Opportunity Analysis Final Report: Aerospace Training in Canada

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PREPARED BY:
InnovaIT Professional Services, for
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Executive Summary

In the summer of 2022, Downsview Aerospace Innovation and Research (DAIR) contracted InnovaIT Professional Services (InnovaIT) to contribute analytical, consulting, and project management services to an Ontario Aerospace Council (OAC) / Skills Development Fund 2 (SDF2)-funded micro-credential pilot for Enterprise Resource Planning (ERP) Integration in Aerospace Manufacturing. A multi-phase plan was designed to examine and improve existing decision support tools, assess the performance of the program delivery, use the experience to provide a framework for future program deliveries, and scan the aerospace training landscape for related and future opportunities and strategies.

Findings of the labour market and environmental scan illustrate a complex industry that contributes significant value to the country through the provision of advanced aerospace capability, employment of a large, advanced manufacturing workforce, and GDP contributions of billions of dollars annually. The pandemic severely affected the industry, but recovery is already underway and some sectors – such as defence – remained stable and are poised for tremendous future growth. That growth and recovery is threatened by labour market challenges across the country, including a homogenous and aging workforce, insufficient recruitment, and substantial time to market for learners and others transitioning into the industry.

The level of investment in aerospace recovery has been criticized as inequitable relative to its contribution to GDP and in comparison, to other countries. Meanwhile, industry investment in training has been less than ideal – in part due to insufficient resource allocation such as dedicated training staff within aerospace small-and-medium-sized enterprise (SME) and uncertainty as to what training opportunities are available to meet industry needs.

The aerospace training market is characterized by a triad of actors including higher education, industry, and accrediting bodies. Each sector brings unique approaches and strategies to training, while collaborations between them leads to customized training, applied research, program accreditation, and various training supports like national occupational standards, training associations, and working groups. Increasingly, these traditional providers are unable to meet the rapidly changing skill requirements due to the lag between program enrolment and completion. Consequently, new training models are emerging as alternatives to those systems of learning. The evolution of competency-based training and micro-credentials offers new opportunities for higher education to stack short training experiences into recognized undergraduate and postgraduate credentials. It offers industry a way to efficiently upskill and re-skill employees and presents accrediting bodies ways to accelerate certification training. Work integrated learning and applied research also present important new directions to efficiently prepare learners to become productive in the workplace.

In general, the challenges (and therefore opportunities) for Ontario and Canada include building on Canada's reputation in export markets, embracing the needs of the defence industry, and adopting technological innovations and other emerging trends. Shortening the transition from learner to trained worker and reducing barriers to certification, such as confirming immigrant qualifications, may require a look at those emerging models of training delivery. Funding support and promotional marketing is needed to attract youth and diverse populations to aerospace as a viable career. The development of national training centres - as proposed in the Aerospace Industries Association of Canada (AIAC) Vision 2025 report - is a vital initiative to continued success and may be timely considering Ontario's recently announced intent to develop centres for skilled worker training[1]. Collaboration within the industry is another critical factor and that requires development of metrics that clearly and consistently measure and evaluate impact of training initiatives.

The work of each sector support organization and related industry facilitator has its own place in the ecosystem. There many be some overlaps in mandates, but there are also rich opportunities for collaboration among them.

[1] https://news.ontario.ca/en/release/1002850/ontario-building-training-centres

Overview

Project Objectives

The Downsview Aerospace Innovation & Research hub (DAIR) has established short and long-term goals that focus on the development of innovative training solutions for the aerospace industry. This offering is intended, as far as possible, to complement the current programming offered by other organizations. In 2022, as part of these goals, DAIR - in partnership with Centennial College, the Ontario Aerospace Council (OAC), which secured project funding through the Ontario Ministry of Labour, Immigration, Training and Skills Development Fund 2 (SDF 2)- developed and delivered a micro-credential pilot program which integrated technical SAP/Enterprise Resource Planning (ERP) training into pre-existing aerospace and advanced manufacturing curriculum. The pilot was delivered in two cohorts between July 2022 and February 2023.

On-site management and delivery of the micro-credential pilot was accommodated within existing organizational and partner capacities. However, it was recognized that an additional benefit could be realized through related activities such as program evaluation, strategy planning and opportunity analysis to measure the success, impact and future potential of the piloted program and identify further opportunities for organizations like DAIR and the OAC to support the industry through training. InnovaIT Professional Services, a management consulting firm, was selected to develop and manage a Program Review and Opportunity Analysis project. InnovaIT was engaged due to its team's expertise and experience in

higher education, aviation and aerospace (A&A)[2] training, project management, labour market research, program review, and strategic management consulting.

The project objectives and deliverables were designed to facilitate a review of the impact and delivery process of the micro-credential pilot, and to create an opportunity analysis to provide DAIR and the OAC, identified stakeholders, and the broader industry with recommendations about potential gaps and areas of collaboration. The opportunity analysis also includes guidelines on effective investment, and strategic directions in training initiatives for the industry as well as related Research and Innovation (R&I) opportunities. The primary focus is on Ontario but, where appropriate, recommendations support a pan-Canadian reach and the broader nation-wide needs of the industry.

Profile information for the project's lead organizations is presented later in this document.

Approach/ Methodology

InnovaIT, in consultation with DAIR, developed a project charter to define outcomes, objectives, reporting structures, and scope. The team also created a Gantt chart, and project planner in a Microsoft SharePoint site to support communication and collaboration as well as to ensure transparency and accountability through the project.

Each of the project's three phases included both quantitative and qualitative analysis of data gathered through a variety of methods. This section describes the approach to analysis including activities, constraints, and deliverables for each of the identified phases.

All details collected through survey and interviews have been amalgamated and anonymized. Any quotes or specific details will be shared only with express permission of the individual or organization.

Program Review

The primary focus in this phase was a review of the *ERP-SAP Essentials for Advanced Manufacturing and ERP-SAP Integration micro-credential pilot project.* The review process included development of a training review framework that was applied against the pilot program to illustrate its potential as a key component of a review approach which can be utilized in future offerings and by different organizations.

Secondary research included the review of metrics and measurements of the program through the SDF 2 and observation of assessment criteria used in other programs. Supporting information was also gathered through public sources including stakeholder websites.

Primary research included interviews with faculty and the support team (of partner Centennial College), DAIR management, the OAC, and industry representatives who had placed participants in the pilot, as well as an online survey with participants, all collected post-program. Given the small enrolment, review timing (shortly before the Christmas holiday), and lack of sponsor requirements for stakeholder input, the sample sizes for program review research activities were smaller than hoped for. Nevertheless, findings from the program review are integrated into this report.

Systems Analysis

This phase included review of existing data capture and decision support systems in use, which led to additional data normalization and recommendations to support information gathering for opportunity analysis.

[2] A&A (aviation and aerospace) training: traditionally, aerospace tends to be associated with engineering and manufacturing-related occupations, while aviation is focused on maintenance, pilot, and crew training. For the purposes of this report these are merged as A&A for simplicity and readability, unless otherwise stated.

It also involved development of use case and systems design for improved decision support for evaluation of future training and partnership opportunities.

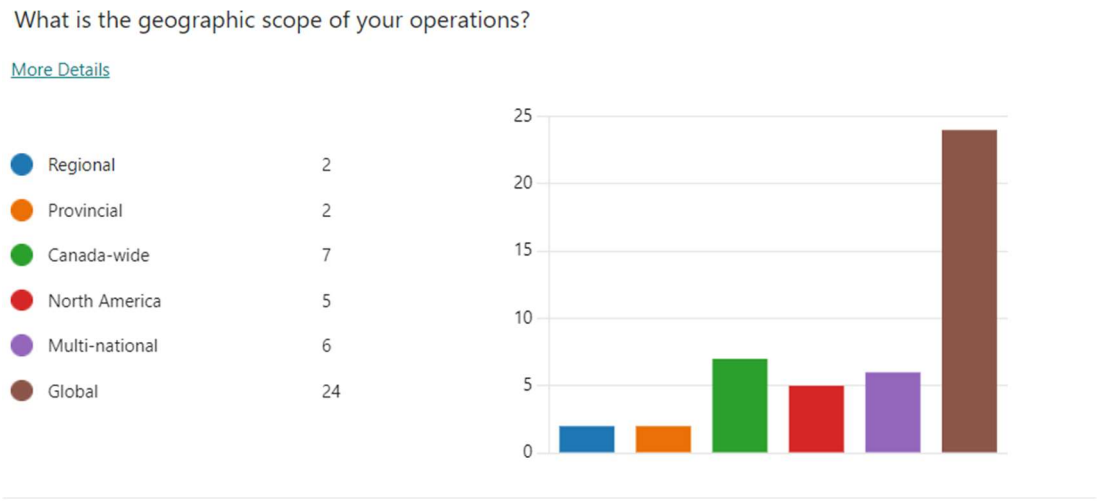
Opportunity Analysis

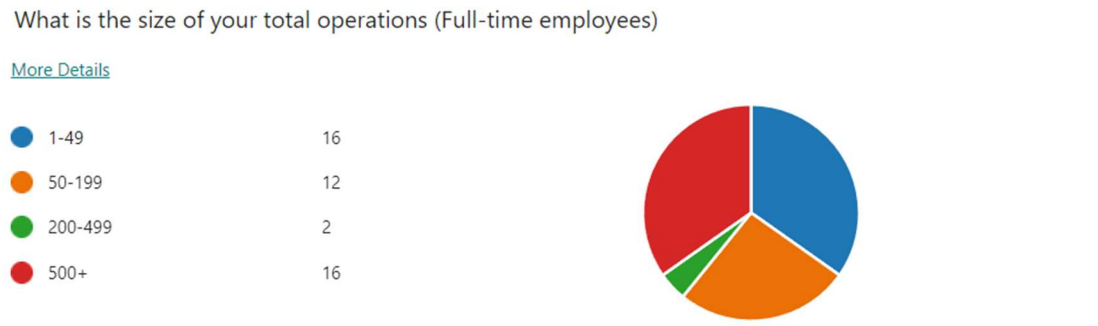
The opportunity analysis was the most detailed and comprehensive phase and incorporated methods, approaches, and findings applied in the earlier stages.

Secondary research involved literature review and gathering of labour market information. See Appendix B: References for a detailed list of these sources.

Primary research focused predominantly on an online industry survey completed voluntarily. This survey was distributed through mailing lists of the OAC, the Canadian Council for Aviation and Aerospace (CCAA), and DAIR to a total of approximately 1,500 addresses. Overlap would be anticipated with these lists and recipients were asked to forward the survey invitation if there was a more appropriate person to respond. Responses were anonymous, but participants had the option to provide direct contact information if they were interested in follow-up or more information. Forty-six responses were received with representation from large and small companies with different roles in the aerospace industry and from all geographic regions, the largest component (48%) from Ontario, the primary target audience of two of the three email lists.

Follow-up from the survey included extended interviews which supplemented a panel of industry experts identified through the survey and introductions from project stakeholders. The figures below outline the profile of respondents to the survey including geographic scope, size, and primary area of focus.





What are your organization's primary area(s) of focus (select all that apply).

More Details

Manufacturing	22
Design/ Engineering	13
Assembly	13
MRO	15
Testing	9
Airline Operations	8
Air Freight	2
Military/ Defence	10
Airport/ Airline Services	2
Other (Specify)	8
Other	13

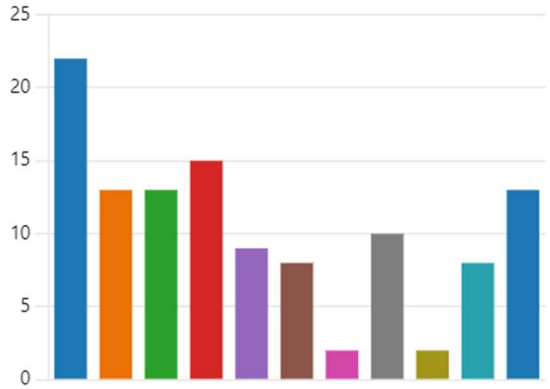


Figure 1 Survey Profile

Findings

Canadian Aerospace Industry

The aerospace sector is a significant contributor to the economy and workforce culture in Canada. Spanning domestic and export services and supply chains, it is a highly stratified industry characterized by a hierarchy of structures, tiers, and market segments. In 2021, the industry contributed over $24B to National gross domestic product (GDP) while creating direct employment to over 125,000 workers, down from a high of $33B and 161,000 jobs in 2019. Most of the revenue base (69%) and employment (50.2%) is generated in manufacturing and support activities.[3] Scheduled and non-scheduled air transportation fill out the balance of production revenues and direct employment in the industry.[4] Indirect and related employment adds at least half again the number of jobs in the economy.

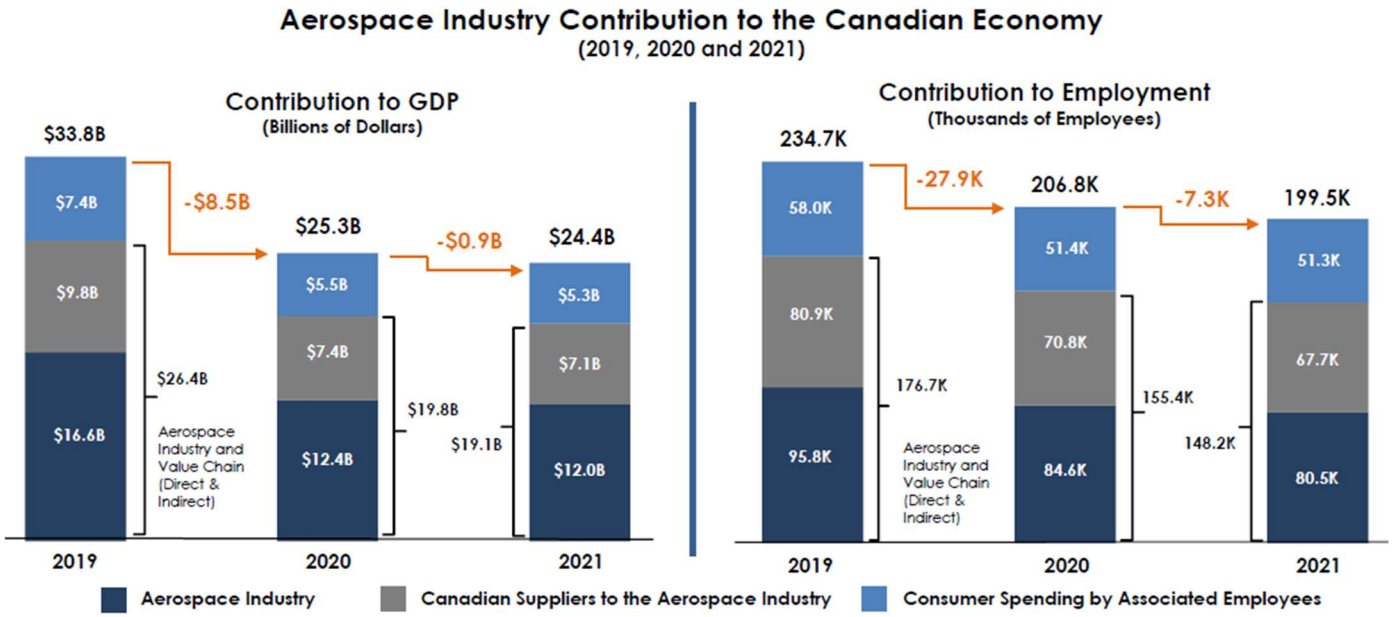


Figure 2 State of Canada's Aerospace Industry Report, AIAC, Summer 2022

Canada's aviation and aerospace sector mirrors the global market in having a small number of large dominant firms – original equipment manufacturers (OEMs, i.e., aircraft manufacturers) and Tier 1 supply chain firms – alongside a much larger number of smaller OEMs, suppliers, engineering design, and support firms. Canada's market is different from the American landscape in terms of the balance between the number of large and smaller companies competing in the space – Canada having only about 5% of large enterprises (>500 employees) in its total of about 700 industry firms compared to around 30% large firms in the US industry. Much of that may be attributed to ongoing consolidation within the US, a phenomenon that is also being observed more frequently in recent years in Canada.

Manufacturing holds a significant focus of the industry with most aerospace contributions to GDP coming from production. Canada ranks in the top five countries in the world for civil flight simulators (#1), civil aircraft engines (#3), and civil aircraft (#4). More than 90% of aerospace manufacturing is exported, with more than half of that in supply chain markets.

[3] Based on 2017 Stats Canada data, collected through Lightcast Data's economic modelling application, see Appendix C

[4] Key NAICS Codes for the industry include 3364 (Aerospace products and parts manufacturing), 4811 (Scheduled Air Transportation), 4812 (Non-scheduled Air Transportation) and 4881 (Support Activities for Air Transportation)

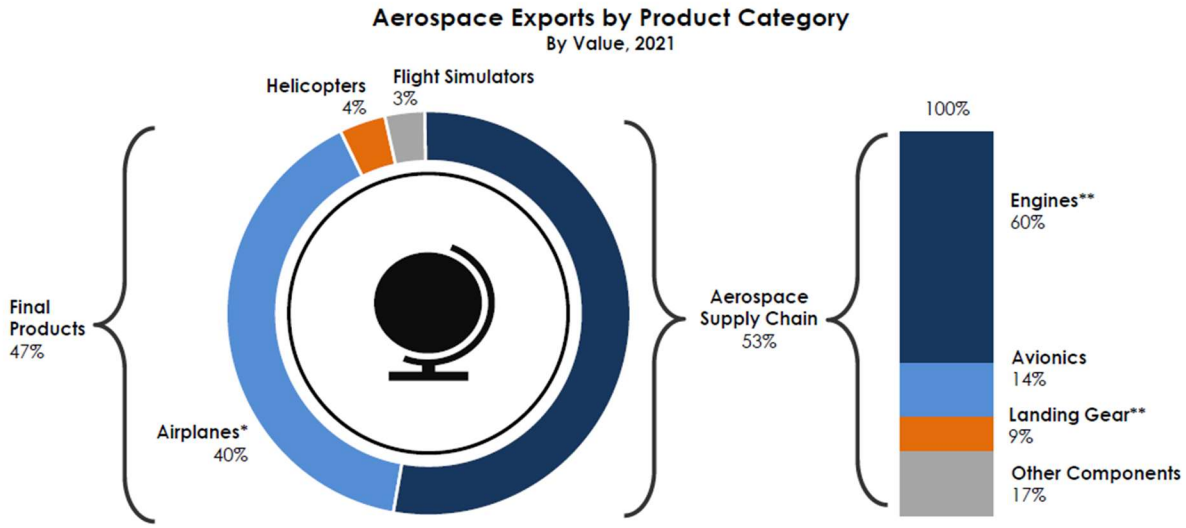


Figure 3 Aerospace Exports, Source AIAC

While overall manufacturing employment in Canada has declined by about 14% from 2005 to 2019, aerospace manufacturing has seen an increase in employment numbers of over 20% in the same timeframe, and nearly a doubling of production revenues. The supply-side figures belie that the industry has struggled to fill those jobs with willing and skilled employees for a decade or more.

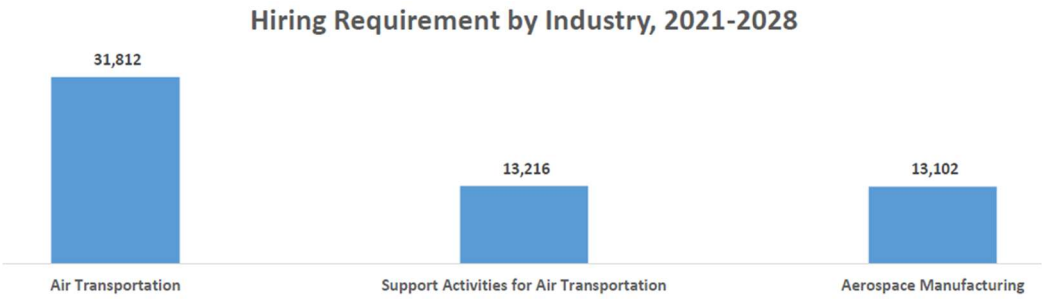
The COVID-19 pandemic put a dent in that growth, shutting down global travel and crippling many airlines resulting in the number of jobs in the industry plummeting between 2019 and 2021. With reduced demand in the global market, revenues for civil aircraft production dropped by nearly 34% in Canada, still faring better than the global market which lost nearly 40% of its earnings in the period.

Figure 4 Aerospace Jobs 2001-2027+, highlight change 2017-2023, Lightcast data, see Appendix C – Selected Data and Statistics

The industry in 2023 is already in recovery with a pronounced slowing of the revenue decline. A panel of international subject matter experts predict a return to 2019 production revenue levels by end of 2024[5]. Jobs, however, are not predicted to rebound to 2019 levels until 2028 or later. Despite this, there is concern about the ability of the industry to meet staffing levels. A report from the Canadian Council for Aviation and Aerospace (CCAA) shows a recruitment gap of

[5] State of Canada's Aerospace Industry Report, AIAC, Summer 2022

nearly 48,000 entrants to A&A from 2021 to 2028.[6] Note that this gap is across multiple industry classifications including air transportation, support activities for air transportation and manufacturing for the aerospace sector (encompassing the four major NAICS codes associated with the industry)[7]. Approximately 20% is directly attributable to aerospace manufacturing.



Industry	Total Hiring Requirement 2021 – 2028	Share of 2020 Employment
Air Transportation	31,812	58%
Support Activities for Air Transportation	13,216	50%
Aerospace Manufacturing	13,102	25%

Figure 5 Data provided by CCAA from 2022 Aerospace Summit presentation.

Aerospace Manufacturing
- 2,309 new entrants make up only 18% of the required additional workers until 2028
- 10,793 workers needed from other industries and jurisdictions (recruitment gap)

Air Transportation
- 5,012 new entrants to the labour force make up less than 20% of the required workers by 2028
- 26,800 workers needed from other industries and jurisdictions (recruitment gap)

Support Activities for Air Transportation
- 2,823 new entrants to the labour force make up 21% of the required workers by 2028
- 10,393 workers needed from other industries and jurisdictions (recruitment gap)

Note: New entrants are defined as the share of the population aged 15 to 30 in the labour force for each industry

Figure 6 Components of Hiring Requirement, Canada, 2021-2028, CCAA 2022

Aerospace Training & Human Capital Development Market

The landscape for aerospace training in Canada is a vast and complex ecosystem that encompasses a variety of providers. Post-secondary institutions offer a range of undergraduate and post-graduate aerospace programs from specialized engineering to management and administration programs, flight management, and technician training programs. A growing number of baccalaureate and post graduate programs have emerged in aerospace-specific engineering design and quality control, particularly in Ontario and Quebec (see the college diploma, undergraduate and post-graduate listing in

[6] CCAA Aerospace Summit presentation
[7] Key North American Industry Classification System (NAICS) codes for aerospace: 3364 – Aerospace product and parts manufacture, 4811 – Scheduled air transportation, 4812 – Non-scheduled air transportation, and 4881 – Support activities for air transportation

Appendix D). Other educational institutions do not stream undergraduate students into an aerospace specialization but offer tailored masters and PhD degrees in related engineering areas.

Transport Canada Approved Training Operations (ATOs) typically cover certified training in areas like Maintenance, Repair and Overhaul (MRO), as well as transportation services such as those for pilots and air travel support occupations. Appendix D shows a listing of ATOs and approved programs across Canada.

Technologies and aerospace manufacturing and maintenance jobs are increasingly demanding more cross-functional purpose and skills. This has prompted training-focused (and other) organizations to develop both specialized courses and programs, and ones integrating transferable technical, leadership, and soft skills. A non-exhaustive list of courses and programs is shown in Appendix D. While some of these programs are not aerospace-focused, they provide skills and competencies critical to the industry.

Identifying Training Priorities

DAIR's 2023 survey identified technical engineering and manufacturing skills, quality assurance and corporate leadership to be among the most popular subjects for employee training in the past three years. Technical engineering, manufacturing and computer applications were noted as those most urgently sought in the near future (1-2 years, see *Figure 8 Training plans and priorities o*n the following page). Several survey respondents and panel interviewees identified their organizations as being "niche" and requiring very specialized skills. Therefore, a capability in training-related data and analysis creates a service opportunity to help organizations like these to define and construct a custom training pathway for employees.

While equipment-specific or "type" training is needed in many aspects of the work, there are a significant number of competencies that are common not only across distinct companies but even across unique positions and occupations throughout the sector. CCAA has been developing its *National Occupational Standards* for many years, and in the summer of 2021, developed a competency-based framework that clearly illustrates that the same competencies or skills often exist across those classifications. The project proves that competency-based models can be used to upskill, re-skill and cross-skill employees in shorter timeframes than traditional "authorized" pathways.

Of those companies responding to the industry training survey, less than half have their own training department or training officer. For smaller companies (<200 full time employees) only a quarter of respondents have dedicated training resources. In a survey by online learning industry leader D2L and Innovative Research Group, employers asked about low levels of investment in worker training cited lack of resources (27%) and uncertainty about what skills to target (12%). For many, poaching from other companies, and outsourcing skills is seen as easier than training existing employees.[8] About a third of the survey respondents have used mediated or facilitated services (e.g., DAIR, OAC, CCAA, etc.) to help with training programming and logistics. Their rating of the experience is very positive - averaging close to four out of a possible five stars on that survey response. Interview respondents noted the provision of logistical and administrative functions as among the most valuable in the experience of using an external facilitator for employee training. Given the lack of internal dedicated resources and the lack of a central "clearing house" for training programs, it is not surprising that many of the firms surveyed, particularly small companies (SMEs) like those we interviewed, seemed generally unaware of the availability of training programs and funding initiatives they can leverage to upskill and re-skill employees.

[8] Enabling Upskilling at Scale, D2L and Innovative Research Group, Dec 2021

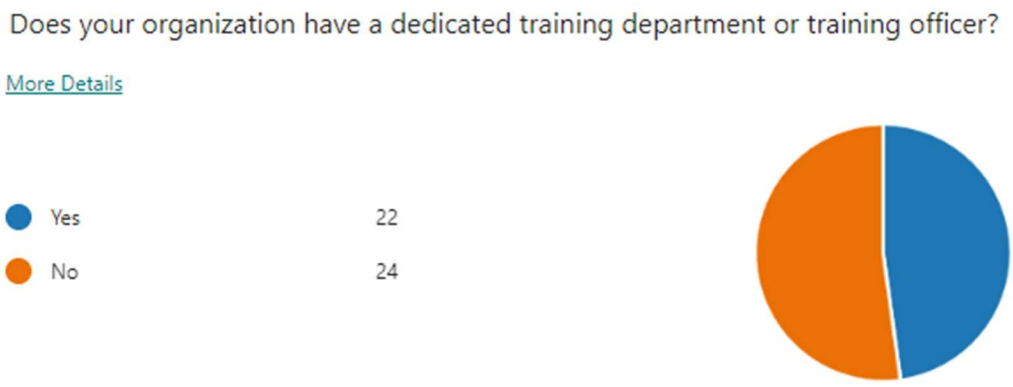


Figure 7 Dedicated training resources

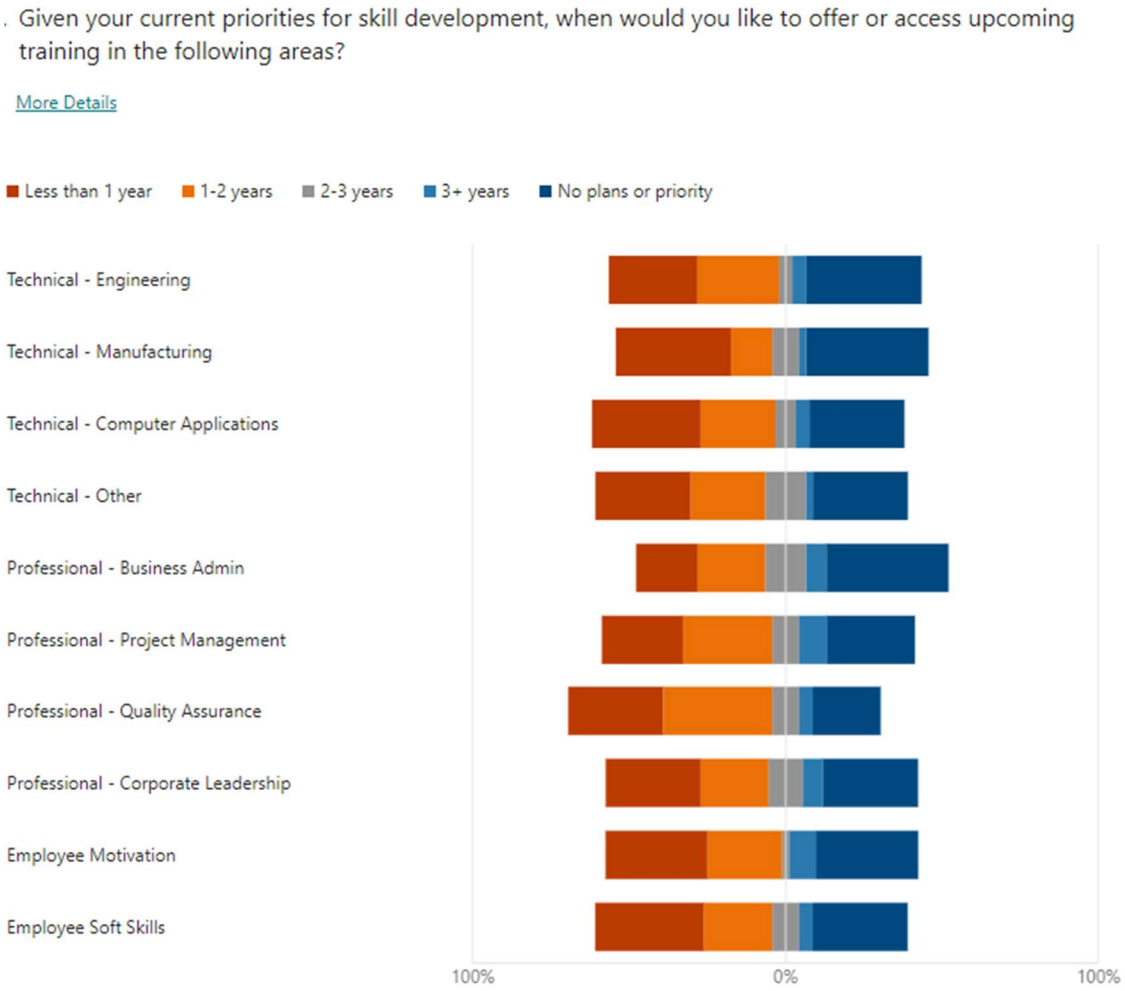


Figure 8 Training plans and priorities

Market Challenges & Opportunities

Given the history and context noted above, several challenges and opportunities arise for those looking to contribute to aerospace training and skills development. As illustrated in the following sections, challenging demographics and insufficient funding are often discussed as hurdles to overcome while inadequacies in traditional models of education present questions – and openings – for academic redesign. New models for delivery of contemporary (and often quickly

emerging) skills suggest agile training methods that can incorporate innovative work-integrated learning, applied research, and micro-credential deliveries of competency-based training.

Navigating Training Options

The rapid changes in the number and variety of training organizations and aerospace-related training options have made it difficult for individuals and industry to identify and compare training options. Several organizations work to support companies in understanding available opportunities, including DAIR and the OAC. Since 2022, DAIR has been developing a resource to help address the challenge with a database of aerospace and related training that catalogues dozens of courses and programs from both traditional and non-traditional sources of learning and certification. The data has been structured to classify programs according to provider, credential, duration, purpose, delivery mode and other characteristics that may be valuable in helping make better connections between training providers, industry, and learners. The hope is to use this capability to better track and communicate training opportunities to companies and their employees (See Figure 9 Sample from database).

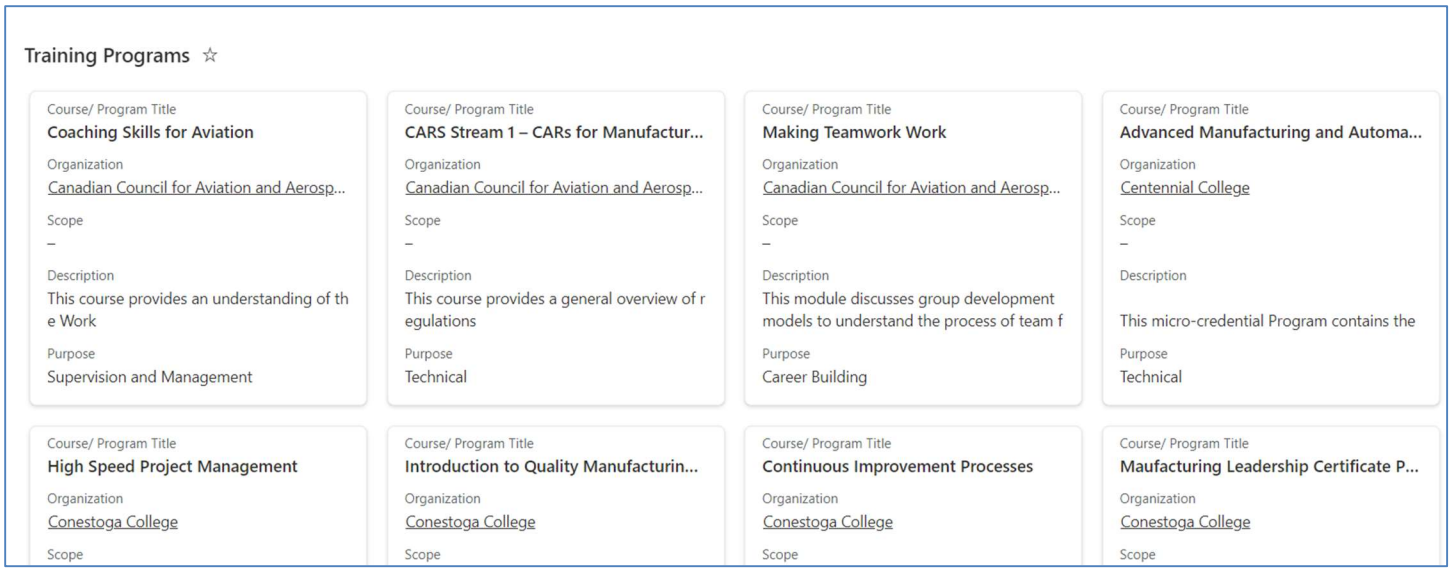


Figure 9 Sample from database

Recruitment Gap/ Demographics

Practically every industry sector among first-world countries is impacted by the reality of an aging workforce and a much smaller labour market left behind as the baby-boomer demographic retires and exits. The Canadian aerospace industry average worker age of above 45 years (some sources suggest it is well over 50 years) indicates an outmigration of senior workers over the coming decade[9].

The shortfall in recruitment for the industry was made worse by declining enrolments and temporarily suspended aerospace engineering, technical maintenance, and related training programs during the pandemic. Because of the time required to complete training this will affect recruitments over a two-to-three-year period. As noted in the CCAA report, only about 20% of the hiring requirement will come from new entrants, implying that nearly 80% of the recruitment gap will need to be filled from other industries or jurisdictions.

It is well known fact that, while some progress is being observed, aerospace remains a culturally homogenous and highly male-dominated industry. To summarize, men make up nearly 70% of the workforce, only 3% of workers are indigenous, almost half are above 45 years-old and nearing retirement (less than 7% of workers are 25 or younger), and nearly three-quarters are non-immigrants.[10] As such, increasing diversity would help alleviate the industry's labour-related pressures, thereby increasing its resilience, innovation capacity and overall competitiveness.

Canada saw record population growth in 2022, with immigration accounting for the vast majority of the 1.05 million new residents[11]. Among native resident communities, the indigenous population is showing exceptional growth.[12] Meanwhile, even with skill scarcity, immigrants and women appear to face barriers to entry into the aerospace workforce. [13] Immigrant policies are emerging to build the workforce, and some policy is pointed to attracting certain critical skill sets including technical skills like those sought by aerospace. However, numerous other industry sectors are also clamoring for the same skills as technical competencies grow in demand and unskilled jobs diminish.

Another trend of interest is the strong emerging "grey market" for experienced senior advisors, consultants, and part-time and casual technologists, in part to retain and leverage critical legacy knowledge and in some cases to act as mentors and instructors. This phenomenon is contributing to some degree to the "gig economy" where workers take on short-term or casual work without committed full-time employment conditions – or benefits. Younger participants in the gig economy include talent-on-demand who cannot or do not wish to be employed in an exclusive contract with an employer.[14] Freelancing can be lucrative and beneficial to both parties but can often leave gig workers without access to regular benefits like corporate-sponsored training. Unemployed and under-employed labour may find it difficult to access training that would allow them to engage and contribute in a timely way. Several funding programs in Ontario such as OAC's COAST program, and others across Canada (e.g., Nova Scotia's SkillsPass, BC/Alberta's ReTrain program) have emerged to try to support such gaps.

Funding for Skills Training

The 2021 D2L study showed a third of Canadian employer respondents felt internal training was sufficient and preferable to external training while highlighting lack of resources as a significant reason for not seeking and providing external

[9] 45 year-old average quoted by Lightcast data from census; CCAA reasons the number to be over 50.
[10] Insights from the Canadian Aerospace Industry Diversity, Equity & Inclusion Survey, EY Canada, 2022
[11] *Canada sees record population growth in 2022 from immigration*, Jack Guy, CNN
[12] The Indigenous population grew by 9.4% from 2016 to 2021, surpassing the growth of the non-Indigenous population over the same period (+5.3%). Statistics Canada, 2021 Census
[13] *Industry 4.0, the Future of Work and Skills*, 2021, Diversity Institute et al
[14] The Future of Work and Learning in the Age of the Fourth Industrial Revolution – Canada, D2L,2018

training for employees. Panelists in the DAIR study frequently identified resources, including costs (and lost productivity) as a deterrent to employee reskilling, upskilling, and cross-skilling.

For years, aerospace business associations and trade unions have been arguing that the Canadian industry is at a disadvantage compared to other jurisdictions and have urged all levels of government to invest more for the industry to compete at the same level. The catastrophic consequences of the COVID-19 pandemic put even more pressures on the industry but, as an example of the disparity of support, by 2021 the Canadian government had not announced a strategy for aerospace and in 2020 provided aid of only 1.3% of 2019 ticket sales to support the airline industry recovery in comparison to pledges by the US (32.7%), France (36.1%), Germany (19.5%), and the UK (7.1%). [15] No direct support had been provided to the aerospace industry until the creation of the Aerospace Regional Recovery Initiative launched in 2021 which has been generally well received. Upskill Canada, a sector-agnostic $250 million 3-year initiative meant to address advanced manufacturing workforce-related pressures was launched in May 2023[16]. In November 2022, the government announced the contribution of $39 million to the CCAA's "Industry Led Training for the Aviation and Aerospace Sector" project[17].

The Jean Charest-chaired 2019 report for AIAC (Vision 2025) outlined several areas of potential investment related to training including the creation of a national system to coordinate co-op and work-integrated learning (WIL) placements, initiatives to promote the industry's high-paying and attractive workplace to students, financial incentives to persuade experienced workers to stay on the job, fast track immigration processes to recognize learning, development of dedicated national training centres and the incorporation of homegrown digital training solutions.[18] The federal Aerospace Review, lead by former Minister David Emerson, in its November 2012 report was already calling for the need to develop (co-funding and maintenance) research and training infrastructure in existing aerospace hubs such as Toronto and Montreal. While these reports have brought attention to the pressing need, there is still considerable uncertainty in 2023 as to how these goals might be accomplished.

Several panel members and contributors to this work noted the paradoxical challenge of building long-term skills capacity through contemporary short-term funding strategies. Tying government programs to sustainable models of human capital development for aerospace will require non-partisan awareness and acceptance of the importance and critical challenges of aerospace training and recruitment. Extended program supports will allow the time needed to effectively develop, deliver, monitor, and improve learning outcomes. With access to longer-term funding, courses can be developed, delivered, reviewed, and evolve based on the needs of industry. Meanwhile, it is also clear that industry needs to increase its long-term investment in training if it wishes to have a work force trained in contemporary technologies and practices. Half of the companies responding to a related survey question say they spend 5% or less of overall budget on training.

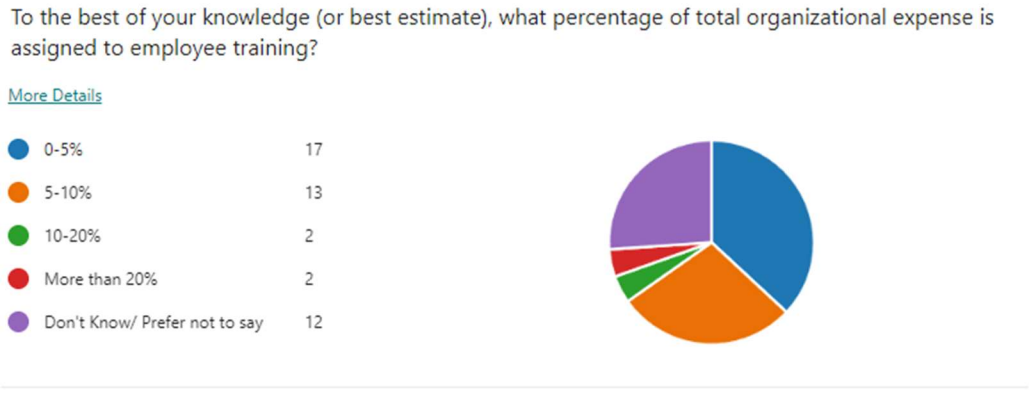


Figure 10 Spending on Training

[15] Industry 4.0, Diversity Institute et al
[16] https://ised-isde.canada.ca/site/upskilling-industry-initiative/en
[17] https://www.canada.ca/en/employment-social-development/news/2022/11/government-of-canada-invests-in-skills-training-for-workers-and-job-seekers-in-the-aerospace-sector.html
[18] Charting a New Course, Canada as a Global Aerospace Champion, AIAC,2019

Canada's focus on civil aviation (as opposed to its smaller footprint in the defense-oriented industry) also has an impact on strategic funding for skills training, potentially missing the opportunity for many to engage in defense projects. As noted in the State of the Aerospace Industry Summer 2022 report, even during the worst of the pandemic when civil manufacturing was plummeting, defense spending in aerospace continued to stabilize and even rise in intensity. One participant in our panel of experts noted that defense industry training investments in Canada appears "set to explode". With U.S. and NATO-centric pressure on Canada to increase defense spending, training and applied research will be critical requirements for design, development, and manufacturing process as well as MRO and operational skills. Programs like the Government of Canada's Future Aircrew Training (FAcT) program is already gearing up to renew aircrew training services to help maintain a multi-purpose and combat capable air force[19]. Canada's Industrial and Technological Benefits (ITB) Policy presents a significant financial opportunity for both R&D and skills development related to defense procurement contracts in Canada. The ITB policy leverages these activities through evaluative multipliers in the value proposition and associated re-investment by successful bidders.[20]

Post-secondary Credentials, I4.0, and Skills Obsolescence

Several factors serve to compound the challenge of addressing skill gaps in a timely fashion. Traditional models of education supporting aerospace-related training typically require commitment to a program of 2, 3, or 4-plus years of study. Some critics note that by the time a 4-year engineering graduate enters the market, at least a quarter of the skills and knowledge embedded in their course curriculum is obsolete. A high level of skill lag and obsolescence has also been observed in shorter 2- or 3-year programs. Panelists in the study note that even with current learning intensity, graduates are still not ready to fully engage and contribute to the work for another 6-12 months of experience and practice.

The emergence of the third industrial revolution put a focus on knowledge-based industries, signalling a further shortening of the obsolescence cycle. In recent years, a Fourth Industrial Revolution (Industry 4.0, or just I4.0) has been identified where an increasing number of high-school and post-secondary learners will be preparing for a world in which the jobs they might be hired into do not yet exist. This new age is characterized by robotics and automation, which has been, to some extent, adopted by aerospace, but also by connectivity, real-time monitoring and analytics, artificial intelligence, and virtualization, which to date are less-well employed in aerospace manufacturing and related services.

In the April 2021 Industry 4.0 aerospace study led by the Toronto Metropolitan University Diversity Institute, a definition is used that focuses on production quality control and continuous innovation. "In a manufacturing context, I4.0 includes development of a virtual factory; virtual supply chain management; predictive maintenance; and real-time control of quality and production volume and flows".[21] It also suggests a need for increased requirement of cross-skilling- the need to have professionals and technical workers understand concepts across the supply chain and production environment. Indeed, this was a critical concept in the development of the pilot ERP-SAP micro-credential program by DAIR, Centennial College and the OAC. Although the implementation of I4.0 does not affect all workers and does not affect them all in the same way, several general trends stand out: 1) an increasing sophistication of monitoring devices, 2) an increase in work standardization, and 3) a reduction of workers' collective and individual control over work.[22] From a training perspective, the industry must shift from one based on tacit knowledge and skills to codification and standardization of tasks necessary to implement I4.0 and to a culture of continuous, lifelong (and often just-in-time) learning.

[19] https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/air/snac-nfps/ffpn-fact-eng.html#a1

[20] Industrial and Technology Benefits Policy, Government of Canada extracted from https://ised-isde.canada.ca/site/industrial-technological-benefits/en, on April 6, 2023

[21] Industry 4.0: The Future of Work & Skills, Diversity Institute et al

[22] Ibid

Many have questioned whether Canada's traditional post-secondary and Transport Canada-controlled training model can keep up with this cyclical and systemic obsolescence. A 2018 report by D2L questions the relevancy of credentials earned through traditional post secondary pathways in the age of Industry 4.0. "As tuition fees and student debt increase, students who want to learn and attend post-secondary education have mixed experiences in translating their credentials into earning power...Knowledge is becoming more accessible, PS credentials are becoming increasingly required but less affordable, and their relevance lasts for shorter periods of time."[23] Beyond the need to address obsolescence, the question is whether current post secondary institutions and certification bodies like Transport Canada can pivot to accept the potential of incremental, targeted training like micro-credentials, badges and emerging competency-based short programs to replace or supplement 20th century monolithic models (based on seat-time) for technical credentials.

Systemic roadblocks in this environment frustrate upskilling, re-skilling and certification initiatives focused on efficient work transition. A large manufacturing and MRO company in Western Canada noted that, while it has been very actively recruiting from local graduating classes, they have also been aggressively recruiting skilled foreign workers to fill the gap. However, they are constantly frustrated with the amount of time it takes to get foreign workers certified to Canadian standards because our regulatory climate is not structured to support getting employees engaged in key projects in a timely fashion. Meanwhile, to further complicate the transition, in recent years Transport Canada has severely limited or declined targeted competency-based models and alternate deliveries for technical certification programs.

CCAA's emerging competency-based framework and initiatives such as the 2020 micro-credential pilot[24], the OAC's COAST program, and the recent DAIR- Centennial College ERP micro-credential[25], illustrate viable supplements to occupation-specific credentialling for key industry needs. While no industry or government stakeholder wishes to relax quality standards, many are hoping that current resistance and outdated restrictions on competency-based models can be reviewed to help Canada increase its ability to efficiently address the emerging training pressures of the industry. While current limitations exist, Canada will struggle to fill employment gaps and to fully engage in the opportunities of Industry 4.0.

Opportunities related to competency-based training models are more fully described later in this document.

WIL/ Applied Research & Development

Responses to our survey as well as comments from the panel of experts suggest that higher education programs do a fair job of delivering basic theoretical knowledge but provide insufficient experience and practical application to make graduates ready to engage in analytical aspects, problem-solving, and independent configuration, and operation of technologies. In a recent D2L poll, only 11% of advanced manufacturing CEOs asked about whether graduates have the skills needed to be productive on entry say they do and yet, 96% of university CLOs say they are doing a great job providing the skills that graduates in these fields need to be productive.[26]

Last year alone, Canadian colleges and institutes were involved in over 7,300 research partnerships that generated over 4,400 innovations, including new processes, products, prototypes, and services, approximately 87% of which were completed in less than one year.

Applied Research Comes of Age, 2019 CICAN

[23] The Future of Work and Learning, D2L
[24] https://www.avaerocouncil.ca/en/ccaa-bulletin-2020/ccaa-micro-credential-training-aviation-aerospace
[25] https://www.dairhub.com/initiatives/sap-micro-credential/
[26] The Future of Work and Learning, D2L

Considerable interest has been shown in Work-Integrated Learning (WIL) approaches, pairing students with employers to develop higher level practical skills and experience. Over and above traditional apprenticeship training, opportunities abound including basic in-course work placement, mentorships, and internships as well as knowledge capture and transfer, innovation as a skill specialization, and focused skills practice to reach higher levels of technical competencies. Co-op is a common option for students amongst undergraduate programs to integrate hands-on experience into their learning. In spring 2018, the Government of Canada announced support for work-integrated-learning opportunities for college students through their Innovative Work Integrated Learning (I-WIL) Program. High-quality internship opportunities provide obvious advantages for students. They gain work experience and develop valuable skills they will need in their careers.

One area of special interest is the engagement of graduate and post-graduate students in applied research and collaborative R&D projects in industry. In 2019-2020, 42,000 students contributed to applied research projects at college and institute laboratories and research centres (an increase of 45% over two years). Colleges and institutes received over $354 million in 2019-2020 to support applied research activities, an increase of 19% over two years. [27] As many of our respondents noted, and evidence suggests, the development of learners' engagement in R&D goes beyond scientific or technical development to incorporate essential skills including teamwork, collaboration, communication, project management, and many more fundamental 'soft' skills being sought by industry. For businesses, these interns offer applied research expertise that advances R&D (and experiential learning opportunities) at a time when Canadian companies face shortages of such research talent.[28]

Several organizations have emerged or expanded to capture and deliver work integrated learning such as CCAA's student work placement program (SWPP)[29], Mitacs Internship funding[30], CICAN bursaries[31], NGEN's workforce transformation fund[32], CMAI's Placement Program[33], numerous initiatives from Government of Canada's Future Skills programs[34], and a host of regional WIL initiatives such as those sponsored by Ontario's Skills Development Fund[35] and the Ontario Aerospace Council. Some of the programs across the country are generic (not aerospace specific) and those that are directed to aerospace training have tended to focus on relatively narrow occupational definitions or have specific regional, sectoral, or institutional eligibility requirements. Appendix B references several programs and sources of funding and logistic support to work-integrated learning.

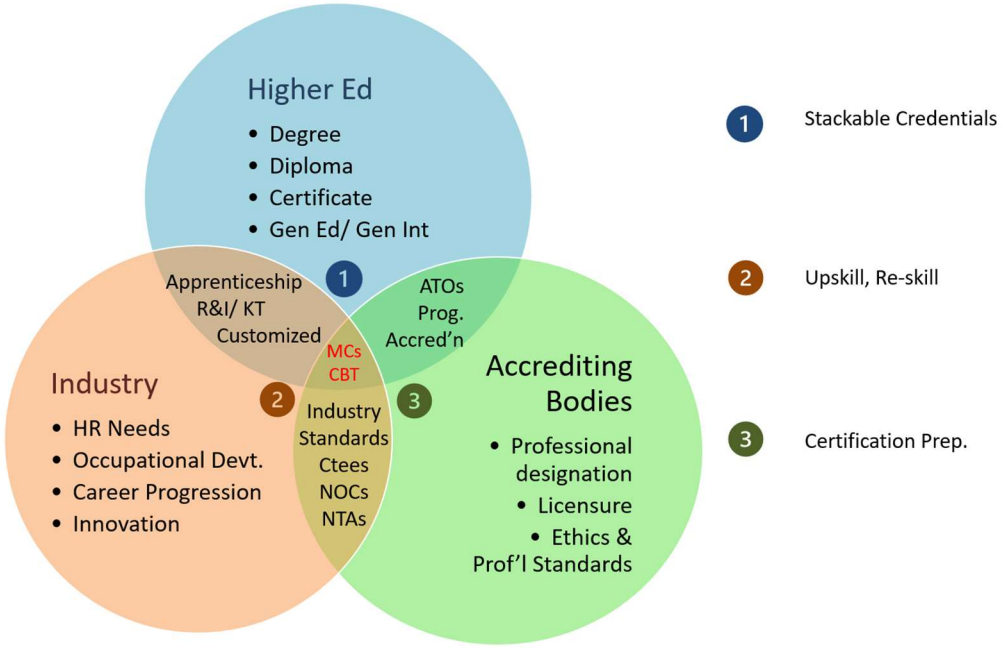
Competency-based Training (CBT) and Micro-credentials

Referenced in the sections above, the increasing interest of competency-based training (CBT), with its potential for micro-credential delivery options, is a response to the need for alternate models of training that can focus on currency in occupational requirements while delivering skilled workers more quickly than traditional credentialed programs. Competency-based training methods focus on what a learner can *do* rather than on *seat-time* in training. Micro-credentials offer intensive learning experiences that focus on a specific competency or group of competencies delivered in short courses, seminars, and workshops, or through modular online or hybrid training. The Venn diagram below illustrates some of the critical relationships between various players in the aerospace training ecosystem, highlighting core areas of interest,

[27] Applied Research at colleges and institutes, retrieved from https://www.collegesinstitutes.ca/arsurvey/ October 2022
[28] Applied Research Comes of Age, 2019, Research Money & Colleges and Institutes Canada
[29] https://www.avaerocouncil.ca/en/swpp
[30] https://www.mitacs.ca/en
[31] https://www.collegesinstitutes.ca/what-we-do/bursaries/
[32] https://www.ngen.ca/futureready
[33] https://placementspot.ca/
[34] https://www.canada.ca/en/employment-social-development/programs/future-skills.html
[35] https://www.ontario.ca/page/skills-development-fund

shared priorities and activities, and an integrated role for competency-based training (CBT) and micro-credentials (MCs) - represented by numbered indicators.

Figure 11 CBT and MCs in Aerospace Training ©2023 InnovaIT



Legend:
R&I= Research and Innovation; KT=Knowledge Transfer; MC=micro-credential; CBT=Competency-based Training; NOCs=National Occupational Classification; NTA=National Training Associations; ATO=Authorized Training Organizations

The core business of **Higher Education (HE)** is the preparation and certification of learners to curriculum standards and programs that define credentials within each institution's own framework – career-focused degrees, diplomas, certificates and, to some degree, education for general knowledge or general interest (continuing education). Where competency-based training and micro-credentials are concerned, one area of increasing interest is the idea of "stackable" micro-credentials leading to established academic awards within the HE framework.

Industry's priorities in training tend towards human resource requirements – the skills that define occupations/job descriptions – and career advancement (and to a lesser extent research and innovation activities). Areas of shared interest between HE and Industry include customized training (or contract training), as well as knowledge transfer stemming from applied research activities.

MCs and CBT present unique opportunities to quickly re-skill, upskill and cross-skill employees with minimal interruption of operations, especially when offered in flexible, and online formats.

Accrediting bodies see training as necessary to achieve professional designation and licensure standards, as well as to promote and enforce standards such as codes of performance and professional ethics. Accrediting bodies share training priorities with industry in the formation of occupational standards committees, and national training associations. They also share priorities with HE institutions in the granting of authority to deliver standards training through Authorized Training Organization (ATO) status, and accreditation of HE programs and courses.

For accrediting bodies, MCs and CBT can be instrumental in advancing or refreshing certifications through short, focused preparatory courses most often in collaboration with authorized training associations, academic institutions, or through direct workshop or online training. Our survey showed an interest in increased use of intensive learning experiences –

shorter courses and workshops. Intensive workshops showed a greater increase (by percentage) in future versus past delivery modes than any other single option in the survey. Two respondents to the panel interviews identified CBT as an approach that might accelerate foreign worker certification and allow faster employment in regulated projects.

Customized Training Solutions, Curation, and Collaboration

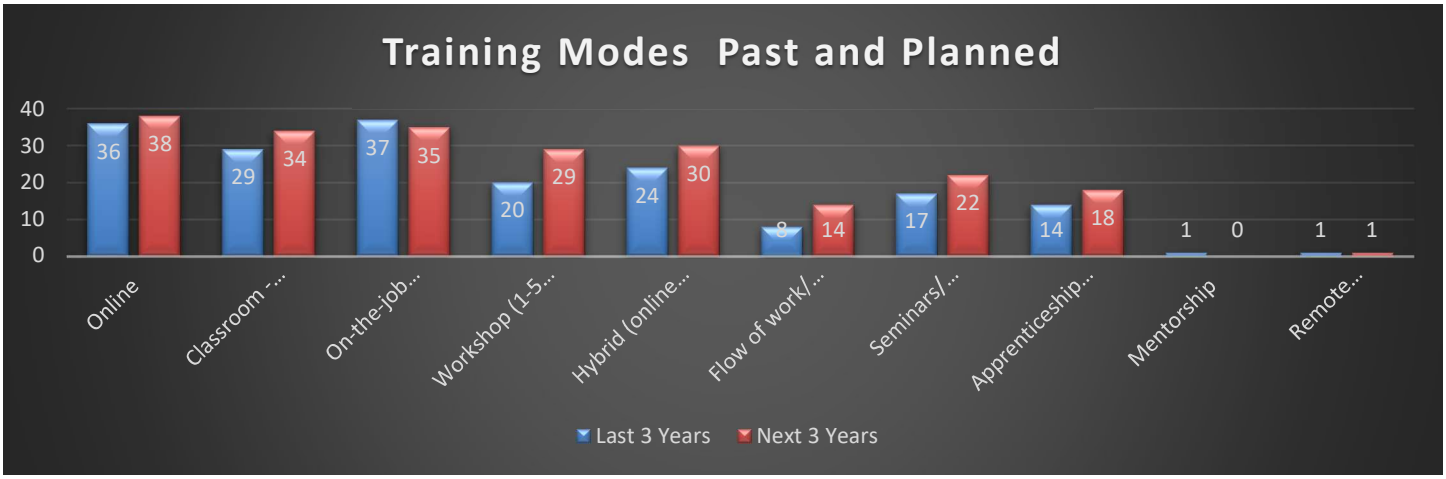


Figure 12 Past and planned modes of training delivery

In the past, companies relied heavily on workplace training, with online training lagging slightly behind. According to our survey results, on-the-job training will likely lose some ground to online training in the next few years while face-to-face/ classroom delivery will increase for the responding companies. The results also show a significant increase and interest in shorter training modalities including workshop, seminars, and flow-of-work (just-in-time) training.

Colleges and universities across the country attempt to serve industry's needs through regular interactions and engagements such as participation on Program Advisory Committees (PACs) as well as development of contract and customized programs for more focused and specialized requirements. PACs tend to be well engaged in cases of core programming (i.e., certificate, diploma, and degree programs), but less so in shorter programs and standalone courses. Contract and customized programs, meanwhile, tend to be focused on a single client and are often limited by the expertise and facilities available by the offering institution.

The complex needs of, for example, aerospace SMEs attempting to leverage new Industry 4.0 technologies are difficult to serve without facilitation that includes needs analysis, curation of custom, multi-institution solutions, and logistic support for enrolment, tracking and reporting. During the review of the recent collaboration between DAIR, OAC and Centennial College to deliver an ERP-focused micro-credential, it was noted by industry participants that the value of centralized coordination and logistics support were critical to the success of the program. In this case, the coordination involved the delivery of courses by only one institution (Centennial) and one primary funder, but this initiative demonstrates the capacity to develop and deliver custom solutions which could just as easily be across numerous delivery and funding partners.

In our country of small businesses, where over 99% of companies are considered small or medium-sized enterprises (SMEs), collaboration is often the key to growth and innovation. It is what spurs ingenuity, helping a business to punch above its weight. But several reports note that Canada lags in innovation among OECD countries which requires sustained measures including support for innovative partnerships.[36]

[36] Applied Research Comes of Age, Research Money/ CICAN

Opportunities and Approaches

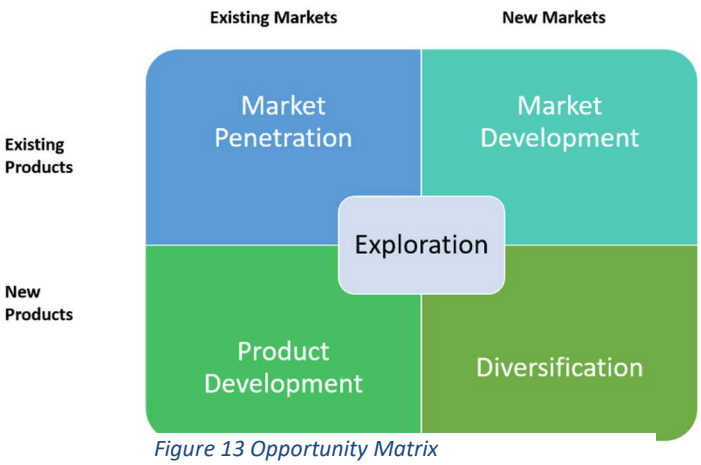


Figure 13 Opportunity Matrix

In general, pursuing new opportunities for most organizations comes down to some combination of market or product/ service expansion (or both). Markets refer to the consumer/ buyer needs that an organization targets to serve, although they can also be described in terms of geographic or demographic scope and other characteristics. Products and services are the bundle of benefits the organization offers to solve those market needs. In the following discussion, DAIR and the OAC are used as examples of how such strategies can be applied. These examples are not meant to endorse or recommend a particular action, rather to show how they might be applied for similar organizations.

The simplest strategy by most measures is that of **market penetration** since it does not require finding new markets to serve or developing new products or services. Penetration typically involves getting a bigger piece of the existing pie, being more effective in reaching prospects, acquiring, and maintaining client loyalty, and capturing share from competitors. It can also result from changing geographic scope – that is, reaching people with the same needs for the same products or services but in areas that the firm has typically not been able to reach with existing distribution or marketing tactics. Using a training facilitation service like DAIR as an example, this strategy could involve geographic expansion of present services from regional to national scope as well as a larger portion of project resources, possibly by more fully controlling and servicing projects and/or clients. The AIAC Vision 2025 report calls for industry and government to "Create national training facilities and invest in the adoption of digital training solutions".[37] An organization like DAIR could apply market penetration by becoming one of those national centres of excellence leveraging its existing partnership, physical infrastructure and equipment, and customized training solutions to a national scale.

Market development, arguably the next most efficient approach, involves finding new needs and uses for the existing set of services or capabilities. In many cases, this is a matter of reimagining who might use or need the services and products an organization can offer. It can also occur through persuasion aimed at helping new markets identify that they have a need for what the firm offers. Using DAIR again as an example, this strategy could include expanding the scope of training facilitation and logistics management to other residents of Downsview park or reaching out to offer existing support services for a variety of new clients outside of aerospace companies. Using the OAC as an example, this could involve expanding COAST programming to aerospace adjacent companies throughout Ontario.

Product development requires a firm to create additional, revised, or ancillary products and services to satisfy their existing markets. This usually requires bringing in new staff, processes, or equipment or developing the capacity of the existing systems and resources to better meet market need. Advancing the use of an organization's databases and systems, location and facilities, and strategic hiring to offer a broader set of services to both existing clients and to prospective regional, provincial, and as applicable, national clients would be key to this strategy.

A firm might opt to pursue wholly new markets with new products and services in a strategy of **diversification**. This is often achieved through integration, mergers, and acquisition. It is generally the most complex, risky, and expensive strategy although, when done well, it can mitigate overall risk and create revenue streams not easily met in any of the other approaches. DAIR and the OAC, or a similar organization could, for example, hire educational specialists or merge with a skills development services organization and get into the business of defining or developing learners' certification pathways

[37] Charting A New Course - Canada as a Global Aerospace Champion, Hon. Jean Charest, Chair

or “badges” held by the organization and supporting, specific or specialized segments of the aerospace industry, such as defense contractors.

While not specifically a strategic approach, the option exists for an organization to mix and match strategies, to **explore** and integrate multiple approaches combining various forms of market and product development, and possibly engaging current or new partners more fully in their own strategic directions. This could be illuminated through investigating business simulation or conducting further market research on specific opportunities prior to commitment.

Opportunities in the Ontario and National Marketplace

There is a saying that “In every problem lies an opportunity”[38]. If that’s true, then A&A training in Canada presents a wealth of opportunity. But it is not only current problems that present the chance to contribute and to profit through innovative solutions. As noted earlier, Canadian aerospace manufacturing is already well established in a variety of export markets and these products would be accompanied by related product usage, maintenance, and logistics training. Referencing the opportunity matrix of the previous section, market penetration can expand on those export channels through geographic expansion or broadening the focus from a primarily civil base to an emerging global need for military and defence services. New, emerging trends like increased environmental consciousness, and emergence of Industry 4.0 technologies including data analytics, artificial intelligence (AI), unmanned aerial vehicles (UAVs), virtualization and augmented reality, digital twinning in manufacture, etc. offer an opening for new training models and market development. Industry consolidation and collaboration along with growth of applied research can result in diversification that will generate viable revenue streams for knowledge transfer activities, change management, and technology-driven competency-based training.

The problems identified in the findings are not insurmountable, but they are significant. The gap in employment as identified by CCAA and others will require either increasing the number of seats in traditional programs, or adopting training models that can transition, upskill, re-skill, and cross-skill workers more efficiently than current program deliveries. The protracted time-to-market for transitional employees and immigrant workers is one of the more challenging problems facing the industry. Shorter, focused, and competency-based training, assessment, and certification are essential to closing those gaps. Meanwhile, *selling* aerospace as a viable career path after the turbulent years of the pandemic, will take some outreach effort through school promotions, career guidance, and job fairs, and a coordinated approach by all stakeholders.

Funding support must also be addressed. While government programs, including those discussed in this document, are helping to inspire innovative collaborations, much more investment will be needed to close employment gaps and to

[38] Saying is attributed in some sources to Robert Kiyosaki

support Canada's adoption of Industry 4.0 advancements. Some funding must come from industry, but this study shows that industry resource limitations may be more about gaps in supports for needs analysis, custom training design, curation, and facilitation of unique training pathways, logistics, and collaborative applied research. Financial investment in existing and new sector support organizations must move the needle from short term incentives to long-term strategic viability and sustainability.

National training centres, with well equipped labs and workshops, integrated logistical and data analytics capabilities, competency-based training courses aligned to national standards, and strong industry-academic networks can support innovative training design including work-integrated learning, applied research, and customized learning deliveries. The existing aerospace innovation hubs in Quebec and Ontario need support and development to create or enable those national training centres, while work is also needed to integrate Western-headquartered aerospace firms into hubs in those regions and to develop R&I and training facilities on both coasts and the North.

As was discovered in the program review, one valuable function that National Training Centres could offer is to establish common metrics by which funded training can be consistently and objectively assessed and improved. The Future Skills Centre has partnered with consulting firm, Blueprint, to build an emerging model for rigorous evidence-based project evaluation[39]. A model developed in this project (see Appendix E) similarly provides a proposed set of decision supporting metrics for improved transparency, accountability, and viability of programs and courses offered in publicly funded training initiatives. In addition to evaluating traditional metrics like training demand and industry need, the rubric provides guidance to training providers for both feasibility (doing the right thing) and quality (doing the thing right). It also looks at how to improve on any given partnership's impact and value to the industry – and the sponsoring agency.

Collaboration is a vital key to success. While larger tier-one firms and established academic partners should contribute significantly to the effort, they will also be primary beneficiaries of the investments, particularly when they help to build a reinforced lower tier making available those centres, programs, and facilities to SMEs and supply chain partners. A&A in Canada is an ecosystem – when all parts are well supported and provided opportunities for success, the sector as a whole will grow and thrive. For sector support organizations, a necessary level of redundancy is to be expected with overlapping and shifting mandates creating conditions we call *co-opetition* - where they will compete for resources at one point while collaborating on common projects at another.

[39] https://fsc-ccf.ca/innovation-projects/evaluation-strategy/

Summary

This project, enabled by funding acquired through the OAC's COAST programming and the Government of Ontario's Skills Development Fund, has spent nearly nine months of research and analysis of the Aviation & Aerospace industry, current training regimes, supporting systems, and developing trends to identify, define, and categorize challenges and opportunities of the industry's training marketplace. Following a substantial national-scope environmental scan, we used the context of Downsview Aerospace Innovation and Research (DAIR) hub and the Ontario Aerospace Council (OAC) as central players, leveraging their well-established partnership, contacts and network, and training experience as an exemplar for the application of relevant strategic directions. We have been able to summarize some of the most critical challenges and to show how organizations like DAIR and the OAC, as well as other partners, might overcome hurdles to advance opportunities in the marketplace.

Real challenges exist for A&A in Canada, but industry strengths are also in abundance. The work of sector support organizations and myriad other related facilitators cannot be underestimated. Each has its own place in the A&A ecosystem. Consolidation and collaboration of efforts could be improved with a national strategy and the development of National Training Centres (NTCs), as called for by the AIAC Vision 2025 report. In our estimation DAIR, in conjunction with the OAC, and the Quebec aerospace cluster present the most viable and sensible starting points for robust NTC development, followed by work to develop Western Canada and related (albeit potentially smaller) centres on the coasts and in the North.

We present A&A in Canada (and its related training marketplace) as an ecosystem of industry, academic, sector support, and government players. As such, there needs to be a coordinated and collaborative approach to its growth and progress, while noting that some overlap in organizational mandates will naturally occur. Those who study and manage ecosystems understand the need to carefully cultivate the landscape with intentional sector-wide strategies and tactics that advance the health of the whole sector. The strongest elements in the system benefit by reinforcing lower level, supportive systems and by close monitoring and tending of the individual elements of the broader sector.

The success of this ecosystem will depend on effective training models and practices, focused government, and sector policy development, supports for applied research and innovation, and facilitated collaboration among the various members of the community. There is a bright future for aviation and aerospace in Ontario and Canada, but only if government and industry leaders can seize the kind of bold ambition that characterized the early history of aerospace in this country. Otherwise, foreign competition and quickly emerging modern trends will challenge the ability for Canada to compete, grow and thrive in global aerospace.

Appendices

Appendix A – Project Proponents

About DAIR

The Downsview Aerospace Innovation & Research (DAIR) hub brings together academics, companies, research organizations, and government stakeholders around a shared goal – to advance Canada's global aerospace industry leadership. Located at Downsview Park in Toronto, DAIR builds on the legacy of visionaries, leaders and workers who helped make Canada a global aerospace and aviation champion.

First envisioned in 2012 by Centennial College, the University of Toronto and Bombardier, DAIR began as a working group seeking to strengthen Canadian aerospace R&D and education. In 2018, DAIR expanded its operations, staff, and physical site leading to its incorporation in 2020 and the appointment of a Board of Directors and a full-time Executive Director to direct continuing growth.

DAIR's stated purpose is to facilitate innovative collaboration between industry and academia to strengthen Ontario's aerospace ecosystem to the benefit of the Canadian sector. Its immediate goals are to foster strong R&D partnerships and create transformational solutions that can significantly boost competitiveness.

About InnovaIT Professional Services

InnovaIT Professional Services (InnovaIT) is focused on meeting the needs of small and medium-sized enterprises (SMEs), NGOs, and other organizations for professional/ technical services, strategic training development, and management consulting. InnovaIT provides a range of professional services including:

- Customized organizational/ training development
- Strategic management consulting
- Business analysis
- Project/ program management
- Process and systems engineering/ improvement
- Educational technology services

InnovaIT employs a proven model of collaboration and professional approaches supporting its clients with consulting services, research, and technical expertise to help identify and advance their strategic objectives. InnovaIT has been proudly doing that for over two decades. Recent engagements include consulting in competency-based micro-credential program development for the Canadian Aerospace sector, process improvement for a private aerospace trainer, online program evaluation for a large regional college, and research and analysis of certification opportunities in the non-destructive testing industry.

About Ontario Aerospace Council

Established in 1993, the Ontario Aerospace Council (OAC), a not-for-profit organization, is comprised of more than 200 member companies, representing over 70% of the Ontario aerospace industry employment base and spans all

tiers, business activities and sizes, and also includes colleges and universities and companies that do business with the aerospace sector.

The purpose of the OAC is to enhance recognition of Ontario's capabilities as a leader in global aerospace markets and work together to build greater expertise to assure continued growth and prosperity. OAC fosters relationships between all stakeholders: industry, academia, researchers, governments and associations to gather and share industry intelligence, identify and facilitate funding as well as being an active catalyst for industry growth.

OAC COAST – Competencies Online Advancement Skills Training program was established in April 2020 – March 2021 through funding from the Ministry of Labour, Training and Skills Development (MLTSD) Skills Catalyst Fund. OAC COAST was awarded funding under the MLTSD Skills Development Fund 1 in April 2021 – March 2022 and Skills Development Fund 2 April 2022 – March 2023. Through these industry- led programs COAST has developed and delivered 5 technical in-demand programs and 19 non-technical programs to support aerospace's COVID recovery, growth and retention of a skilled workforce.

Appendix B – References

The following list provides some of the key sources and resources used in collecting the findings for this report:

Books, periodicals, data sources, and articles

State of Canada's Aerospace Industry Report, AIAC, 2022
Ontario Aerospace & Aviation Industry Critical Strategic Skills Priority Survey, OAC, 2022
Aerospace Summit Presentation, CCAA, 2022
Insights from Canadian Aerospace Industry Diversity, Equity & Inclusion Survey, EY Canada, 2022
Enabling Upskilling at Scale, Desire to Learn (D2L) and Innovative Research Group, 2021
Canada sees record population growth in 2022 from immigration, Jack Guy, CNN, 2023
Industry 4.0, the Future of Work and Skills, Diversity Institute et al, 2021
The Future of Work and Learning in the Age of the Fourth Industrial Revolution–Canada, D2L/ CICAN,2018
Charting a New Course, Canada as a Global Aerospace Champion, AIAC,2019
Applied Research Comes of Age, Research Money/ CICAN, 2019
Four Aerospace Occupations in Canada, Lightcast Data/ NSCC, 2022
North American Industry Classification System (NAICS)
College Quality Assurance Audit Process, Ontario College Quality Service, 2022
Blueprint's FSC Evidence Summary 2021: Our Insights, April 2022, Future Skills Centre and BluePrint
Stats Canada 2021 Census

Websites and online resources

Future Aircrew Training, https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/air/snac-nfps/ffpn-fact-eng.html#a1
Industrial and Technology Benefits Policy, Government of Canada, https://ised-isde.canada.ca/site/industrial-technological-benefits/en
CCAA Micro-credential Project, https://www.avaerocouncil.ca/en/ccaa-bulletin-2020/ccaa-micro-credential-training-aviation-aerospace
DAIR SAP/ERP micro-credential, https://www.dairhub.com/initiatives/sap-micro-credential/
DAIR Mission, Values & Vision, https://www.dairhub.com/about-us/mission-values-vision/
Applied Research at Colleges and Institutes, https://www.collegesinstitutes.ca/arsurvey/
Student Work Placement Program, CCAA, https://www.avaerocouncil.ca/en/swpp
MITACS, https://www.mitacs.ca/en
Next Generation Manufacturing Canada (NGen) https://ngen.ca
CICAN Bursaries, https://www.collegesinstitutes.ca/what-we-do/bursaries/
Future Ready, NGen, https://www.ngen.ca/futureready/
PlacementSpot, https://placementspot.ca/
Future Skills Centre, https://www.canada.ca/en/employment-social-development/programs/future-skills.html
Ontario Aerospace Council COAST, https://www.oaccoasttraining.ca/
FSC Evaluation Strategy, https://fsc-ccf.ca/innovation-projects/evaluation-strategy/
Ontario Skills Development Fund, https://www.ontario.ca/page/skills-development-fund
Ontario Building Training Centres, https://news.ontario.ca/en/release/1002850/ontario-building-training-centres
Ontario's Labour Market, https://www.ontario.ca/page/labour-market
Wikipedia, https://wikipedia.org

Organizations and individuals

Although they will remain anonymous, we wish to thank the many individuals and organizations who have contributed to the project. In particular we are grateful for the input and support of the staff and executive of Downsview Aerospace Innovation & Research (DAIR), Ontario Aerospace Council (OAC), Canadian Council for Aviation and Aerospace (CCAA), the dozens of companies who responded to our survey, the exceptional group of industry leaders who composed our panel of experts, and the faculty and staff of Centennial College who provided invaluable advice and input on the SAP/ERP program review.

Appendix C – Selected Data and Statistics

All stats courtesy Lightcast Data Q32022 Data Set

Parameters

Industries:

Code	Description
3364	Aerospace product and parts manufacturing
4811	Scheduled air transportation
4812	Non-scheduled air transportation
4881	Support activities for air transportation

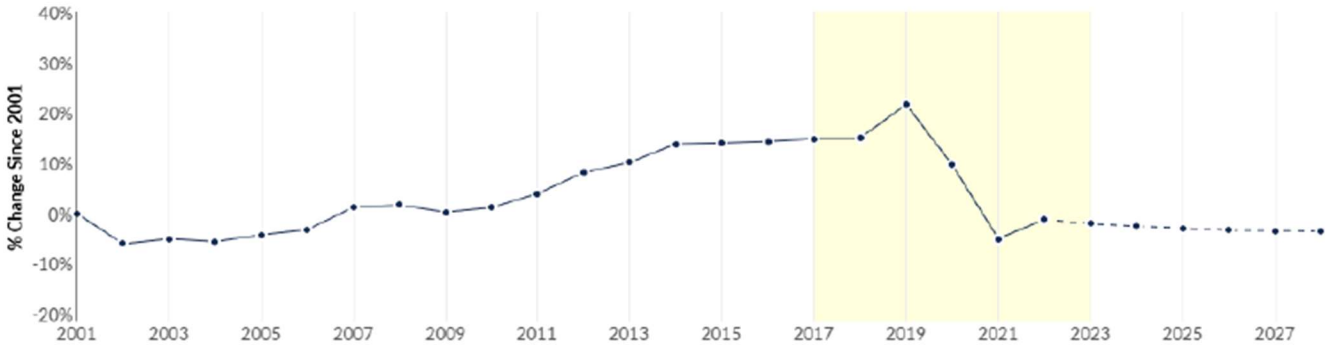
Regions:

Code	Description
01	Canada

Timeframe: 2017 - 2023

Datarun: 2022.3 – Employees and Self-Employed

Employment Trends



Region (Canada)	2017 Jobs	2023 Jobs	Change	Change %
	152,338	129,917	-22,421	-14%

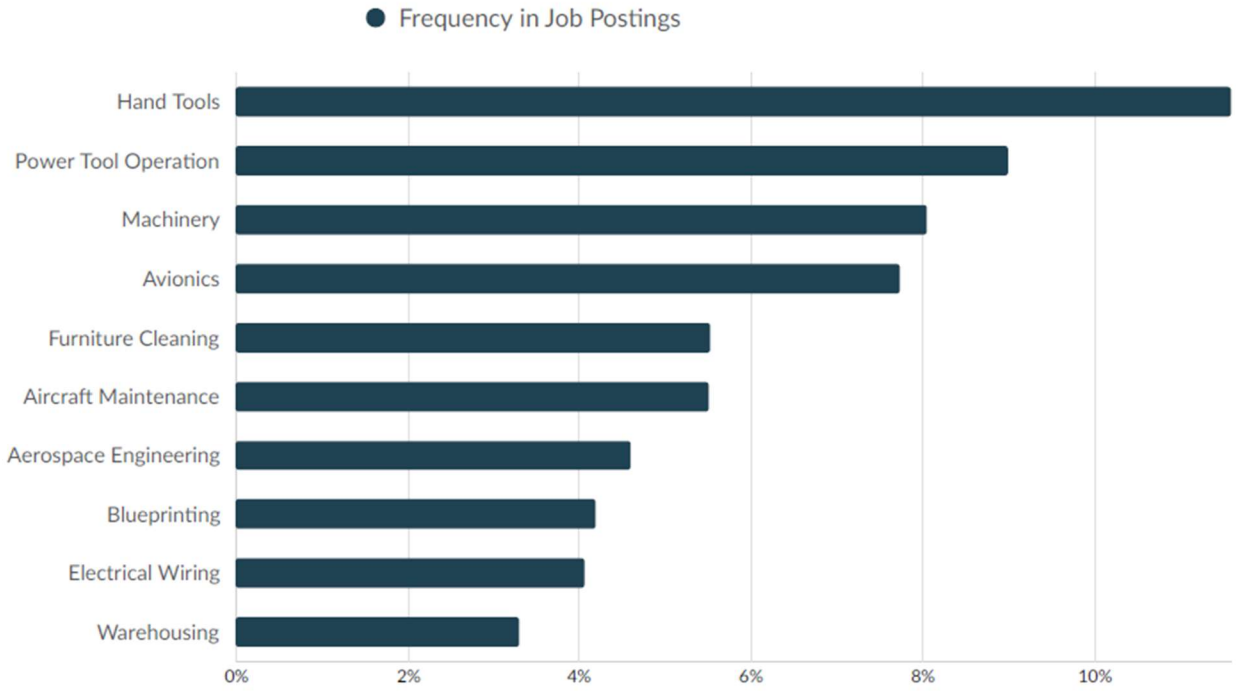
Occupations Employed by these Industries

Description	Employed in Industry Group (2022)	% of Total Jobs in Industry Group (2022)
Airline ticket and service agents	12,674	9.7%
Pursers and flight attendants	11,919	9.1%
Air pilots, flight engineers and flying instructors	11,255	8.6%
Aircraft assemblers and aircraft assembly inspectors	10,961	8.4%
Aircraft mechanics and aircraft inspectors	9,917	7.6%

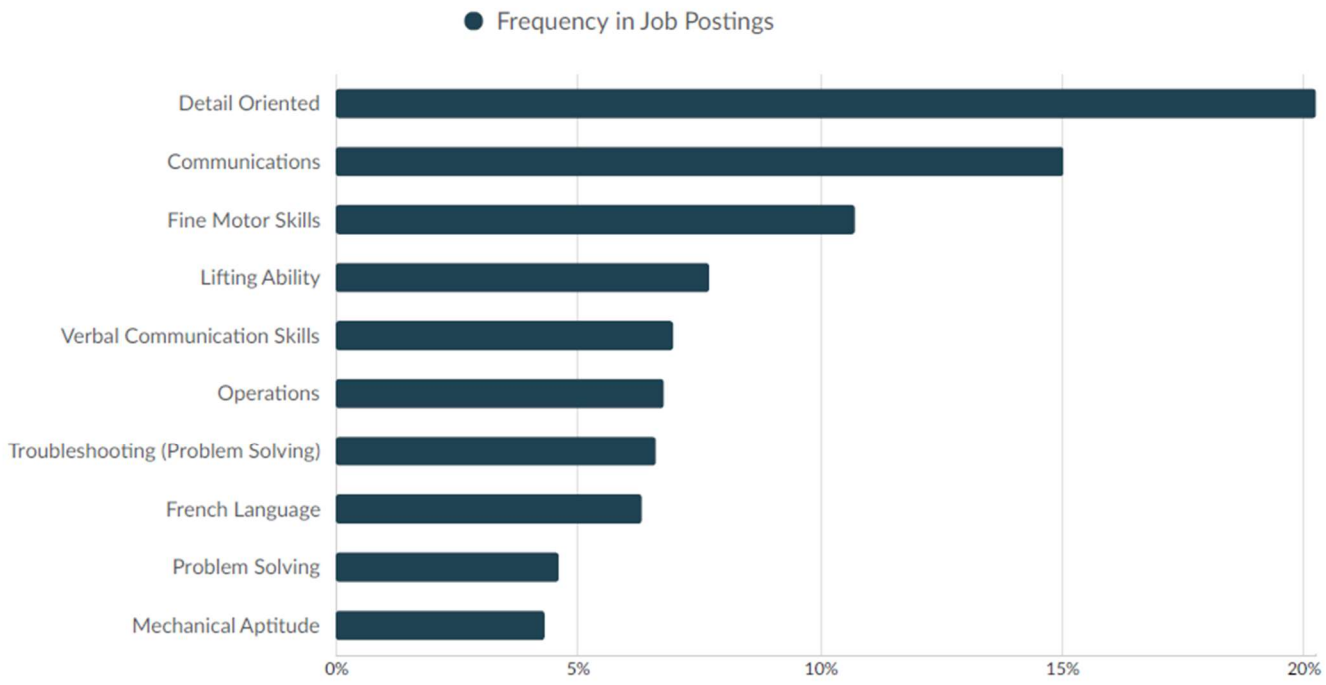
Most Jobs are Found in the Aerospace product and parts manufacturing Industry Sector

Industry	% of Occupation in Industry (2017)
Aerospace product and parts manufacturing	37.8%
Support activities for air transportation	12.4%
Scheduled air transportation	11.2%
Defence services	9.4%
Non-scheduled air transportation	4.9%
Architectural, engineering and related services	4.5%
Other	19.8%

Top Specialized Skills



Top Common Skills



Appendix D – Aerospace Training Programs in Canada

The following is a partial listing of programs identified. The programs and courses noted here were current at the time of collection but may have since been suspended or modified. This listing is not comprehensive of all aerospace-related training in Canada but focused on established programs of study in known ATOs and post-secondary institutions, as well as a selected list of the cross-functional, short courses, and/or soft-skill courses that the aerospace industry can access.

Transport Canada Approved Training Organizations (ATOs)

ATO	Course/ program title	Facility location	TC approval number	Effective date	Applicable credit
Algonquin College of Applied Arts and Technology	Aviation Technician – Aircraft Maintenance Technician	Ottawa, ON	2015-04-4199	Apr-15	18 months experience & knowledge
British Columbia Institute of Technology (BCIT)	Aircraft Maintenance – Basic M	Richmond, BC	2001-09-7000	Sep-01	18 months experience & knowledge
British Columbia Institute of Technology (BCIT)	Aircraft Maintenance – Basic E	Richmond, BC	2001-09-7001	Sep-01	18 months experience & knowledge
British Columbia Institute of Technology (BCIT)	Aircraft Maintenance – Basic S	Sea Island Campus, Richmond BC	2001-09-7002	Sep-01	10 months experience & knowledge
Canadore College of Applied Arts and Technology	Aviation Technician - Aircraft Maintenance	North Bay ON	2013-05-4175	May-13	18 months experience & knowledge
Canadore College of Applied Arts and Technology	Aviation Technician - Avionics Maintenance	North Bay ON	2013-05-4176	May-13	18 months experience & knowledge
Canadore College of Applied Arts and Technology	Aviation Technology - Aircraft Maintenance and Avionics	North Bay ON	2013-05-4177	May-13	24 months experience & knowledge for «M» only.
Canadore College of Applied Arts and Technology	Aviation Technology - Aircraft Maintenance and Structural Repair	North Bay ON	2013-05-4178	May-13	24 months for experience ''M'' or 12 months experience ''S'' & knowledge
Canadore College of Applied Arts and Technology	Aircraft Structural Repair Technician - Manufacturing and Inspection Program	North Bay ON	2018-06-4257	Jun-18	14 months experience & knowledge
Canadore College of Applied Arts and Technology	Aircraft Structural Repair	North Bay ON	2001-09-7012	Sep-01	10 months experience & knowledge
Centennial College of Applied Arts and Technology	Aircraft Maintenance Technician	Downsview, ON	2019-01-4256	May-18	18 months experience & knowledge
Centennial College of Applied Arts and Technology (anglais seulement)	Aviation Technology – Aircraft Maintenance & Management	Toronto (Downsview Aerospace & Aviation Campus)	2019-03-4258	12-Mar-19	18 Experience & Knowledge
Centennial College of Applied Arts and Technology (anglais seulement)	Aviation Technology – Avionics Maintenance & Management	Toronto (Downsview Aerospace & Aviation Campus)	2019-03-4259	12-Mar-19	18 months Experience & Knowledge

College of the North Atlantic (CNA) (*formerly CNCC)	Aircraft Maintenance Engineering Technology (M & E)	Gander NL	2001-09-7005	Sep-01	21 months experience & knowledge
College of the North Atlantic (CNA) (*formerly CNCC)	Aircraft Structural Repair	Gander NL	2001-09-7006	Sep-01	10 months experience & knowledge
Confederation College of Applied Arts and Technology	Aviation Technician - Aircraft Maintenance Program	Thunder Bay ON	2001-12-7021	Dec-01	18 months experience & knowledge
Fanshawe College of Applied Arts and Technology	Aviation Technician – Avionics Maintenance	London, ON	2011-08-4128	30-Aug-11	18 months experience & knowledge
Fanshawe College of Applied Arts and Technology	Aviation Technician - Aircraft Maintenance	London, ON	2013-08-4174	14-Aug-13	18 months experience & knowledge
Fanshawe College of Applied Arts and Technology	Aviation Technician - Aircraft Maintenance	London, ON	2018-02-4248	Mar-18	24 months experience & knowledge
Fanshawe College of Applied Arts and Technology	Aircraft Structural Repair Technician	London, ON	2019-09-4268	Sep-19	10 months experience & knowledge
GS5 Corporation	Aircraft Maintenance Technician (AMT) Program	Oakville, ON	N/A	Dec-20	N/A
GS5 Corporation	Aircraft Structures Technician (AST) Program	Oakville, ON	N/A	Apr-21	N/A
GS5 Corporation	Aircraft Avionics Technician (AVT) Program	Oakville, ON	N/A	Jul-21	N/A
International Career School (ICS) Canada	Aircraft Mechanics	Montreal QC	N/A	Dec-06	N/A
L'École Nationale d'Aérotechnique du Collège Édouard-Montpetit (ÉNA)	Avionics Program (DEC 280.D0)	St-Hubert QC	2009-05-5141	Aug-08	19 months experience & knowledge
L'École Nationale d'Aérotechnique du Collège Édouard-Montpetit (ÉNA)	Aircraft Maintenance Technology (DEC 280.C0)	St. Hubert QC	2007-08-5118	Jul-07	19 months experience & knowledge
L'École Nationale d'Aérotechnique du Collège Édouard-Montpetit (ÉNA)	Structures Repair Program - EMAM (999.38)	St. Hubert QC	N/A	Oct-04	N/A
L'École Nationale d'Aérotechnique du Collège Édouard-Montpetit (ÉNA)	Avionics Element Program (EWA02)	St. Hubert, QC	N/A	May-09	N/A

L'École Nationale d'Aérotechnique du Collège Édouard-Montpetit (ÉNA)	Structures Technical Program (280.C0)	St. Hubert, QC	N/A	Jun-12	N/A
L'École Nationale d'Aérotechnique du Collège Édouard-Montpetit (ÉNA)	Aircraft Maintenance and Structures Elements Program (EWA.0X)	St. Hubert, QC	N/A	Nov-12	N/A
L'École Nationale d'Aérotechnique du Collège Édouard-Montpetit (ÉNA)	Structures Repair Program - profile 280-B0 (999.40)	St. Hubert QC	N/A	Oct-04	N/A
L'École Nationale d'Aérotechnique du Collège Édouard-Montpetit (ÉNA)	Aircraft Maintenance (999.49)	St. Hubert, QC	N/A	Jan-10	N/A
L'École Nationale d'Aérotechnique du Collège Édouard-Montpetit (ÉNA)	Elements of Aircraft Maintenance - profile Bombardier Profile (999.43)	St. Hubert QC	N/A	Dec-04	N/A
L'École Nationale d'Aérotechnique du Collège Édouard-Montpetit (ÉNA)	Elements of Structural Repair - profile CCEA (999.44)	St. Hubert QC	N/A	Dec-04	N/A
L'École Nationale d'Aérotechnique du Collège Édouard-Montpetit (ÉNA)	Aircraft Maintenance Program (AEC EWA.0X)	St. Hubert QC	2021-12-5236	Sep-21	13 months experience & knowledge
Mohawk College of Applied Arts and Technology	Aviation Technician - Aircraft Structures	Hamilton, Ontario	2012-11-4158	Nov-12	12 months experience & knowledge
Mohawk College of Applied Arts and Technology	Aviation Technician - Aircraft Maintenance	Hamilton, Ontario	2010-04-4109	May-10	18 months experience & knowledge
Mohawk College of Applied Arts and Technology	Aviation Technician - Avionics	Hamilton, Ontario	2019-05-4261	May-19	18 months experience & knowledge
North Island College	Aircraft Structures Technician	Campbell River, BC	2004-05-1042	May-04	11 months experience & knowledge
Northern Lights College (NLC)	Aircraft Maintenance Engineering - Basic M	Dawson Creek BC	2001-11-7020	Nov-01	18 months experience & knowledge
Nova Scotia Community College	Aircraft Mechanic	Shearwater, NS	N/A	Oct-02	N/A
Nova Scotia Community College	Aircraft Maintenance Technology - Avionics	Dartmouth, NS	2009-08-6002	Aug-09	18 months experience & knowledge
Okanagan College	Aircraft Maintenance Engineer - Category S	Kelowna Airport Campus, Kelowna BC	2012-01-1127	Jan-12	10 months experience & knowledge

Red River College – Stevenson Campus	Aircraft Maintenance Journeyperson	Winnipeg and Southport MB	2001-09-7015	Sep-01	48 months experience & knowledge
Red River College – Stevenson Campus	Aircraft Structural Repair Technician	Winnipeg and Southport MB	2002-02-7025	Feb-02	12 months experience & knowledge
Red River College – Stevenson Campus	Aircraft Maintenance Diploma Program	Winnipeg and Southport MB	2003-02-2000	01-Feb-03	19 months experience & knowledge
Saskatchewan Indian Institute of Technologies	Aircraft Maintenance - Basic M	Saskatoon SK	2010-10-2003	12-Oct-10	18 months experience & knowledge
Sault College of Applied Arts and Technology	Aircraft Structural Repair Program	Sault Ste. Marie ON	2007-09-4093	01-Oct-07	10 months experience & knowledge
Southern Alberta Institute of Technology (SAIT)	Aircraft Maintenance Engineering Technology	Calgary, Alberta (Art Smith Aero Center for Training and Technology)	TC 2014-04-2005	21-May-14	18 months experience & knowledge
Southern Alberta Institute of Technology (SAIT)	Aircraft Avionics Program	Calgary, Alberta (Art Smith Aero Center for Training and Technology)	2010-08-2001	05-Aug-10	18 months experience & knowledge
Southern Alberta Institute of Technology (SAIT)	Aviation Structural Repairs	Calgary, Alberta (Art Smith Aero Center for Training and Technology)	2010-08-2002	05-Aug-10	10 months experience & knowledge
University College of the Fraser Valley	Aircraft Structures Technician	Abbotsford, BC	2003-01-1003	Jan-03	11 months experience & knowledge
University College of the Fraser Valley	Aircraft Maintenance Engineer – Basic M	Abbotsford, BC	2017-06-1148	Jun-17	18 months experience & knowledge

Undergraduate aerospace specialized programs.

Program Name	Institution	Duration
Bachelor of Aerospace Engineering	Carleton University	4 years
Bachelor of Aerospace Engineering	Concordia University	4 years
Bachelor of Aerospace Engineering	Polytechnique Montreal	4 years
Bachelor of Aerospace Engineering	Royal Military College of Canada	4 years
Bachelor of Aerospace Engineering	McGill University	4 years
Bachelor of Aerospace Engineering	Toronto Metropolitan University	4 years
Bachelor of Applied Science in Mechanical Engineering (Aerospace Option)	University of British Columbia	4 years
Bachelor of Applied Science in Mechanical Engineering (Aerospace Option)	University of Manitoba	4 years
Bachelor of Applied Science in Engineering Science (Major in Aerospace Engineering)	University of Toronto	4 years
Bachelor of Engineering in Space Engineering	York University	4 years
Bachelor of Engineering in Aerospace Engineering	University of Windsor	4 years

Certificate, Diploma, and Post-graduate courses and programs

Institution	Program Offered
Toronto Metropolitan University	Professional Master's Diploma in Aerospace Design Management
Fanshawe College	Graduate Certificate in Applied Aerospace Manufacturing
Georgian College	Advanced Diploma in Aviation Management
Yukon University	Diploma in Aviation Management
Centennial College	PG Diploma in Aerospace Manufacturing Engineering Technician;
	Advanced Diploma in Aerospace Manufacturing Engineering Technology
British Columbia Institute of Technology (BCIT)	Diploma in Aviation Maintenance Technician - Avionics
	Certificate in Aircraft Gas Turbine Technician

Selected List of cross-functional, short courses and soft-skills courses

Course/ Program Title	Organization
Adapting to Change	Canadian Council for Aviation and Aerospace
Advanced Quality Systems Auditor	Canadian Council for Aviation and Aerospace
Aviation and Aerospace Manager - Level 1	Canadian Council for Aviation and Aerospace
Aviation and Aerospace Manager - Level 2	Canadian Council for Aviation and Aerospace
Aviation and Aerospace Manager - Level 3	Canadian Council for Aviation and Aerospace
Avionics Training: Fundamental Skills For Aircraft Electronics and Electrical Systems	Canadian Council for Aviation and Aerospace
Cabin Interiors	Canadian Council for Aviation and Aerospace
CARS Stream 1 – CARs for Manufacturers – General	Canadian Council for Aviation and Aerospace
CARS Stream 10 – Repair Design Approvals	Canadian Council for Aviation and Aerospace
CARS Stream 11 – Supplemental Type Certificates	Canadian Council for Aviation and Aerospace
CARS Stream 12 – Technical Standing Order Design Approvals	Canadian Council for Aviation and Aerospace
CARS Stream 13 - Type Certificate Holders	Canadian Council for Aviation and Aerospace
CARS Stream 14 – Design Approval Holders	Canadian Council for Aviation and Aerospace
CARS Stream 15 – Persons Performing Work – Manufacturing	Canadian Council for Aviation and Aerospace
CARS Stream 16 – Person Responsible for Activities – Manufacturing	Canadian Council for Aviation and Aerospace
CARS Stream 17 – Accountable Executives – Manufacturing	Canadian Council for Aviation and Aerospace
CARS Stream 2 - Persons Performing Work on Aircraft	Canadian Council for Aviation and Aerospace
CARS Stream 3 - Aircraft Maintenance Engineer	Canadian Council for Aviation and Aerospace
CARS Stream 4 – Persons Performing Work in a Shop	Canadian Council for Aviation and Aerospace
CARS Stream 5 – Persons Performing Elementary Work	Canadian Council for Aviation and Aerospace
CARS Stream 6 – Person Responsible for the Control of Maintenance – Approved Operator	Canadian Council for Aviation and Aerospace
CARS Stream 7 – Person Responsible for Maintenance – Approved Maintenance Organization	Canadian Council for Aviation and Aerospace
CARS Stream 8 – Accountable Executive – Approved Maintenance Organization	Canadian Council for Aviation and Aerospace
CARS Stream 9 – Part Design Approvals	Canadian Council for Aviation and Aerospace
Coaching Skills for Aviation	Canadian Council for Aviation and Aerospace
Communicating for Results	Canadian Council for Aviation and Aerospace
Company Aviation Safety Officer	Canadian Council for Aviation and Aerospace
Concise Technical Correspondence	Canadian Council for Aviation and Aerospace
Corrective Action Plans	Canadian Council for Aviation and Aerospace
Critical and Creative Thinking	Canadian Council for Aviation and Aerospace
Customer Relations	Canadian Council for Aviation and Aerospace
Emotional Intelligence and Self-Management	Canadian Council for Aviation and Aerospace
Fatigue Risk and Management System	Canadian Council for Aviation and Aerospace

Health & Safety for Aircraft Technicians	Canadian Council for Aviation and Aerospace
Making Teamwork Work	Canadian Council for Aviation and Aerospace
Managing Conflict	Canadian Council for Aviation and Aerospace
Managing Time and Stress	Canadian Council for Aviation and Aerospace
Mentor Skills	Canadian Council for Aviation and Aerospace
Optimal Service Delivery	Canadian Council for Aviation and Aerospace
Performance Improvement	Canadian Council for Aviation and Aerospace
Person Responsible for Maintenance Control	Canadian Council for Aviation and Aerospace
Problem-Solving and Decision Making	Canadian Council for Aviation and Aerospace
Quality Assurance Manager	Canadian Council for Aviation and Aerospace
Quality Systems Auditor	Canadian Council for Aviation and Aerospace
Regulatory Requirements & Management Strategies for 702 Operators.	Canadian Council for Aviation and Aerospace
Troubleshooting/Critical Thinking	Canadian Council for Aviation and Aerospace
WHMIS (2015)	Canadian Council for Aviation and Aerospace
Working Across Generations	Canadian Council for Aviation and Aerospace
Human Factors Classroom Workshop	Canadian Council for Aviation and Aerospace
Human Factors E-learning	Canadian Council for Aviation and Aerospace
Advanced Manufacturing and Automation Pre-Operator Level 1	Centennial College
Advanced Hydraulics	Centennial College
Automation and Industry 4.0	Centennial College
Cybersecurity Governance	Centennial College
Hydraulic Fundamentals	Centennial College
Manufacturing and Production	Centennial College
Quality Control	Centennial College
Practical Communication Skills	Centennial College
ERP-SAP micro-credential	Centennial College; DAIR
Continuous Improvement Processes	Conestoga College
Data Analyst Micro-credential	Conestoga College
Introduction to Quality Manufacturing micro-credential	Conestoga College
Manufacturing Quality	Conestoga College
Manufacturing Leadership Certificate Program	Conestoga College
PLC Programming micro-credential	Conestoga College
The Business of Tomorrow	Conestoga College
High Speed Project Management	Conestoga College
AVIA 1090: RPAS REG and Flight Operation	Fanshawe College
Lean Supervisory Certificate (20 hour)	Fanshawe College
Lean Supervisory Certificate (50 hour)	Fanshawe College
Lean Supervisory Certificate (90 hour)	Fanshawe College
Quality Management Micro certification	Fanshawe College
Advanced Manufacturing Certificate of Accomplishment	Humber College
Production and Operations Management for the Maintenance Manager	Humber College

Introduction to Data Analytics	Lighthouse Laboratories
Advanced Leadership Skills	McMaster University
Advanced Manufacturing Industry 4.0 Certificate	McMaster University
Advanced Manufacturing Materials Certificate	McMaster University
Advanced Manufacturing Process Certificate	McMaster University
Advanced Operations Management	McMaster University
Certification in Carbon Management	McMaster University
Certification in Circular Economy	McMaster University
Certification in Leading Transition to Circular	McMaster University
Industry 4.0 Operations Leadership & Management	McMaster University
Leading and Managing Change During Unstable Times	McMaster University
Strategic Thinking: Performance with Impact	McMaster University
Tactical Planning and Execution	McMaster University
Industry Business Unit Management	McMaster University
Automation Programming Introduction	Mohawk College
Aviation English Preparation	Mohawk College
Data Systems and Visualization for Manufacturing	Mohawk College
Advanced Manufacturing Technician	Northwest Skills Institute
Manufacturing Productivity - Lean/Six Sigma	Northwest Skills Institute
Mechatronics and Industrial Automation Technician	Northwest Skills Institute
21st-Century Management	Ontario Aerospace Council
Aircraft Structural Assembler	Ontario Aerospace Council
Aircraft Component Assembler	Ontario Aerospace Council
Change Management	Ontario Aerospace Council
Collaboration	Ontario Aerospace Council
Communities of Practice	Ontario Aerospace Council
Composite Technician	Ontario Aerospace Council
Conflict Management	Ontario Aerospace Council
Critical and Analytical Thinking	Ontario Aerospace Council
Focus and Achievement	Ontario Aerospace Council
Innovation	Ontario Aerospace Council
It's Not What You Say, It's How You Say It: Professional Business Writing for a Variety of Media and Culturally Diverse Audiences	Ontario Aerospace Council
Mentorship Program	Ontario Aerospace Council
Ontario Aerospace: Blue Skies Ahead	Ontario Aerospace Council
Ontario Aerospace: Our Heritage, Our Sector and Future-Proofing Your Career	Ontario Aerospace Council
Ontario Aerospace: Diversity and Bias in the Workplace	Ontario Aerospace Council
Problem-Solving	Ontario Aerospace Council
Resilience at Work	Ontario Aerospace Council
Team-Building	Ontario Aerospace Council
Training for the Technical Trainer	Ontario Aerospace Council

Advanced Manufacturing - Manual Measuring Tools	Seneca College of Applied Arts and Technology
Advanced Manufacturing Blueprint Reading	Seneca College of Applied Arts and Technology
Advanced Drone Pilot	Seneca College of Applied Arts and Technology
Advanced Manufacturing Rapid Skills (CNCP)	Seneca College of Applied Arts and Technology
AutoCad Essentials	Seneca College of Applied Arts and Technology
Mechanical Design Tools: Solidworks	Seneca College of Applied Arts and Technology
Integrated Automation Systems – Rockwell	Seneca College of Applied Arts and Technology
CNC G-Code Programming	Seneca College of Applied Arts and Technology
Shop Floor Supervisor Skills	Shift Management
Quality Assurance and Compliance: Documentation	St Lawrence College
Supply Chain Strategy for Manufacturing Leaders	Supply Chain Canada
Advanced Negotiations: A Real-Time Virtual Experience	University of Toronto
Business Analytics: Data-Driven Decision Making Online	University of Toronto
Corporate Finance for Executives	University of Toronto
Demand Driven Planner	University of Toronto
Machine Learning Online	University of Toronto
Strategy & Competitive Advantage	University of Toronto
Inclusion by Design	University of Toronto
AVIATION FUNDAMENTALS (AVIFUN)	University of Waterloo
Supply Chain Management Fundamentals,	University of Waterloo
Siemens Mechatronic Systems Certification	University of Windsor
Aerospace Sealer [Level 1]	Work Based Learning Consortium
Aerospace Sealer [Level 2]	Work Based Learning Consortium
Autism and Advanced Manufacturing	Work Based Learning Consortium
CMM Operator	Work Based Learning Consortium
CNC Machinists Hiring Program	Work Based Learning Consortium
CNC Machinists Upskilling Program	Work Based Learning Consortium
CNC Operator Work-Based Learning Program	Work Based Learning Consortium
CNC Programmer	Work Based Learning Consortium
CNC Setup	Work Based Learning Consortium
Electrical / Electronic Assembler	Work Based Learning Consortium
Mechanical Assembler	Work Based Learning Consortium
Mold Maintenance Technician [Level1] Work-Based Learning Program	Work Based Learning Consortium
QuickLearn: microlearning modules for CNC Machinists	Work Based Learning Consortium
Structural Airframe Assembler	Work Based Learning Consortium
Technical Trainer Effectiveness Program	Work Based Learning Consortium

Appendix E: Metrics for Program Review Template

As part of the program review phase DAIR, in collaboration with InnovaIT Professional Services, developed an instrument to support course and program assessment for the recently delivered SAP/ERP Micro-credential. The following section highlights the key metrics applied, purposes, and recommended criteria of each to the program assessment, a template that can equally be applied by different organizations to existing and new programs.

INFORMED DECISION MAKING

This category is used to identify and evaluate training options that will meet both organizational mandates and identified needs of industry. In other words, details that answer the question "Is this the right opportunity?"

RELEVANCY

Is this the best opportunity and program for our organization?

Possible criteria: demand from industry and/or individuals; opportunity to fill a gap or to complement existing related offerings, fit with organizational mandate; and training cost effectiveness.

PATHWAYS

Are there multiple clear connections/options for stakeholders?

Possible criteria: Credential(s) offered; admission requirements; graduation requirements; and identified articulations and credit transfer.

COLLABORATIVE ALIGNMENT

Is this the right partnership and format for collaboration?

Possible criteria: Institutional profiles; reporting and communication structures; value/goal alignment; defined roles and responsibilities; and the opportunity to make complementary contributions.

PROGRAM REVIEW

Measures the quality of program design, tools for assessment, physical environment, student support systems, and a process for responding to changing needs of leaners and industry. In other words, details that answer the question "How did we do in delivering this opportunity?"

QUALITY

Curriculum - Was the course / program designed to standards required by all stakeholders?

Possible criteria: Program/ course design; outcomes/ objectives; and assessments designed to measure outcomes.

Resources - Did instructors and participants have the materials required for optimal impact?

Possible criteria: Learning environment; equipment and materials; textbooks; and faculty and other supports.

STAKEHOLDER IMPACT

Measures how the program changed the experience of the delivering impacted partner institutions, participants, and employers/industry. What benefit was provided to each of the stakeholder groups?

Partner(s) - Did the program benefit the delivery partner and/or other collaborators?

Possible criteria: Revenues and institutional progress; and development of curriculum, intellectual property and/or human capital capacity.

Students - Did the program lead to success for learners?
Possible criteria: Graduate rates and time to completion; student and graduate satisfaction; certifications and registration achieved; successful work term placement; and employment or advancement opportunities on completion.

Employees / Industry - Did the program benefit employees and employers?
Possible criteria: Feedback on placements, employment; alignment to identified industry needs; and alignment to student and/or employer expectations.

COLLABORATIVE EXCELLENCE

Measures used to identify partnership experience, review effectiveness of communication and reporting structures, and conduct review of the benefits and challenges of the experience.

Performance - How effective was the partnership?
Possible criteria: Efficiency of partnership (logistics, on-budget, on-time delivery); flexibility and responsiveness; and effectiveness of communication and reporting.

Learning & Growth – Did the collaboration benefit partner(s)?
Possible criteria: Partner satisfaction; lessons learned; and desire for future collaboration.