude or commitment towards works (71%), critical thinking skills (47%), communication skills (34%), management skills (34%), and leadership skills (31%).

Question 4: What are the critical impediments to attracting and retaining in-demand skills and occupations?

The major themes that came out of the roundtables, interviews and survey with employers regarding critical impediments to attracting and retaining in-demand occupations included:

- Strong competition for workers within the industry and with other industries;
- Aging of the existing workforce;
- Perceptions of the industry (low awareness and appreciation of opportunities in the industry, particularly amongst youth);
- Limited success in attracting and retaining millennials;
- Constraints to attracting workers from other regions;
- Difficulties in retaining workers in the industry during economic downturns;
- Limited use of economic immigration and temporary worker programs;
- Concerns regarding the ability of the industry to respond to changing technologies;
- Absence of a coordinated labour market and industry development strategies; and
- Low levels of gender diversity.

These themes are further described in the following paragraphs.

Strong Competition for Workers

Employers reported strong competition for workers from other employers in the aerospace industry in BC, aerospace employers in other regions, and other industries. The December 2017 unemployment rate of 5.7% in Canada is the lowest on record (since the current methodology was adopted in 1976) and, at 4.6%, the unemployment rate in BC is even lower. The unemployment rate in BC declined by 1.2% over the past 12 months, indicating that market conditions have continued to tighten.

As a result of the tight labour market conditions, it has been common for employers to hire workers away from other employers in the industry. As noted earlier, there is an ongoing flow of pilots drawn away from smaller employers to the larger employers (e.g., major carriers). To a lesser extent, the same pattern exists in the MRO sector. The employers surveyed estimated that over one-quarter of their new hires were working with another employer in the aerospace industry at the time they were hired, while one-third were working in BC but outside of the aerospace industry. Similarly, about 30% of the employers identified strong competition for workers from other employers as a major factor contributing to employee turnover within their organization. Fifty-seven percent of employers identified strong competition for workers from other aerospace companies in the region while 48% identified strong competition from outside the aerospace industry as contributing to their difficulties in attracting good candidates with the required skills. Globalization of the supply chains in the manufacturing and MRO segments, combined with international labour shortages, have contributed to the increased competition.

Aging of the Existing Workforce

Cyclical downturns in the industry have contributed to periodic losses of younger workers in the industry, and has resulted in a workforce which is, on average, significantly older than the workforce in BC overall. Whereas 39.7% of the workforce in BC was aged 45 to 64 in 2015, 61% of aircraft assemblers and inspectors, 50% of aircraft mechanics and inspectors, 48% of pilots and 44% of aircraft instrument, electrical and avionics mechanics, techs and inspectors were between the ages of 45 and 64.[29] Forty-six percent of employers identified aging of the workforce as contributing to their difficulties in attracting good candidates with the required skills.

Some of the older workers have joined the "gig economy", working with contract employers to meet the temporary and on-going needs of employers. Contract employers were identified as a potential growth area within the industry and a means through which employers can address temporary shortages. Some workers, both older and younger, express a preference for contract work because it enables them to work part of the time, not make longer-term commitments, and experience more variety in the types of work they do.

Low Awareness or Negative Perceptions of the Industry

Previous generations viewed the aerospace industry as being on the leading edge and a very desirable place to work. Even though elements of the industry remain very much on the leading-edge technologically, the industry does not have the same allure that it once did. When asked about the perception of the industry amongst potential labour markets entrants, employers noted that:

- ICT industries, from gaming to social media, as well as other growing or emerging industries, have tended to displace older industries, including aerospace, as the place to work. As the unemployment rate declines, an increasing number of industries and education programs are competing for the same pool of bright, young students.

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- As a heavily regulated industry, aerospace is perceived as a difficult industry to enter. Significant upfront training is required, which can be time-consuming, costly and difficult to finance. Compensation for entry level positions may not be competitive with that of some other alternatives.

- The industry tends to be highly cyclical, which can greatly increase employment risk particularly for the more junior, recent labour market entrants. The industry tends to be more cyclical amongst manufacturers than MROs, particularly OEMs and Tier 1 suppliers.

- The industry is not well understood by prospective entrants. Much of the industry's activities are not visible to the general public. Although there are some exceptions, the industry has not been very active in developing linkages with the secondary school system or in opening its doors to showcase its operations to potential future workers. A common suggestion was for employers to work together to promote the industry. A roundtable participant noted work that had been done in the Langley area to build relationships with 40 to 50 schools to generate youth interest in the industry; prior to that initiative, there had been no information provided to schools in the region regarding opportunities in aerospace and aviation.

- Some elements of the industry tend to be very hands-on and labour intensive, which may not appeal to younger workers.

It was noted during one of the roundtables that the Air Cadets program, which historically has helped to feed youth into the industry, continues to attract youth participants. However, it appears that few of the participants continue on into aerospace, choosing instead to move into other streams of education and eventually into other industries. There may be opportunities to better link with Air Cadets with industry, as a means to attract future workers.

Limited Success in Attracting and Retaining Millennials

Most industries and employers are struggling with how to attract and retain the millennial generation (people born between 1980 and 2000). By 2020, millennials will account for about one-half the workforce in North America. They are the first generation to reach the workforce with a better understanding of a vital technology (e.g. social media and communication tools) than more senior workers.

The general consensus in the roundtables is that the BC aerospace industry has not been providing millennials with the types of opportunities and support they are looking for in their careers. In some respects, millennials are very similar to previous generations. However, in some respects they are clearly not. In particular, research indicates that millennials tend to be less loyal to their employers and much more willing to consider changes in employers and careers than previous generations.[30] A recent survey of 7,700 millennials by Deloitte found that two-in-three millennials worldwide (61% in Canada) expect to change employers in the next three to four years, and more than one-in-four would do so in the next year if given the choice. This is not a function of their current position or level of responsibility; the likelihood of leaving was nearly as high for millennials who are in management positions (57% expect to leave) as those in more junior positions.

The dissatisfaction of millennials with their current employment situation is found primarily in their opportunities for further development. In the Deloitte survey, 63% felt that their leadership skills were not being fully developed and only 28% felt that their organizations were making full use of the skills they have to offer. In a similar survey of 4,364 millennials conducted by PWC, 52% identified opportunities for career

30 Deloitte, The 2016 Deloitte Millennial Survey

progression as the leading factor that make an organization an attractive employer.[31]

Millennials tend to be less tolerant of rigid corporate structures and more desiring of flexible approaches to work. Research indicates that there is a strong correlation between the likelihood a millennial will stay with an employer and the extent to which:

- The values of the organization align well with the personal values of the employee;
- The employer is committed to the development of the millennial;
- The employee feels that he or she is in control of his or her career; and
- There is open and free flowing communication.[32]

It should also be noted that, while millennials place a high priority on values, personal development and work-life balance, most also strive for financial security and want to own their own home. In the Deloitte study, pay and other financial benefits are the single most important factor in the initial decision to work for an employer. In the PWC study, the opportunity for personal development was the leading factor.

The Deloitte study also identified particular aspects of employment that were a high priority to millennials and those that were a lower priority. The study did the same for employers. The results are grouped into four quadrants depending on whether the aspect was identified as a high priority by both millennials and employers (upper right quadrant), for neither (bottom left quadrant), and for one but not the other. The shaded upper left quadrant identifies the aspects identified as a higher priority by millennials but a lower priority by employers (i.e. there is a mismatch in priorities).

Comparison of the Priorities of Millennials and Employers

Priority for Millennials	Priority for Employers: Lower	Priority for Employers: Higher
Higher	• Providing a good income for employees • Being the best possible place to work • Improving the skills of our workforce • Providing services/good that make a difference to people lives • Generating and supporting jobs	• Being as efficient as possible • Ensuring the long-term future of our company/organization • Continuous improvement/increasing knowledge in our areas of activity • Making the best possible product/being the best business in our areas of activity
Lower	• Making a positive contribution to the local communities/society • Collaborating with other organizations to create new ideas/better solutions • Improving and protecting the environment	• Making money/maximizing profit • Growth of the businesses/becoming bigger (e.g. entering new markets) • Being well-known/increasing our public profile • Creating wealth/contributing to economic growth

Some strategies that have been used in other industries to attract and retain millennials include:

- Having someone act as their mentor, providing advice and demonstrating the employer's commitment to their development (mentorships are still not used extensively in Canada);
- Offering flexible working conditions including the opportunity to work remotely;
- Establishing reward strategies that more closely align with what motivates millennials (e.g., the

31 PWC, Millennials At Work: Reshaping the Workplace
32 Deloitte, The 2016 Deloitte Millennial Survey

opportunities for personal development and improved work/life balance); and
- Providing regular feedback on an on-going basis.

Pratt & Whitney, a company from outside the region that was interviewed as a key informant, has launched a program called UTFlex to attract and retain young professionals. The program offers options such as flexible hours, shorter work weeks, teleworking, and longer initial vacation periods.

Constraints to Attracting Workers from Other Regions

Some of the factors identified by employers as constraining the ability of BC aerospace employers to attract workers from other regions include the high cost of living (and particularly the cost of housing in the Lower Mainland); the smaller size of some of the communities in which operations are based; the availability of suitable employment for spouses; the cyclical nature of the industry; the prevalence of similar skills shortages in other regions (i.e., competing opportunities for employment); and the extent to which wages paid in the industry may be sufficient to attract workers from other regions.

Ability to Retain Workers During Economic Downturns

In the roundtables, participants noted that the cyclical downturns experienced by the industry not only impact its financial strength but has also tended to result in the loss of junior staff members to other occupations, industries and regions. It was suggested that the industry needs to get much better at working together to develop strategies (such as staff pooling or temporary placements) that will help to help retain those workers in the industry (provide an easier path through which workers laid off at one employers can transfer to another employer). One suggestion was the use of a reverse recruiting program, which would provide a platform to connect workers that are being laid off with other employers in the industry.

Limited Use of Economic Immigration and Temporary Worker Programs

Skilled immigrants form an important part of Canada's labour supply and will become increasingly important as the population ages. In 2014, immigrants accounted for 22 percent of working-age (25 to 64 years old) Canadians, a share that has been increasing over the past 15 years.[33] Economic immigrants account for over 60% of permanent immigrants arriving to Canada (IRCC Facts and Figures). Four categories of economic immigrants are potentially relevant to the BC aerospace industry:

- Federal Skilled Workers (FSW), which is an economic class under which skilled workers can apply to become permanent residents in Canada on the basis of their ability to become economically established in Canada. Applicants are assessed based on selection factors including language skills, education, work experience, age, existence of a job offer and adaptability.

- Canadian Experience Class (CEC), which is a permanent resident category for those individuals who have skilled work experience in Canada. It targets temporary workers and foreign graduates with qualifying Canadian work experience.

- The Provincial Nominee economic class, under which provinces enter into bilateral agreements with the federal government which allows them to nominate individuals for permanent residence based on their economic and other (community) needs. Under its Skills Immigration Stream, the Government of BC accepts applications for high-skilled positions at NOC levels 0, A and B. Some of the requirements include two years of directly related work experience and a full-time job offer of

33 Government of Canada. Budget 2014. http://www.budget.gc.ca/2014/docs/jobs-emplois/pdf/jobs-emplois-eng.pdf

indeterminate length from an eligible BC employer for an in-demand NOC 0, A or B occupation for which the applicant is qualified.

- The Federal Skilled Trades Program, which is a pilot program that allows individuals who want to become permanent residents of Canada based on their qualification in skilled trades. The pilot started in 2012.

In a typical year, approximately 20,000 to 25,000 permanent residents immigrate to BC under the economic immigration programs. Beginning in January 2015, applicants under the FSWP, FSTP, CEC and a portion of PNP nominations must be processed through the Express Entry, a new electronic application management system developed for Canada's key economic immigration programs.[34] Under this system, applicants are invited to complete a profile on which they are ranked against others in a pool. Following that, only those that receive an 'Invitation to Apply' from IRCC are able to apply. The Express Entry is based on a scoring mechanism, the Comprehensive Ranking System (CRS), tied to predictors of economic success. This system rewards migrants who are likely to achieve high employment earnings based on their profile (age, language skills, education, etc.) or who have a Labour Market Impact Assessment (LMIA) job offer from a Canadian employer.

In addition to these programs, the Temporary Foreign Worker Program (TFWP) allows BC employers to seek foreign nationals to fill temporary labour and skill shortages in cases where qualified Canadian citizens or permanent residents are not available. In 2015, there were nearly 50,000 International Mobility Permit holders in BC.

Some countries, such as Australia, have used their immigration and temporary foreign worker programs effectively to ease some of the labour shortages in the aerospace industry. In the survey, BC aerospace employers reported only employing only 27 Temporary Foreign Workers and 88 workers who had immigrated to Canada in the past five years. In one of the roundtables, it was suggested that the industry has not been effective to date in demonstrating that there are shortages in key occupations such as pilots, AMEs, and aerospace engineers.

Ability to Respond to Changing Technologies

The rate of technological change in the aerospace is high and accelerating. Over time, it will impact all segments and all positions within the industry. Currently, the industry is not well positioned to attract and upgrade worker skills on an on-going basis. In the roundtables, interviews and surveys, employers highlighted the importance of:

- Being able to attract increasing numbers of workers with highly developed skill sets, often in areas which were not previously required in the industry (e.g., big data analytics, automation and robotics, and advanced materials). The industry is becoming, and will continue to become, much more reliant on information technologies, composite materials and robotics.

- Attracting workers into the industry who have the capability to learn about new technologies, products, and processes on an on-going basis. Employers noted that, thirty years ago, employees could learn their job and continue to do largely the same functions year after year. In the future, change will be continuous, and staff will need to be comfortable in the digital age and capable of lifelong learning of new skills. Much of the existing workforce may need to be re-tooled and re-skilled to meet the changing requirements. People will need to take refresher courses and upgrading to cover topics, materials or technologies which may not have existed when they were educated 10 to

34 IRCC (2015).http://www.cic.gc.ca/english/resources/publications/employers/express-entry-presentation-

15 years ago. Some concerns were expressed about the ability of some of the existing workers to make the transition to working with new technologies.

- Increasing the level of investment in upgrading programs, preferably at the industry level rather than just at the employer level. It will be important to identify common needs across employers with respect to training and, where possible, develop joint or common programs which can benefit multiple employers in the industry.

- Developing and testing new training models which may be able to meet the needs of the industry more quickly, efficiently, and effectively.

- Being able to pursue alternative strategies to increase the supply of skilled workers. One option which was suggested was to target workers in other industries and provide support to them to facilitate inter-industry migration, mid-career.

- Pursuing strategies to share employees, particularly those with highly specialized skills, through some form of hub-and-spoke model.

Employers noted that it will also be important for the industry to have access to resources, including financial resources, that will facilitate the development and adoption of new technologies.

Absence of a Coordinated Labour Market and Industry Development Strategy

Most employers believe that there are significant opportunities to further increase the size of the BC aerospace industry, specifically highlighting opportunities in the MRO, space and remote sensing, and manufacturing segments. However, in order to realize the full potential for growth, industry, educators, and government will need to work more closely together in building the cluster. Companies, educators and government tend to work in isolation. Towards that end, some of the employers and other key informants recommended the development of:

- A labour market strategy for the industry, designed to increase access to the skilled workers that will be needed with a particular focus on improving recruitment, education and training activities; and;

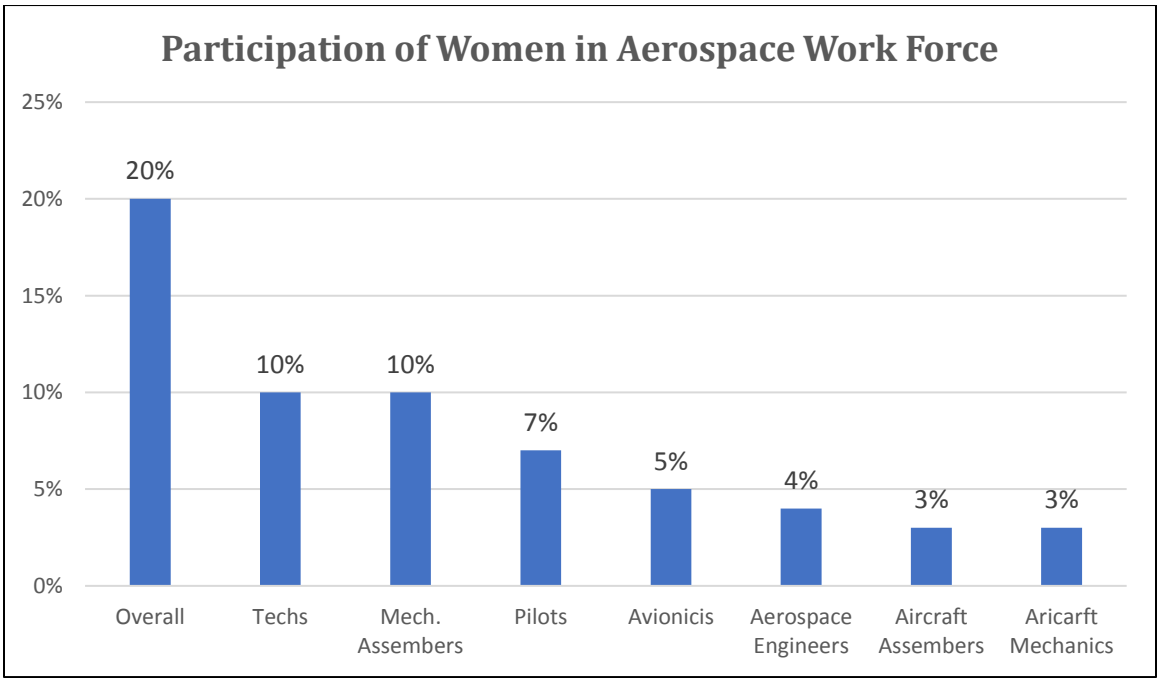
- An industry development strategy. It was suggested that industry and government in other regions, particularly Quebec, have been much more effective in working together to promote further development of the industry. Some of the key elements which were highlighted in the interviews and roundtables included the need for:
    - strong government leadership;
    - joint marketing activities (e.g., a coordinated program to market the skills and capabilities of businesses in the province)
    - leveraged investments in research, development and innovation
    - strengthening linkages in the supply chain and with the industry in other regions
    - improving and streamlining the regulatory environment
    - support for the implementation of new technologies, and
    - making more effective use of available programming, government procurement, and policies including the ITB Policy.

It was also suggested that Canada would benefit from a national industry development strategy.

Low Levels of Gender Diversity and Indigenous Participation

Occupations in the BC aerospace industry are still very much male-dominated, and efforts to date to attract more women have not been very successful. Amongst the companies that were surveyed, women made up only about 20% of the workforce.

The percentage is much lower amongst aerospace specific occupations. According to the WorkBC data drawn from the Labour Force Survey, the percentage of workers in aerospace-specific occupations who are female ranges from a high of 10% of mechanical engineering technologists and technicians, as well as 10% of mechanical assemblers and inspectors; to 7% of pilots, 5% of avionics mechanics, technicians and inspectors, 4% of aerospace engineers, and 3% of aircraft assemblers and inspectors, as well as 3% of aircraft mechanics and inspectors.



Source: WorkBC Profile of Selected Occupations

Although statistics are not available, the level of involvement of Indigenous people in the industry is considered very low. The Indigenous population in BC has grown by 38% over the past decade (three times faster than the population overall), reaching 270,585 according to the 2016 Census. Indigenous people now account for 6% of the BC's population, up from 5% in 2006. The Indigenous population tends to be younger (an average of 33 years of age as compared to 42 for the rest of the BC population). Indigenous youth will account for a significant percentage of new entrants into the labour market over the next decade (26% of the population is under the age of 14, as compared to 15% of the broader population). In 2017, the level of labour market participation tends to be higher amongst the Indigenous population than amongst the general population (67.9% versus 64.3%) as was the unemployment rate (13.7% versus 5.4%).[35]

Question 5: To what extent is the educational sector in BC fulfilling the education, training and skills development needs of the industry?

The major findings of the review regarding the effectiveness of the educational sector in BC fulfilling the

35 Government of Canada, Labour Market Bulletin: BC, March 2017.

education, training and skills development needs of the industry are as follows:

While a variety of education, training and apprenticeship programs have been established to support the industry, most of the workers in the industry do not have aerospace specific education, training or licenses.

Reflecting industry needs, a variety of education, training and apprenticeship programs have been established to support the industry. ITA BC administers two apprenticeship programs related to the industry including:

- Aircraft Maintenance Technician is a four-year program (7,200 hours of workplace based training) that trains people who will perform inspections and troubleshooting of an aircraft, including airframe structures, engines and aircraft systems; disassemble and remove defective parts, assemble and install replacement parts, interpret technical manuals, drawings and blueprints, test aircraft systems, record problems and actions taken to rectify them, and maintain an accurate statement of the maintenance history of the aircraft. As of February 2017, there were 152 active apprentices.

- Aircraft Structural Technician is also a four-year program that has involved 480 hours of technical training (4 weeks per year) and 6,720 hours of workplace-based training. The program is under review. There are 50 people currently registered in the trade who are continuing to work towards a Certificate of Apprenticeship.

In addition, the Ministry of Advanced Education, Skills and Training provides funding for a college program focused on avionics.

Transport Canada licenses Aircraft Maintenance Engineers (AME) across Canada and approves the organizations who are eligible to deliver the basic training required by the licensees. Licenses are issued with five different ratings depending on the area of work. An overview of the requirements associated with each different type is provided in the table below.

Overview of Transport Canada AME Licenses and Requirements

Rating	Basic Training	Experience	Skill	Exams
M1	1000 hours Aircraft Maintenance theory (non-turbojet aircraft)	Total: 48 months Specialty: 12 months Civil: 6 months	Record of Maintenance tasks required	• Airframe • Powerplant • Standard Practices • Regulations
M2	1000 hours Aircraft Maintenance theory (all other aircraft)	Total: 48 months Specialty: 12 months Civil: 6 months	Record of Maintenance tasks required	• Airframe • Powerplant • Standard Practices • Regulations
E	1000 hours Electronics theory	Total: 48 months Specialty: 12 months Civil: 6 months	Record of Maintenance tasks required	• Avionics • Standard Practices • Regulations
S	550 hours Aircraft Structures theory	Total: 36 months Specialty: 24 months Civil: 6 months	Record of Maintenance tasks required	• Structures • Standard Practices • Regulations

Rating	Basic Training	Experience	Skill	Exams
Balloons	Acceptable course in balloon maintenance	120 hours	Record of Maintenance tasks required	• Regulations

Of the total number of workers who comprise their existing workforce, employers identified 51% as possessing education or professional certifications which are either required or important for their positions. Some of the commonly identified qualifications included pilot (rotary or fixed; 9.6%), AME – Maintenance (e.g., M1 or M2 or Aircraft Maintenance Technician: 8.9%), AME – Structural (e.g., Category S or Aircraft Structural Technician) (6.3%), and AME – Avionics (3.0%).

The following table summarizes various aerospace related programs that are delivered by educational institutions in BC.

OVERVIEW OF AEROSPACE EDUCATION IN BC

Institution	Preliminary Overview of Programs

British Columbia Institute of Technology (BCIT)	BCIT has a 300,000 square-foot state-of-the-art Aerospace Technology Campus featuring a fleet of 20 aircraft including a Boeing 737 and a Bombardier CRJ aircraft. This dedicated campus in Richmond, BC specializes in Aviation and Aerospace programs and is a key supplier of labour in the sector. BCIT's School of Transportation offers several aerospace programs including:
	• Aircraft Gas Turbine (jet) Engine Technician | Full-time, Certificate
	• Airline and Flight Operations - Commercial Pilot
	  ○ Fixed-Wing option: Full-time, Diploma
	  ○ Rotary-Wing option: Full-time, Diploma
	• Aviation Maintenance Technician – Avionics: Full-time, Diploma
	• Aircraft Maintenance Engineer Category 'M' (Maintenance): Full-time, Diploma
	• Airport Operations: Full-time, Diploma or On-line Part-time, Associate Certificate
	• Part-time courses: Airport/Airline Core; Airport Operations; Aviation; Introduction to Unmanned Aircraft Systems (UAS)
	Aside from these specialized programs, BCIT offers a wide range of technical training programs from which the aerospace industry draws (machining, welding, IT, electronics, etc.). BCIT's Training Partners include Lufthansa Technical Training and has articulation agreements with Embry-Riddle Aeronautical University and Vancouver Canada's Dorset College. These agreements provide students with an opportunity to transfer into both undergraduate and graduate aviation focused degree program with Embry-Riddle Aeronautical University (ERAU) in the USA and enable international students to study transportation specific technical English in an English immersion environment at Dorset College, preparing students for the BCIT School of Transportation full-time programs.

Northern Lights College	Northern Lights College offers Aircraft Maintenance Engineering (AME) in its 999Aerospace Centre of Excellence, located on the Dawson Creek Campus. It delivers a program in association with Okanagan College. Northern Lights College offers two types of AME training: • Basic Training: This 15-month AME program provides graduates with the full training component and 1.5 years of the four-year experience component required for an AME license, category M1 or M2. Aircraft Maintenance Engineer is also an apprentice level trade. • Type Training: Field Maintenance courses for specific types of helicopter airframes and engines that are Transport Canada approved and meet the training required by regulation prior to exercising the privileges of the AME licence to certify maintenance completed on Canadian registered, turbine powered helicopters. NLC's Type training program has attracted students from around the world looking to upgrade their

Institution	Preliminary Overview of Programs
	certification.
North Island College	North Island College offers an Aircraft Structures Technician (AME-S) program and an Aircraft Sheet Metal Manufacturing Technician program.
Okanagan College	The Commercial Aviation diploma program provides students with business experience along with aviation training required by Transport Canada. The business portion is completed at Okanagan College and normally consists of two business courses per semester for a total of eight courses over two-years. The flight-training portion is taken with Southern Interior Flight Centre (1993) Ltd. consists of Transport Canada prescribed flight training, theory and exams. Okanagan College also offers Aircraft Maintenance Engineer and Aircraft Structural Technician apprenticeship and Transport Canada approved training.
University of Victoria (UVic),	UVic's Engineering Faculty and Aerospace Research Center is active in aerospace research and its undergraduate and graduate programs in mechanical engineering include aircraft. UVic's aerospace design team, originally located in a small office on the UVic campus, moved in 2013 to a new centre near Sidney. With a $671,500 grant from Western Economic Diversification Canada, UVic's new Centre near Victoria International Airport is producing an airframe fleet or "family" of UAVs (Unmanned Air Vehicles) from the ground up, including conceptualization, design, manufacture, testing, operation and monitoring. The UVic UAVs will have a broad range of purposes primarily focused on commercial and industrial applications, including port security, civil disaster response, search and rescue, forest firefighting, coastal patrol, agricultural crop monitoring and aerial mapping.
University of the Fraser Valley (UFV):	In partnership with flight training companies, UFV offers a Bachelor of Business Administration (Aviation) degree. Students finish the program with a university degree, as well as private and commercial pilot licenses certified by Transport Canada and supplemented by both night and multi-engine instrument ratings. In the fourth year, students have the option to specialize in either heavy jet transport operations or professional flight instruction. It also offers a two-year Aviation diploma which mixes classroom studies, in-air flight training, and simulator training which enables students to earn a commercial pilot license certified by Transport Canada and undergo multi-engine and instrument training. UFV also has other training options related to aerospace, such as welding. Other aerospace related capabilities at UFV include: executive and leadership training; safety management training; touch labour training in aircraft structure including composites; customizable leadership and human factors training, airport and airline operations training, and technical English / ESL. In addition, it offers diploma programs in the areas of Aircraft Structures Technician and Aircraft Maintenance Engineer (M).
University of British Columbia (UBC)	Several faculty members and students from UBC's Faculty of Applied Science engage with the aerospace industry, for example, through the Composites Research Network which has the following capabilities in the area of composites manufacturing and design: material characterization (thermo-chemical-mechanical); manufacturing process development (autoclave, OOA, LCM, Compression Moulding, Drape forming); manufacturing process simulation and optimization; mechanical testing (static, dynamic: low-speed impact, high-speed impact); NDI testing (Ultrasonic, infrared, DIC); and damage characterization and simulation. The UBC Composites Group is based in the Department of Materials Engineering and the Department of Civil Engineering.

There are also various private sector firms that provide training to the industry. For example, some of the BC-based training organizations that are approved by Transport Canada include Air Canada Technical Services, Alpine Helicopters, Cascade Aerospace, CHC Helicopters, Jazz Aviation, KF Aerospace, Pelesys and West Point Helicopters Services.

Employers generally considered the existing education and training programs to be effective in providing basic education and skills training as well as in facilitating journeyperson credentials and Transport Canada certifications. However, employers identified a variety of opportunities for

improvement.

These included:

- **Targeted training**: The diversity of the industry makes it difficult for educators to tailor programs to meet with the needs of particular employers. As such, it is recognized that new graduates typically require considerable time (e.g., two years) and on-the-job training before they can become productive. However, it was suggested that education and training programs could still do more to increase job-readiness by providing more opportunities for practical hands-on experience, particularly in the workplace, and putting more of an emphasis on soft skills and applied training. Larger employers, such as some of the major carriers, are developing more targeted training by working directly with educational institutions to establish programs specifically for them.

- **Up-to-date curriculum and technology**: Given the pace of technological change, it is increasingly difficult for educators and trainers to keep their curriculum and technology up-to-date. Training will need to increasingly incorporate new technology, simulations (including virtual and augmented reality), computer skills and working with advanced materials. As part of an updated curriculum, some employers also highlighted the need to incorporate a wider range of skills into the training and expose students to more facets of industry.

- **New training models**. There was considerable discussion, particularly in the roundtables, regarding the need to develop and test new training models for the industry. It was considered an appropriate time to review the models given the rate of change in the industry as well as the fact that the ITA programs are under review and changes are being considered to the Transport Canada regulations and certifications. Suggestions to improve training models covered a wide range of areas including:

    - Getting students into the workplace and onto the shop floor earlier in the process, through placements, co-op programs or the adoption of a more traditional apprenticeship model (where employees go back and forth between the workplace and the school). The objective is to provide them with directly relevant experience, including experience using more modern technology and machinery than they typically have access to in the school. Student internships, co-ops and other integrated work-learning opportunities did not appear to be used extensively. Some employers suggested that onsite placement should be mandatory, and that government provide financial support to facilitate that (e.g., through a program similar to the BC Tech Co-op Grants Program).

    - Enabling students to enter right into industry from high school, by incorporating some of the training into the secondary school system and/or by actively recruiting students to enter into pilot, AME training, or engineering right out of high school. Germany was identified as a country that has been particularly successful in accelerating the entry of youth into the industry.

    - Developing strategies to reduce the cycle time for training. It can take five years of training before a technician works on an airplane without supervision. By restricting the training and opening up the workplace, it may be possible to reduce the timelines.

    - Adopt an approach that focuses more on outcomes than on process. It was suggested that, for example, there needs to be a detailed review of the regulatory environment around aerospace. Existing regulations were viewed as slowing the rate of innovation in the industry, both in terms of education and training and, more broadly, how industry operates.

    - Further investment in distance education options as a means to increase access to training, for

both new market entrants and for upgrading purposes.

- **Promotion of the education and training programs.** It was suggested that industry needs to get much more involved in promoting aerospace as a potential career, particularly by building relationship with the K-12 education system. Filling spaces in existing education programs and developing new programs is not solely the responsibility of educators and trainers; rather it is the industry that benefits and therefore it is the industry that needs to take the lead role in making that happen. Organizations like ITA and the Ministry of Advanced Education, Skills and Training can also play an important role in the process. There may be opportunities to lever existing initiatives including the work being undertaken in Langley, the Air Cadets program, The Sky's No Limit - Girls Fly Too! Program, and the ITA youth initiatives team.

- **Strengthen linkages between industry and educators.** Some of the employers have been involved in serving on advisory committees, providing feedback on curriculum and hosting interns or coop students. However, many are not very involved. Opportunities were identified to better tailor education to the specific needs of employers and to better coordinate the formal training programs with on-site training provided by the employers. A program, such as MITACS, could also help to connect industry with the academic sector to facilitate collaboration, innovation and talent development through the term engagement of interns.

  While the focus on the discussion was primarily on aerospace-related education and training, it was also noted industry will have to get more involved in advising educators on other types of programs which will become increasingly relevant to the industry as technology evolves (e.g., big data scientists, advanced manufacturing, and chemical engineering).

  The Learning Factory for Advanced Composites at UBC's Okanagan campus was identified as a potential best practice in terms of strengthening relationships between industry (Avcorp Industries) and academia. The Learning Factory focuses on advanced composite manufacturing and will integrate industrial production with learning and research, providing UBC students and faculty with opportunities for research, knowledge translation, and hands-on experiential learning. The Learning Factory will also provide technical and skills training opportunities for students from partner institutions, such as Okanagan College.

- **Training of international students.** Industry would benefit from further development of education and training programs in the provinces. Further promoting programs to international students was identified as an important vehicle through which the education and training sector in BC can be expanded.

- **Upgrading of existing workers.** Employers identified a need to increase the level of investment in upgrading programs, preferably at the industry level rather than just at the employer level. The introduction of new technology will require the existing workforce to learn a range of new skills (e.g., some concern was expressed about the ability of older workers to learn these skills). It will be important for industry and educators to work together to identify common needs across employers with respect to training and, where possible, develop joint or common programs which can benefit multiple employers in the industry.

- **Access to financial assistance**. In particular, it was noted that the high cost of pilot training, combined with the limited level of student loans and grants available, makes it more difficult to attract students.

- **Additional government support**. Both employers and educators highlighted the rising cost of training, particularly related to advanced technology and applied sciences (e.g., costs of new/more advanced technologies and faculty). Concerns were also expressed about the current ability of institutions to provide sufficient compensation to instructors (i.e., above industry rates) to be able to retain them.

- **Increase coordination and coordination across institutions and with other regions and sectors**. Within BC, it will be important to share information and coordinate programming between the various institutions. Communicating with educators and trainers in other regions (e.g., Seattle, Quebec, and Asia) and sectors will also be important in keeping abreast of current trends. One of the biggest challenges that educators will face is being able to monitor key trends and predict upcoming changes in the industry. Red River College in Winnipeg was identified as an institution that was very effective in building partnerships with industry and keeping up-to-date with respect to technology and equipment. It was also suggested that the commercial side of the industry could learn from the training provided on the military side, which tends to be further ahead.

The absence of an aerospace engineering program in BC was identified by employers and other key informants as constraining further development of the industry.

There are no aerospace engineering programs currently in place in BC, which is one of the factors contributing to a relatively low number of aerospace engineers (about 300) currently employed in BC. A number of aerospace or aeronautical engineering programs operate in other provinces, particularly in Ontario and Quebec. Universities offering engineering degree programs in aerospace, aeronautics and space include

- Carleton University - B.Eng., M.Eng., M.A.Sc. and Ph.D.
- École Polytechnique de Montréal - B.Ing. and M.Ing
- Royal Military College of Canada - B.Eng. (Aeronautical Engineering), M.A.Sc. and Ph.D.
- Ryerson University - B.Eng., M.Eng., M.A.Sc. and Ph.D.
- York University - B.A.Sc. (Space Engineering)

Other engineering degrees with some form an aerospace option are offered at a variety of institutions across Canada including Concordia University, École de Technologie Supérieure, Laval University, McGill University, Université de Sherbrooke, the University of Toronto, University of Windsor and University of Manitoba - B.Sc. (Mechanical Engineering). While the University of Victoria has a Centre for Aerospace Research, it does not have a specialized aerospace engineering undergraduate program.

According to Statistics Canada, there are nearly 9,000 aerospace engineers in Canada[36] The strong demand for engineers in central Canada, combined with factors such as the high cost of housing in BC have contributed to difficulties in attracting these engineers to BC. While the province produces other types of engineers, there are no bridging programs in place to give those engineers a grounding in the aerospace industry.

Educators and other key informants noted a series of key trends that are impacting education and

36 https://www.jobbank.gc.ca/report-eng.do;jsessionid=493943C859EDDE0761FE49465F5F2110.imnav1?area=0236&lang=eng&noc=2146&action=final&ln=n&s=2&source=8#outlook. The figures is overstated somewhat because Aerospace Engineers (NOC 2146) are grouped in with Other professional engineers, n.e.c. (NOC 2148).

training.

These include:

- Rising cost of training, particularly related to advanced technology and applied sciences (e.g. costs of new/more advanced technologies and faculty)
- Increasing industry demand for highly technical skills and skills not traditionally linked to aerospace (e.g., big data scientists, advanced manufacturing, chemical engineering)
- Increasing international demand for training in aerospace (increased numbers of international students)
- Low profile/cyclical nature of the industry makes it less attractive for students
- High demand for retraining is not adequately addressed
- Lack of comprehensive strategy to address skills and labour shortages

Data from the BC Labour Market Outlook, 2017-27 indicates a need to increase the number of graduates coming out of the education and training programs.

The table below summarizes data from latest BC Labour Market Outlook, 2017-27 on the projected increase in the demand for, and supply of, workers in particular occupations over the ten-year period. As indicated, demand will come from both the creation of new positions (expansion) and the need to replace people who are leaving the industry (replacement). Supply will come from new entrants (mostly graduates from post-secondary programs), net in-migration (the balance of people moving internationally or inter-provincially to and from BC), and occupational mobility (moving in from occupations).

Each of the positions is in a negative position (i.e. a tightening labour market with more growth in demand than supply) based on employment growth rates that range from 0.6% to 1.9% annually. If the industry growth rate were to be 4% the shortages would become much more significant under the projected supply rates, indicating a need to expand post-secondary and more aggressively promote the industry to new market entrants and established workers internationally and in other regions of Canada.

Projected Growth in Demand and Supply for Selected Positions, 2017-27

NOC	Employ-ment 2017	Annual Growth	Demand			Supply				Net
			Expan-sion	Replace-ment	Total	New Entrants	In-Mi gration	Job Mobility	Total	
2146 Aerospace engineers	300	1.7%	65	77	142	83	23	19	125	-17
2232 Mechanical engineering technologists and technicians	1,840	1.2%	266	378	644	669	281	-380	570	-74
2244 Aircraft instrument, electrical and avionics mechanics, techs & inspectors	1,380	1.6%	277	426	703	243	194	190	627	-76
2271 Air pilots, flight engineers & instructors	4,390	1.9%	1,174	1,310	2,484	693	595	824	2,112	-372

NOC	Employ-ment 2017	Annual Growth	Demand			Supply				Net
			Expan-sion	Replace-ment	Total	New Entrants	In-Mi gration	Job Mobility	Total	
7315 Aircraft mechanics & aircraft inspectors	3,580	1.7%	832	1,174	2,006	1,083	557	78	1,718	-288
9521 Aircraft assemblers and inspectors	190	0.8%	29	59	88	60	18	-5	73	-15
9526 Mechanical assemblers & inspectors	730	0.6%	33	192	225	114	269	-171	212	-13

Source: BC Market Outlook 2017-27

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- *MRO Market Update and Industry Trends,* Presentation by Jonathan M. Berger, ICF, MRO Latin America Conference, January 25-26, 2017, Cancun, Mexico.
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