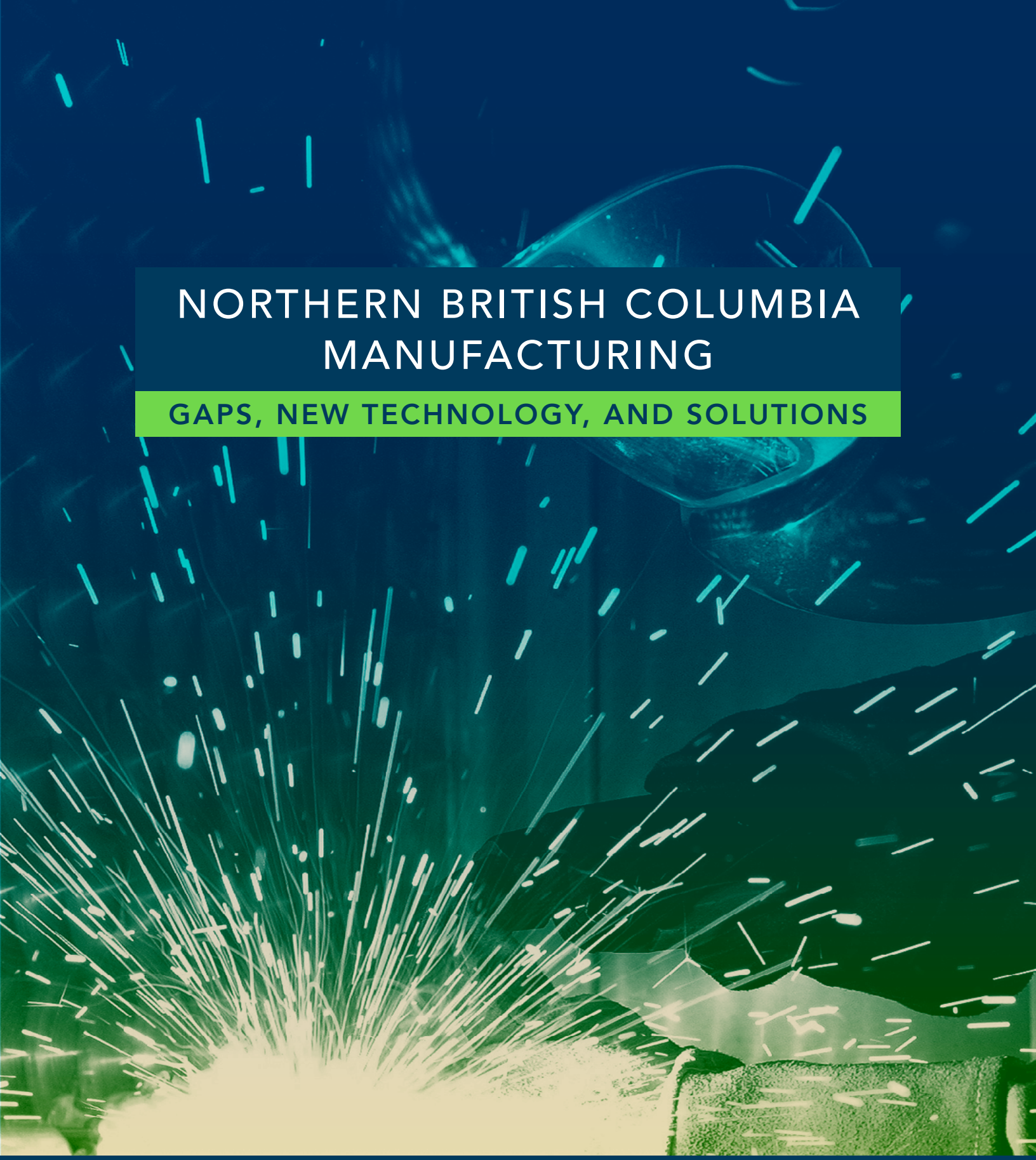

# NORTHERN BRITISH COLUMBIA MANUFACTURING

## GAPS, NEW TECHNOLOGY, AND SOLUTIONS

FACILITATED BY CONSTRUCTION FOUNDATION OF BC
SUPPLY CHAIN RESILIENCY GRANT
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Prepared by: Construction Foundation of British Columbia and Red Acres Resources Management Ltd.

I certify that the work described herein fulfills the standards expected of a member of the Association of British Columbia Forest Professionals and that I did personally supervise the work.

Sam Coggins, PhD RPF #4756

# Executive Summary

## Purpose and Objectives

The purpose of this project is to ensure that manufacturers in northern British Columbia can compete for service, supply, and construction contracts on major projects. The region is subject to investments by a number of industries, principally from oil and gas proponents, who have committed to engage local services for their projects. Other industries with interests in the north include: mining, hydroelectric, construction, among others. Manufacturers typically consist of steel fabricators, welding services, electronic engineering, and construction companies.

Several barriers exist that prevent these companies from effectively competing for and winning contracts in the region. To overcome these barriers, the objectives of this research were to:

1) Complete a manufacturing skills gap analysis. In this the skill sets available within northern manufacturing small and medium-sized enterprises (SME's) were defined along with barriers facing companies and workers in the north;

2) Undertake a manufacturing capacity analysis to determine the upcoming capacity requirements of major projects and the skills and experience provided by manufacturing SME's in northern British Columbia;

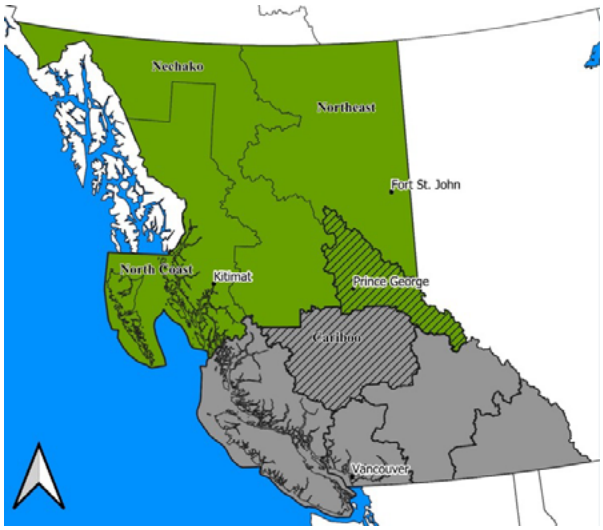
3) Define new technologies and innovations that could increase the competitive capacity of northern manufacturers; and,

4) Provide solution-based recommendations for government, proponents, and employers to bolster capacity and competitiveness for companies in northern British Columbia.

## Geographic Location

Northern British Columbia describes the northern half of the province, from approximately the 55th latitude north to the border with Yukon and North West Territories. The province of Alberta is located to the east; and, to the west, the Pacific Ocean and the US state of Alaska. The north covers an area of 569,444 km2 or 62% of the province (British Columbia is 922,508 km2).

The four regions that comprise northern British Columbia, include North Coast, Nechako, Northeast, and Cariboo. Of these regions, North Coast, Nechako, and Northeast are entirely within the north. The Cariboo region overlaps the northern and southern regions of the province (see hashed area below).



## Methods

To meet these objectives this research project examined impacts to British Columbia's industries, as well as from other jurisdictions, including: Canada and other countries including, but not limited to: Australia, United Kingdom, United States, Asian countries, and Europe. Other jurisdictions were examined to determine whether recommendations to other governments may prove worthwhile in British Columbia.

Overall, industry in British Columbia is facing sometimes unprecedented impacts and influences, although are responding to these at a time when technology is able to improve efficiencies in workflows. The complexities and demands society and the environment are helping to forge a new way forward for SME's in British Columbia's manufacturing industry. To demonstrate these, perspectives gathered during the research have been incorporated and led to findings. These can be found throughout each of the sections provided in the research contained in this report. The findings naturally lend themselves to recommendations. A summary of the findings and recommendations are provided below.

This research was informed by literature-based reviews, corroborated with data analysis from Indigenous, provincial, and federal government databases. Key points were checked with subject matter expert interviews. Influences on northern British Columbia and northern manufacturing SME's have included the COVID-19 pandemic and climate-related disasters (wildfires, heat domes and atmospheric rivers that led to flooding). These have impacted supply chains; price of raw materials (e.g., metal); and, communication lines between industry, government, and educators. Furthermore, impacts to northern manufacturers have been experienced as opposition to forestry and some oil and gas projects has caused declines in current and potential clients.

## Research Summary

The research is briefly summarized in the sections below. These summaries report the outcomes of literature reviews, data analysis, and key informant interviews. These summaries provide context to a list of several recommendations.

### Skills Gap Analysis

To meet the first objective of this research a manufacturing skills gap was completed to determine the type of skills and training employers, government, and proponents could provide the manufacturing industry. It also examined the existing skills and training within northern manufacturing SME's, identified barriers to training programs, provided examples of best practices from other jurisdictions, and listed funding opportunities for skills and training.

The outcomes of this research indicated that training programs need to be responsive to industry requirements and require government involvement. That during the COVID-19 pandemic, communications between groups have become more difficult. Committees comprised of educators, industry, and government need to be reestablished following the pandemic that included the Program Advisory Committees (PACs) and Sector Advisory Groups (SAGs). Formalities like terms of references could be established to ensure groups are provided with overall direction both within a group and among all the groups.

Training programs need to focus on potential changes to skill development and training. Following the pandemic increased focus is required to add new and emerging technologies into training programs by including skills like digital literacy. Also, training is required to focus on soft skills to meet equity, diversity, and inclusion requirements in the workplace and within the PACs and SAGs. Perspectives from under-represented groups are required to ensure needs are being represented for all workers.

Other initiatives can also be implemented, specifically mentoring programs. Direct mentoring through workplace partnerships between an experienced worker (the mentor) and a new worker (the mentee) will likely help to ensure success. An experienced worker can pass along lessons learned from years and bring realistic learning moments to a mentee. However, both the mentor and the mentee require training in this situation. The mentor may need to understand how to communicate with the mentee, and equally the mentee needs tools to ensure they listen and have correctly understood the mentor.

Northern British Columbia (and elsewhere across Canada) is experiencing a shortage of skilled workers. Despite their being many workers among under-represented groups, training is required to bring these workers into many of British Columbia's industries. Temporary Foreign Workers and foreigners who want to live permanently in Canada bring skills with them that will likely require minimal effort by industry to ensure industrial standards are maintained. To this end, northern SME's need assistance from government to expedite programs to bring foreign workers to the region.

Last, funding opportunities are available to support SME's when providing new and existing workers with skills and training programs.

## Capacity Analysis

The second objective examined the capacity for northern manufacturers to service large projects in the oil and gas, mining, and utilities industries; examined best practices in other jurisdictions; identified barriers to for northern manufacturing SME's to increase capacity; and, determine available funding to support capacity expansion. Analysis was completed with both Federal and Provincial databases that indicated the number of projects planned for the north and underway in the north as well as workforce capacity. The scan of best practices was completed through literature reviews using literature provided by reputable sources. Gaps and hindrances were identified through key informant interviews and from articles provided in mainstream media and other technical-level sources. The available funding was drawn from federal and provincial databases.

The northern manufacturing SME's have the capacity to work on large projects. Most of the manufacturers interviewed provide services to similar sized projects throughout British Columbia, other jurisdictions in Canada, and abroad (e.g., the United States). Also, capacity provided by northern manufacturers will be in demand over at least the next decade. This could result in work for northern manufacturers, although most of the key informant interviewees stated that work in some industries has been difficult to obtain.

There is a strong complement of businesses in the north who face unique challenges and have different requirements compared to their southern counterparts. Some distinct barriers include the existing worker shortage, the COVID-19 pandemic, climate-induced natural disasters, supply chain woes, out-of-province expertise coming to the north, and capacity within SME's to address diversity and inclusion. There are a number of solutions that could take effect more immediately than others. One of those would be the formation of producer co-operatives which have proven effective in other jurisdictions to help a collective achieve a common goal.

Northern British Columbia is being increasingly considered for large industrial projects. As these projects go beyond the exploratory phase and into implementation, proponents have committed to employing local companies. However, many of these companies are not from the region and may not be aware of the talent or how to communicate effectively with northern SME's. A potential solution to this would be to create a catalogue of local companies across the north, host this in a website, and advertise this to proponents. The website could also be a database of SME's with information about each of the companies related to the work experience and services provided. Funding opportunities to increase capacity could also be included.

Last, the province has defined a number of plans in the StrongerBC report with an aim to build a strong economy in British Columbia. As and when these plans are implemented the full spectrum of perspectives from across the province will be required. Northern businesses need to inform all phases of the plans as they are researched and implemented. Furthermore, as other funding is implemented (e.g., through the InBC Investment Corp) it should be equally shared among businesses throughout the province. Funding needs to recognize that businesses in among the regions may need assistance to overcome barriers identified earlier in this section.

## Manufacturing Innovation

Innovation among many industries is a driving factor, especially after the COVID-19 pandemic. The pandemic proved that if technology available today is used more widely that companies can still do business

and through this continue to contribute to the economy. This section examined new and emerging technologies are available to manufacturers; determined how new technology is being used in national and international jurisdictions; future skill requirements; advances in corporate values and implications for SME's; and, funding programs available for businesses to adopt new technology. Again, these completed using literature-based research, compiling information from provincial and federal databases, and for the future skill requirements using scientific peer-reviewed literature to inform the analysis.

Innovations have led to a new evolution of industry, termed "Industry 4.0". This new phase of industry is leading to innovations to introduce efficiencies to manufacturing processes. However, challenges are being experienced especially in northern British Columbia, due in part to the nature of the region. The specific challenge to northern companies is lack of reliable and functional internet, which forms the basis of northern SME's adopting new technologies. While this issue has been recognized by the federal and provincial governments, it requires greater emphasis to provide equal advantages to northern SME's as afforded to their southern counterparts. Furthermore, technological advances will create the need for additional training to help northern SME's to full implement technological advances.

Further to increased internet capability and training, the manufacturing industry needs supports to help them understand the new technologies that are available, how these may be used, and how to incorporate technology into work processes. To assist northern SME's funding is to hire a digital adoption expert to assess existing processes and to help SME's understand where and how they can incorporate new technology. Part of a plan could be to identify specific digital processes that provide a competitive advantage to northern SME's.

As other industries (e.g., forestry) experience curtailments and job losses, manufacturing is poised to become an industry that can support the economy of British Columbia. This will require work to adopt new technologies and to employ workers with transferable skills. Further to developing specific digital processes, northern SME's could also work with product development experts to determine niche products (with a focus on low volume, high value) leading to the provision of distinct services above those provided by competitors from elsewhere in the province or from out-of-province. Funding to employ an expert in this capacity is available. Also, government has economic development officers available who could assist northern SME's to develop products and provide updates related to funding programs, technological advances, and other initiatives available to northern SME's.

While a number of funding programs are available, northern companies need to be made aware of programs. Given regular means of communication between funding agencies and business owners rely on internet capabilities, so different means are likely required to reach northern businesses.

### ESG in Manufacturing

Environmental, Social, and Governance (ESG) was not an initial objective of the research. However, an ESG focus became apparent during the research especially given: government's intent to start an ESG Centre of Excellence; the importance placed on the role of ESG in the future; and, that an ESG thread was woven through most sections of the report. ESG responsibilities have become increasingly important for companies to meet corporate goals. The StrongerBC report also acknowledged the importance of ESG by announced the planned formation of an ESG Centre of Excellence along with a brand for ESG values and principles.

Accordingly, standards are required to ensure companies demonstrate and report on ESG values. Government, through the ESG Centre of Excellence, can help SME's by creating a framework and standards for SME's to incorporate ESG values and to implement an ESG strategy. A standard and easy-to-use approach will help SME's to incorporate ESG and could lead to increased contract and investment opportunities. As well, part of ESG reporting could include SME's enrolling in certifications like PAR (fulfilling in part the social of aspect of ESG).

As the ESG Centre of Excellence is established, input should be included from SME's to ensure plans and outcomes are not prohibitive to these businesses. Also, that SME's can take advantage of ESG when manufacturing products or employing workers. In other words, while ESG is important to all companies in British

Columbia, the ESG values and principles should be matched to the capacity of SME's.

SME's could incorporate ESG standards by documenting values that will increase the transparency of their operations. The objectives of which will build trust and relationships with community, supply chains, and customers. By reporting, SME's may gain a competitive advantage as well as experience increased profits, along with other benefits.

## Recommendations

### Skills Capacity

1) Terms of Reference's for Program Advisory Committees (PACs) and Sector Advisory Groups (SAGs) need to be updated to define a clear framework to engage and participate in training and advisory programs. Any framework needs established objectives, with achievable and measurable outcomes to ensure training provides appropriate skills for now and the future to support the manufacturing industry.

2) All participants need consistent engagement to ensure the PACs and SAGs achieve their objectives (including government, industry, and Indigenous organizations).

3) Mentoring initiatives could be created to facilitate successful employment, with training provided equally for mentors as well as mentees.

4) Expedite applications for the Provincial Nominee Program and fast track certifications to support the manufacturing industry (and others).

### Capacity Analysis

1) SME's in northern British Columbia could form a cooperative to pool resources (raw materials, equipment, and skilled workers), share funding opportunities, and examine innovation collectively.

2) Industry has identified the need for a website for small and medium-sized businesses in the north, including projects completed, services offered, rates, location(s), partnerships that exist (add this to the Major Project Inventory).

3) The website should also contain a centralized database of funding sources available to manufacturing companies.

4) Ensure that manufacturing SME's are included in work to be implemented for the province's 2022 StrongerBC plan (e.g., northern manufacturers should be included in the Industrial and Manufacturing Action Plan; Goods Movement Strategy, and an ESG Centre of Excellence, among others) and receive a fair share of funds through the InBC Investment Corp.

### Manufacturing Innovations

1) Reliable internet is required in the north to ensure new technologies can be supported and grow. Internet should be provided to the same standard as in the southern part of the province (e.g., 5G fibre optic network) as well as the capacity to use the internet.

2) Industry wants appropriate supports to incentivize technology adoption and provide ongoing support to help manufacturing SMEs to achieve digital maturity.

3) Work with research and development specialists to determine which new technology to bring into local companies.

4) Provide linkages between tech companies and northern SME's in a tailored program to help niche technology development.

5) SME's in the north could work with a business development expert to make a niche product or provide workers with specialized skills to meet niche requirements.

6) Opportunities could be created to help research and development in the manufacturing sector, specifically to determine high value/low volume products for SME's in northern British Columbia.

### ESG in Manufacturing

1) SME's could benefit by building stronger relationships with First Nations to increase workforce size and provide long-term local employees and require capacity development opportunities to encourage this work.

2) Supports in the workplace could be provided for under-represented groups (e.g., Indigenous, women, etc.)

3) Industry could support the creation of an ESG guide and report card that could be implemented in accordance with international and/or Canadian standards for ESG. This report card could include (but not be limited to):

    - Indigenous values
    - Community values
    - Workplace values for under-represented individuals (e.g., Indigenous, black or person of colour, 2SLGBTQQIA+, neuro-diverse, persons living with a visible or invisible disability, women, youth from care, non-binary, other)
    - Worker progression through training and education (beyond gaining experience)
    - Contract awards provided
    - Creation and sales of high-value products that reflect a green economy (e.g., low carbon).

4) Government could encourage relationship building by providing engagement funds and/or facilitating meetings between businesses and Indigenous organizations and governments.

5) SME's could consider applying for Progressive Aboriginal Relations (PAR) certification.

6) Industry needs increased administrative support from government that should be provided for SME's in northern British Columbia to find workers to fill high-demand positions and to increase equity, diversity, and inclusion.

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# Glossary of Acronyms

**AI:** Artificial Intelligence

**BETW:** Building and Educating Tomorrow's Workforce

**BIPOC:** Black, Indigenous, and People Of Colour

**CME:** Canadian Manufacturers and Exporters

**CNC:** Computer Numerical Controls

**COVID-19:** CoronaVIrus Disease 2019

**CRII+:** Coronavirus Response Investment Initiative Plus

**CRRF:** Covid-19 Response and Recovery Fund

**CSR:** Corporate and Social Responsibility

**DRIPA:** Declaration of the Rights of Indigenous Peoples Act

**EDI:** Equity, Diversity, and Inclusion

**ESG:** Environmental, Social, and Governance

**EIF:** European Investment Fund

**ITA:** Industry Training Authority

**LMI:** Labour Market Information

**NAICS:** North American Industry Classification System

**NOA:** National Occupational Analysis

**NOC:** National Occupation Classification

**NZTE:** New Zealand Trade and Enterprise

**PAC:** Program Advisory Committee

**PEPP:** Pandemic Emergency Purchase Program

**PAR:** Progressive Aboriginal Relations

**PNP:** Provincial Nominee Program

**PSTA:** Provincial Sales Tax Act

**RS:** Red Seal

**RSOS:** Red Seal Occupational Standard

**SAG:** Sector Advisory Group

**SME:** Small and Medium Enterprise

**SOC:** Standard Occupational Classification

**SR&ED:** Scientific Research and Experimental Development

**STE:** Skills Training for Employment

# Glossary of Acronyms

**STEER:** SG Together Enhancing Enterprise Resilience

**UNDRIP:** United Nations Declaration for the Rights of Indigenous People

**VET:** Vocational Education and Training

**WIL:** Work Integrated Learning

# Introduction

## Purpose

The purpose of this project was to ensure that manufacturers in northern British Columbia can compete for service, supply, and construction contracts on major projects that require a high degree of specialization and efficiency. Northern manufacturers are actively engaged in building prosperous companies with a sustainable workforce to supply services to industrial projects in the north and to international clients.

Northern British Columbia is experiencing increased interest in the construction of large-scale industrial projects. These projects require services that could be provided by local small and medium-sized manufacturing companies (or small and medium-sized enterprises; SME's). However, several barriers exist that prevent these companies from effectively competing for and winning contracts in the region. To overcome these barriers, the objectives of this research were to:

1) define the skill sets available within local SME's and the barriers facing the companies and workers in the north;

2) determine the upcoming capacity requirements of major projects and the skills and experience provided by manufacturing SME's in northern British Columbia;

3) define new technologies and innovations that could increase the competitive capacity of northern manufacturers; and,

4) provide solution-based recommendations for government, proponents, and employers to bolster capacity and competitiveness for companies in northern British Columbia.

## Methods

To meet the objectives for this research the project was divided into phases with each phase representing an objective. The objectives 1 to 3 (defined above) involved analyzing established databases provided by Indigenous organizations, and provincial and federal governments. Analysis was used in combination with internet-based research using technical reports, peer-reviewed scientific literature, and newspaper articles. The research was further backed up information gathered from subject matter expert interviews and a site visit to SME's in and around Prince George. The analysis and interviews informed several recommendations (Objective 4) that are presented in the final section of this report.

This approach was used rather than surveys and extensive interviews as other groups were conducting similar work at the onset of this research. By concentrating effort on obtaining information from a smaller number of subject matter experts, supported by literature reviews, we were able to avoid survey fatigue among the larger community. Interviews were conducted with subject matter experts from across northern British Columbia and Canada. These included a number of manufacturing SME's; Indigenous leaders and organizations; high ranking local government employees in Terrace, Fort St. John, Prince Rupert, and Prince George; educational institutions across Canada; major project proponents; funding agencies, and professional and technical associations.

## Roadmap

This report is presented in five distinct sections: introduction; manufacturing skills gap analysis; manufacturing capacity analysis; manufacturing innovation; and conclusions and recommendations. The first provides a background of manufacturing in northern British Columbia along with statistics that describe the northern portion of the province, the active industries in the region, defines manufacturing in the context of this research, and provides background on Indigenous involvement in northern British Columbia. The subsequent three sections are research-based components derived using the methods described above. These describe challenges faced by manufacturing SME's in terms of skills and training, capacity to provide services to major projects, and to adopt new technology and innovations. The final section provides

conclusions from the report, leading to recommendations which are based in the context provided by the research.

## Background

Northern British Columbia presents equal opportunities and challenges to proponents and companies working in the north. This section provides a brief background on the characteristics of the region including, a description of geography, communities and population statistics, and the industries that work in region.

### Northern British Columbia

Northern British Columbia describes the northern half of the province, from approximately the 55$^{th}$ latitude north to the border with Yukon and North West Territories (Figure 1). The province of Alberta is located to the east; and, to the west, the Pacific Ocean and the US state of Alaska. The north covers an area of 569,444 km$^2$ or 62% of the province (British Columbia is 922,508 km$^2$).

The four regions that comprise northern British Columbia, include North Coast, Nechako, Northeast, and Cariboo. Of these regions, North Coast, Nechako, and Northeast are entirely within the north. The Cariboo region overlaps the northern and southern regions of the province (see hashed area in Figure 1).

This vast area is intersected by rivers, large lakes, and is home to a litany of wildlife including large predators, ungulates, birds, amphibians, and many fish species. The region is characterized by a mountainous west coast with lush, wet, forests and large trees that transitions to flat terrain with dry forests with dense small diameter trees. The City of Kitimat is within this western portion while Prince George is located in the dry interior. In the northeast this dry interior gives way to the northern Rocky Mountains, with Fort St. John located east of the Rockies.

This terrain and the northern climate have presented significant logistical issues to proponents from outside the province who have not accounted for significant precipitation (e.g., snow) in the winter or the amount of water that can populate worksites during spring freshet. The communities in the north are widespread, with many having a history in industrial activity occurring as British Columbia was colonized. Travel distances are long and can be arduous in winter conditions, made more difficult as industrial worksites are often located many kilometres on a network of gravel roads that are used and maintained by industrial traffic.

### Communities

The north is stratified into four regions, each of which contain Regional Districts and population centres (cities, towns and villages; Table 1). Prince George is the largest with a population of approximately 82,000 and is the industrial centre and 'gateway to the north'. The work undertaken in this project will focus on SME's in the Prince George area.

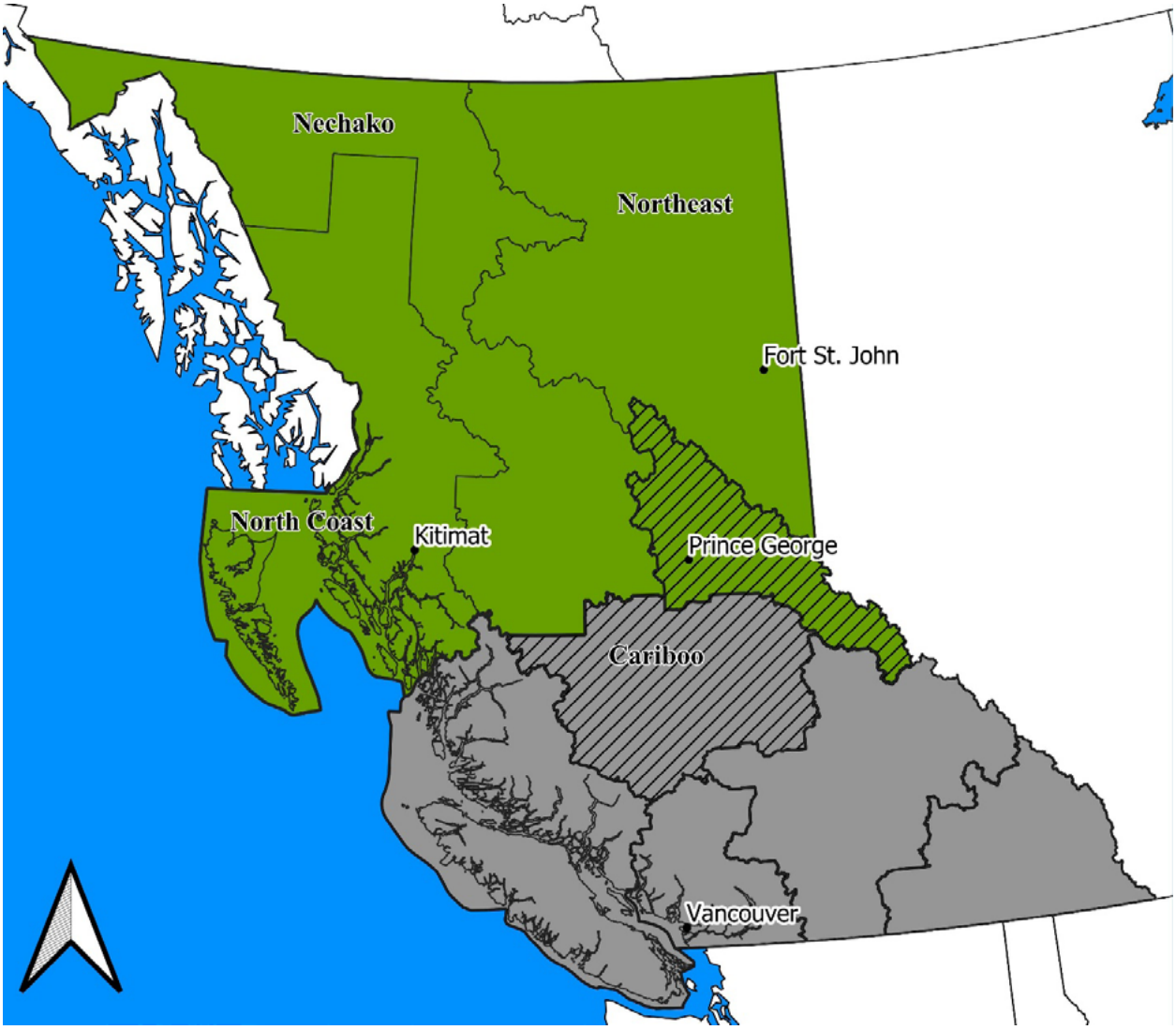



*Figure 1: Map of northern British Columbia*

## Population

The population of northern British Columbia in 2020 was 276,013 people (Statistics Canada 2021; Table 2) or approximately 6% of the provincial population.

The rest of the British Columbia is significantly more populated, especially along the international border. The total population is 5,147,712 (including the north) with the remaining 4,871,699 people living in the southern portion of the province.

Since 2011, the population of the north has grown by 16,332 which represents an increase of 6% over the last 10 years. For comparison, the rest of the province experienced a population increase of 629,276 or 13%. The north has experienced steady increases in population over the last 10 years (Figure *2*: Population of northern British Columbia with per cent population change.Figure 2).

*Table 1: Regions, regional districts, and main population centres in Northern British Columbia (CivicInfoBC 2022).*

| Region | Regional District | Main Population Centres |
|---|---|---|
| Cariboo* | Fraser-Fort George | Prince George |
| | | Mackenzie |
| | | McBride |
| | | Valemount |
| | | Hixon |
| North Coast | North Coast | Skidegate |
| | | Sandspit |
| | | Masset |
| | | Prince Rupert |
| | Kitimat-Stikine | Terrace |
| | | Kitimat |
| | | Stewart |
| | | Hazelton |
| | | Telegraph Creek |
| | | Dease Lake |
| Nechako | Bulkley Nechako | Burns Lake |
| | | Smithers |
| | | Vanderhoof |
| | | Fraser Lake |
| | | Houston |
| | | Fort St. James |
| | Stikine** | Atlin |
| | | Lower Post |
| Northeast | Northern Rockies | Fort Nelson |
| | | Muncho Lake |
| | Peace River | Dawson Creek |
| | | Chetwynd |
| | | Fort St. John |
| | | Hudson's Hope |

* Only part of the Cariboo Region is within northern British Columbia. This report does not include the Cariboo Regional District.

** Stikine is not considered a regional district. When regional districts were established in the 1960's it did not have sufficient population of property assessment value to support being established as a regional district.

*Table 2: Population of Northern British Columbia.*

| Region | Population (2020) |
|---|---|
| Cariboo* | 103,975 |
| North Coast | 59,335 |
| Nechako | 40,423 |
| Northeast | 72,280 |
| **Total** | **276,013** |

* Includes only the Fraser-Fort George Regional District as this is in the northern portion of the Cariboo region.

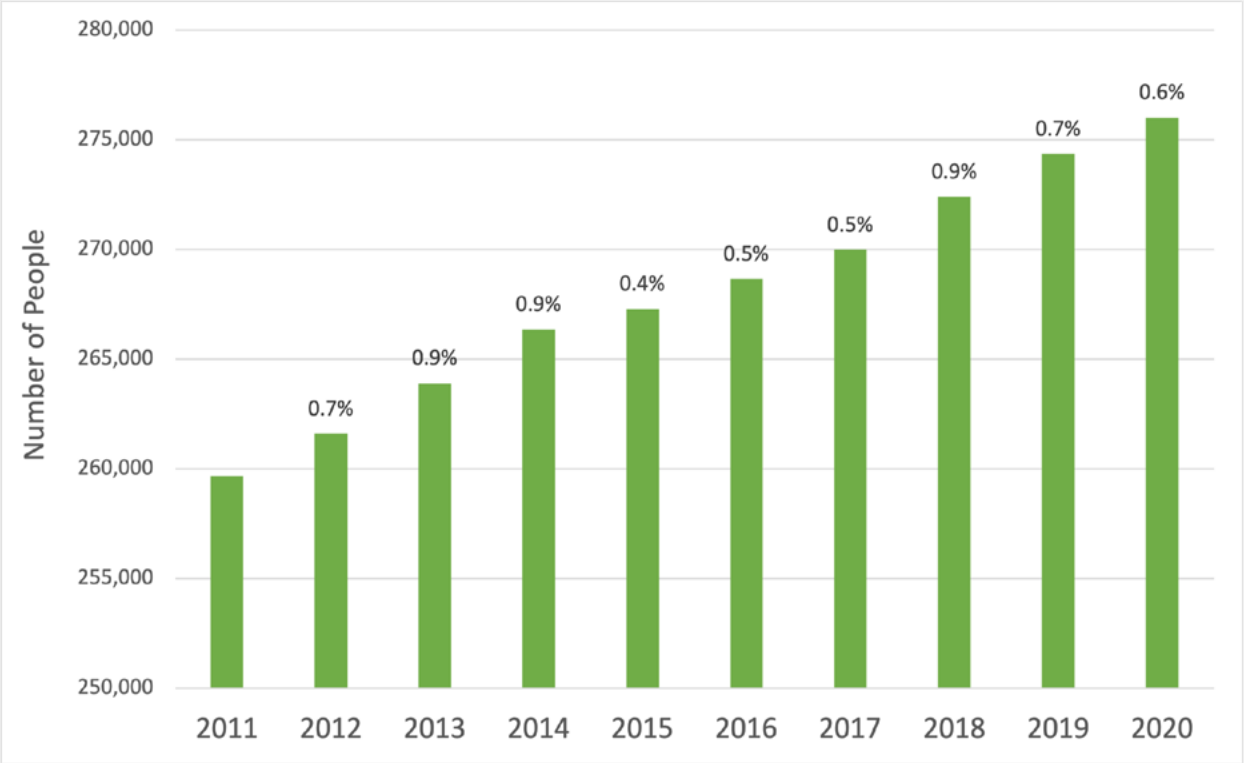



*Figure 2: Population of northern British Columbia with per cent population change*

## Northern Industries

The industries within each of the regions are briefly described below to provide context about the types of work underway in northern British Columbia, employment statistics, and information to support logistics to these regions. Geographic descriptions are available in Figure 1. The data provided below is provided by WorkBC's descriptions of the regions (British Columbia 2019a; British Columbia 2022a).

The **North Coast & Nechako** regions are combined because both have the lowest populations in the province. The regions are connected to the rest of British Columbia by a single highway that connects Prince George to Prince Rupert, and provides access to the northern parts of the province, and onto Yukon and Alaska.

The area is home to the facilities and sections of pipeline for the newly established oil and gas industry, and tourism and warehousing (especially as the Port of Prince Rupert has expanded) are becoming increasingly larger employers. Otherwise, forestry and mining have historically been the largest employers

in the region. Along the coast, fishing also provides employment opportunities. Other industries that play a minor role include: hunting and trapping, utilities, construction, and manufacturing.

Despite these industries, the North Coast & Nechako has had a higher unemployment rate than other regions in the province. The forecasted employment growth in the region up to 2029 will result in total employment of 45,500 and 9,900 job openings (including new jobs resulting from economic growth and retirement replacements) with a forecasted average annual growth rate of 0.3%.

The **Cariboo** region's main industries include forestry, manufacturing, mining, oil and gas, fishing, utilities, construction, agriculture, hunting and trapping. Traditionally, the Cariboo has a long history in industrial forestry; Prince George accommodates several lumber mills as well as pulp and paper manufacturing. This supported by forestry companies who have major offices in the city, (e.g., Canfor). Unemployment in 2020 was 10.0% compared to a provincial average of 8.9%. The region typically has one of the lowest rates of employment in the province. WorkBC forecasts that there will be 87,100 jobs leading up to and including 2029 (including 21,400 job openings), with an employment growth rate of 0.7%.

Prince George city acts as the hub for the north, is home to a major airport with connections to Vancouver, but unlike other northern airports also services Calgary and Edmonton. Transportation routes include Highway 16 (Yellowhead) that to the west connects Prince George to Prince Rupert and Kitimat, and to the east to the rest of Canada. Highway 97 intersects with Highway 1 to run from Vancouver through Prince George to eventually to Watson Lake in Yukon before leading through to Alaska. Freight can also be transported via rail lines that run from Vancouver to Prince George and onto Fort Nelson and Dawson Creek, and west to Kitimat and Prince Rupert.

The **Northeast** region covers almost one-quarter of the province. The industries that commonly employ workers in the region include: agriculture, forestry, mining, oil and gas, fishing, hunting and trapping, utilities, construction and manufacturing. The unemployment rate in the region in 2020 was 6.4%. Employment growth between 2019 to 2029 was forecast to account for 17,900 job openings, with 48,700 jobs available in 2029 versus 39,400 in 2019, and an average annual growth rate of 2.1%.

The region has a long traditional in forestry and mining, but is also serviced by the oil and gas industry. The raw gas for the liquefied natural gas facilities constructed or proposed on the west coast are supplied by gas extracted from the northeast. Given the gas supply in the region and the proximity of this region to the established pipeline network in Alberta, there are several companies who transport gas from the region into Alberta via pipeline. Increased activity has also been experienced in mines close to Tumbler Ridge and BC Hydro's Site C dam is located within the region. Outside of these projects the Northeast has also been subject to court ruling which found the Crown had unlawfully breached promises made to local First Nations when Treaty 8 was signed. The ruling resulted in an agreement that may enable 195 oil and gas and forestry projects to go ahead, which should reinforce economic stability and job prospects in the region.

## Small and Medium-Sized Enterprises

The majority of the businesses in northern British Columbia are SME's (Table 3). The size of business is directly correlated to the number of employees rather than revenue or other such measure. Small Business BC defines business size by number of employees, where SME's are those with less than 50 employees. Further analysis of the number of small businesses is available later in the report.

***Table 3: Number of SME's in British Columbia***

| Number of Employees | Number of Businesses | Percent of total | Growth 2014 - 2019 | Growth Rate 2014 - 2019 |
|---|---|---|---|---|
| 0 to 4 | 442,700 | 83% | 58,000 | 15.1% |
| 5 to 9 | 39,200 | 7% | 2,900 | 8.1% |
| 10 to 19 | 25,700 | 5% | 3,000 | 13.1% |
| 20 to 29 | 9,200 | 2% | 800 | 10.2% |
| 30 to 49 | 7,100 | 1% | 1,000 | 16.7% |
| Large businesses (50+) | 8,700 | 2% | 1,100 | 13.9% |
| **Total** | **532,500** | **100%** | **66,800** | **14.4%** |

## Manufacturing Defined

The manufacturing industry in Canada has experienced growth in 2021. The industry in British Columbia made $5.1 billion in sales in November 2021 (Statistics Canada 2022), representing 8.1% of all manufacturing sales in Canada. Also, worth noting is that sales by British Columbia-based manufacturers remained reasonably similar between 2019 and 2020, and saw an increase in 2021 (Figure 3).

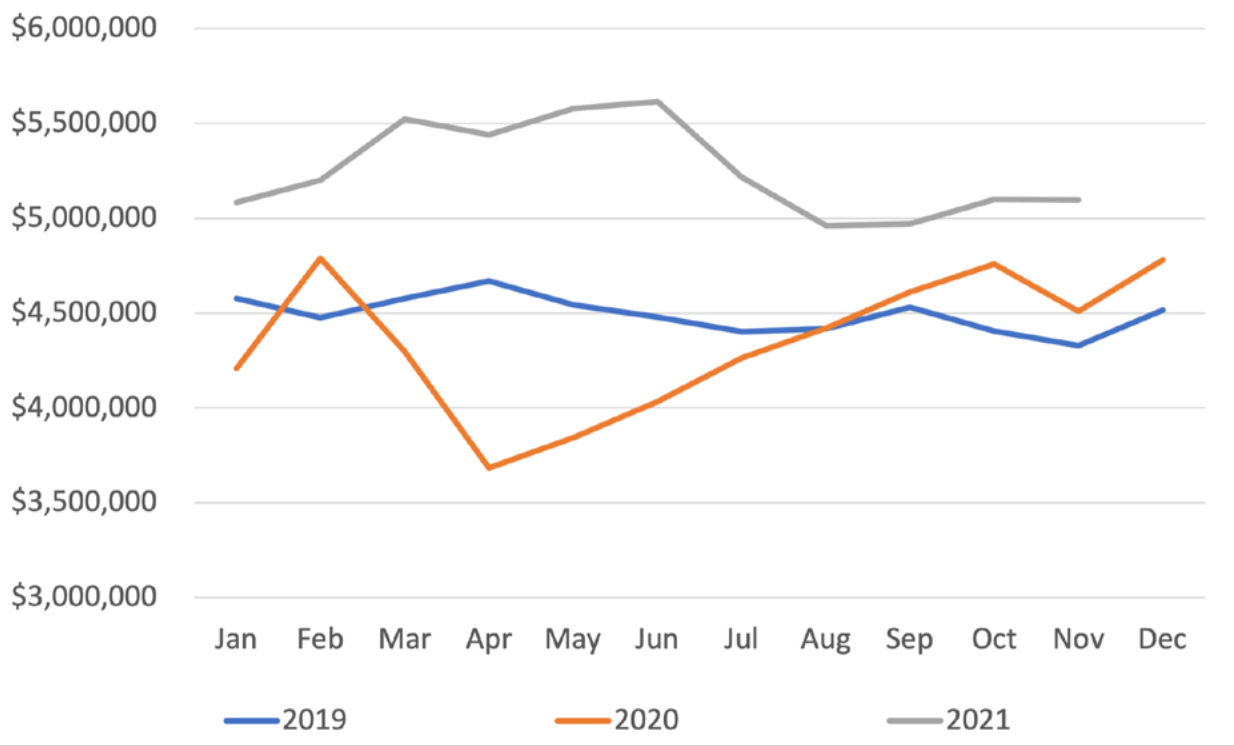



***Figure 3: Annual manufacturing sales in British Columbia (Statistics Canada 2022)***

Manufacturing in the context of this report focuses on the companies in Prince George and across northern British Columbia who fabricate structures, as well as construction, installation, and maintenance services for forestry, mining, oil and gas, manufacturing, and energy infrastructure. These companies provide component parts to major development projects in the north. Work in northern British Columbia is being

driven by the need for a skilled workforce to provide services to an influx of major projects, mostly in the oil and gas sector. These projects have so far provided contracts to large companies outside the region, with local capacity providing supporting roles.

Manufacturing in this context focuses on those companies who work in natural resources extraction and construction or provide support services to these industries. To provide a fulsome background on manufacturing in British Columbia we provide an overview below of the main industries, which includes several sub-sectors, including:

1) Wood products: wood panels and manufactured homes
2) Construction: concrete and metal fabrication
3) Chemical: chemical production, chiefly to supply local wood products mills
4) Food: farms, bakeries, and breweries
5) Other: pottery and other small-scale businesses

These sub-sectors are serviced by a range of companies that operate businesses in the north and are generally considered smaller than comparable companies operating elsewhere in Canada and North America. This research will focus on manufacturers who provide services to the industrial sector, e.g., wood products, construction, and chemical manufacturers. These and other manufacturing sub-sectors include:

### Wood Product Manufacturing

Historically, Prince George has a legacy of manufacturing related to the forest industry. Several companies have strong capacity to manufacture wood products and operate facilities that provide local employment. Typically this involved manufacturing dimensional lumber, board (e.g., plywood and oriented strand board) and paper. Given this history, Prince George is primed to be involved with innovation in wood products, for example venturing into cross-laminated timber production. The University of Northern British Columbia is home to the recently built Wood Innovation and Design Centre and Wood Innovation Research Laboratory, both of which focus on solving design issues and providing wood-based solutions to the construction industry.

### Chemical Manufacturing

Prince George and the surrounding area is served by one company that specializes in chemical manufacturing. Chemtrade is an Americas-based company, it operates locations throughout North America with a head office in Toronto and a single location in Brazil. In Prince George, Chemtrade manufactures sodium chlorate for pulp and paper manufacturing.

### Construction Manufacturing

Construction manufacturing consists of companies who provide fabrication and pre-formed structures to use in the construction industry. Specifically in the Prince George area construction manufacturing services are focused on metal and concrete fabrication.

At least twenty companies provide metal fabrication services in Prince George. These include: custom fabrication, welding services, facility shutdowns and maintenance, CNC plasma cutting, industrial installation, and machining, among others. These services are provided to a number of industries including oil and gas, mining, chemical, pulp and paper, refining, and power and hydro energy.

Several companies provide concrete services. This usually consists of providing concrete from a batch plant to infrastructure projects, then either constructing forms to pour concrete, or providing pre-formed structures that are positioned on site. Concrete companies also provide aggregate products: sand, gravel, shale, and rock.

With the recent influx of major projects in the region, metal and concrete manufacturing is in high demand.

### Food and Other Manufacturing

Prince George has a number of small businesses that produce food. These include local farmers and a flour mill (Black Fox Flour). Several local bakeries also produce food and the city is also home to several breweries and a winery. Many of the products manufactured by these businesses are sold at local farmer's markets or direct from the farm.

Other manufacturing tends to be restricted to grass-roots enterprises that produce pottery and other items commonly sold at farmer's markets or directly from businesses. These tend to be small-scale in comparison to other manufacturing sub-sectors.

## Opportunities and Challenges

Manufacturers in northern British Columbia (and across the province and Canada) each have opportunities based on their location to projects, the opportunity to embrace new technology, and to develop niche products (Figure 4).

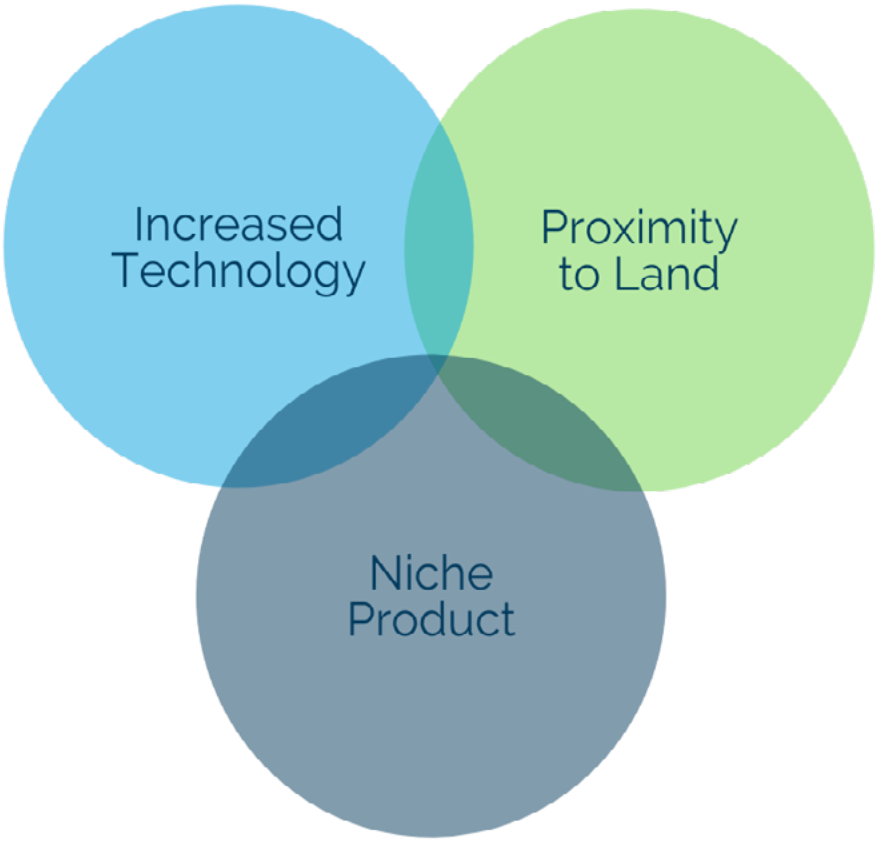



***Figure 4: The interaction of opportunities for manufacturers in northern British Columbia.***

These opportunities are specific to northern manufacturers when considering emphasis placed on developing environmentally sustainable products, companies closer to the source will have a lower carbon footprint, shorter travel time, are closer to raw materials (e.g., lumber for forest products), among others. Companies who define niche[1] products can offer those as standalone products (or services), niche products are ideally high value, low volume products and are preferably protected by intellectual property rights. These products cover a corner of the market that may be novel or innovative, or that are offered elsewhere but could be provided closer to the customer base (assuming they are not protected). These products can differentiate a manufacturer from others, leading to potential contracts to supply those products. Last, by embracing new technology manufacturers can reduce costs and increase efficiencies.

These opportunities are discussed at length throughout the research sections of this report.

## Opportunities

Further opportunity is provided in the north as major projects are keen to invest for a number of reasons. 1) proximity of deep-water ports with access to Asian markets (China, Malaysia, Japan, and India); 2) shipping routes from Prince Rupert and Kitimat are closer to Asia than locations further south on British Columbia's south west coast or in the United States; 3) rail and road infrastructure provides the means to transport some products, and; 4) the region has suitable power and water supplies to support projects.

Of the major projects coming to the north, the LNG Canada conglomerate designed a liquified natural gas processing facility worth $40 billion, widely advertised as Canada's largest infrastructure project. Gas is transported to the facility by the Coastal Gaslink pipeline. Both projects reached a financial investment decision in 2018 and have implemented construction of the facility in Kitimat and a pipeline that traverses the northwest from sites north of Prince George to the facility in Kitimat. These projects require workers from across the northwest, British Columbia, Canada and globally. Other major projects are proposed in the north, and are discussed in more detail in the Manufacturing Capacity Analysis.

The northwest is a feasible location for additional major projects, there are approximately $225 billion of projects proposed in the north, representing 61% of projects in British Columbia. Therefore, it is likely that over the next 10 years proponents will construct projects that require the services of local manufacturers. These will require northern manufacturers to provide a constant and reliable workforce is available.

Of additional importance is the drive to embrace new technology, to offer new and innovative ways of producing products and services. The province, throughout the COVID pandemic has provided funding to enable businesses in British Columbia to embrace and adopt new technologies to find efficiencies in their processes. These new technologies will involve training existing staff to work with new processes and will likely result in changes to curriculum at training and education institutions. Many of which are beginning to recognize that industries will continue to diversify, while also requiring traditional workers. For example, the University of British Columbia's Faculty of Forestry in 2020 implemented a bioeconomy sciences and technology degree that teaches non-traditional uses of wood and wood products (e.g., for biofuels and bioproducts).

## Challenges

Northern British Columbia has a strong legacy in wood products manufacturing and to support mining. As such, manufacturers in the north are required to diversify to serve emerging industries. The recent influx of major projects has created significant opportunity that will enable businesses to expand and be successful. However, several challenges face these manufacturing companies. Not least that northern British Columbia had been subject to major project investigations and assessments for some time without indication of a positive investment decision. Final investment decisions by LNG Canada and Coastal Gaslink were positive news and were hoped to bolster the economy in northern BC. In addition, other projects are being investigated with an aim to start construction soon.

1 Niche is defined as: a specialized segment of the market for a particular kind of product or service.

Despite positive news and expectations, companies in the north have faced significant challenges in gaining valuable contracts. These challenges have reduced the ability of northern companies to fully participate in projects. Some preliminary observations of challenges included, but are not limited to:

1) Increased incidence of natural disasters including, but not limited to, wildfires and flooding. Thus far the southern part of the province has experienced higher impacts than the north;

2) Decreased supply and increased prices of raw materials (e.g., plywood and steel). This has been exacerbated by the COVID-19 pandemic as supply companies were forced to either close operations or decrease production. Other notable impacts to supply were a fire at Japanese supplier;

3) Limitation of current road and highway infrastructure prevents ability of local manufacturers to assemble or build large scale components to meet the requirements of some customers. Large modular components are more easily constructed in southern British Columbia and shipped to sites.

4) Competing (project bidding) with out of province competitors, e.g., Alberta due to their advantage of lower tax structure and employee wages. In some cases, outside contractors leave projects without addressing deficiencies. That creates opportunities for local companies to provide repair and maintenance as follow up with certain customer's projects.

5) Regional and local skills training needs to recognize gaps between training and regional skill requirements. Trainers need to provide training to address availability of skilled or job ready employees. Training should focus on demands of regional and local manufacturers or businesses. Training providers need make their decisions on training programs through consultation with local business and employers. Anecdotal information suggests there is a disproportionate focus on foreign students and not enough on skills training to address the regional and local employer needs.

6) There is a lack of local skills training for specialized needs such as instrument technicians. Certain training programs are only offered at one or two provincial locations which limits access for local workers.

7) Skilled worker shortages. Industrial activity in the north is attracting skilled workers and decreasing availability for new projects. Forestry and mining are both experiencing increased prices for products which is creating jobs. At the same time, people from the north are leaving school and choosing white collar jobs rather than trades.

In addition to these challenges, British Columbia is facing a period of uncertainty for some conventional industries. Most are implementing reconciliation efforts with Indigenous communities and ensuring is Indigenous Rights and Title are protected. In 2019 the forest industry underwent significant curtailments and permanent mill closures as a result of decreased timber supply following wildfires and the mountain pine beetle infestation. In 2020 the industry was contending with increased pressure to reduce logging in old growth forests, where environmental groups have called for old growth forests to be protected.

The claims regarding old growth removal came after a provincial government taskforce to examine old growth values in the province determined that management improvements, transition to new approaches, and immediate responses were required. As government implemented these recommendations, operations continued in blocks scheduled for logging (including old growth). This has prompted the largest civil disobedience since the Clayoquot Sound protests in the 1990s. The most recent actions have involved: protests, highway blockades, and others, resulting in almost 1200 arrests to date. The provincial government subsequently announced logging deferrals on 2.6 million hectares of forest and has asked for affected First Nations to determine whether the deferrals should be implemented. Most of the Nations have responded by saying the consultation period for the decision is too short to enable informed decision making. Meanwhile protests continue and the forest industry could face unprecedented job losses as a result. The British Columbia Council of Forest Industries estimates 18,000 jobs will be lost along with 14 to 20 sawmills, 2 pulp mills, as well as value-added facilities (Council of Forest Industries 2021), and approximately $400 million in government revenues each year. This on top of mill curtailments in 2019. While the 2019 reductions created impacts to facilities that were mostly located in British Columbia's interior

(e.g., Williams Lake and 100 Mile House), additional curtailments in 2022 have started to affect mills in the north. For example, Canfor announced reduced production at their Plateau Mill near Vanderhoof, which was forecast to impact up to 70 employees (Canfor 2022).

In addition, West Coast Olefins had proposed to build a petrochemical manufacturing facility in Prince George. The project would have transported liquid natural gas byproducts via pipeline from the Enbridge West Pipeline to its proposed processing facility in Prince George. There it aimed to separate the byproducts and supply Prince George, BC, and Canada with butane, propane, and condensate. This along with a second facility would process ethylene to make plastics. These projects were voted down by the regional district after 2,000 people signed a petition against constructing the project on 13 hectares of agricultural land reserve near Prince George. The regional district stated the project could be placed elsewhere

There are several other projects in British Columbia that have resulted in additional civil disobedience. These have taken the form of protests and blockades and have resulted in arrests and court action. These have mostly been related to pipelines, first TransMountain, and second the Coastal GasLink pipeline. The latter traverses northern British Columbia. Civil disobedience is focused on an area of the unceded Traditional Territories of the Wet'suwet'en and Gitxsan.

Both the old growth deferrals and the blockades have created polarized view points throughout British Columbia and Canada, as well as internationally. No matter which point of view a person subscribes to, ongoing unrest over major projects creates a difficult environment for proponents when considering to invest in British Columbia, on top of an already strict environmental legal and regulatory regime and additional efforts required to engage, consult, and accommodate with multiple First Nations. As a result, SME's who have traditionally worked in the forest industry (e.g., to supply bridges, complete facility maintenance, among other services) are experiencing a downturn in revenue and will need to diversify their services, looking to the increasingly popular oil and gas industry.

These challenges and opportunities are further investigated in the later sections of this work. Our research determines the full extent of the impacts to businesses in northern British Columbia. This work will identify barriers to local companies and lead to the recognition of gaps and provide recommended solutions.

### COVID-19

The Coronavirus Disease 2019 (COVID-19) pandemic was first reported to the World Health Organization in December 2019. The disease (when symptomatic) is characterized by fever, loss of appetite, muscle aches and pains, runny nose, nasal congestion, sore throat, diarrhoea and breathing difficulties. These symptoms present themselves in a wide range from people who show no symptoms, to those who require hospitalization and breathing assistance.

Following initial reports, the World Health Organization declared a Public Health Emergency of International Concern on 30 January 2020, and a pandemic on 11 March 2020. Thus far, the pandemic is considered one of the deadliest in history, as of 11 January 2022 there have been 304 million cases worldwide, and 5.4 million deaths (World Health Organization 2022). Most recently cases have increased 55%, corresponding to 15 million new cases and over 43,000 deaths.

In British Columbia, as of 11 January 2022, there have been 293,521 cases (with 251,846 recovered and 35,943 active cases) and 2,468 deaths with the majority being associated with highly populated areas. At the onset of the pandemic, many manufacturing companies devoted their efforts (where possible) to produce personal protective equipment and other medical supplies as basic items like hand sanitizer, toilet roll, and medical masks sold out. The provincial health officer declared a state of emergency and set in place restrictions under a provincial health order to mitigate transmission, these included, but were not limited to: limited gatherings, use of face masks, hand washing or sanitizing.

WorksafeBC supported the provincial health order by requiring companies to instigate a COVID-19 safety plan including mask wearing, reduced contact with others, hand washing, among many other requirements. Where possible some workplaces implemented remote work options for staff to continue to do their jobs (e.g., provincial and federal government workers were able to work from home). However, while

working from home allowed workers to continue their jobs, when day cares announced closures it forced parents to not only do their jobs, but also look after children at the same time. Further impacts from the pandemic were experienced across British Columbia, Canada, and the rest of the world. Companies were forced to either close temporarily while some announced huge revenue losses and were forced to permanently close. When COVID-19 cases broke out at workplaces, the workplace inevitably closed for a short time. This has affected supply chains the world over leading to shortages of many items.

Since the onset of the pandemic, biotech companies have developed vaccines, three of which were approved for public consumption, along with anti-viral pills to help combat COVID symptoms. At the time of writing, 84.7% of British Columbians have been vaccinated with at least one dose and 79.25% are fully vaccinated. However, of the five health regions, the north has the lowest vaccination rate (61.83%; Covid-19 Tracker Canada 2022) which prompted extended restrictions to communities along Highway 16 from Prince George to Kitwanga in 2021. Further to this, British Columbia and Canada is in the midst of a 4$^{th}$ wave of the virus resulting in the need for booster shots to provide increased immunity in addition to the initial rounds of vaccines.

## Indigenous Involvement

The area now known as British Columbia has a rich diversity of Indigenous people, it is home to 199 First Nations communities who speak 34 distinct languages and over 90 dialects (making up 60 per cent of all Indigenous languages spoken in Canada). The term "Indigenous" is used throughout this report as it also recognizes Metis and Inuit. The 2016 census reported 89,405 Metis people living in British Columbia, while Inuit refers to any of the 53 communities in northern Canada (although Inuit people may live in British Columbia). The north of the province contains approximately 50 First Nations and their Traditional Territories.

The United Nations Declaration for the Rights of Indigenous People (UNDRIP) is an international declaration which sets out minimum standards that states how to interact with Indigenous peoples. In 2016 Canada adopted UNDRIP with an aim to incorporate it into legislation. UNDRIP addresses several inherent rights of Indigenous Peoples that are to be respected, such as: ownership and other rights to traditional lands and territories, cultural and ceremonial expression, identity, language, health, and self-determination, self-government, among others. While not yet legal in Canada, British Columbia has passed legislation to make UNDRIP law: the *Declaration of the Rights of Indigenous Peoples Act* (*DRIPA*).

Also, the Truth and Reconciliation Commission's made 94 Calls to Action, some of which address equal rights for education and employment for Indigenous People[2]. Two calls for action related to employment includes:

1) We call upon the federal government to develop with Aboriginal groups a joint strategy to eliminate educational and employment gaps between Aboriginal and non-Aboriginal Canadians (Call to Action 7, Education)

2) Ensure that Aboriginal peoples have equitable access to jobs, training, and education opportunities (Call to Action 92(ii), Business and Reconciliation)

Given British Columbia's and Canada's commitments to Indigenous communities, it is important not to overlook businesses and workers in these communities. Indigenous communities often include either economic development agencies or entrepreneurs that offer an additional workforce. Additional work may be required to determine challenges faced by Indigenous People to share in the opportunity presented by increased activity in the manufacturing sector.

In further support of reconciliation and Indigenous involvement in the province's economy, the 2022 StrongerBC report lists a number of initiatives to support Indigenous communities, individuals, and workers. These include the creation of a Small Business Diversity and Inclusion Action Plan (British Columbia 2022b).

2 Truth and Reconciliation Commission Calls to Action: http://trc.ca/assets/pdf/Calls_to_Action_English2.pdf

# Manufacturing Skills Gap Analysis

This section will analyze the skills and training capacity of manufacturing SME's in northern British Columbia. It can be broken down into several sub-components that when completed will contribute findings and recommendations to the final report.

These sub-components include:

1) an assessment of skills and training required by major project proponents in the manufacturing sector
2) a review of existing skills and training for manufacturing SME's (including Indigenous companies and organizations) in the north
3) identification of gaps relating to required skills and training provided by institutions, this will be accompanied by an analysis of barriers to training programs
4) a scan of skills and training best practices in other jurisdictions: Ontario, Alberta, and Australia that have experienced similar impacts from major projects
5) scan of funding opportunities to provide proponents access to training programs.

These activities will be undertaken by conducting literature-based research coupled with subject-matter expert interviews to inform and corroborate findings. This approach will ensure manufacturers are not subject to survey fatigue from this research, which is additional to that being carried out by project proponents and the City of Prince George.

This section is expected to provide recommendations about the type of skills and training employers, government, and proponents need to be focusing on to provide for the manufacturing industry in the future. Successful skills and training strategies undertaken in other jurisdictions will be provided, with an aim to adopt parts for British Columbia. Work in this phase will also identify the gaps between the skills and training required by proponents and those provided by training institutions. Recommendations could be provided regarding communications, recruitment and retention strategies, creating curricula for elementary and high schools, connecting training to jobs, and funding to implement skills and training.

Additional information from the research may include information regarding barriers to workers when obtaining new skills or an institution's ability to provide training. We identify high demand occupations in manufacturing, the need to determine unrecognized skills in the workplace (e.g., computer and digital literacy or cultural sensitivity training) and provide databases of training providers and funding opportunities in the north.

## Skills and Training Required by Major Project Proponents

Major project proponents require skilled workers either through direct employment or through contracted labour. As discussed, skilled workers are in short supply. Occupations to support these projects and the manufacturing industry in general are required across Canada. While most occupations are required to meet this demand, this section determines the occupations that are most needed. We also examine potential training updates to suit the workplace (e.g., so called soft skills), in-demand skills, and new requirements based on technological or other innovations (e.g., ESG or EDI).

### Current Skills and Training Requirements

According to WorkBC data there are 64 occupations associated with the manufacturing industry (see Appendix 1). Of these, 28 are high opportunity occupations (those that are in high demand, are easy to obtain both now and in the immediate future, and offer livable wages). As well, there are seven in demand trades (including: welders and related machine operators, electricians (except industrial and power system), carpenters, construction millwrights and industrial mechanics, automotive service technicians, truck

and bus mechanics and mechanical repair, heavy equipment operators (except crane), and construction trades and helpers). Of these, two occupations are both high opportunity occupations and in demand trades: construction millwrights and automotive technicians.

Each occupation is classified under categories in the National Occupation Classification for Canada (Government of Canada 2021). The NOC determines where in a job hierarchy each occupation falls. The occupation hierarchy for each of the occupations in the manufacturing sector is provided in Table 4. We indicate the percent of occupations considered to be high opportunity occupations[3].

***Table 4: Occupational hierarchy of high opportunity occupations***

| Occupation Hierarchy | Percent of occupations listed as High Opportunity Occupations |
|---|---|
| Management | 100% |
| Business, Finance and Administration Occupations | 100% |
| Natural and Applied Sciences and Related Occupations | 89% |
| Trades, Transport and Equipment Operators and Related Occupations | 21% |
| Natural Resources, Agriculture and Related Production Occupations | 25% |

This brief assessment indicates that all the Management; and, Business, Finance and Administration Occupations in the manufacturing industry are high opportunity occupations. Most Natural and Applied Sciences and Related Occupations are also high opportunity occupations. While about a quarter and one-fifth of Trades; and, Natural Resources, Agriculture and Related Production Occupations are high opportunity occupations, respectively.

As well as general demand for specific occupations, certain skills are in required for today and tomorrow's workforce[4]. Skills are defined in the WorkBC profiles for each of the 64 occupations listed for the manufacturing industry (see Appendix 1) and are provided with an importance rating and a skill strength. These ratings were determined in the O*NET content model (National Centre for O*NET Development 2021). To determine which skills are in highest demand the top ten skills for each of the 64 occupations was listed. Overall, the two most important skills most frequently listed in each rank of all occupations were critical thinking and active listening (Figure 5). The skill most frequently listed as the most important among each of the 64 occupations was Operation Monitoring followed by Active Listening.

3 Note that only one occupation was classified under the Business, finance and administration occupations category.
4 Skill definitions are provided here: https://www.workbc.ca/Jobs-Careers/Explore-Careers/Skills-Definitions.aspx


***Figure 5: Skills ranked by importance for each of the manufacturing occupations.***

The most important skills required in the future were determined by listing each of the top ten most important skills for each occupation. To achieve this ranking the manufacturing jobs defined in Appendix 1. Then the skills most frequently listed in each numerical ranking from one to ten (with one being most important and 10 least important) were listed to determine the most important and most frequently occurring skill at each numerical rank (see Appendix 2). The skill most commonly ranked in Rank 1 or the most important skill was Operation Monitoring[5]. Other skills ranked as highest importance are provided in Table 5. Several skills appear more than once; e.g., Active Listening and Judgement and Decision Making. These were the most frequently occurring and most important skill required under each numerical ranking, as there are 64 jobs and 10 numerical ranks these skills appear multiple times in the analysis.

In addition, the most important and frequently occurring skills are listed within each NOC code category. The most important skill in each category included (see Appendix 3 for tabular data):

- Management: Critical Thinking
- Business, Finance and Administration Occupations: Speaking
- Natural and Applied Sciences and Related Occupations: Critical Thinking
- Trades, Transport and Equipment Operators and Related Occupations: Critical Thinking
- Natural Resources, Agriculture and Related Production Occupations: Operation Monitoring
- Occupations in Manufacturing and Utilities: Operation Monitoring

5 Defined as "Watching gauges, dials or other indicators to make sure that a machine is working properly."

*Table 5: Important skills in manufacturing jobs.*

| Skill | Occurrence | Rank |
|---|---|---|
| Operation Monitoring | 21 | 1 |
| Critical Thinking | 14 | 2 |
| Active Listening | 18 | 3 |
| Monitoring | 14 | 4 |
| Active Listening | 11 | 5 |
| Judgement and Decision-Making | 9 | 6 |
| Speaking | 16 | 7 |
| Reading Comprehension | 11 | 8 |
| Judgement and Decision-Making | 11 | 9 |
| Judgement and Decision-Making | 10 | 10 |

## Future Demand for Skills and Training

The Fourth Industrial Revolution has begun with the advancement of new technologies over the past decade (World Economic Forum 2020). To embrace the introduction of those new technologies the public sector will need to tackle long standing delays in improving education and training providers systems. Recognizing the importance of incorporating new technologies in the work place and corporate value innovations (e.g., Environmental, Social, and Governance[6]) either directly or indirectly.

**The introduction of new machines, digitalization, and predictive processes will require new workforce skills**[7]. Those new skills will also have to be coupled with the changing landscape of career expectations within existing jobs as well as what the jobs of tomorrow will bring to the forefront of job satisfaction. The impact of greening the work production process, the demands of a digital economy will require employers to support their employees' transitions to the demands presented by the changing scope of the workplace**. Supporting workers in new skills training as well as upskilling will be at the lead of employer's strategies in meeting the challenges of new technologies in the workplace**.

To support this, over 60% of employers are willing to introduce new job skills and upskill existing employees; however, the uptake of those skills is lagging (World Economic Forum 2020). With only 42% of employees taking on new skills training opportunities whether in a formal or informal process the way forward for employers, will be challenging.

The workforce of today and that of tomorrow is already seeing a dramatic change in focus on skills demands and will only be amplified, as new technologies are introduced. Emerging skill clusters are predicted to include increased requirement for a number of skills including: Critical Thinking, Problem Solving, Self-Management, Working with People, and Use of Technology and Development (World Economic Forum 2020).

Furthermore, skill requirements are expected to change by 2025, especially as new technologies become more embedded in the workplace. Requirements for digital skills and "soft skills" are forecast to be in demand, and to continue to rise significantly (Royal Bank of Canada 2021). In general, occupations are expected to require workers who have skills in (World Economic Forum 2020):

- Analytical Thinking and Innovation
- Active Learning and Learning Strategies
- Complex Problem Solving

6 ESG is discussed in the context of innovation later in this report

7 Further discussion about the influence and impact of incorporating new technology is provided later in this report.

- Critical Thinking and Analysis
- Creativity, Originality, and Initiative
- Leadership and Social Influence
- Technology Use, Monitoring and Control
- Technology Design and Programming
- Resilience, Stress Tolerance, and Flexibility
- Reasoning, Problem-Solving and Ideation
- Emotional Intelligence
- Troubleshooting and User Experience
- Service Orientation
- Systems Analysis and Evaluation
- Persuasion and Negotiation

The impact of the COVID-19 pandemic has created both challenges and new opportunities for industry. The recognition that training will not be wholly delivered as an autonomous activity but rather by a hybrid delivery will mean unique opportunities for educators and trainers. However, technology needs to updated in northern British Columbia to guarantee the ability for educators to provide training through online (or other) means.

## Findings

1. The manufacturing sector is at the leading edge of adaptations of new technology in their processes and production cycles. To be successful in that constant changing climate new workers and existing workers will need training to be resilient and successful in their place of work.
2. Recognition of skills that are transferrable and travel with a skilled worker from one career to another are critical in minimizing time away from work and subsequent financial hardships. The collective recognition of specific skills that today's workforce participants require to move deeper into the 21st century are clearly defined.
3. Specific skill requirements include complex problem solving, emotional intelligence, technology use, and others identified earlier. The worker for today and tomorrow will have access to training that previously was not considered a part of skills training.
4. The inclusion of those new skills and attributes into established training modes is critical for a more successful and resilient worker, who can meet the ever-changing pace of the manufacturing workplace.

## Skills and Training Requirements for Small and Medium-Sized Manufacturers

Manufacturing in northern British Columbia has faced a number of challenges in recent years with the combination of the COVID-19 pandemic, broken supply chains, and lack of skilled workers. Furthermore, clients of SME's are facing impacts of their own. For example, the forest industry experienced significant curtailments in 2019 as timber supplies decreased following massive wildfires and insect infestations. In 2021, government deferred logging on 2.6 million hectares of old growth. These in combination with similar impacts experienced by the manufacturing industry (e.g., lack of truck drivers to transport timber to mills) has curtailed the forest industry in general.

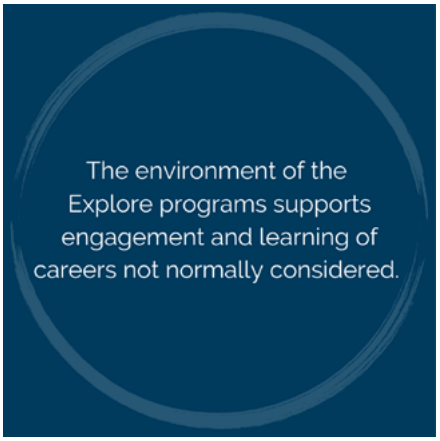
The downturn in client industries has decreased revenues for manufacturing SME's. These companies are required to diversify their client-base which will require workers who possess traditional skills, as well as future-looking skills in new technology. Downturns in other industries could result in an increase in workers who have received training in other industries, including those who have transferable skills for the manufacturing industry. Forestry, mining, oil and gas, environmental services, construction each contain occupations that could be transferred into the manufacturing industry.

To meet demands of new workers in the manufacturing industry, education requirements will need to be diversified. Albeit that traditional skills and core components of trades programs will need to remain focused on providing technical and management skills provided in college and university programs. However, new programs will require a greater diversity of skills for the future worker to ensure they understand new and emerging technologies. Accordingly, training for skilled trades workers must evolve to bring new skills to the industry and ensure innovative technologies and practices are managed by trained and qualified people.

Manufacturing SME's need to hire workers who possess this new range of skills. By bringing these workers into their businesses northern manufacturers will remain relevant as technological advances are made. While workers need to diversify their skills, managers and business owners need to seek greater understanding of the requirements placed on manufacturers so they can pre-empt new technologies.

The existing training environment encompasses trades training for new workers following on from high school. Programs are also being brought into the school curriculum to support youth who are interested in pursuing trades training. Training is also required for skilled workers as they refresh certifications and obtain additional qualifications to support their employers. These training programs are administered by local colleges and high schools, and can help young and existing workers to achieve successful careers.

## Youth




The engagement of youth while still in the secondary school system is a critical recruitment, and capacity building strategy for post-secondaries allowing youth to begin before turning 19. The success of the ITA led youth trade programs have been recognized by other post-secondary career disciplines outside of trades. Post-secondaries working with secondary school partners have developed dual-credit pathways that allow youth to not only obtain credits toward their K-12 graduation but also, credits towards their post-secondary graduation. Those dual-credit programs build on the model developed for trades and provide youth accelerated pathways to employment. The dual-credit programs provide youth with tuition funding for approved post-secondary program credits.

In British Columbia, the Industry Training Authority (ITA) supports various Youth Trade Programs: Discover, Youth Explore the Trades Programs, Youth Train in Trades Program, and Youth Work in Trades Program. These promote and support early entry of secondary school students (K-12) into Trades.

### *Youth Explore The Trades Program*

Otherwise known as the Explore program, this initiative is designed to engage all youth (Indigenous, women, new-Canadians, 2SLGBTQQIA+, and those with barriers) who are in their grade 10 to 12 years between the ages of 15 and 18. The Explore programs facilitate young people to explore trades occupations and enter part-time apprenticeships, that can support northern manufacturers and in essence act as recruiting strategies that bring more youth, to manufacturing trades. The success of the Explore program is built on key relationships between employers, secondary school career counsellors, ITA, and post-secondary trades training faculty and administrators. The design of the ITA Explore program facilitates young people to try trades without direct expectations to immediately commit to a trades career pathway. The environment of the Explore programs supports engagement and learning of careers not normally considered.

They provide hands on experiences for young people rather than attending pre-COVID education/career fairs. Young people that decide to continue beyond the Explore programs now have several options available to them, while still in the secondary school system. The programs support early entry into trades such as Welder, Machinist, Industrial Mechanic (formerly known as Millwright), Construction/Industrial Electrician, and others that follow the Red Seal interprovincially-designated trades programs as well as provincially designated trades.

*Youth Train in Trades and Youth Work in Trades*

The Youth Train in Trades, and Youth Work in Trades programs build on the Explore program to provide more specialized trades training for youth in grades 11 to 12 who are generally between the ages of 16 and 18. Progression from Explore programs is not a pre-requisite to enter a Youth Train in Trades or Youth Work in Trades program but does provide youth a much better understanding of expectations in apprenticeships. The programs allow youth to take the technical training, and on the job elements of an apprenticeship. Youth can obtain up to 16 credits towards their secondary school graduation, and apprentice level 1 technical training credits, and 480 work based hours. As an incentive, successful Youth Train and Work graduates can also receive a $1,000 award. The value of the ITA Youth programs is that they prepare young people for successful careers in trades. With access to technical and on the job training while still in secondary school and working with employers' youth now enter their career from an informed decision-making process. The programs also provide participating employers the opportunity to sponsor young apprentices that bring a higher level of work preparedness and ability to contribute to workplace projects.

## Existing Workers

Manufacturing SME's in northern British Columbia work for clients in diverse range of industries, although the majority of these are based in the natural resource extraction realm. Those interviewed work for: forestry, oil and gas, mining, transportation, construction, and utilities. More specifically, for each of these industries the manufacturers fulfill niche services, with examples including:

- Forestry: bridge construction and maintenance (including steel girder and wood decking); pulp, paper, and sawmill facility maintenance; and, vehicle maintenance;
- Oil and gas: module fabrication and welding services;
- Mining: infrastructure construction and maintenance;
- Transportation: provision of services to support the rail industry and repair to vehicles (e.g., buses);
- Construction: fabrication and welding for steel structures, and carpentry; and,
- Utilities: welding services for the hydroelectric industry.

Such diversity requires workers to have knowledge and experience in a number of industries, to adapt to safety and environmental requirements, to meet specifications set by industry and client standards, and may require workers to tolerate worksite conditions that are unique to northern British Columbia (e.g., working in remote settings without access to the cellular network, living away from home, travelling long distances in inclement weather in highways and also long gravel roads). These requirements, coupled with a diverse industrial environment means that workers are required to be generalists within the manufacturing industry, rather than specialists. Workers are required to demonstrate a variety of skills that can also include working with clients on site and troubleshooting issues alone.

Education among the workers in manufacturing SME's consists of, for the majority, trades qualifications for specific occupations (e.g., welder, millwright, etc.). Some of the SME's also employ technologists who possess college diplomas, high school graduates, and some who possess a university education. One company owner had their Masters Certificate in Project Management, while another had a business management qualification. That being said, most of the small companies have been built from the ground up by owners

who started out in trades and were able to build reputations and gain enough work to support their own companies.

Technical training curricula in the case of apprenticeship is driven at both federal and provincial levels. At the federal level there is a national standard of competency known as the Red Seal. It is identified as an inter-provincial accreditation and provides holders of that to have mobility in their craft in participating Canadian provinces. At the provincial level there are Certificates of Qualification that are only recognized within the issuing province. The curricula that support either of those accreditations is generally of a prescriptive nature based on national occupational classifications and does not allow significant adoption or enhancement, without comprehensive consultation.

Companies have also taken on apprentices and provided enough work and experience for them to gain a trades qualification (e.g., Red Seal). These jobs are supported by trades training institutions who provide theoretical training and run examinations to ensure students have learned skills to appropriate standards. Further to trades employees, secondary occupations are also required, including administrative staff. For example, larger SME's may employ their own bookkeeper and janitorial staff. These skills, while secondary to the skilled workers, still require in depth training and experience to be provided by a secondary education institution.

**Further to the current skills, as these manufacturing industry advances new techniques, processes, and equipment will be required. Workers will need to understand new and emerging technologies in the manufacturing industry. They may also need to understand new technologies available in other industries, given they provide services and products. For example, some of the work involved maintaining facilities, as these advance the skills required may diversify to include traditional maintenance activities, and also to work on new machinery with electronic components. Therefore, workers and training providers will need to diversify their skills and introduce training to work on new machinery. Ultimately, training and skills need to remain relevant to the demands of the individual industry. Educators, training authorities, industry, and funding agencies will be required to respond quickly and work together to ensure workers stay with the pace of innovation in the manufacturing industry.**

Technical trades training curricula is governed at various levels of government and its agencies, post-secondary training providers, and third-party agencies such as the Canadian Council of Directors of Apprenticeship. There is an established consultative relationship between those parties on ensuring that curricula is robust and provides a consistency of recognized competencies to learners. The role of industry and employers in contributing to and affirming competencies is through subject matter experts who are called on to validate competencies in curricula. **The challenge of the existing structure of curricula development and affirmation is that there can be gaps in the consultative processes**. For all intents, public post-secondary Colleges could have Program Advisory Committees (PACs). They are comprised of institute faculty, local and regional employer representatives, and in some cases learners in the program of discussion. PACs are voluntary in nature and are held throughout the academic calendar year generally Fall and late Spring. The purpose of PACs is to bring in comment from industry employers to discuss and review program curricula (competencies) and how they match those in the workplace. **In many cases PAC terms of reference are well defined by the hosting institution but in some cases PAC member expectations are not well stated**. Other challenges that PAC contributors encounter is the perceived lack of curricula change that reflects their input. Here again the issue can be poorly defined terms of reference as well as, not fully understanding the broader picture of how curricula changes are initiated. Research interviews also found that due to COVID-19, PACs at many institutions did not happen or became less regular than they were before the onset of the COVID-19 pandemic. That created a vacuum in feedback to institutions as they moved ahead with their curricula adaptations in response to COVID-19 and the link to industry dissipated.

PACs work at the local and regional level whereby Sector Advisory Groups (SAGs) operate at the provincial level and in industry sectoral clusters. Like the PACs, SAGS are a voluntary structure comprised of industry employers, ITA staff, industry associations, and others. The terms of reference are well defined for SAG members by the ITA and allow for a constructive consultative exchange on competencies within respective training curricula. The ITA has reissued a plan to reactivate the SAGs that like PACs, were delayed due to COVID-19 as well as other internal changes. The value of a consultative structure to inform curricula is

critical to ensure relevance of the competencies in meeting industry and employer's needs. The limitation between the two advisory groups is that there is no formal structure that allows communication between the two (Figure 6). In some cases, subject matter experts participate at both the PACs and SAGs to bring a more intimate insight of activities and realities that impact employers at the local level. The benefit of sharing knowledge between PACs and SAGs is currently not a formal process and leaves a gap for conformation of competencies that speak to both regional and provincial industry and employer needs, a terms of reference for communications is required.

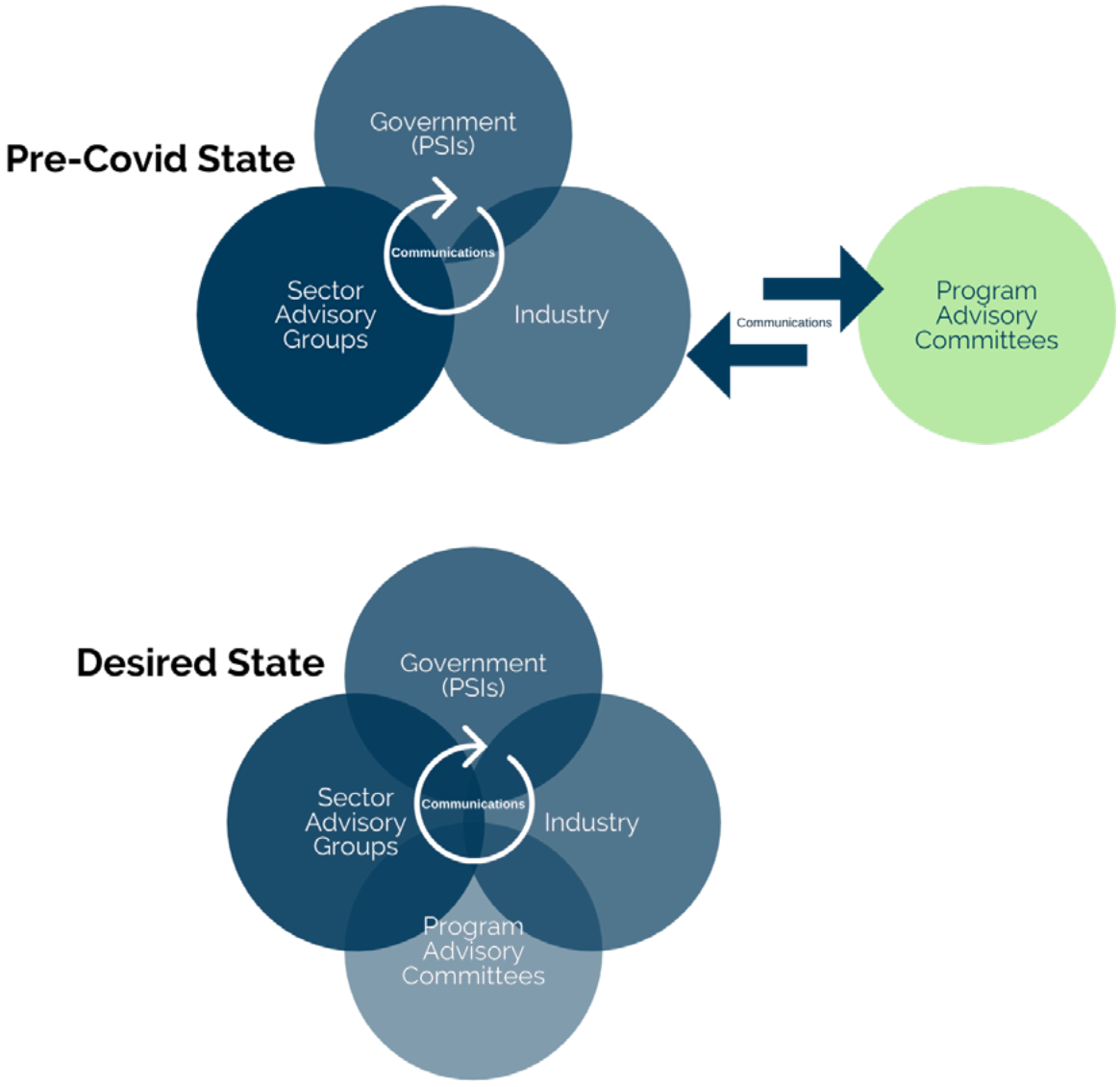



***Figure 6: Pre-COVID-19 (top) and desired communication (bottom) states of how PACs and SAGs communicate with each other and with industry and government.***

## Institutions that Support Training

Most post-secondary (Northern Lights College, College of New Caledonia, Coast Mountain College, and University of Northern British Columbia) programs have pre-requisites that the K-12 students must meet before entry into a dual-credit educational stream. In the case of College's (that focus on career training or applied learning) an example of a relevant accredited College program are pre-apprenticeship programs known as Foundation. They have academic pre-requisites such as Math, English, and Physics. Those pre-requisites provide a level of quality assurance (success) that the student will meet the academic rigour of the post-secondary program. Dual-credit programs also prepare youth for universities (that tend to focus on professional and academic learning programs). Examples of those that are relevant to the manufacturing sector can include Mechanical, Civil, Electronics, and Computer Science engineering programs. Also, business programs in Business Administration, and Office Administration and as well as other University disciplines. In some cases, students begin their post-secondary career pathway in college and then progress to complete their degree or professional status in university.

## Skills Training Innovation

Skills training innovation is critical in the constant effort to align curricula with industry, and workplace realities. There are two principal categories of curricula. They are credit and non-credit courses. The distinction between the two is important to understand as it directly relates to how quickly a training provider whether University, College, or private post-secondary can respond to the ever-changing scope of workplace practices. Credit courses are the units within programs that contribute to completion within a stated discipline. In general terms, credit courses are within academic or professional programs and contribute to an individual meeting their graduation requirements. The development of credit courses is governed by various steps that involve program Curriculum Chair Committees, and Academic Councils. At each step, course content (competency) is evaluated to determine its effectiveness in providing the learner the opportunity to develop knowledge, and application skills to successfully master the competency**. The process to approve new programs and their credit courses can be a lengthy process. That process at times, can impede the ability of a post-secondary to introduce programming that will prepare learners for emerging skills in the workplace**. The perception is that of a lag time or unresponsiveness from post-secondary to the demands in the workplace.

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In so much credit courses are developed and maintained by each individual post-secondary there are programs that do not generate academic credits. Non-credit courses, and programs are generally not governed by an institutes Academic Council but may in fact, be third-party regulated as is the case with many skilled trades technical courses. In addition, non-credit courses may also be part of Adult Education through Community based courses and are delivered on a fee for service basis. That model of delivery is the foundation for institutes contract training, which is a for profit delivery model. The benefit of the latter two modes of course/training delivery is that it is responsive to changes in the Community or workplace environment. Examples of third-party regulated courses or programs are the apprenticeship technical training competencies. Those are delivered at both public post-secondaries but also, private trainers. The nature of apprenticeship technical training is that it is part of the national Red Seal standard which is regulated outside of post-secondary Academic Councils.

For the purposes of this paper, the focus will be on applied practitioner or competency-based training (a mix of credit and non-credit courses) that more directly relates to the manufacturing sector. It should be noted that professional and academic programs also have a role in manufacturing but not as immediate as competency-based programming. It is well understood that the digitizing of many workplace environments and changing worker duties are happening more quickly than ever anticipated. That change is being driven by the need of manufacturers to maintain their competitiveness. That is accomplished by using innovative practices, driven by digitization in all aspects of the manufacturing cycle.

To meet the challenges faced by manufacturers, training providers also had to move to innovative program development, and delivery modes. The impact of COVID-19 had a particular impact on the relationship between industry and training providers. It provided the opportunity to accelerate ideas that were pre-COVID-19 identified but not yet implemented. In the case of competency-based curricula it has always been the practice to adhere to in-class face-to-face delivery modes. The rational was based on the technical/applied nature of competency-based training as it relates to skilled occupations such as Welder, Machinist, Industrial/Construction Electrician etc. The initial response to the pandemic by trainers/educators was to completely adhere to public health office guidelines and cease all in-class modes of training/education. In the case of skilled workers, their apprenticeship progression was now immediately stopped. Industry however did not stop and the delay in training of their apprentices directly impacted the businesses skill base.

### Mentoring

During apprenticeships, existing and experienced employees can provide mentorship. Mentoring programs have proved highly effective at ensuring successful training and to ensure new workers meet the expectations in the workplace. Some staff may naturally be good mentors, they may demonstrate abilities to teach and guide new workers.

The Canadian workforce is aging, and manufacturing is particularly vulnerable to this trend. The number of workers aged 55 and over in manufacturing increased 161% from 1996 to 2018, while the overall number of workers in the sector decreased (Ontario 360 2021). Older and retiring workers are a valuable source of experience and know-how. Policymakers can develop mentorship programs that mobilize retirees and older workers to teach and mentor younger generations (Ontario 360 2021).

Whereas other employees who may be skilled in their chosen trade may require additional help to be mentor. Choosing mentors in a small company may be presented with challenges, some staff may not want to mentor, others may want to mentor but not have the capability to do so and may need training, and some employees may be natural mentors. For those that do not want to be mentors, they may need encouragement and to be incentivized to work with new workers. They and the workers who want to be mentors may require training to properly guide and help new workers.

## Findings

1. Manufacturing SME's need to hire workers who possess skills to support traditional occupations, but also need to possess a new range of skills that encompasses new technology and soft skills to support diversity and inclusion.

2. Training programs and funding are available through the ITA to attract new workers into the workplace to build capacity and to support existing workers to obtain new skills or refresh qualifications.

3. To support the coordination of skills training and to determine what the industry demand is, advisory committees (PACs and SAGs) have been crucial to bring together the voices of government, educators and industry to inform curricula and move the industry forwards. These committees help to establish a forward-looking direction to train workers, support and enhance trades programs and industry (through inclusion of new skills), and ultimately economic development and longevity in British Columbia.

4. These committees have the ability to continually recognize demands placed on industry and evolve training to meet demand. Another initiative that can support new workers is mentoring, it is valuable to not only support the new workers (the mentees) but also the existing workers who will provide mentoring. Such initiatives have proven highly successful in terms of both retention and to acquire skills and be successful through their training.

## Gap Analysis Relating to Skills and Training

There are a number of existing gaps in skills and training relating to skilled trades. These are related to impacts brought about by the COVID-19 pandemic and the reduction of in-class teaching and training; the inclusion of digital literacy in training to ensure future workers understand technological advances; the implementation of work-integrated learning and microcredentialling; and, remote learning opportunities for rural communities.

To address the impact of no in-class teaching, training providers immediately reviewed their curricula and identified opportunities to change the mode of delivery. The first review and adaptations where reactive and created a series of frustrations for all parties concerned with training and delivery. That first reactive response had limited or no consultation with industry, relevant government ministries, and apprentices or students. As consultations were undertaken, they were still primarily between training providers and government agencies such as the ITA who hold the apprenticeship standards, funding, and processes portfolios. As the new modes of training delivery continued to roll out, feedback from apprentices and their employers started to come back with significant concerns on the strategies being used. The two most significant concerns dealt with lack of consultation for the change in curricula modes of delivery and the use of technology.

Essential Skills now known as Skills for Success have always included digital literacy as an essential skill. That skill is now seen as digital literacy which is driven by the changing workplace environment of more complex equipment or machinery, and production processes. With the digitization of curricula and deliveries via web-based portals it became immediately clear that apprentices and other students did not have the digital literacy required to move into the new mode of delivery. The prevailing assumption by many training providers was that current apprentices and other students had basic computer skills. That was not the case as evidenced when computer-based learning was introduced to apprentices. Their ability to access web-based resources, login/out of controlled quizzes and exams, and navigation between live and recorded video lectures were limited in success. The impact of that lack of digital literacy had a direct result. Many apprentices did not successfully complete their progression to certification and thereby impacted their employer's ability to assign them more responsible duties.

The impact of that delayed certification of apprentices due to lack of digital literacy skills was very quickly identified by training providers. Instead of being reactive as was the first response at the onset of COVID-19 they now saw the opportunity to be pro-active. Seeing the gap in digital literacy by apprentices prompted training and educational providers to review the Skills for Success and reintroduce those into curricula as well as independent courses delivered under institutional contract training units. The reintroduction of Skills for Success has been seen by government and its agents as critical to the success of apprentices but also, other skilled occupations students. Both levels of government have provided funding to continue the enhancement of curricula with the Skills for Success which include digital, communication, numeracy, writing, adaptability, collaboration, reading, problem solving, and creativity and innovation. All those nine skills are required by skilled workers to be successful as we move into the Fourth industrial Revolution. Built into those skills such as collaborative are fundamental elements that will inform learners (as well as educators) about the new norms in the workplace. Those norms include a diverse workforce, equitable treatment of all members of the workforce, and an inclusive respectful workplace.

In so much the Skills for Success have been identified through a consultative process including government and its agencies, educators, industry, and business leaders there has not been significant consultation on how to best introduce those, into prescriptive competency-based curricula.

Many policy efforts to build a qualified workforce in manufacturing overemphasize "hard", technical skills.

This overlooks the importance of "soft" or nontechnical skills, such as critical thinking, active learning, problem-solving, which are as important in advanced manufacturing as is being trained in STEM fields. These skills will be incentivized, taught, and practiced if curriculum development mainstreams soft skills in training and educational programs. Upcoming work by the Smart Prosperity Institute and Future Skills Centre finds that demand for soft skills will grow across a range of net-zero emissions sectors, making investments in these skills even more important for growing clean technology companies (Ontario 360 2021).

### Work Integrated Learning and Microcredentials[8]


Work-Integrated-Learning (WIL) is an enhanced extension of adult co-operative education. Where co-operative training is an on-the-job paid credit course requirement of a specific program, WIL looks at work-based training and education on a continuum. The concept of WIL programs is the melding of a student's educational plan with that of the workplace skills expectations. The goal of WIL is to achieve workplace knowledge, employability and mobility skills, recognize, and apply practices of life-long learning and its importance to workplace adaptability. Examples of WIL include internships, field and clinical placements, professional practicum, and the well-known apprenticeship model of training. WIL has taken the later examples and formalized the relationship/partnership between educational institutes, employers, and students so that all become part of the students/apprenticeship employment goals.

**For post-secondary institutions and employers to maintain relevant relationships it is critical that curricula align with the demands of employment. To ensure those relationships remain relevant it is important that current and future Labour Market Trends (LMI) trends are identified and applied to inform both post-secondary institutes and industry to maintain a competitiveness, and nimbleness in support of economic growth**. The integration of LMI trends to inform curricula development is essential and is now recognized in the introduction and growth of microcredentialling. The purpose of microcredentials is varied but the core principle is to facilitate life-long learning opportunities for workers, students, practitioners, etc. "A microcredential is a certification of assessed competencies that is additional, alternate, complementary to, or a component of a formal qualification.

There are seven guiding principles for microcredentialling (Colleges and Institutes Canada 2022):

1. Microcredentials can be a complement to traditional credentials (certificate, diploma, degree or post-graduate certificate) or stand alone.
2. Microcredentials are subject to a robust and rigorous quality assurance process.
3. Microcredentials should represent competencies identified by employers/industry sectors to meet employer needs.
4. Microcredentials may provide clear and seamless pathways across different credentials (both non-credit and credit) and may be stackable.
5. Microcredentials are based on assessed proficiency of a competency, not on time spent learning.
6. Microcredentials are secure, trackable, portable and competency is documented in students' academic records.

8 A microcredential is a certification of assessed competencies that is additional, alternate, complementary to, or a component of a formal qualification (Colleges and Institutes Canada 2022).

7. Microcredentials are to follow institutional approval processes.

### Remote Skills Training

Much of British Columbia's north region is characterized by rural and remote communities, some situated many hours from larger municipalities. Some of these communities may only be accessed via marine or air transportation. Even land-based communities can be remote or isolated due to distance away from larger community settings. For most of those communities, access to reliable connectivity is an issue that contributes to their isolation. To address that is the commitment from the "Stronger BC" Economic plan to expand and meet the challenge of limited connectivity for isolated and remote communities. With the introduction of more connectivity, comes the opportunity to bring education and skills training to Indigenous communities and other rural and remote communities. Many of whom would not consider attending education or training due to the separation from community. In community education will provide the opportunity for introduction to Skills for Success, such as digital literacy. That skill will open web-based education portals in both credit and non-credit course and programs that will lead to accreditation and certification in careers of high demand both in, and outside communities.

To complement the expansion of connectivity the ITA has developed a model of in-Community-Based Training that brings skilled trades technical training to remote and isolated communities. The model allows community members to begin training in desired skilled occupations to contribute to economic expansion, build out and repair of homes, critical infrastructure projects such as water and waste systems etc. The model of delivery begins to address the barrier of isolation and in some cases, provides intrinsic value and recognition of traditional/cultural skills as they apply to current educational competencies. The building of relationships through education and skills training builds pathways towards meaningful partnerships that lead to outcomes that can and will address workforce skills shortages in northern British Columbia.

## Findings

1. The ongoing COVID-19 pandemic has provided a number of barriers, but existing technology was quickly adapted to ensure that training and teaching could continue. The pandemic has created the opportunity to embrace new technology to support the continuation of the economy in British Columbia (e.g., by allowing workers to meet by video-conferencing).

2. New technology has also been recognized to offer distinct efficiencies in work processes and many funding opportunities are now looking for companies (including SME's) to incorporate new technology. This is especially important for SME's as incorporation of digital technology can provide a advantages over competitors. Given that much of northern British Columbia is rural and remote, provision of training and use of digital technology and distance-learning can be difficult in the region (e.g., lack of reliable and efficient internet).

3. SME's need workers who are trained to use and understand processes including new technology. They require knowledgeable staff who can maintain new technology across a number of industries. Training providers can help SME's by providing microcredentials to upskill existing workers. Additionally work-integrated learning can be implemented in partnership between the training providers and the employer.

## Best Practices in Manufacturing Industry Skills and Training

Many jurisdictions are facing worker shortages, especially in skilled trades and for trades specific to the manufacturing industry (Royal Bank of Canada 2021). This presents a distinct challenge to the manufacturing industry the world over and in British Columbia. Some jurisdictions however, have moved closer to solutions. Thus giving the opportunity to mine ideas to bolster the skilled worker shortage in British Columbia.

First, Canada has a distinct shortage of skilled tradespeople. The skilled workforce is defined here as the 56 Red Seal (RS (national trades certification system)) trades. These were projected to experience a worker shortfall of approximately 10,000 workers from 2020 until 2025, and are not expected to recover to the same levels as in 2012. That shortage will also be exacerbated 10-fold when the 250 provincially accredited skilled trades occupations are also included in that forecast (Hughes 2021; Figure 7). Of these jobs, shortages are expected among industrial mechanics (millwrights), boilermakers, and welders (Royal Bank of Canada 2021).

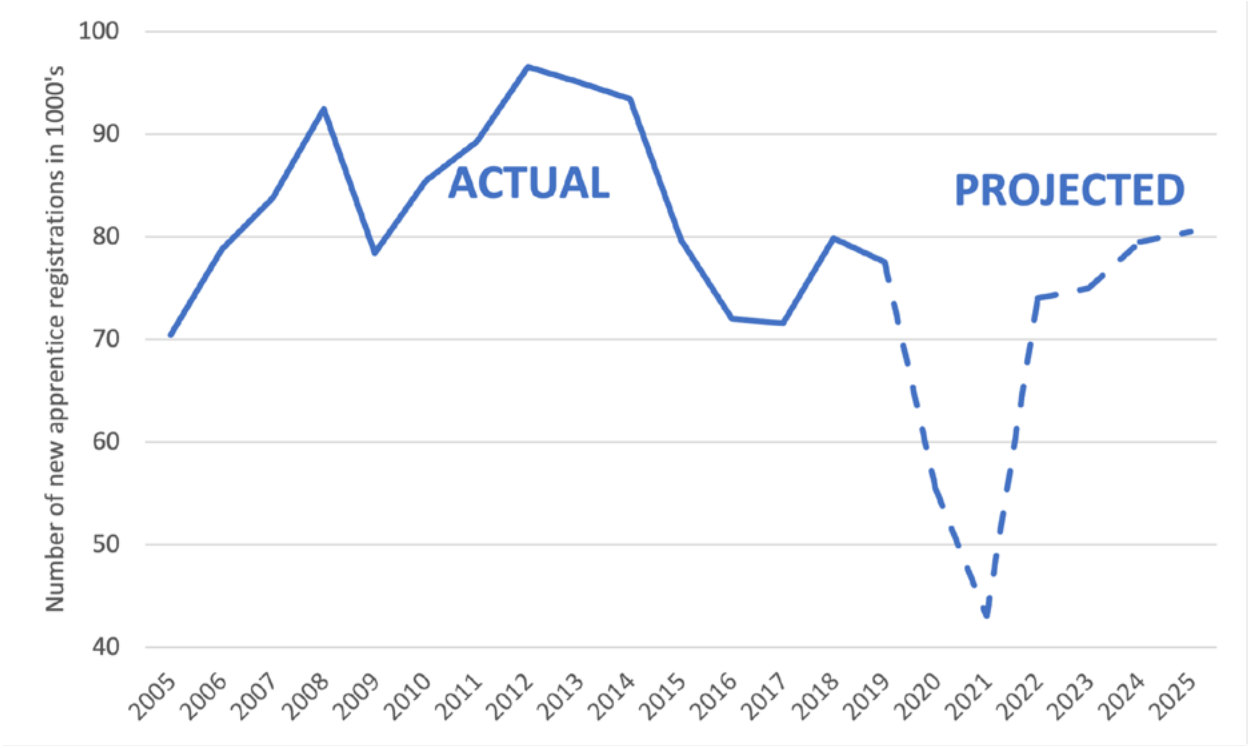


***Figure 7: New apprenticeship registrations in major trade groups by year, in thousands (Statistics Canada 2021)***

To address the skilled worker shortages, multiple strategies have been attempted and/or implemented. Those include strategic immigration programs such as the Federal Skilled Trade Program, Temporary Foreign Workers. The government projected target of 3,000 newcomers annually meeting that program's criterion has achieved approximately 80 percent success. The challenge for the program is attracting immigrants to Red Seal occupations with only approximately 8.7 percent representation in apprenticeship. The skilled occupations are generally not well understood with the belief that that related careers are unsafe and not financially rewarding which contributes to the lack of interest in pursuing them.

Of equal concern if not even more pressing is the challenge facing the current skilled workforce of new technologies and innovations. The digitalization of careers will require those in the skilled trades to adapt to new practices to keep pace with their on-the-job demands. It is anticipated that of the 4,000,000 Canadian skilled trades workers one quarter (25%), will need to increase their digital literacy skills.

The following two examples are from jurisdictions (Alberta and Australia) who have worked to mitigate their skilled worker shortages during major capital projects within the Oil and Gas sector:

### Alberta

- During the buildup of the Alberta Oil and Gas Sector it was immediately recognized that a workforce strategy had to be implemented to meet the skilled workforce demands of that rapidly expanding

sector. Alberta initiated a 10-year strategy "*Building and Educating Tomorrow's Workforce, 2007"* (BETW) that identified 17 key government strategies to ensure better trained workers, attraction of more skilled workers, and adoptions to enhance innovations in the workplace (Alberta Government 2007). To meet the expectation of those strategies the Alberta government involved key stakeholders with industry, labour groups, professional organizations, volunteer and community agencies, education and training providers, and where appropriate, other orders of government. Key to the success of those stakeholders is the need for collaboration and partnerships between the participating groups, and government as well.

The Alberta Energy Sector is primarily comprised of the following[9] :

1. exploration and production of both conventional and non-conventional crude petroleum and natural gas, including oil sands and coal-bed methane;
2. mining for coal[10];
3. electric power generation transmission and distribution; and,
4. oil and gas pipelines.

The Alberta energy sector directly supports and is supported by the manufacturing sector, industrial construction and transportation. Each of those supporting sectors had unique and individual workforce strategies developed to ensure skilled worker supply met the growing oil and gas sector demand. Looking specifically at the metal manufacturing sector which includes but not limited to metal fabrication and machinery. The overall shipments from metal fabrication to the Alberta energy sector in 2006 was approximately 52 percent or $2.4 billion of the total metal manufacturing[11] requirements of the Alberta energy sector (Alberta Government 2007). Continuing with the example of the metal manufacturing sector it is important to review their skilled workforce challenges and development in meeting the ever-changing landscape of production/output demand.

It is well documented the impact of an aging workforce and their leaving fulltime employment especially in the skilled trades. The impact of losing their collective knowledge and experience in maintaining higher production levels is an issue that today's industry and educational leaders are working on solving. In Alberta various strategies towards enhancing skills training have been identified and implemented. The goal is to solve both the loss of knowledge from an aging workforce, to training that meets the demands of new technologies introduced in production-based industries, such as metal fabrication. Unique to skilled trades is the apprentice model of developing skilled workers. The apprentice model incorporates both in-school technical training, approx. 30 to 20 percent of total required training hours (approx. trade average is 6400 hours) as well as, on the job-training comprising of 70 to 80 percent of the required hours leading to Red Seal (RS) certification[12]. To meet the emerging skills training demands it is critical to "*identify and organize specific training programs needed to support growth and innovation in metal fabrication." "establish a metal fabrication incubator in the region by strategically leveraging assets including redundant schools and equipment."* (Community Futures Wild Rose 2017).

Alberta continues to build on previous workforce skills development with the future outlooking *"Alberta 2030: Building Skills for Jobs"* initiative. Elements of the initiative will look at expanding and retooling the current apprenticeship training modes to new models of delivery. Examples will see more education delivered through paid on-the-job mentorship programs. Refreshing the post-secondary education system with

9 The definition of the energy sector closely follows that used by Calgary economic Development in their energy sector profile titled: *Calgary: A Global Energy Sector.*

10 This workforce strategy focuses on Alberta's energy mineral including oil. Oil sands, natural gas and coal. Mining for non-energy minerals including sand and gravel, salt, silica, stone and gold is not included in this strategy.

11 Sub-sectors include machine shops, boiler, tank and shipping container manufacturing, and other fabricated metal products, definition from Statistic Canada.

12 Pan-Canadian skilled trades certification is based on specific criteria to meet the recognized Inter-provincial Red Seal (RS) standard. The unique skill sets of each RS occupation are developed through the Red Seal Occupational Standard (RSOS) which is a specific/unique enhanced development of the National Occupational Analyses (NOA).

greater engagement with industry to facilitate real time adaptions to teaching and learning outcomes. Approve the ability for post-secondary institutions to fast-track educational accreditation/approval processes for new training programs as well as introduction of new competencies in existing programs curricula. Key to the success of Alberta's skills training refreshing is supporting the engagement of training providers and that of industry.

### Australia

- The rapid expansion of the Australian oil and gas sector saw an unprecedented growth in its workforce from 9,000 workers in 2006 to 19,000 workers in 2017 (National Energy Resources Australia 2019). That direct increase in oil and gas workforce indirectly contributed to a further expansion of an additional 10 jobs within the oil and gas supply chain[13]. In early 2012 Western Australia's minister for commerce and small business Simon O'Brien referenced the *Assessment of the Engineering Design Capability and Capacity in the Oil and Gas Sector in Western Australia* study complied by Martin West, of Curtin University. The study details the strengths and weaknesses of the domestic engineering design industry and calls for 'substantial' government involvement in securing contracts for local firms. In addition, minister O'Brien states "*Any success in attracting engineering work to Western Australia also has positive spinoffs for other local manufacturers, as local engineers become more familiar, for example, with the skills of our local fabricators here in Western Australia."* (Culley 2012).

With the rapid growth of the oil and gas construction phase, manufacturers had to adapt by introducing new processes in production. Those adaptions in turn required skills upgrading of their existing workforce as well as hiring new workers with adaptive skills. Examples of new production processes include plasma cutting tables. Those in turn can be fitted with computer numerical controls (CNC) that minimize cutting mistakes thereby, increasing production turn-around time. The operation of CNC plasma table now requires a skilled hand-held torch fabricator to develop digitalization skills to operate the new introduced equipment. To accomplish new skills adoptions, the oil and gas construction phase industry and manufacturers employers will need to work with training providers and education to highlight the changing workplace environment that will see advances in technology. That will mean recruitment of adept workers who bring not only operational skills but also maintenance skills. Employers will also need to provide training of new processes to existing skilled workers, to support their transitioning into new production work roles.

One of the key learnings for going forward is the need for involved stakeholders to collaborate on workforce planning issues. That will facilitate both an increase in efficiency and industry productivity. Issues that need to be addressed include the following:

- Co-operation on key operational standards to de-bottleneck industry (e.g. shutdowns)
- Arrangements with the supply chain to develop a more flexible and integrated contracting model
- Working with government, community, and other stakeholders to maintain social license
- Common standards of training and competencies across disciplines (e.g. new LNG framework; National Energy Resources Australia 2019).

To meet the ever-changing complexities of manufacturing and other industries the Australian government has embarked on an initiative through their "Skills Organization" strategy to deepen industry engagement and improve the Vocational Education and Training (VET) system (Australian Government 2021). The Skills Organization strategy will bring industry and employers together to lead strategic thinking on workforce and skilling issues including career pathways, how they will recruit people and what is needed for businesses to grow. The initiative will test ways to enhance the VET model to be more responsive to industry and employers skilled workforce needs. The project will look at ways to improve quality of training delivery and assessment, identifying skills needs, and developing qualifications that provide improved understanding of actual abilities of graduates.

13 The definition of direct (core) oil and gas workforce as people directly employed by oil and gas extraction and production companies, while the indirect workforce comprises of people in the supply chain and wider economy whose jobs indirectly rely on the oil and gas industry.

## Findings

1. Skilled worker shortages have been a persistent issue since the beginning of the 21st century. The issue or gaps in skilled workers was acutely exacerbated during the rapid build out of the oil and gas industries in both Alberta, and Australia.

2. The competition for skilled workers was to some extent seen as a recruitment issue rather than a communication gap between industry, education, and government. In both jurisdictions the role of each of the three parties was critical to participate in dialogue that could meet the ever-increasing need for training of skilled workers. Building on the recognition of a shared issue, provided the foundation for greater collaboration between the three primary influencers on developing and upskilling a skilled workforce.

3. Strategic relationships are critical to meeting the demands of training new workers in the skills needed for the workplace. In addition, the upskilling of existing workers to ensure that they can adapt/adopt to new process and procedures will be critical to meet the changing workplace landscape. Meeting the challenge of skilled worker shortages will require partnerships with clearly defined roles and understanding of what strengths each partner brings to the discussion to meet the demand of training new skilled workers.

## Funding Opportunities

Canada, like many countries, has been experiencing a country-wide labour shortage and needs to fill in-demand positions, while training workers to meet labour demands. To help businesses many countries and smaller jurisdictions within countries, have established funding opportunities. Many of these are in response to the COVID-19 pandemic, but are also focusing on establishing new skills to increase aptitude for digital technologies and innovation. Funding is also being provided to increase diversity and inclusion in the workplace.

Funding opportunities, subsidies, deferrals, and other incentives and measures provided by Canada and British Columbia are listed below. These opportunities focus specifically on skills and training diversity among the workforce. In a later section we provide a list of funding opportunities to help manufacturing SME's to diversify the products and services they provide.

### British Columbia

British Columbia set up several programs in 2020, a description of which are provided in British Columbia (2020a). Many of the provinces funding streams are now closed to applications. Some of the programs designed to help SME's in the north are briefly described below.

Small Business BC provides a list of funding programs available through government and non-government agencies: https://covid.smallbusinessbc.ca/hc/en-us/articles/360050726773

Aside from these, there are a number of funds available, most of which are tailored to encouraging skill development in new technology, low carbon initiatives, and increasing diversity and inclusion. Some of these include:

Royal Bank of Canada Future Launch (https://www.rbc.com/dms/enterprise/futurelaunch/) which provides several initiatives including scholarships.

The province is also provides skills training to vulnerable and under-represented groups through the Skills Training for Employment (STE) program: https://www.workbc.ca/training-education/skills-training-for-employment.aspx

Innovate BC has a number of programs to support hiring, research and development, pilot funding and mentorship, with its main function being to use funding, expertise and connections to drive innovation and growth for British Columbia: https://www.innovatebc.ca

British Columbia has implemented a new *Skilled Trades Act* that among other measures, provides funding to the Industry Training Authority (to be renamed SkilledTradesBC in summer 2022; ITA 2022) to ensure trades workers can get access to training and upskilling, and complete apprenticeships and certification: https://news.gov.bc.ca/releases/2022AEST0007-000215.

British Columbia's StrongerBC economic plan outlines a number of initiatives to support diversity and inclusion in the workplace by providing funding for female entrepreneurs, Indigenous workers, and other under-represented groups. The provincial government is also promoting education by providing spaces at universities, colleges, and other institutions. A major component of the plan includes the creation of a Future Ready: Skills for the Jobs of Tomorrow plan which will foster innovation and attract new talent to the province. The Skills for the Jobs of Tomorrow is discussed in the economic plan and will be fully realized in 2022.

In addition to these programs, the province sponsors immigrants in short- and long-term programs that bring skilled workers from other countries to Canada and British Columbia. These programs are covered in the capacity analysis section of this report.

### Canada

A summary of Canadian funds are provided below. These do not provide exhaustive information about each program. Rather the programs were reviewed and then selected based on their relevance to SME's in northern British Columbia. A full list can be found here: https://www.canada.ca/en/department-finance/economic-response-plan.html#businesses

Canada Summer Jobs, which provides funds to employers to create summer work experience opportunities for people aged between 15 to 30 years: https://www.canada.ca/en/employment-social-development/services/funding/canada-summer-jobs.html

Innovator Skills Initiative provides up to $10,000 to hire a new employee from an under-represented group get their first job in the tech sector and support companies facing skills shortages to grow and expand. Up to 10 grants are available to companies for up to 10 employees. The funds are available to non-tech companies also. https://www.newventuresbc.com/2019/05/isi-grant-program-attracts-top-international-student-talent/.

Jobs and Growth Fund (https://www.wd-deo.gc.ca/eng/20185.asp): Is provided for SME's, providing $700 million over 3 years. The fund supports:

- transition, adoption and development of clean and green technologies.
- diversity and inclusion
- activities that strengthen capacity in sectors critical to Canada's recovery and growth.
- Projects supporting scale up and market expansion activities that bolster traditional areas of strength and highly impacted sectors.
- Projects that facilitate the development of emerging areas of global competitive advantage that offer opportunities for future growth.
- Projects that attract investment in key sectors.

Canada Recovery Hiring Program is a subsidy provided as a result of the COVID-19 pandemic to cover employee wages: https://www.canada.ca/en/revenue-agency/services/subsidy/recovery-hiring-program.html. The company must be a Canadian-controlled private corporation where at least 50% of the partnership's interests are held (directly or indirectly) by employers eligible for the CRHP.

Scientific Research and Experimental Development (SR&ED) funding is also available to companies operating in Canada that are interested to undertake research and development endeavours. These are provided as tax credits in the form of an advanced loan: https://fundeasly.com/

## Findings

1. There are a number of programs from the governments of British Columbia and Canada to support new and existing employees to learn new skills. There are other funds also available through private entities to support new and young workers.
2. Most of the funding is dedicated to the integration of new technology, to "green" initiatives, increasing diversity and inclusion, and upskilling.
3. Much of this funding was inspired by the onset of the COVID-19 pandemic, with the need to bolster companies emerging from the pandemic and the onset of technological capabilities realized during the pandemic.

# Manufacturing Capacity Analysis

The section will analyze the capacity of manufacturing SME's in northern British Columbia. The analysis is separated into several sub-components that when completed will contribute findings to the final report.

The sub-components of this section include:

1) an investigation of manufacturing capacities required by major project proponents who are preparing to do work in northern British Columbia
2) a review of existing capacity for manufacturing SME's in the north (including Indigenous companies and organizations). Interviews will be conducted with a selection of manufacturers to fully understand their capacities as well as the barriers faced in competing with companies from outside the region
3) a scan of manufacturing capacities and examination of best practices from other jurisdictions (e.g., Europe, Australia, New Zealand, United States, Canada, and elsewhere in British Columbia). The key to this work will be to examine jurisdictions that were presented with similar challenges and opportunity that is facing northern British Columbia
4) identification of hindrances to increasing manufacturing capacities in the north, along with an analysis of barriers to increased capacity for northern manufacturers
5) determine funding opportunities to provide proponents access to capital funding.

These activities will be undertaken by conducting internet-based research coupled with subject-matter expert interviews to corroborate findings. This approach will ensure manufacturers are not subject to survey fatigue from this research, which is additional to that being carried out by project proponents and the City of Prince George.

This phase is expected to provide an overview of the current capacities of northern manufacturers, the requirements of major project proponents, and identification of challenges to increasing capacities (e.g., cost, transportation corridors, availability of raw materials, and power requirements). Gaps between required and actual capacities will partially fulfill the purpose of this research. Information from the scan of capacities in other jurisdictions and subject matter expert interviews will help reinforce findings from previous sections of this phase. This may lead to recommendations supported by local, regional, national and global expertise to identify limitations to economic growth, mitigate impacts to businesses relating to infrastructure or financing, provide solutions, and determine improvements to be made.

## Manufacturing Requirements of Major Project Proponents

This sub-section provides an overview of the major projects proposed or being undertaken in northern British Columbia along with their estimated value, project industry, locations, and required capacities. This

will help determine the type of work occurring in northern British Columbia, the industries involved and the extent of projects (in both physical and financial terms). It also examines the occupations that may be required to provide services for major projects. **This provides the opportunity for manufacturing SME's to determine potential contract opportunities and whether they are able to meet proponent's workforce requirements.**

## Major Projects Proposed or Under Construction in Northern BC

A first step to determine required capacity is to assess the major projects underway in northern British Columbia and which industries are involved. British Columbia has developed a Major Project Inventory that provides information about private and public construction projects. To be included in the inventory a project must have a value greater than $15 million (or greater than $20 million in the Lower Mainland-Vancouver). At the time of writing the cost of major projects in British Columbia was worth approximately $381 billion worth of projects proposed for British Columbia, with 61% of these projects ($232 billion) either taking place in or proposed for northern British Columbia (British Columbia 2021a).

The Inventory divides the province into eight geographic regions:

1) Vancouver Island/Coast
2) Mainland/Southwest (Vancouver area)
3) Thompson-Okanagan
4) Kootenay
5) **Cariboo**[14]
6) **North Coast**
7) **Nechako**
8) **Northeast**

The Inventory is informed by government agencies, general contractors, media, developers, architects, and site visits. It provides information about estimated project costs, start and finish dates, and project status (classified as proposed, under construction, completed, or on hold). The Inventory is updated quarterly. Projects that are on hold for longer than two years and completed projects are removed and similarly new projects are added (British Columbia 2021b). The data presented below is derived from the 2nd quarter of 2021, accessed on September 30, 2021.

The Inventory contains 972 records for British Columbia, including 148 projects for the north. Of the 148 projects these are divided into those completed, under construction, proposed, or projects on hold (Figure 8).

Completed: 2 projects have been completed. The completed projects include a 205-unit residence in Prince George and a hydroelectric energy project in the North Peace.

Started Construction: 26 projects have started construction, for an estimated value of $65.5 billion. These are projects that could have ongoing contract opportunities that manufacturers could pursue.

Proposed: 97 projects are proposed, for an estimated value of $145 billion. Projects in this category range from those that are in preliminary stages through to those that have an environmental assessment certificate and are awaiting a construction start date. These represent projects that manufacturers could be researching to determine contract opportunities.

On Hold: 23 projects are on hold. The Inventory does not provide reasons in several cases, and when reasons are provided these include: waiting for demand for the project (usually associated with wind

14 For the purposes of the information presented, only major projects located in the northern portion of the Cariboo region have been included in this analysis (see Figure 1).

energy), waiting for better markets (e.g., coal mines), seeking financing, waiting for Environmental Assessment decision, or power purchase agreements need to be secured. Projects on hold account for $21 billion.

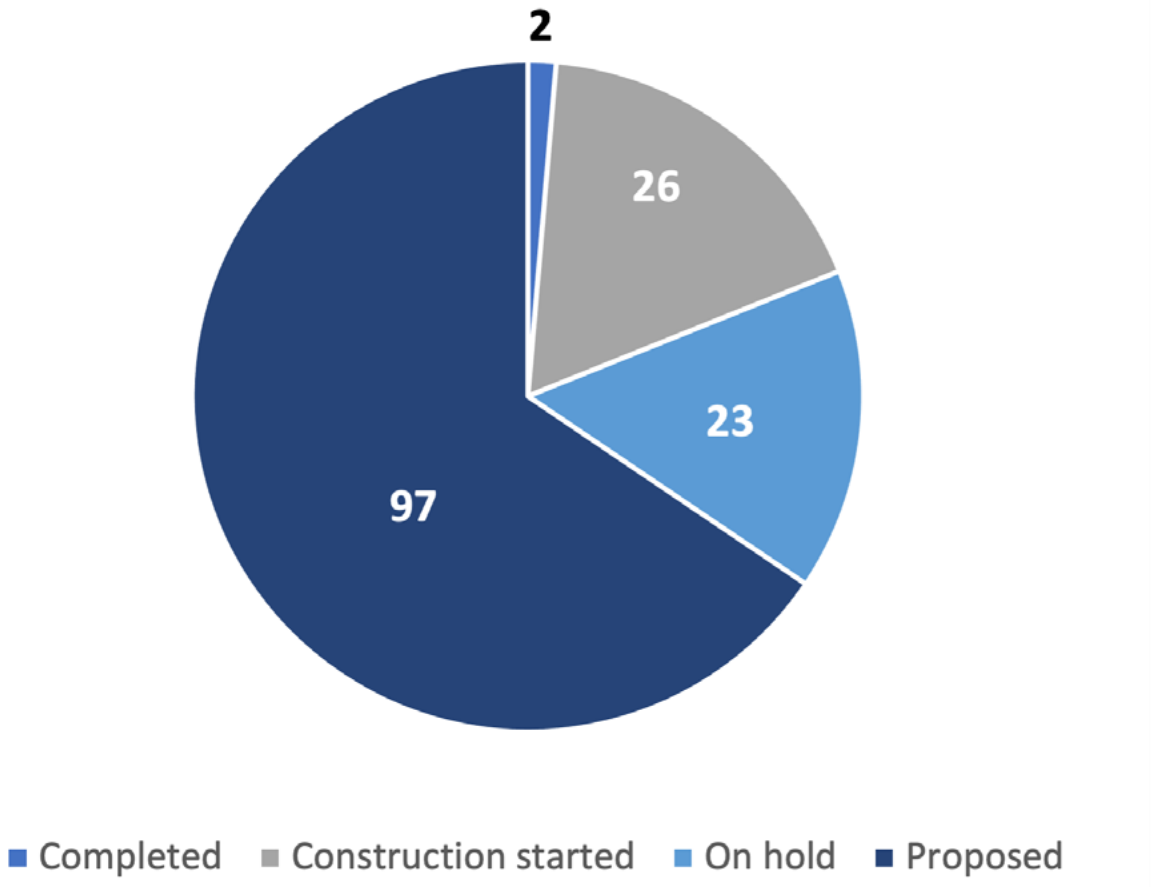


***Figure 8: Projects in northern British Columbia that are either completed, have started construction, are on hold, or proposed.***

There are 123 projects either under construction or proposed in northern British Columbia. The location of these projects by region is 41% in North Coast, 36% in Northeast, 20% in Cariboo, and 16% in Nechako (Figure 9).

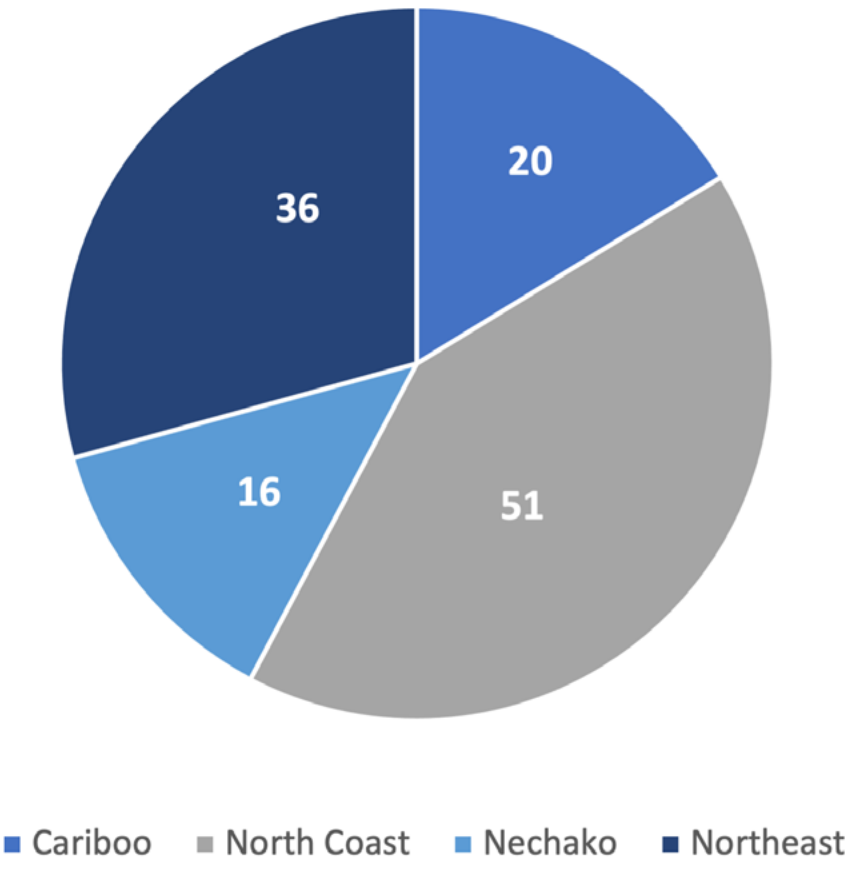


***Figure 9: Location by region of projects that are under construction or proposed.***

Prince Rupert has the highest number of projects either proposed or under construction (Figure 10).

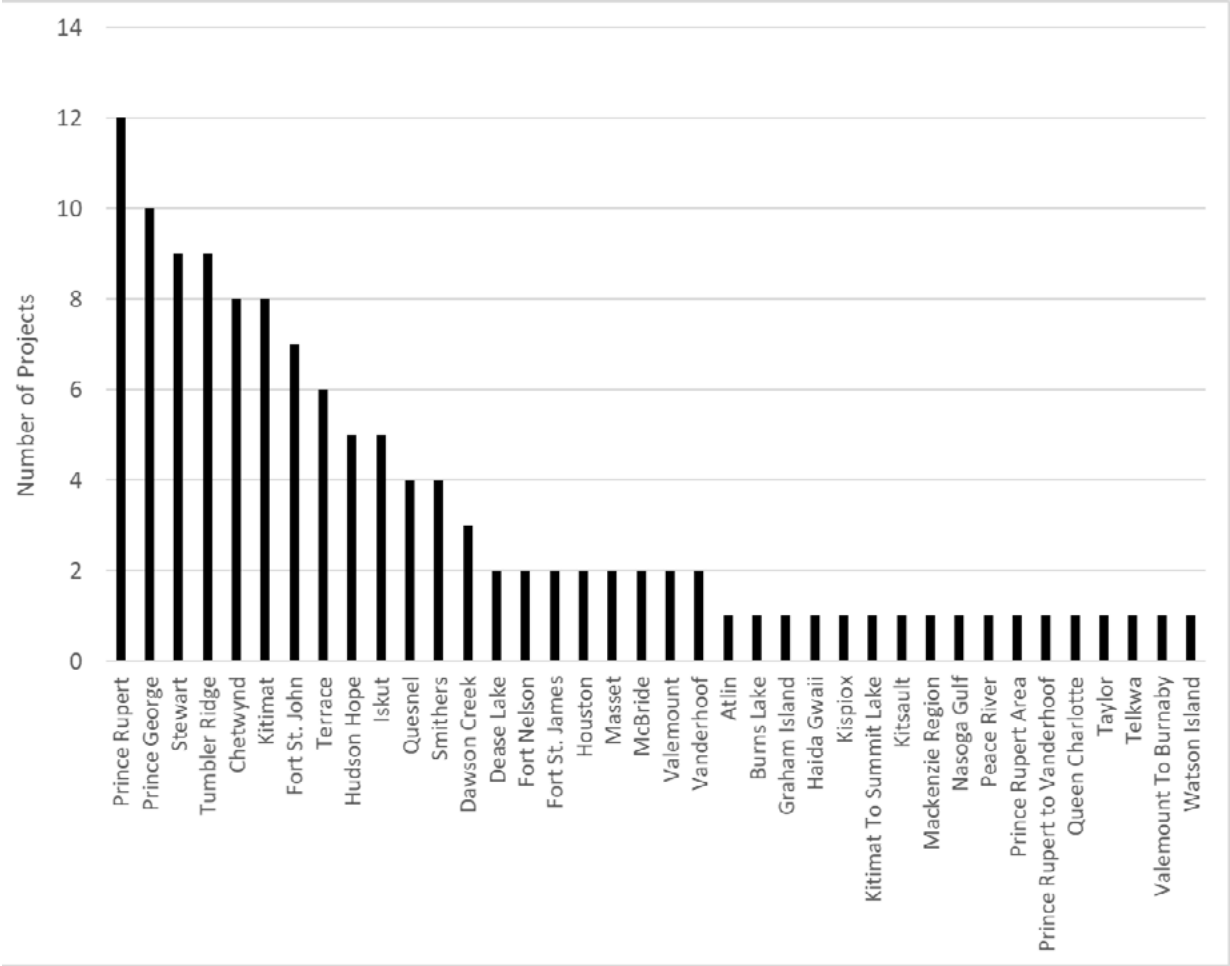


***Figure 10: The number of projects either proposed or under construction in northern British Columbia according to the Major Project Inventory.***

**Northern British Columbia is expecting many major projects to start in the next 10 years.** Fort St. John has the highest number of projects that are already under construction (five projects) while Hudson Hope and Quesnel each have three projects, and 15 jurisdictions each have up to 2 projects each under construction. Of the proposed projects Prince Rupert is expecting 11 while Prince George has 10, and other jurisdictions with a high number of proposed projects include: Tumbler Ridge (9 projects), Stewart (8), Chetwynd (7), and Kitimat (6).

Projects in these locations that are under construction or proposed are categorized by industry in the Major Project Inventory (British Columbia 2021a). In northern BC, mining and oil and gas extraction has the greatest potential to yield construction projects in which local contractors could obtain work. Mining and oil and gas extraction has 43 projects either underway (2) or proposed (41) for construction. Local contractors have the opportunity to work in several other industries, although most projects are currently proposed (Table 6).

*Table 6: Projects by industry under construction or proposed in northern British Columbia (British Columbia 2021a).*

| Industry | Under Construction or Proposed | Under Construction | Proposed |
|---|---|---|---|
| Mining & Oil & Gas Extraction | 43 | 2 | 41 |
| Utilities (incl sewage treatment) | 27 | 7 | 20 |
| Transportation & Warehousing | 23 | 11 | 12 |
| Public Services | 12 | 5 | 7 |
| Manufacturing | 9 | 0 | 9 |
| Residential/Commercial | 9 | 1 | 8 |
| **Total** | **123** | **26** | **97** |

The Major Projects Inventory categorizes projects into industry-standard construction types. At a high level these include: commercial, residential, industrial, infrastructure, and institutional, and are further sub-characterized according to the industry completing the project. The number of projects in northern British Columbia according to industry sub-type that are either proposed or under construction are provided in Table 7.

*Table 7: Projects by industry sub-type that are under construction or proposed (British Columbia 2021a).*

| Industry | Under Construction or Proposed | Under Construction | Proposed |
|---|---|---|---|
| Accommodation | 1 | 0 | 1 |
| Education | 5 | 3 | 2 |
| Government buildings | 1 | 1 | 0 |
| Health | 5 | 1 | 4 |
| Manufacturing - Petrochemical | 6 | 0 | 6 |
| Manufacturing - Wood Products | 1 | 0 | 1 |
| Mining | 29 | 1 | 28 |
| Oil & Gas | 25 | 5 | 20 |
| Other Commercial | 5 | 0 | 5 |
| Other Manufacturing | 2 | 0 | 2 |
| Other Transportation | 6 | 2 | 4 |
| Primarily residential - Single use | 2 | 0 | 2 |
| Retail | 1 | 1 | 0 |
| Roads & Highways | 7 | 5 | 2 |
| Utilities | 27 | 7 | 20 |
| **Total** | **123** | **26** | **97** |

## Required Capacity to Service Major Projects

A second step in the analyses examines the occupations that will be required to service major projects. To obtain contracts, manufacturing SME's will require workers in specific occupations. Data provided by WorkBC estimates the employment in each industry identified by the major projects inventory and estimates the number of job openings between 2019 and 2029. (Table 8). **Each industry will require an increased workforce by 2029.** In particular Construction will require the highest number of workers before 2029. Transportation and Warehousing, Manufacturing, and Support Activities for Mining and Oil and Gas Extraction will also require significant increases in workforce between now and 2029. For most industries the first half of the decade will require more workers than the second half, although estimates indicate that demand will remain in the second half of the decade.

***Table 8: Employment in 2019 and job openings between 2019 and 2029 in manufacturing and related industries.***

| Industry | Region | Employment (2019) | Job Openings | | |
|---|---|---|---|---|---|
| | | | 2019-2024 | 2024-2029 | 2019-2029 |
| Manufacturing | North | 14,984 | 1,043 | 1,020 | 2,064 |
| Primary Metal Manufacturing | North | 2,023 | -45 | 244 | 200 |
| Fabricated Metal Product Manufacturing | North | 752 | 27 | 67 | 94 |
| Oil and Gas Extraction | North | 1,433 | 437 | 362 | 799 |
| Support Activities for Mining and Oil and Gas Extraction | North | 2,324 | 656 | 655 | 1,311 |
| Mining | North | 2,309 | 158 | 526 | 682 |
| Utilities | North | 1,037 | 211 | 197 | 408 |
| Construction | North | 17,437 | 2,749 | 2,491 | 5,240 |
| Transportation and Warehousing | North | 11,369 | 2,904 | 1,792 | 4,696 |
| Public Administration | North | 3,745 | 489 | 506 | 995 |
| | **Total** | **57,413** | **8,629** | **7,860** | **16,489** |

Specific occupations are in demand within these industries. WorkBC provides outlooks for most of the industries listed by the Major Project Inventory, and within each Outlook the top in demand occupations. A full list of occupations in the manufacturing sector and related industries is provided in Table 8 (also see Appendix 1). **Of the list of jobs, WorkBC estimates that 28 will be High Opportunity Occupations, those that are expected to experience highest demand or receive the highest pay compared to other occupations (British Columbia 2019b).** In addition, 7 occupations are listed as trades in demand[15], these include: Construction Trades Helpers and Labourers, Construction Millwrights and Industrial Mechanics, Heavy Equipment Operators (except crane), Welders and Related Machine Operators, Carpenters, Automotive service technicians, truck and bus mechanics and mechanical repair, and Electricians (except industrial and power system). Of these occupations, two are also High Opportunity Occupations: Construction Millwrights and Industrial Mechanics, and Automotive Service Technicians, Truck and Bus Mechanics and Mechanical Repair.

Furthermore, several occupations are listed across several industries (see Appendix 1), 31 occupations will be in demand in 2 or more industries or sub-industries meaning a person could work in more than one industry.

15 Trades in demand is calculated based on the estimated number of job openings between 2019 and 2029.

**Within these regions and for the jobs examined, the Northeast is expected to experience the most growth, where all jobs (except those marked in Appendix 1 as N/A, 18 jobs) have a positive average annual growth over the course of the decade. Occupations in the Cariboo region are mostly expected to experience positive growth; 13 occupations will experience negative growth and nine occupations have no data. Occupations in the North Coast & Nechako will experience the least growth. However, if projects that are currently proposed move into construction the number of workers could increase.**

## Findings

1. Northern British Columbia has a number of major projects under construction, which are likely to require capacity from manufacturing SME's in northern British Columbia. These projects are serviced by employees of the major projects, but also by companies who provide construction and manufacturing services.
2. The number of major projects could increase, given the number of proposed projects, suggesting increased demand for capacity from companies in northern British Columbia who provide these services.
3. According to WorkBC forecasts, occupations in industries undertaking major projects will experience overall growth before 2029. This growth will require increased workforce to meet demand.
4. In addition, these industries require workers in several high demand occupations. Companies need to attract key occupations to meet the potential demands of major project proponents. Government also needs to work with industry to attract new workers to in-demand occupations to fulfill workforce requirements.

## Existing Capacity for Manufacturing SME's in Northern British Columbia

**Manufacturing SME's in northern British Columbia offer expertise in a number of industries. Major projects are expected to place increased demand on manufacturing companies, especially given that many major projects have committed to using local businesses during construction and post-construction.** This part of the report examines the capacity of businesses in the northern half of the province to meet the requirements of major projects.

To meet the potential labour demands of major projects, businesses in major population centres were examined. Towns and cities across the northwest have categorized businesses by industry, most of which are organized according to standards used across Canada. The population centres examined included: Prince George, Fort St. John, Fort Nelson, Terrace, Kitimat, Stewart, and Prince Rupert,

Industries included those identified by the Major Projects Inventory. Accordingly, current and future developments will be undertaken by Mining and Oil and Gas Extraction, Utilities (including sewage treatment), Transportation and Warehousing, Public Services, Manufacturing, and Residential/Commercial Construction. There are a number of tertiary industries that could also require services, including:

- Agriculture, forestry, fishing, hunting;
- Administrative and support, waste management and remediation services;
- Accommodation and food services;
- Other services (except public administration);
- Management of companies and enterprises; and,
- Professional, scientific and technical services.

**The north has a strong presence in many of these industries, many of which employ highly skilled trades that can be transferred across industries.** Traditionally, forestry has included logging and road building; there are many established businesses in the north that can clear land and build industrial roads. Mining

also has a long history in the north, this along with other industries are supported by waste management and remediation services, as well as industrial accommodations, camp services, laundry, janitorial etc. A relatively new sub-industry will be the addition of increased food services as grass roots food production from hobby farms, bakeries, etc., are becoming more common in British Columbia. In addition, large projects require environmental services, health and safety, engineering, surveying, and project management, all of which can be provided by the north's increasing business services.

## Small Business in BC

To understand the capacity of northern manufacturers, first it is necessary to determine the number of businesses that could service major projects. This project focusses on manufacturing SME's. Typically these businesses in British Columbia are classified as those that employ fewer than 50 people (British Columbia 2021c). There are 523,000 small businesses operating in British Columbia, with growth occurring in all regions of the province (British Columbia 2021c). North Coast and Nechako in particular experienced the highest growth rate of 31.2% (representing an increase of 1,900 new small businesses); the number of small businesses operating in Cariboo also increased between 2014 and 2019. Only the Northeast decreased (British Columbia 2021c). The number of businesses in the north that service natural resources industries involved with major projects is estimated to be 73,600 (Table 9).

***Table 9: Number of businesses operating in major populations centres across northern British Columbia (Statistics Canada 2021)[16].***

| Industry | British Columbia | Cariboo | North Coast & Nechako | Northeast | Per cent of total |
|---|---|---|---|---|---|
| Accommodation and food services [72] | 163,100 | 4,200 | 2,600 | 2,200 | 6% |
| Agriculture [111-112, 1100, 1151-1152] | 28,700 | 0 | 0 | 0 | N/A |
| Construction [23] | 213,200 | 5,800 | 4,100 | 3,600 | 6% |
| Forestry, fishing, mining, quarrying, oil and gas [21, 113-114, 1153, 2100] | 40,600 | 4,200 | 2,100 | 4,000 | 25% |
| Manufacturing [31-33] | 162,000 | 8,300 | 4,700 | 1,500 | 9% |
| Other services (except public administration) [81] | 100,400 | 4,200 | 1,500 | 2,500 | 8% |
| Professional, scientific and technical services [54] | 226,100 | 3,600 | 1,500 | 2,100 | 3% |
| Transportation and warehousing [48-49] | 127,300 | 5,000 | 3,000 | 2,900 | 9% |
| Utilities [22] | 18,100 | 0 | 0 | 0 | N/A |
| **Total number of businesses** | **1,079,500** | **35,300** | **19,500** | **18,800** | **7%** |

**The majority of the businesses in northern British Columbia (including the portion of the Cariboo in the north) are small or medium-sized businesses (Table 10). Across all regions, businesses that employ 1 to 4 employees outnumber businesses that employ 5 to 499 employees.** There are also a significant number of companies that have no employees on payroll, these are companies that solely contract workers or are run by family members.

16 Numbers in brackets refer to the North American Industry Classification System (NAICS). The classifications are provided here: https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1181553.

*Table 10: Number of businesses in each region, by employee size (British Columbia 2021d).*

| Region | Number of Businesses | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No Employees | 1 to 4 | 5 to 9 | 10 to 19 | 20 to 49 | 50 to 99 | 100 to 199 | 200 to 499 | Total |
| **Cariboo*** | 15,040 | 2,328 | 950 | 652 | 421 | 143 | 53 | 26 | **19,613** |
| **Nechako & North Coast** | 11,799 | 1,991 | 808 | 520 | 301 | 126 | 42 | 24 | **15,611** |
| **Northeast** | 12,143 | 2,424 | 709 | 457 | 319 | 86 | 38 | 23 | **16,199** |
| **Total** | **38,982** | **6,743** | **2,467** | **1,629** | **1,041** | **355** | **133** | **73** | **51,444** |

* This includes only those businesses in the northern portion of the Cariboo region.

## Indigenous Businesses

A sub-section of these business are SME's that are owned and operated by Indigenous organizations and individuals. The Indigenous Business and Investment Council has compiled a database of Indigenous businesses with over 1200 entries (Indigenous Business and Investment Council 2021). There are 138 Indigenous businesses that could service major projects in Nechako & North Coast, Northeast, and Cariboo (Table 11). Again, the number of businesses with 1 to 4 is most common (Table 12).

*Table 11: Number of Indigenous owned or operated businesses in northern British Columbia.*

| Industry Sector | Number of Companies |
|---|---|
| Mining, quarrying, and oil and gas extraction | 32 |
| Utilities | 3 |
| Construction | 45 |
| Manufacturing | 10 |
| Transportation and warehousing | 24 |
| Professional, scientific and technical services | 1 |
| Management of companies and enterprises | 22 |
| Not categorized | 1 |
| **Total** | **138** |

*Table 12: Number of employees in Indigenous Businesses in northern British Columbia.*

| Number of Employees | Number of Businesses |
|---|---|
| 1 to 4 | 36 |
| 5 to 9 | 17 |
| 10 to 19 | 3 |
| 20 to 49 | 13 |
| 50 to 99 | 7 |
| 100 to 199 | 2 |
| 200 to 499 | 2 |
| Not categorized | 58 |
| **Total** | **138** |

These businesses operate as standalone entities, are run by entrepreneurial individuals, or are economic development organizations that operate at-arms-length from an Indigenous government. These businesses offer the same or similar services as non-Indigenous companies. While Indigenous businesses can be successful, many face numerous barriers during start up and as they run. To overcome potential barriers and to further reconciliation with British Columbia's Indigenous peoples, major project proponents have negotiated agreements with Indigenous governments. Agreements can include benefits such as: profit sharing, land awards, and funds for employment and training.

A common approach to provide competitive advantage for Indigenous businesses is to create joint venture partnerships with non-Indigenous companies to compete for contracts. Joint ventures are become more necessary, especially as Canada and British Columbia move closer to reconciliation objectives. Criteria for major projects commonly require a non-Indigenous company to have a partnership, whereby a partnership also provides the opportunity for the non-Indigenous company to obtain work by showing they are engaging with local communities. Joint venture partnerships are managed in several ways and are only as effective if the partners involved in the venture collaborate with each other to meet the intent of a joint venture agreement. More information about joint ventures is discussed in the hindrances section below.

## Characteristics of Manufacturing SME's

The manufacturing SME's in northern British Columbia typically specialize in construction, maintenance and repair of facilities (e.g., for forestry: pulp mills) or manufacturing products. They have typically worked in a number of industries including: as sub-contractors for larger manufacturers, forestry (e.g., pulp and paper, sawmills, repairs to logging trucks), mining, utilities (e.g., hydroelectric and waste water), transportation (e.g., rail), petrochemical, and general construction. Some companies reported working on small, short-term contracts in the oil and gas industry. These companies are typically run from a top-down approach with the owner generating business that keeps technical staff working on the shop floor.

Of the manufacturers interviewed for this Project most were operating small businesses, those up to 50 employees. Several operated with a consistent workforce of up to 10 people; employees increased depending on the season or the amount of work available. One company regularly employed 50 people and had doubled their workforce. They were able to support a workforce of 200, but this requires extra administrative staff to ensure the business operates smoothly. The manufacturers employ a core staff, who are supplemented by providing short-term contracts to either new employees or through sub-contracts. Typically these contracts last for a short length of time, unless more work becomes available , after which the company lays off the short-term employee unless more work is available.

Interviewees mostly work in northern British Columbia, although have also been able to acquire work in southern parts of the province or in Alberta. Several also mentioned obtaining contracts or establishing locations in the United States, although this approach is expensive. **In general, SME's operate on multiple**

**short-term contracts, albeit with established clients who provide regular ongoing work.** Some companies have long-term contracts, these are mostly connected to the forest industry. Contracts often operate on budgets that range from a few hundred-thousand dollars to million-dollar projects. The northern manufacturers have proven track records to successfully complete these projects. However, attempts by northern manufacturers to establish new clients in the oil and gas industry has been mostly unsuccessful, despite obtaining a few small contracts or sub-contracts. However, these are not of similar value to contracts awarded to other companies.

Large companies have been awarded contracts and bring in other companies with specific technical skills to work on projects. **Sub-contracts have been awarded to northern manufacturers from larger companies that needed increased staffing or expertise. In this sense, northern manufacturers are used to bolster the workforce of a larger company.** Under these arrangements the sub-contract can run many levels deep and frequently relies on the entity that holds the direct contract to be paid first before others down the line are paid. As such, a small company can be required to run a high debt load for significant time periods, while accumulating new additional debt through ongoing sub-contracts. On occasion, when contracts have been awarded the general conditions are very long and take time to review and navigate. This places additional burden on a small company, which can involve acquiring legal expertise to ensure they correctly understands conditions.

Based on interviews, manufacturers in northern British Columbia possess transferable skills that could be used in the oil and gas industry. **There are several advantages for major project proponents to use small or medium-sized companies during construction and maintenance.** Chiefly, that these companies are local to the area, understand the challenges and conditions in the north, and can provide solutions for projects. They can also supply staff from nearby locations thereby reducing travel and accommodation costs on projects close to population centres and have proven ability to run large projects. These companies can also provide needed skills and expertise as they employ workers whose skills are in high-demand. Given many of the manufacturing SME's employ Red Seal certified workers or journeypersons, minimal training is required because workers already have established skills and expertise. There are several barriers to acquiring labour for SME's in northern British Columbia, these are discussed in the section about hindrances below.

**In 2022, British Columbia committed to creating an Industrial and Manufacturing Action Plan.** The aim of which was to create more domestic manufacturing capacity and capabilities, increase cross-sector collaboration, and create new jobs as well as high-value, sustainable goods across sectors.

## Findings

1. The manufacturing SME's in northern British Columbia have the abilities and the potential to provide services to major projects. These manufacturers work across several industries in a wide geographic area that includes northern British Columbia, other areas of the province, neighbouring provinces and territories, and international work (mostly in the United States of America). This experience has provided the opportunity for northern manufacturers to develop skills and expertise that are considered high-demand and are easily transferred to industries such as oil and gas.

2. Northern manufacturers are characterized by lots of small businesses with few employees, although can adapt and bring workers in to service projects. With the number of projects underway or proposed in the north there will likely be a shortage of workers. Short-term contracts limits job security for workers and increased major project activity means that workers may not be available if a large contract were awarded. Furthermore, due to small numbers of employees and administrative limitations provided by a top-down approach it is unlikely one company alone would be able to service a major project on their own.

3. Despite many advantages offered by SME's to major projects, the manufacturers face several barriers. First is to generate relationships with major project proponents. Contracts with major projects in northern British Columbia have been awarded to very large companies who have offered smaller companies sub-contracts for parts of the work. Contract agreements with large compa-

nies tend to be complex, northern manufacturers need increased support to review and agree to contracts. Second, administrative resources are limited in small companies which may prevent them from being available to meet additional demand placed on them by working with major project proponents. Last, local skilled labour may be more difficult to find in the future as more projects are started, especially as some occupations are already in high-demand, making it harder for SME's to operate efficiently.

4. The province will create an Industrial and Manufacturing action plan in 2022. This should include insight in how the province will help SME's located in northern British Columbia to succeed.

## A Scan of Manufacturing Capacities and Examination of Best Practices from Other Jurisdictions

Manufacturing capacities in other jurisdictions were examined to determine best practices or new practices. Challenges and opportunities that are currently facing northern British Columbia (e.g., Europe, Australia, New Zealand, United States, Canada, and elsewhere in British Columbia). **There is an opportunity to learn lessons from other jurisdictions about challenges that were faced and overcome.** Organizations in these jurisdictions have studied challenges and discuss solutions.

By way of internet-based research we examine lessons learned in other jurisdictions and how these may be applied in northern British Columbia to mitigate potential challenges to capacity and to examine best practices undertaken in other jurisdictions.

**A key resource in this research was COVID-19: International Manufacturing Policy Responses (Update; University of Cambridge 2020). The report was provided to the UK government with an aim to guide responses to COVID-19. The report is specific to the manufacturing sector and summarizes international policy responses to mitigate impacts of COVID-19.** Some of these responses include long-standing issues that were identified prior to the pandemic, which if addressed will help manufacturers recover and prosper. These were corroborated in other global scale reports (e.g., World Economic Forum 2020). Key outcomes included the need for diversity and inclusion in the workplace (World Economic Forum 2020; Deloitte Development LLC 2021a) and the need for technological advances to ensure manufacturers remain efficient (Deloitte Development LLC 2021b; Royal Bank of Canada 2021).

International policy responses were distilled into eight themes, and those relevant to manufacturing in northern British Columbia are included below. Specific examples of individual policies are available in University of Cambridge (2020) and examples of responses internationally that may be helpful in British Columbia are available in Appendix 4.

1. Ensuring continuity of manufacturing businesses:
    a. By providing fiscal and financial supports to help manufacturing firms survive and retain workforce.
    b. Some of these supports have included tax deferrals and exemptions for manufacturers and businesses.
    c. Other supports have included helping businesses restart by focusing on safety in workplaces (e.g., in France manufacturers were provided with masks) and Australia established a Coronavirus Business Liaison Unit.
2. Mobilizing manufacturing towards critical supplies: This theme concerned the manufacture of medical supplies. While important, is it not relevant to the manufacturing sector in northern British Columbia which is primarily focused on products and services in the natural resources sector.
3. Supporting post-crisis manufacturing growth:
    a. Measures included: capital investment, skills development, research and development funding, support for new business models and market diversification, consumption incen-

tives, and digitization.

   b. Several countries are planning to take advantage of technological advances by promoting research and development: France, Italy, Korea, China, Singapore, New Zealand, Australia, and the United States.

   c. Japan has recognized the need to repair supply chains and to offer remote-based business models.

   d. Many countries are trying to remove regulatory barriers (e.g., France and Australia).

4. Cross-sectoral approach to manufacturing support:

   a. Grants, liquidity support, guarantees and tax deferrals are provided to all companies, and in some cases focusing on manufacturing SME's.

   b. In order to ensure companies can access funding, broad eligibility criteria are being used. Singapore, Australia, and China all provide examples.

   c. While less common, some countries have targeted specific sub-sectors of the manufacturing industry. France, Germany, and China are concentrating on the automotive industry.

5. Reshoring:

   a. Providing supports to manufacture more products within countries rather than relaying on imports. Japan is offering subsidies and grants to help companies reshore their production and diversify their production bases.

   b. South Korea has provided tax cuts, financial aid, on-site support, and advisory services for 100 Korean firms to reshore by 2022.

6. Supply chains:

   a. Manufacturing has experienced direct disruptions due to domestic lockdown measures to curb the spread that has in some cases reduced the number of workers, curtailed production, or experienced temporarily or permanently closures. Otherwise, countries experienced disruptions to international trade, production bottlenecks, and drops in demand. These led to fall in investments, providing negative impacts to companies.

   b. To combat supply chain disruptions, fiscal and financial, as well as import and export supports were provided. Ireland has an existing support for market diversification.

   c. Japan, China, and Australia are promoting the use of technology to bolster supply chains. Australia has introduced a Manufacturing Modernisation Fund (as a part of a $1.5 billion fund to reinvigorate domestic manufacturing) that aims to help manufacturing operations transform and upgrade. Japan is providing a subsidy to repair supply chains and support shifts to remote work.

7. R&D-related support mechanisms:

   a. Several countries have recognized that R&D programs are at risk as companies focus on short-term needs.

   b. Some governments are providing support to R&D intensive companies and technology starts ups, as new technology will likely provide increased efficiencies in the manufacturing sector. Prime examples include: New Zealand, Italy, France, and China, each of whom are providing incentives to continuing R&D or for start-ups. Some countries are targeting specific manufacturing sub-sectors, those involved in green technology (e.g., electric vehicles).

8. Public research and technology organizations and centres of excellence:

    a. Efforts have increased to improve manufacturing capabilities and develop public research and technology centres.

    b. In the United States, funding to support medical manufacturing has been announced, in part to ensure that medical supplies can be produced domestically.

    c. Germany is also supporting medical manufacturing by focusing on life sciences to support vaccine development, improve IT infrastructure, among other initiatives.

While these incentives and measures provide promise and a fresh outlook in the industry, the real test will be to determine the long-term impacts, especially as election cycles create an environment for changed mandates that sometimes do not support a prior government's initiatives. **The manufacturing sector requires long-term capacity and capabilities to effectively address long-standing issues, rebuild following the pandemic, and create a disruption-proof and resilient industry** (Mazzucato et al. 2021; Deloitte Development LLC. 2021b).

Some key recommendations from Mazzucato et al. (2021) for long-term capacities include:

- Build strong core government functions and necessary capacities such as digital infrastructure for public service delivery and transparent institutional frameworks.
- Clearly articulate how to achieve long-term resilience and the public value these aim to provide.
- Build institutions that enable the implementation of resilience-drive developmental plans, and plan to use systems based on sustainability, equality, protection of human rights, privacy, and political impartiality.

Recommendations for increased capabilities include:

- Build in-house capabilities and focus skills training on adaptability and learning.
- Strive to innovate and create the ability to widely disseminate information.
- Provide access to data infrastructure and public digital platforms that offer neutral evidence, in so doing to mitigate the spread of misinformation.
- Explore new mechanisms to accelerate learning and foster innovation.

## Findings

1. Manufacturing is an important industry to the economies of many countries that generously contributes to gross domestic product and in many countries provides thousands of jobs. The manufacturing sector has faced historical issues, which have been further exacerbated by the COVID-19 pandemic. Historic and additional issues brought about by the pandemic need to be addressed and overcome.

2. Solutions to many of the issues have been for governments to provide funding or other monetary incentives and measures to revitalize the manufacturing economy following the impacts of COVID-19. The pandemic has provided many countries with the perfect opportunity to inject funds into the industry to increase resilience to future disruptions and also for research and development to determine more efficient ways of creating products. However, funding criteria needs to be open and inclusive for companies to benefit, without hidden barriers such as company contributions.

3. Aside from monetary incentives in the post-pandemic world and the need to create efficient solutions, the pandemic provides additional opportunity to begin to address social issues, for example: diversity and inclusion in the workplace. By doing so providing welcoming and environments for women and Indigenous workers.

## Hindrances and barriers to manufacturing capacities in the north

Northern manufacturers are facing a number of hindrances to be able to supply products and services to customers. The largest of which has been the COVID-19 pandemic which has caused numerous challenges and created knock-on effects. The ongoing pandemic has had direct economic effects on global markets and supply chains.

**The full range of impacts have also included: wildfires, contract awards to out-of-province expertise, and large infrastructure projects in the United States of America. These coupled with a long predicted skilled worker shortage in British Columbia (The Globe and Mail 2013; Financial Post 2021) have collectively provided long-term hindrances to manufacturers in the province.**

### COVID-19 pandemic

**The real long-term impacts of the pandemic have yet to be fully realized, however the immediate effects on small businesses across British Columbia have included** (Small Business BC 2020):

- Lower sales;
- Staffing layoffs;
- Temporary closures;
- Increased operating costs; and,
- Deferred or cancelled marketing projects.

These effects were also reported by Indigenous businesses, 84% of businesses experienced a reduction in revenues, and 89% anticipated further reductions in the future. In addition, 18% expected to lay off all their staff.

To help reduce debt loads among workers who were laid off or unable to work, the Canadian and British Columbia governments offered payments and loans. Some these programs continue into 2022 as the pandemic continues. While helpful to many British Columbians, some of these programs prevented people from returning to full-time jobs. In particular low paid, unskilled workers received higher income through these payments than when they were employed. Also, having being laid off or terminated, some people took the opportunity during COVID to retrain and change careers.

Employers also received aid during as the pandemic continued in British Columbia. Property tax bills were cut for commercial properties by as much as 25%; payments for PST, carbon tax, and others were deferred by six months; a support service was established for BC Businesses; and, hydro bills were forgiven. A host of incentives and measures to build confidence for SME's have been announced, including: tax credits for businesses that hire new workers; temporary PST rebates on select machinery and equipment; the launch of a $300 million recovery grant; and, provide supports to help businesses manufacture critical products (British Columbia 2020a).

The impacts of the pandemic have weaved into many aspects of the economy and impacted the ability to restart the economy. One of the principal impacts has been a low vaccination rate across northern British Columbia, which prompted the Provincial Health Officer to implement extra control measures for parts of the north.

### Climate Change

Other than COVID-19, a key hindrance for SME's were transportation disruptions through British Columbia's interior. **Climate change has increased the incidence of wildfires and flooding** (Abbott and Chapman 2017).

Wildfire activity has been increasing in recent years as a result of increasingly warm summers along with an overabundance of fuel following decades of wildfire suppression and a recent insect infestation that

caused mortality to just over half of the province's pine forests.

Risks associated with wildfires were addressed by the Auditor General of British Columbia (2001). The Auditor General report concluded that governments in British Columbia needed to do more to prepare for major interface fires. In 2003, large area wildfires burned in the Okanagan, which prompted an independent review of wildfire management in the urban interface (Filmon 2004). This review provided 60 recommendations. The implementation of these recommendations, plus those made by the Auditor General's 2001 report was reviewed by the Auditor General of British Columbia (2005). According to this review, government had implemented recommendation from both reports.

The 2017 and 2018 wildfires consecutively were record breaking years in terms of area burned. Collectively fires burned approximately 2.5 million hectares (1.2 million, 2017; and 1.3 million, 2018) causing the loss of about 350 structures, the evacuation of thousands into emergency shelters, and severely impacted air quality to most areas of British Columbia that caused respiratory concerns for people and prevented aircraft from flying. A state of emergency was declared in both years.

Despite a break in 2019 and 2020, wildfires returned to British Columbia in 2021. The 2021 season began slowly. However, a heat dome brought record breaking temperatures and dry lightning storms that eventually caused 67 wildfires of note (these are either highly visible fires or pose a threat to public safety). A state of emergency was again declared as larger communities were impacted in the Interior. Many people were evacuated from communities, some multiple times, and was coupled with the ongoing COVID-19 pandemic. Several structures were lost during the season, including the majority of the town of Lytton. These wildfires forced the closure of the main transportation corridor from Vancouver to Prince George, and from Prince George to areas further north. The north did not experience large burns because the heat dome was quickly followed by wet, cool weather.

In the latter part of 2021, weather systems (referred to as a pineapple express, a type of atmospheric river) deposited rain over southern British Columbia and parts of the northwest United States. In British Columbia 20 rainfall records were broken. For example, the town of Hope experienced 277.5 mm of rain for November 9 and 10, where the monthly average is 352.5 mm. The resultant flooding claimed several lives, caused the evacuation of the entire town of Merritt, loss of structures, mortality of farm animals in the Fraser Valley, and road washouts on each major highway connecting the Lower Mainland to the rest of the province. This, along with the impacts of the pandemic and the wildfires earlier in the year led to increased expenses to transport supplies for northern manufacturers, and caused raw material shortages. Where it used to take 9 to 10 hours to drive from Vancouver to Prince George, this was extended to approximately 14 hours as transporters navigated road closures. Additional costs of transportation are being taken on by the northern manufacturers.

### Supply Chains

**The COVID-19 pandemic has directly impacted supply chains, with many products and services being affected.** These have either been unavailable or scarce as the pandemic has slowed or halted production and transportation. Some products have increased in price as a result of supply and demand dynamics, while some services are unavailable. For example, microchip shortages have resulted in decreased vehicle production or services like rental cars have become increasingly expensive. Other items such as certain foods, fixtures, and construction materials have experienced increased prices (The New Yorker, 2021) or are otherwise unavailable. In addition, shipping costs and times have increased leading to increased production costs and unreliable delivery estimates for products.

Increased import costs are one factor causing many manufacturers (where possible) to reshore or shift towards the use of domestic supply chains. Reshoring helps to build domestic business, with some countries placing emphasis on reshoring (e.g., United Kingdom, France, South Korea, and the United States of America, among others). Domestic supply chains may not require the same COVID-19 containment measures or be subject to costs that are placed on imported products used in the manufacturing process. By reshoring, impacts to production may be somewhat mitigated; however, there is no guarantee of supply chain security and resilience. Domestic supply chains are still subject to transportation disruption (e.g., from

floods and fires) and to staff shortages based on lack of available workers and time away as a result of the ongoing pandemic (Conference Board of Canada 2020). Key takeaways from a Canadian survey include:

- Diversify suppliers to better cope with supply chain disruptions
- Build long-term relationships with selected suppliers
- Test the impact of potential disruptions; and
- Adopt digital tools.

Of particular importance to the manufacturing industry in northern British Columbia is a reliable and consistent supply of steel. The ongoing COVID-19 pandemic and steel requirements for infrastructure projects in the United States, Canada's largest steel supplier, have decreased the steel supply in Canada. COVID-19 has caused production curtailments or temporary mill closures that reduced worker hours or the number of employees. During the pandemic, businesses such as Amazon and Walmart have thrived as online purchases have increased, leading to demand for increased infrastructure (e.g., warehousing). During 2020 these impacts caused a backlog log of demand and decreased supply. In 2021, with the advent of vaccines and a gradual return to work for workers, the supply chain is backlogged. For example, the cost of steel has tripled between 2020 and 2021. Ongoing demand has elevated , costs , from a low in 2020 of about $460 to a high of almost $2,000 in July 2021.

To compound this issue, northern manufacturers need specific steel that withstands cold environments. **Interviewees discussed the steel supply in detail, mentioning reduced supply and some of the realities of trying to stay in business as a result. While steel is in limited supply, contracts between providers and the manufacturers now include new provisions for mill allocation and mill acceptance.** Meaning that while a mill may have steel, the product may not be allocated to SME's in the north. For example, a Vancouver supplier also provides steel to the Canadian coastguard; to which supply is prioritized over northern manufacturers.

**To alleviate supply issues, local manufacturers decided to collaborate and placed an order for steel. The collaboration increased the amount of steel in an individual order, which was large enough to be allocated to the manufacturers in Prince George.** The manufacturers were able to secure 150 tons of steel, which then provided a competitive advantage. Other manufacturers, when bidding on work, are limited to delivering products depending on steel inventory. As such, products can be delayed. The manufacturers in Prince George are able confirm products will be delivered on time because they have inventory. Despite the financial burden to acquire and hold inventory, this strategy resulted in 3 months work.

To help reinstate supply chains the province will develop a Goods Movement Strategy in 2022 (British Columbia 2022b). The strategy will promote leadership and coordination among the transportation industries and encourage greater coordination among railways, ports, and roads. The goal is to ensure inputs and final goods move as efficiently as possible, with the aim to increase economic growth throughout the province.

### Out-of-Province Expertise

Representatives of local governments in towns and cities across the north were interviewed. Most stated that since the influx of major projects (for liquified natural gas, mines, oil, etc.) they had noticed an increased number of large consulting companies moving into their municipalities. In some cases these companies open an office to employ local people, although some companies operate shell offices which once established remain dormant. Of the companies moving into Prince Rupert, only one has established a full-time office that is staffed with employees. The nature of major project work prevents the need to establish full-time companies in small towns across the north because the work has a finite lifespan.

As a result of major project activity, some local companies had experienced increased work. However, these experiences were limited to indirect services (e.g., cleaning, laundry, landscaping, breweries, etc.) as a result of increased disposable income of local citizens. Much of the local accommodation was also taken a long time in advance and typically parking lots are filled with industrial vehicles rather than the

usual tourist traffic.

**Northern manufacturers could service the oil and gas industry, and with many proponents showing interest in northern British Columbia, many SME's valued the opportunities for work that major projects offered. Many companies interviewed were concerned about barriers to obtaining work in the oil and gas industry.**

Upon announcing a financial investment decision, the LNG Canada and Coastal Gaslink projects each procured prime contractors for the projects. These contractors consisted of very large engineering companies, the majority of which have come from outside British Columbia, and in some cases out of Canada. Typically, these companies have extensive experience building pipelines, although British Columbia presents challenges in terms of environmental regulatory framework, First Nations consultations and accommodations, difficult terrain, and in the north, harsh winters.

Local companies can still play a role, but are often restricted to small, one-off contracts. Typically, in northern British Columbia the communities are close and working relationships have been long established, providing on-going, if irregular work. The manufacturers have found it difficult to create relationships with the oil and gas industry. The industry is relatively new in British Columbia, save for the Pacific Northern Gas pipeline that was constructed in the 1960's. This lack of relationship has left some manufacturers needing work, while new companies who have recently moved into the region, are thriving. A distinct barrier to this will be the size of local manufacturers, while the major projects require companies with many employees and in some cases specialist skills that have been honed with experience.

Local manufacturers were concerned about products being built outside of the province, with lower cost labour (British Columbia has one of the highest minimum wages at $15.20 per hour, soon to be raised to $15.75) and reduced taxes. For example, products built in Alberta will be exempt from provincial sales tax. In this case however, the New West Trade Agreement governs trade between the three western provinces and seeks to level the playing field by ensuring Albertan companies pay provincial sales tax on imported products.

### Worker Shortage

**Industries the world over are reporting worker shortages, Australia, the UK, the United States, and Canada have all reported worker shortages. These are due to a number of factors that include: increased competition for workers from other sectors, retirements, market declines, and shutdowns due to the COVID-19 pandemic.** These shortages pose a threat to the economies of western countries, driving production abroad.

A recent report by the Royal Bank of Canada (Royal Bank of Canada 2021) found that Canada will be short of at least 10,000 Red Seal certified trade workers, a number that increases tenfold when the provincially regulated trades are included. In British Columbia, projected Red Seal requirements will total 2,690.

The most severe shortages will be among industrial mechanics, welders, and boilermakers; all trades that are pivotal to the manufacturing industry (Royal Bank of Canada 2021). To further exacerbate the situation, over 700,000 skilled tradespeople are expected to retire by 2028, and while recruitment drives are being carried out, these have fallen short of expected targets. Furthermore, not only are employers facing a worker shortage, with advances in new technology the current workforce requires significant upskilling to ensure workers can work with new technology. Also, given the rate of innovation it is likely workers will require consistent upskilling to keep pace. This along with additional training in so called "soft skills" like problem solving, creative thinking, and also for diversity and inclusion.

Northern manufacturers are having a hard time attracting new workers, in part because the public perception is that these are blue collar jobs. However, these jobs pay between $80,000 to $100,000, and more. Typically, larger companies pay more money, making these jobs increasingly attractive and difficult for SME's to retain skilled and experienced workers.

Former incentives to work in the north are also playing a part. Previously young people could move to the

north and afford a home. However, housing prices elsewhere in the province are driving people further afield, and bring them to northern British Columbia. In addition, the pandemic has created opportunities for people to work remotely, many people have taken advantage of technology (e.g., videoconferencing) and social distancing to be able to set up a remote office away from cities and the traditional office environment. Also, the oil and gas and mining industries have been steadily increasing activities, offering people high paying jobs and for those who have lived in the north long enough to already own housing, disposable incomes. This has brought more people into rural communities, which has in turn increased the demand for housing in communities that traditionally had not invested in housing, and increased housing prices. The average sale price in July 2021 was $385,883, a gain of 8.5% from July 2020 (Canadian Real Estate Association, 2021)

People are attracted to northern living as increased industrial activity has provided employment opportunities. Other reasons may also include:

- career advancement: greater responsibility can be achieved with less competition for jobs. In addition, much of the current workforce are becoming eligible for retirement shortly, leaving gaps for skilled workers.
- affordability: historically homes and lifestyles are more affordable than elsewhere in the province, especially given less expensive housing in the north (compared to houses in the south).
- greater sense of community: initiatives in the north can be largely driven by volunteer efforts, plus there is a sense of closeness as groups in northern communities work together. For example, Shames Mountain is a ski co-op in Terrace BC that has kept the ski hill open largely through volunteerism.
- arts and culture: the north has developed a thriving arts and culture scene. Plus, the north has a rich and diverse Indigenous history.
- year-round recreation opportunities: the north experiences four seasons in a year which brings opportunity to ski, snowshoe, ice fish, and snowmobile in the winter, while in summer there is plenty of opportunity for hiking, biking, watersports, and fishing.
- relaxed pace: lower populations means less traffic on the roads and less people occupying recreation sites.
- city amenities: many northern towns and cities now have newly developed amenities that rival those found in larger cities. These include: restaurants, breweries, theatres, and unique shops.

While these points highlight some of the benefits of northern living, that there are several disadvantages that need to be adapted to. In comparison to the south, people need to understand that some jobs require living away from home in remote work camps, that travel requires long car journeys in inclement weather (depending on the time of year), that daylight in winter months is significantly reduced, healthcare can require significant travel depending on the ailment, and that tourism and promotion of living in the north are removing benefits like affordable housing.

### Indigenous Workers

**Indigenous workers are a much-underutilized and overlooked resource. Initiatives to increase diversity and inclusion are being widely promoted to ensure barriers are overcome to enable Indigenous workers to fully participate in the workforce.** Indigenous communities often contain people with skill sets that could be utilized, plus many Indigenous people want to remain close to their homes and communities, rather than move away. Therefore, offering a workforce that is close to projects.

Reconciliation with Indigenous workers and communities is paramount in British Columbia, the province has legalized the United Nations Declaration on the Right of Indigenous People. Furthermore, the Truth and Reconciliation Commission's made 94 Calls to Action, some of which address equal rights for education and employment for Indigenous People. Two calls for action related to employment includes:

1. We call upon the federal government to develop with Aboriginal groups a joint strategy to eliminate educational and employment gaps between Aboriginal and non-Aboriginal Canadians (Call to Action 7, Education)

2. Ensure that Aboriginal peoples have equitable access to jobs, training, and education opportunities (Call to Action 92(ii), Business and Reconciliation)

Reconciliation can be met with meaningful joint venture partnerships. These partnerships offer local manufacturers increased access to contracts with major projects, due in part to the reconciliation push underway in Canada at the moment.

Specific expertise is required to work collaboratively with Indigenous people, who have faced and are beginning to overcome systemic barriers to inclusion in the workforce. This expertise is difficult to come by, and collaboration must be done well to be effective and meaningful. Without meaningful collaboration, this presents a distinct barrier to obtain and retain Indigenous labour.

Meaningful partnerships could entail a company approaching the First Nation because they want to establish a relationship, rather than asking a Nation because a project defines the partnership must exist. The relationship may involve building trust and working towards common goals that have been identified by both parties. This could mean supporting goals within a community, like education or health care. An important aspect to many First Nations is that the partner should understand the Nation's culture, that each Nation has a different culture. Once that relationship is started, it should continue and like any relationship it needs to be worked at.

This allows a partner to understand barriers that Indigenous communities have faced. Some of these barriers include, but are not limited to: transportation from remote locations, start-up funding, provision of childcare, education, and lack of access to training resources.

In some cases the manufacturer may be able to provide distinct expertise that is lacking in the community. For example, while many Indigenous businesses and entrepreneurs possess the skills and expertise to complete the work, they may not have the business acumen required. In a true partnership the local manufacturer can assist with business advice.

A partnership can mean that the manufacturer and a First Nation work together on a project, have an equal say in decisions and share revenue equally. It can be rewarding to both parties if successful. A distinct hindrance to this is the amount of time it may take to build a level of trust and then apply for work. While a very large engineering company may have the capacity to spare, a small or medium-sized business relies on the owner (or equivalent) to undertake the work to build the relationship, while also trying to run the company. This relationship building is not billable time, so to pay someone to work with a Indigenous partner can become costly.

### Immigrants

**A shortage of skilled workers is driving Canada to increase opportunity to attract and retain foreign workers. These workers can fill gaps in the workforce, and bring additional or specialized skills that are otherwise unavailable or in high-demand.** Companies that have a full complement of skills and services may present an advantage over competitors. Foreign workers may also bring fresh perspective and new methods that may increase efficiencies, and increase the ability of a company to communicate with foreign customers. For example, foreign workers can communicate with potential customers in languages other than English or French. More information for employers about hiring foreign workers is available here.

Without being a permanent resident or citizen, a worker must hold a work permit or be an international student (albeit with specific conditions) to legally work in Canada. There are several ways a person can be legally allowed to work in Canada.

To hire foreign workers, an employer may need to get a labour market impact assessment. The assessment will determine whether a foreign worker is eligible to fill a job rather than a Canadian citizen or permanent

resident. An assessment should also be submitted when a foreign worker applies for working visa. In some situations a potential employee may not need an assessment. Exemption codes are provided by Immigration Canada; the employer should check whether an assessment is required.

Several programs are available to attract foreign workers who are either looking for work in Canada or who are already in the country and available to work. **Two of the most obvious choices are the Provincial Nominee Program (PNP) and Temporary Foreign Worker. The difference between the two is that PNP can lead to permanent residence, whereas the Temporary Foreign Worker brings foreign workers in temporarily who then leave Canada.**

*Provincial Nominee Program*

The PNP is designed for people who have specific skills, education, and experience required by a province or territory, who want to live in that province, and want to become a permanent resident of Canada. Each province or territory will requires applicants to undertake a medical exam and a police check. Each have their own program stream.

In British Columbia, the PNP has four streams:

1. BC PNP – Express Entry BC: provides the fastest way for eligible workers to gain permanent residence in BC. Applications are accepted for high-demand occupations: skilled worker, healthcare professional, international graduate, and international post-graduate (after receiving a post-graduate degree in natural, applied or health sciences).

2. BC Skills Immigration: This stream is for people with skills, experience, and qualifications who would like to become permanent residents of British Columbia. The options within this stream are similar to the Express Entry stream although with an additional option for entry level and semi-skilled workers for high-demand occupations. Specifically these include: tourism and hospitality, long haul trucking, food processing, and other occupations.

3. BC PNP Entrepreneur Immigration: reserved for experienced entrepreneurs who want to actively manage a business in British Columbia. Applicants must have personal and investment funds.

4. BC PNP Tech: This stream offers the opportunity for people in 29 technology-based occupations a chance to gain permanent resident status. The list of occupations can be found here.

A shortage of skilled workers is driving Canada to increase opportunity to attract and retain foreign workers. These workers can fill gaps in the workforce, and bring additional or specialized skills that are otherwise unavailable or in high-demand.

The Skills Immigration and Express Entry streams are most relevant to manufacturers in northern British Columbia. At the time of writing applications for these programs are typically processed in 2 to 3 months, based on the 80% of previous nominations. The PNP Tech stream also has an average processing time of 2 to 3 months.

Each of the PNP streams have several requirements of employers. They must provide a written offer letter, complete their sections of the application forms, and notify PNP if there are changes to employment. Employer requirements to take part in the PNP program include: being a company in good standing, must have a specific business structure, must be permanently established in BC, in northern BC companies must have 3 full-time employees, have history of being a good workplace, are able to provide full-time permanent work, offer a wage that is equal to industry standards, and must meet domestic labour market recruitment requirements. The employer is required to pay the fee for the

Labour Market Impact Assessment. The processing times for LMIA was up to 34 business days at the time of writing. If the potential employee is exempt from an LMIA, an employer compliance fee of $230 is required.

In addition to completing the application, employees may be required to take a language test, verify credentials and competencies, and pay any fees associated with the application. Employees who are invited to apply are ranked based on a registration score. The score is based on the job being offered, its location in British Columbia, the wage, along with prior work experience, education and language ability.

More information about the PNP streams are available at WelcomeBC

### *Temporary Foreign Worker Program*

The Temporary Foreign Worker Program comprises 6 streams, two of which are applicable to manufacturers: Express Entry and Global Talent. Employers must meet several requirements, including: completion of a labour market impact assessment, meet the terms of an LMIA decision letter and any annexes, keep any relevant records for 6 years from the day a work visa is issued, and inform Employment and Social Development Canada of any changes to the working conditions. The Temporary Foreign Worker Program does not require payment of a compliance fee.

### *Other Programs*

Other programs are available that provide short-term working visas. Workers who have an open work permit or have obtained a working holiday visa (e.g., British Universities and North Americas Club) can also be employed. The former requires a number of conditions to be met and the latter is a work permit issued by International Experience Canada, it is available to people up to 35 years of age from a short list of countries. In both cases an LMIA is not required.

Workers can also apply for entry through Federal programs: Federal Skilled Worker; Federal Skilled Trades; and, Canadian Experience Class. These require proof of education, experience, and language comprehension, and for Federal Skilled Trades an offer letter from an employer. A comparison of programs is available here.

### *Foreign Workers in Small and Medium-Sized Manufacturers*

While immigration programs offer companies with options to address labour shortages along with other advantages, employment of foreign workers present challenges for manufacturing SME's. First and foremost, the Temporary Foreign Worker Program has been met with criticism. For example, in 2013 an international mining company hired 201 Chinese workers for a mine near Tumbler Ridge. They argued that workers in British Columbia could not meet the job qualifications, one of which was to speak Mandarin. This, after a large bank faced similar controversy over firing domestic workers and replacing them with foreigners. Following these cases, changes were made to the Temporary Foreign Worker Program. If undertaken appropriately the Temporary Foreign Worker Program enables workers with specialized skills to work for short periods to complete work that is either unavailable or not able to be done by Canadian workers.

Other challenges are linked to administrative involvement. Often SME's cannot retain the services of administrative staff, leaving the task to company owners to find foreign workers and write applications. The companies in Prince George often consist of an owner-operator who runs a small team of staff that complete work on contracts, and additional time is spent completing business development, customer care, and ensuring delivery of products to clients. Interviewees mentioned that a key limitation was the lack of administration to provide oversight. Owners are already working long hours and would then also need to take on searches for foreign workers.

At the time of writing, processing times for working visas were up to 3 months. This may be increased depending on which country a worker is emigrating from. Faster processing times are available through some streams, for example, the Global Skills Strategy can take as little as 2 weeks to process a visa, although the

length of time a worker is allowed to work in Canada is greatly reduced. The Global Skills Strategy allows a temporary foreign worker to work up to 15 consecutive days once every 6 months or up to 30 consecutive days once every 12 months for highly skilled workers. In addition, contracts for SME's are usually short-term, lasting a few months. The nature of processing times could mean that by the time a contract is awarded the term of the contract is over and there is no need for the foreign worker. Often companies need workers once contracts are signed with work being undertaken immediately afterwards. Without knowing whether a contract will be awarded the employer cannot offer secure employment, but then may not have the workforce to complete the work.

The work visas themselves present challenges, some have specific time restrictions that only allow narrow time windows for foreign workers to work in Canada. The nature of work with manufacturing SME's is to support core employee's and to hire additional workers for short term contracts. Foreign workers who enter Canada under the PNP are looking for long-term positions, where manufacturing SME's may not be able to guarantee ongoing work for long periods. The PNP Tech requires workers to have a job offer with a 1-year timeline. This forces the foreign worker to find work elsewhere and may impact an employers ability to employ foreign workers in the future. In either case high-demand skills leave the company due to visa requirements.

In partial solution to these challenges, the Government of Canada hosts a Job Bank that provides a database of opportunities with Canadian companies for Temporary Foreign Worker's, among other worker categories (job seekers, Indigenous, newcomer's to Canada, students, visible minorities, youth, people with disabilities, and armed forces veterans). Some jobs are specific to the Foreign Worker Program which allows employers to post positions to attract workers, and for potential employees to respond. The Job Bank allows employees to connect with a Canadian employer to ease the process of finding an employee. Canadian employers have also travelled abroad to host job fairs that were organized in advance of travel. At these, the employers attempt to attract workers who are interested in certain occupations and want to move to Canada.

### Company Size

One distinct disadvantage to SME's is the size of individual companies. The number of workers required for some of these projects may require a company to recruit a significant workforce at short notice (after a contract is awarded). In the current environment, recruiting workers is increasingly difficult especially for some specialized occupations. Furthermore, some contracts may require specialized or expensive equipment.

**Other industries have overcome hindrances presented by company size through operating producer co-operatives that share equipment, employees, and other resources. So that rather than each company competing with each other, each share the resources they have among each other.** A co-operative increases the number of available workers and potentially saves each of the companies involved by sharing equipment. This approach can ensure work is awarded to local companies, keeping the work local and building the reputation of local companies. Through this approach the co-operative builds relationships collectively with major project clients.

This approach has been used throughout Europe. For example, farms in France operate on a collective basis, sharing employees and equipment. In the UK, a collective of farmers may group together to rent a combine harvester during the harvest season. In either country, the farms share the costs of equipment, then share workers to drive machinery, complete the harvest, and transport product back to their respective farms. This is especially important when low numbers of farm workers are available and because the harvest season is often dictated by weather and markets. Fast and efficient work is required over a short time period.

In Canada, co-operatives have been used to great effect among SME's involved in forestry. One interviewee spoke of encouraging a co-operative to form in Alberta, whereby individual companies were not successful in obtaining work. When the co-operative formed and began working together they were very successful. Of the companies in the co-operative each brought different machinery and workers, and were able to complete contracts to the point where they achieved financial stability.

### Opportunities to Overcome Barriers

To help overcome some of the barriers faced, British Columbia has employed a team of economists from the UK to provide a new mission-oriented innovation strategy to build an inclusive and sustainable economy (British Columbia 2021e). The mission-based approach is centered on business and government working together, steering the economy towards people, planet, and profits. The approach provides the opportunity to shape a different kind of economy, one that is sustainable, inclusive, resilient and oriented around solving problems (Global Public Affairs 2021).

The COVID-19 pandemic has provided an opportunity for transformational change to take place in British Columbia. The province has developed a number of strategies to bring workers back to work and to help businesses survive. These measures must be inclusive and accessible to all industries, without providing barriers and hindrances to the manufacturing industry. Currently, it is unclear whether funds are directly available to the manufacturing industry, as found in other countries (University of Cambridge 2020).

The World Economic Forum (2020) proposed several recommendations to provide temporary and long-term relief. These include:

- Immediate response: Fiscal and monetary packages to protect workers and households
- Mid-term response: Policies to protect vulnerable workers: maintaining health and nutrition, provide access to shelter, income stability, household expense subsidies, extension and expansion of benefits to workers (e.g., employment leave).
- Long-term response: introduce cash payments if economic conditions deteriorate.

Some of the other changes that could be made as the economy is examined and transformed include benefits to retain workers and overcome workforce challenges. With increases in housing prices and the cost of living, workers should have access to fair wages. One CEO in Seattle took a pay cut to be able to afford to pay his employees a minimum wage of $70,000 (BBC News 2020). Some of the benefits of this approach have been staff retention, a happier and more productive workplace, resulted in increased commitment to the company, among others. Other ways of retaining staff, especially as skilled workers are in high demand and there are fewer people entering the industry. Some novel ways of retaining staff have been to offer wages comparable to larger companies and other types of compensation: vacation, holiday, sick time, pension, benefits, healthcare, flexible hours for parents, and promote a work-life balance. Staff can also be offered career maps to show them that the company is invested in their continued development. One interviewee mentioned they were able to negotiate longer term agreements with unions to lock in wages for longer times.

To offer these incentives a company either needs to work constantly on their business development to ensure consistent work is available. Another option would be to work with a research and development organization to determine a product that is required. These can either be simple yet innovative products that can be easily produced. Or a company can develop a high value product in low volume. Alternatively, the business model can remain and diversify. Manufacturing SME's can provide project management, along with local knowledge and experience, to help projects run smoothly.

Last, transformational change should involve contributions from all aspects of society. Indigenous people, while starting to gain a stronger voice, are usually left out of planning and should be at the heart of decision making. Diversity and inclusion is becoming increasingly important across many sectors, recognizing that Indigenous and female perspectives are valuable. Given British Columbia's and Canada's commitments to Indigenous communities, it is important not to overlook businesses and workers in these communities.

## Findings

1. The ongoing COVID-19 pandemic along with climate-induced crises (e.g., wildfires) have presented many challenges, yet the mission-oriented approach to the economic revitalization offers opportunities to make deep change to the economy in British Columbia. To add further complexity, the north is experiencing increased activity from major projects, which offers opportunity for

SME's to benefit, although significant barriers are faced by SME's.

2. To fully realize these benefits, supply chains need to be rebuilt and should foster support from government for manufacturing companies. Governments can also help by providing supports to attract and retain workers. Businesses meanwhile can build relationships with suppliers to stabilize project material orders as well as contribute to controlling cost increases within project life cycle. Businesses can also maintain an inventory of raw materials to complete projects, although this can contribute to financial strain.

3. Government has immigration programs in place to help employers and potential employees connect and bring expertise to Canada. These programs can be long term and lead to ongoing employment or bring people with very specialized skills to Canada for short periods of time.

4. The programs help to support the current and future labour shortages that are being experienced not only Canada, but in many other countries also. Program success could be hampered by the increased administrative effort required to find and bring foreign workers into Canada, despite partial solutions like the Job Bank. Further challenges are faced by processing times for working visas and by time restrictions imposed by visas (albeit that extension may be applied for). Administrative supports to help companies and potential employees are required to help SME's to pursue foreign workers.

5. The PNP program offers the opportunity to attract workers in from specific countries and industries. The PNP has potential to attract workers specifically for the manufacturing industry in northern British Columbia, especially given the labour shortage.

6. Despite programs designed to attract foreign workers, Canada has an under-utilized resource in Indigenous workers. Companies can ensure that diversity and inclusion initiatives are undertaken in workplaces to ensure Indigenous workers feel safe and part of the workforce.

7. Co-operatives have proven ability in other jurisdictions. While an individual small or medium-sized companies may not have the workforce or financial capacity to service a major project, a collective of companies may be able to win contracts. A co-operative offers several other distinct advantages, other than increased size. It also has access to increased equipment and is increased administrative capacity to work with Indigenous people or search for and find Canadian or foreign workers.

## Funding Opportunities

**Funding opportunities have become increasingly available during, and as a result of, the COVID-19 pandemic.** The manufacturing industry is counted an essential service[17] in British Columbia under critical infrastructure services, and transportation, infrastructure, and manufacturing.

**Both British Columbia and Canada have multiple initiatives designed to provide relief or support businesses (and employees). Many of the opportunities are targeted towards advances in green and new technology. Under-represented[18] groups are also being funded, including women and Indigenous-led businesses.** Canada has also prioritized essential services to receive funding, some of these are specific to ensure manufacture of supplies that were in high demand during the pandemic, e.g., medical supplies.

**Funding agencies should ensure opportunities are available without hidden hindrances, to ensure broad eligibility criteria, simple and easy to use application processes, along with simple reporting requirements that meets government's requirements for responsible financial management, without being onerous for the applicant.**

In addition, potential applicants need to be made aware of funding programs and agencies to ensure geographic diversity when administering funds (e.g., to ensure that northern manufacturers benefit from pro-

17 https://www2.gov.bc.ca/assets/gov/family-and-social-supports/covid-19/list_of_essential_services.pdf

18 Under-represented groups include: Indigenous, black or person of colour, 2SLGBTQQIA+, neuro-diverse, persons living with a visible or invisible disability, women, youth from care, non-binary, other.

grams as well as their southern counterparts). The provincial and federal governments and other funders have funding programs available on websites. **Although only some of these are widely advertised and can otherwise be difficult to access for companies in northern British Columbia as they work with less reliable internet.**

Funding opportunities, subsidies, deferrals, and other incentives and measures provided by Canada and British Columbia are listed below.

### British Columbia

British Columbia set up several programs in 2020, a description of which are provided in British Columbia (2020a). **Many of the province's funding streams are now closed to applications.** Some of the programs relevant to SME's in the north (including the manufacturers).

Commercial property tax was cut by an average of 25% and late payment penalties were postponed. More information is available here: https://news.gov.bc.ca/releases/2020FIN0020-000703.

Payments for PST, hotel tax, carbon tax, motor fuel tax and tobacco tax were all deferred. More information is available here: https://www2.gov.bc.ca/gov/content/taxes/tax-changes/whats-new/sales-taxes

Government has provided significant liquidity supports for SME's. A list of the provincial supports is included in this list produced by Business Development Bank of Canada: https://www.bdc.ca/en/documents/special-support/covid-19-supports-for-canadian-businesses.pdf.

15% tax credit on eligible new payroll. The funding deadline was December 31, 2021. The fund provided a one-time tax credit of 15% on remuneration paid during the base (July 1 to September 30, 2020) or qualifying period (October 1 to December 31, 2020). This fund was applicable to new hires, existing employees, and employees who left during the base period or qualifying period. More information is available here: https://www2.gov.bc.ca/gov/content/covid-19/economic-recovery/increased-employment-incentive#eligible-remuneration.

BC PST rebate on PST paid for machinery and equipment between September 17, 2020 and March 31, 2022. The rebate is available to all incorporated businesses. It aims to allow businesses to grow and become more productive: https://www2.gov.bc.ca/gov/content/taxes/sales-taxes/pst/rebate-machinery-equipment. The goods must be:

- described by the definitions found in Schedule II to the federal Income Tax Regulations, as they read on September 1, 2020, for CCA classes 8, 10, 12, 16, 38, 43, 43.1, 43.2, 46, 50, 53, 54, and 55
- not excluded
- obtained substantially (more than 90 percent) for the purpose of gaining or producing income
- purchased or leased in British Columbia, brought into or received in British Columbia, brought into British Columbia for temporary use, received from a related company, or received as a taxable gift, and
- in the case of software taxed under Part 4 of the Provincial Sales Tax Act (PSTA), purchased for use on or with a device ordinarily situated in British Columbia.

Small and Medium Sized Business Recovery Grant: Applications closed in 2021, but provided grants to businesses in hard-hit industries. Eligibility criteria were reasonably generic, although businesses had to show at least a 30% revenue loss when comparing revenues in the same month between 2019 and 2020.

Worksafe BC is waiving the premiums paid on wages to furloughed workers of employers who received the Canada Emergency Wage Subsidy. More information is available here.

Small Business BC provides a list of non-government funds: https://covid.smallbusinessbc.ca/hc/en-us/articles/360050726773

InBC is a Crown corporation set up to manage and invest a $500 million strategic investment fund (announced as part of the StrongerBC Economic Recovery Plan). This fund will provide capital to invest in high growth potential businesses, specifically in SME's that have potential to provide significant financial returns. Investments will also support developing talent, intellectual property, innovation, create jobs in the province, and drive economic growth (InBC Investment Corp. 2021). The investment mandate has a triple bottom line that align with government's priorities; it aims to:

- achieve a financial return on investment;
- promote values that make life better for people in British Columbia, including job creation, advancing reconciliation with Indigenous people, and promoting diversity and inclusion; and,
- establish British Columbia as a globally competitive low-carbon jurisdiction.

InBC's Service Plan for 2021/22 – 2023/24 states that it is currently building operational capacity in order to make investment decisions and will not be in a position to make investment decisions until the end of March 2022. As of January, 2022 a CEO had been appointed and the following intentions had been identified for 2022:

- Build a highly skilled, values-based team using an inclusive hiring approach
- Support the CIO to begin deployment of capital upon the finalization of an Investment Policy that addresses financial return with multiple intersectionalities including:
    - Sectorial
    - Stage
    - Regional
    - Reconciliation
    - Asset classes
    - Diversity, Equity and Inclusion
- Craft an aspirational strategic plan with a long-term outlook generating financial and social returns for all British Columbians
- Engage actively with the ecosystem to develop opportunities for collaboration
- Provide updates to our stakeholders through regular communications and reports.

### Canada

A summary of Canadian funds are provided below. These do not provide exhaustive information about each program. Rather the programs were reviewed and then selected based on their relevance to manufacturing SME's in northern British Columbia. A full list can be found here: https://www.canada.ca/en/department-finance/economic-response-plan.html#businesses

Jobs and Growth Fund (https://www.wd-deo.gc.ca/eng/20185.asp): Is for SME's, providing $700 million over 3 years. The fund supports

- transition, adoption and development of clean and green technologies.
- diversity and inclusion
- activities that strengthen capacity in sectors critical to Canada's recovery and growth.
- Projects supporting scale up and market expansion activities that bolster traditional areas of strength and highly impacted sectors.

- Projects that facilitate the development of emerging areas of global competitive advantage that offer opportunities for future growth.
- Projects that attract investment in key sectors.

Highly Affected Sectors Credit Availability Program (https://www.bdc.ca/en/special-support/hascap) provides loans of $25,000 to $1 million, with 4% interest payments for up to 10 years. Eligibility criteria include: having received Canada Emergency Subsidy or the Canada Emergency Rent Subsidy by having demonstrated a minimum 50% revenue decline for at least three months with the eight-month period prior to date of the application.

Canada Recovery Hiring Program is a subsidy provided as a result of the COVID-19 pandemic to cover employee wages: https://www.canada.ca/en/revenue-agency/services/subsidy/recovery-hiring-program.html. The company must be a Canadian-controlled private corporation where at least 50% of the partnership's interests are held (directly or indirectly) by employers eligible for the CRHP.

Loan Guarantee Program for SME's provides loans to cover operational costs as a result of the COVID-19 pandemic: https://www.bdc.ca/en/special-support/special-support-co-lending-program

Co-Lending Program for SME's provides a loan to support operational cashflow: https://www.bdc.ca/en/special-support/special-support-co-lending-program

Innovator Skills Initiative provides up to $10,000 to hire a new employee from an under-represented group get their first job in the tech sector and support companies facing skills shortages to grow and expand. Up to 10 grants are available to companies for up to 10 employees. The funds are available to non-tech companies also.

CanExport provides an innovation fund of up to $75,000 for SME's, academic institutions, and non-government research centres develop research and development collaborations through partnerships in foreign markets. Other funds are also available: https://www.tradecommissioner.gc.ca/funding-financement/can-export/index.aspx?lang=eng.

Work sharing agreements help employers and employees to avoid layoffs if there is a temporary decrease in the normal level of business activity and the decrease is beyond the control of the employer. More information is provided here: https://www.canada.ca/en/employment-social-development/services/work-sharing.html.

## Findings

1. Canada has a number of ongoing funding programs that were a direct result of the COVID-19 pandemic that could provide support to SME's. British Columbia meanwhile rolled out several initiatives to support businesses; however, many of these funds are now closed.
2. Provincial and federal initiatives are seemingly focused on diversity and inclusion, providing money to under-represented groups, and also to advance green and new technologies. While these are important, SME's are struggling, especially as the COVID-19 pandemic continues, supply chains are disrupted, workers are in high-demand, and out-of-province companies are awarded lucrative contracts.
3. Non-COVID related funding is required at this stage in the pandemic to support essential services (including manufacturers who are not categorized as critical service providers) and to help them prosper post-pandemic. Funds to support to support searching, hiring, and retaining workers in high-demand occupations (e.g., welders) are required. Manufacturing SME's require support to develop high value/low volume or high volume/low value products. Additional funds are needed to help establish research and development of these products.
4. These funds need to be in the form of grants, rather than loans, so as not to place additional pressure on SME's. Also, eligibility criteria, application processes, and reporting requirements should

be generic enough to allow the SME's to apply without hidden hindrances.

5. Different media may be required to reach northern manufacturers who are working with less reliable internet. Media to reach northern companies could include newspaper adverts, email blasts, outreach from the funding agency to the MLA, or leveraging other agencies (e.g., Small Business BC) who already have strong connections to the north.

6. Without funding to support small and medium-sized manufacturers in the north there is an increased possibility that clients will continue to ask companies elsewhere in British Columbia or out-of-province companies to develop and manufacture products. By doing so, manufacturing expertise in British Columbia will be lost, both in terms of companies and workers. The loss could impact the province's GDP and in an era where other industries are challenged (e.g., old growth deferrals and layoffs in forestry), the government has a chance to support the manufacturing sector in northern British Columbia.

# Manufacturing Innovation

Innovation is driving several aspects of the manufacturing industry as a result of supply chain disruptions due to the COVID-19 pandemic and to move the industry forwards into a digital era. To address supply chain impacts some governments have introduced measures to alleviate supply chain disruption, as well as initiatives to promote reshoring. The latter is specific to the production of goods within the country, rather than relying on imported products. Some countries are also using new technology and innovations to upgrade supply chains. These in collaboration with other initiatives to mitigate impacts to research and development and to establish research and technology organizations or centres of excellence.

The industry is also recognizing corporate responsibilities to manage non-tangible assets and align corporate values with healthy and safe workplaces. Historically, corporate success has been measured with economic values, whereas now greater value is being placed on environmental and social values.

This section will include a review of innovations in the manufacturing sector undertaken internationally and examine their potential application in British Columbia. **By examining innovations northern businesses will be able to remain current and anticipate changes that may affect operations in the future. Innovations may also present ways to increase efficiencies and provide advantages when bidding on contracts.** We also include a scan of new skills that may be required in the future, including those that will be needed to work with both technological advancements and with new corporate strategies. Last, we provide potential changes to curricula to support these skills.

## New Technologies to Modernize Production and Increase Manufacturing Capacities

New and emerging technologies are predicted to drive the manufacturing sector in the near future. These advances are considered to be the next phase of evolution in the manufacturing industry. There have been 4 key steps in the evolution of the manufacturing industry, both globally, and in Canada. The stages have included: mechanization, electrification and mass production, globalization, and automation, which has led to digitalization, otherwise known as Industry 4.0 (BDC 2017).

**Industry 4.0 describes the use of digital technologies to help manufacturing become more agile, flexible, and responsive to customers (BDC 2017).** In addition, companies that adopt new technology have the potential to reach a wider customer base as technology allows them to work remotely. **New and emerging technologies have been supported by advances in computing power, storage capabilities, and use of sensors has enabled the practical use of digital innovations in the manufacturing industry (Arinez et al. 2020).** Simply put, more information can be gathered, stored, and used to find efficiencies in the manufacturing process than previously.

In the last decade, Industry 4.0 has moved from talk to reality (Price Waterhouse Cooper 2016a). **Advances**

**pose several benefits for manufacturers including decreased operating costs[19] and raw material expenditures, increased performance, higher production quality, more innovation capacity, reduced waste, increased revenue opportunities, and greater flexibility to develop custom or new products [BDC 2017; Canadian Manufacturers and Exporters (CME) 2019].** Together these benefits are predicted to support the manufacturing industry and create resilient economies (Australian Government 2020a).

Examples of new and emerging technologies include (adapted from Price Waterhouse Cooper 2016; BDC 2017; and, Brookfield Institute 2021):

- Artificial Intelligence (AI): Industrial AI is still in its infancy, with research and development being conducted into how AI could be integrated into current processes, including Industry 4.0 (Lee et al. 2018). Part of AI, machine learning, is predicted to become a powerful tool for the manufacturing industry (Arinez et al. 2020) as it can be employed in automated production lines to remove bottlenecks.
- Big data analytics and advanced algorithms can be used to complete analytics on processes and systems. They offer the opportunity to determine efficiencies to increase production and save money.
- Blockchain: Defines that use of databases to track and monitor information and records through supply chains at specific timestamps. Sometimes blockchain can be used to determine whether a product has been obtained from a sustainable or reputable source.
- Cloud computing: This technology removes the costs of larger expenses for servers, infrastructure, computing power, databases, and software.
- Connect products to the internet using sensors to determine when maintenance may be required or determine which products to manufacture more of based on sales.
- Cybersecurity: With increased reliance on computing, SME's need to ensure they invest in cybersecurity. SME's will be greatly impacted, when compared to large companies, by cyber-crime.
- Experiment with 3-D printing to make prototypes, test products, and fabricate custom products.
- Going paperless to improve filing systems, save time and money, and to reduce errors.
- Improving online presence by: creating a website, advertising, creating a company app, using and maintaining a social media account. And using these resources not only to advertise but also to allow customers to buy products.
- Integrate computer networks to connect with customers, suppliers, and business partners. For example, inventory can be monitored by algorithms that mine additional information about product sales and budgets to determine which materials need to be ordered to continue working.
- Introduce smart processes such as programming machinery to determine their own maintenance schedules.
- Mobile devices: Most people now carry a smart device with them on a daily basis, be it phones or tablets. These devices can be used to communicate with machinery and offer an opportunity to link machines together in applications that are available specific to machines or as part of the application catalogue supported by the device's manufacturer.
- Monitoring and controlling machinery and equipment in real-time. Sensors allow a factory to monitor production and collect data to make process changes on-the-fly (also known as the Internet of Things).
- Optimize processes using software to mine data that improve production efficiencies.

19 In 2016 costs were expected to decrease by 3.6% across multiple sub-sectors of the manufacturing industry (Price Waterhouse Cooper 2016)

- Smart sensor technology has advanced, where products that used to contain multiple sensors now require a single sensor that monitors multiple things: e.g., tire sensors in wheels used to monitor one aspect (e.g., tire pressure), but have been adopted to monitor other variables as well.
- Virtual reality: Headsets can show workers blueprints as they walk through a construction site (Royal Bank of Canada 2021)

According to a survey conducted by Statistic's Canada, new technology adoption was typically higher in western Canada (Manitoba and all provinces west), although emerging technologies (e.g., Internet of Things and blockchain) are more commonly implemented by companies in Quebec and Ontario (CME 2019). **The survey indicated that new or emerging technologies were most likely to have been adopted by large companies, rather than SME's. The survey showed the type of manufacturing was also indicative of technological adoption, highest adoption rates were among companies in the aerospace sector, followed by pharmaceuticals, furniture, computers and electronics, and then machinery manufacturers (CME 2019).** Of relevance to manufacturers in northern British Columbia, approximately 48% of companies in the fabricated metal manufacturing sector use advanced or emerging technologies, and roughly 52% were in the primary metal manufacturing sector. Of the fabrication and welding companies interviewed for this report, new technology is limited due to the uncertain return on investment and high purchase costs. Most interviewees used computer numerical control or CNC machines to undertake custom metal cutting. These machines required skilled operators who can program the cuts. One interviewee stated that a new and recently trained recruit had been able to increase the efficiency of the CNC machine through reviewing and updating the code used by the machine. These companies also use tablets (e.g., iPad or similar) to control some of the machines, which would have previously been controlled manually.

**Despite new technology growth in western Canada, Canadian's companies have some of the lowest growth rates for productivity in the world (CME 2019). Canada is lagging behind other countries in committing capital investment to incorporate new technologies into manufacturing processes (CME 2019). Given advances by other nations, Canada is at risk of falling behind and losing out as other countries forge ahead.** Canada has low investment in machinery, new equipment, and new technology (CME 2019). Jurisdictions other than Canada have implemented resources and measures to encourage companies to adopt new technology. Technology adoption is also lower among SME's, who represent the majority of the workforce among manufacturing and other industries (Brookfield Institute 2021). These businesses face several distinct barriers: lack of digital culture, awareness, and skills; lack of financing and excessive costs; skills and education gaps; increased complexity of new technology; employee's resistance to change; unclear return on investment; and, sometimes poor access to high-speed and reliable internet (BDC 2017; Brookfield Institute 2021). Additional barriers are faced by under-represented groups who face sexism and/or systemic racism that reduces access to services and supports (Brookfield Institute 2021).

The three main reasons that companies have not adopted new technologies (CME 2019) were found to include:

- A lack of information and testing opportunities: This latest evolution provides many options, resulting in myriad choices although the long-term benefits remain unclear to companies given economic conditions, business culture, and the current policy environment.
- High purchase costs and uncertain return on investment: companies are expected to spend large amounts of money in new technology, having stayed in business through COVID and are implementing new practices that disrupt current production when adopting new technology; and,
- Labour and skills shortages: businesses need skilled workers, or need to retrain current workers at the expense of ongoing education to take advantage of new opportunities.

Additional concerns to adopting new technology include the disruption caused by incorporating digital systems into workplaces, lack of computing power, that human workers will be replaced by technology, and provision of reliable internet. Workplaces that implement new technology steadily overtime will experience less disruption (plus will incur the costs of adopting technology overtime) and can gradually increase their computing power to meet the needs of customers. The incorporation of these technologies

relies on experienced human knowhow or input to understand problems, to program AI to overcome challenges, to understand systems to collect the correct amount and appropriate quantity of data, to interpret data, and to determine the interlinkages between machines (Lee et al. 2018). Some of these steps require the creation of new jobs, while others require a shift in skillsets to work with new technology. As such, expertise not previously required in the manufacturing industry will likely be in-demand moving forwards (this is discussed in greater depth later).

Regarding reliable internet, the Federal Government has made a commitment to provide high speed internet to all citizens of Canada. **British Columbia recently committed to accelerating the provision of internet to Indigenous and rural communities, in part to support increased economic growth (British Columbia 2022b).** Work is also being undertaken by the Digital Technology Supercluster, whereby a partnership of communications companies, First Nations, and universities are hoping to bring increased internet capacity to the north and central coast, and Haida Gwaii (Digital Technology Supercluster 2021).

Elsewhere in northern British Columbia, the region has poor internet access and low speeds, especially in rural and remote communities. The Canadian Radio-television and Telecommunications Commission has identified a target internet speed of 50 megabits per second (download), 10 megabits per second (upload). While high speed and fibre optic internet is slowly arriving to the north (via British Columbia Ministry of Citizen Services) along with the 5G network, over 60% of rural communities in British Columbia do not have access to 50/10 Mbps (British Columbia 2021f)[20]. Lack of reliable and strong internet connection is a hindrance to many aspects of the manufacturing industry that is limiting the success of business, especially during the ongoing pandemic (KPMG 2019). As a result, SME's in the north are having difficulties retaining youth, attracting talent, growing businesses, training workers, and adopting new technology (KPMG 2019). During the pandemic the lack of reliable internet has also prevented communications with clients who are located outside the north and who can easily access video conferencing or using online systems. Lack of communications could lead clients to work with businesses that are able to communicate on internet-based technology.

These concerns formed the basis of recommendations included in a 2019 CME report (CME 2019) and need to be addressed with adequate funding for manufacturing SME's. Once overcome, innovation is strongly correlated with increasing success (Price Waterhouse Cooper 2016; CME 2019; Enterprise Ireland 2020). Companies that invest in new technology reported lower operating costs, improved product quality, became more innovative, all of which led to competitive advantages over companies who had not embraced new technology (BDC 2017). These technologies may also have been adopted by clients, when manufacturers adopt the same systems they stand to more clearly and efficiently communicate with their customers. Companies can start by adopting base technologies as a first step (e.g., like cloud computing) before embracing more sophisticated technology (Brookfields Institute 2021). **To get past the initial uncertainty of investment, manufacturers need appropriate supports to leverage policy and incentivize technology adoption, and provide ongoing support to help manufacturing SME's to achieve digital maturity. To this end, manufacturing SMEs could link with technology companies to determine how to incorporate technology into work processes. Specific programs could be designed and implemented to help bring new technology to northern manufacturers, including: the costs associated with incorporation into work processes, the capacities and capabilities required to adopt, and future proofing new technology to ensure it adds production efficiencies in the both the near and distant future. Additionally, British Columbia will build a new trades and technology complex at the British Columbia Institute of Technology (British Columbia 2022b).**

New technology can be applied as a niche product, by helping other companies incorporate digital processes in their workflows, or by producing products that require new technology during manufacturing. A company stands to generate revenue directly as a result of new technology, with it being key to providing a product, rather than the technology being secondary in production.

Key elements to ensuring success of digital adoption is to have a vision and strategy, support from leaders, an environment that rewards risk taking and collaboration, and a focus on training and continuous learning

20 For example, internet in rural Smithers is provided through either satellite or internet hubs that require a cellular signal. At the time of writing the hub provided 6.6 Mbps download and 2.0 Mbps upload. The Federal Government of Canada has released a map of internet coverage and speeds, available here: https://www.ic.gc.ca/app/sitt/bbmap/hm.html?lang=eng.

(Brookfields Institute 2021). Several steps are required for manufacturing SME's to adopt new technology into their business processes (and to become digitally mature). Once adopted, digital capabilities are easier to build upon, thereby companies remain relevant and competitive both within Canada and globally.

Steps to adopt new technologies could include:

1) Create a plan: Hire an expert who can write an implementation plan. The plan will determine where digital technologies could be implemented into the business, identify training that could be provided to workers to ease implementation, mitigate potential disruptions to production, and have goals to be obtained over a defined time period (e.g., 5 years).

2) Run pilot projects: once the plan is finalized, pilot projects can be undertaken to work out potential implementation issues, to determine success, and to obtain confidence from workers when adopting new technology. These pilots act as 'proof of concept' ideas that may be fully implemented. After the pilots have been completed, the implementation plan can be updated to provide solutions to any unforeseen barriers that were demonstrated.

3) Analyze data: This process will provide data that can be used to improve products or build new service offerings.

4) Become a digital organization: Successful pilots may lead to full implementation, which will require leadership either from the top of the organization or from a champion entrusted with implementation by leadership.

5) Create an ecosystem: once digital processes have been adopted they can start to be offered to clients. In some cases this may involve adopting to platforms used by clients, albeit that it should be easier to adopt to a different platform once digital adoption has been undertaken (part of the implementation plan should be to research platforms used by existing clients or common platforms used in the industry).

## Findings

1. Industry the world over is undergoing a 4$^{th}$ industrial age, otherwise known as Industry 4.0. This new age aims to incorporate digitalization into industrial processes. Advances in computing power and incorporation of the internet into everyday life (among other advances) has enabled manufacturers to take advantage of new technology.

2. New and emerging technologies stand to increase production while lowering costs. Several studies have examined adoption of new technology and concluded that SME's experience increased productivity and efficiencies having incorporated new technology.

3. Despite positive outcomes realized by new technology, Canadian companies in general are cautious about investing in the technology sector and as a result could be left behind. Before being able to adopt new technologies, companies in northern British Columbia need to better understand the opportunities presented through adopting new technology and need reliable and in particular need high speed internet connectivity to work with clients and suppliers. Otherwise major barriers are presented to companies wanting to adopt new technology.

4. British Columbia's 2022 economic plan will create new manufacturing opportunities in an innovative economy (British Columbia 2022b). To support this a new trades and technology complex will be built at the British Columbia Institute of Technology (British Columbia 2022b). Furthermore, the province is positioning itself to use Environmental, Social, and Governance values to market products, thus capitalizing on innovative products after they are developed.

## International Responses to New Technology Adoption

This section provides an overview of funding programs from other countries (including Canada and British Columbia) to fund new technology adoption. For comparison, provincial level funding is likely to be lower than country-level funding. Funding initiatives at the country-level are given for context to show examples from other jurisdictions that could be beneficial in Canada and British Columbia.

**Funding for manufacturing SME's to adopt new technologies is available, although this funding needs to be provided in an open and transparent manner to enable manufacturers to apply for and use the funds. Several countries are investing millions (if not billions) of dollars to reinvigorate their economies post-COVID and to use this opportunity to increase economic resilience including, strengthening supply chains, meeting carbon and climate change commitments, developing and encouraging adoption of new technologies, and opening research and development institutes or centres of excellence (University of Cambridge 2020).** Some of which are specifically targeting SME's.

These countries include (University of Cambridge 2020):

- Australia has recognized that the manufacturing industry needs significant investments to advance new technology, in part to meet to commitments made to decrease emissions. This will help the manufacturing industry provide a needed boost to the economy, particularly as a result of the impacts of COVID-19 (Australian Government 2020b). The Australian government is consulting with its citizens on its Technology Investment Roadmap (Australian Government 2020a). Also, specific to manufacturing, Australia is supporting 200 projects worth AUD$1.5 billion through the Modern Manufacturing Strategy that includes the programs:
    - Modern Manufacturing Initiative, a AUD$1.3 billion investment in large transformative projects, aimed to encourage private investment
    - Supply Chain Resilience Initiative (AUD$107.2 million), that seeks to better understand supply chains, identify and address gaps.
    - Manufacturing Modernisation Fund, a AUD$52.8 million fund to support investments in manufacturing technologies and processes.

  In addition to these, Australia has commissioned teams led by industry experts to develop road maps for nationally recognized manufacturing priorities and to identify and overcome barriers to future growth.

- China is supporting the development of new technologies and the adoption of digital technologies. This work will lead to innovation within supply chains led by large state-owned enterprises and private firms, for dissemination to SME's.

- The Digital Europe Programme has recognized the influence digital systems could have on businesses and is aiming for digital independency by developing home-grown solutions in five key areas: supercomputing, artificial intelligence, cybersecurity, advanced digital skills, and ensuring widespread incorporation through digital innovation hubs. This project alone has a budget of €7.5 billion with a chief aim to bring the benefits of digital technology to society, the economy, and SME's (European Commission 2021).

- Ireland offers companies several supports to promote innovation, conduct research and development, and build sustainable management practices in line with climate change commitments. This along with establishing a eiLearn Online Learning Platform with over 450 pieces of customized content. Also, Enterprise Ireland provides a network of advisors in different countries who help companies reach different and new markets.

- Italy has established a Guarantee Fund for SME's that after April 2020 was strengthened to guarantee up to €100 billion on loans. A further €200 billion guarantee on loans was added to support

exports. And €55 billion has been pledged to support businesses and families post-COVID.

- Japan is providing subsidies of up to 75% to SME's to cover costs to repair supply chains and to move to remote working options. Other subsidies include a CDN$3.1 billion fund to reshore production, to have products made in Japan.
- New Zealand has established a COVID-19 response and recovery fund that includes measures that provide short-term loans for research and development intensive businesses. Also, New Zealand has implemented an CDN$8.5 million dollar fund to encourage e-commerce among SME's.
- Singapore is providing grants for companies to adopt digital solutions and to provide training for digitalization of businesses. This along with additional funds to support market diversification, funds include CDN$97,000 to expand internationally and 200% tax deduction on eligible expenses.
- Taiwan has provided grants of almost CDN$1 million for technology upgrading and offers training subsidies for skill upgrading (up to 32 hours per employee).
- The United States of America is funding individual projects of USD$250,000 to USD$10 million that span a range of activities, including the creation of additional production facilities.

### Funding Available in Canada and British Columbia

New technology supports for businesses in Canada and British Columbia are also available. In Canada:

- The Jobs and Growth Fund ($700 million) will in part help to enhance Canada's competitiveness by using digital technologies to improve productivity and manufacturing processes.
- A $1.4 billion fund: Canada Digital Adoption Program. This program provides SME's grants under two streams: 1) to grow business online and/or 2) to boost the use of technology to run a business. At the time of writing, activities supported under stream 2 include hiring advisors to develop a digital transformation plan. Digital transformation under the Program include creating or enhancing websites, using e-commerce to bolster business, or investing in new technology to generate business and improve productivity. Funds to cover 90% of the costs to develop a plan up to $15,000 are provided. Implementation costs are covered by a 0% interest loan from Business Development Canada, up to $100,000. Stream 1 of the Digital Adoption Program are now closed to applications.
- Canada also provides $2.6 billion to BDC to help finance SME's to adopt new technology.
- Mitacs Accelerate provides funding for a partnership between an organization and a PhD, MSc, or post-doctoral fellow to overcome innovation challenges. Funds are provided by Mitacs of up to $7,500 for a 4 – 6 month internship: https://www.mitacs.ca/en/programs/accelerate

Much of the new technology being promoted in British Columbia, is to meet climate change commitments (e.g., by reducing carbon emissions) and to create jobs, while supporting critical industry sectors based in British Columbia (e.g., food and pharmaceuticals). British Columbia has a few funding sources available for companies that want to innovate and adopt new technologies:

- Innovator Skills Initiative: Applications are still open for companies to apply for grants up to $10,000 to hire a post-secondary student to help with post-COVID business planning and operations, or to hire for technology-related roles: https://www.newventuresbc.com/2019/05/isi-grant-program-attracts-top-international-student-talent/
- Innovate BC has a number of programs to support hiring, research and development, pilot funding and mentorship. Under the Innovation Challenges program technology SME's can provide solutions to government and industry: https://www.innovatebc.ca/innovation-challenges/
- Internet connectivity in British Columbia is being addressed through the Connecting British Columbia program that helps to pay infrastructure costs associated with connecting to the internet.

The program is administered by the Northern Development Initiative Trust and is open to internet providers, local governments, Indigenous organizations, and registered not-for-profits (Northern Development 2021). Other potential funding opportunities are listed here: https://www2.gov.bc.ca/gov/content/governments/connectivity-in-bc/connectivity-funding-programs.

- Community Futures offers loans of up to $150,000 to help businesses grow: https://www.communityfutures.ca/
- CleanBC is a provincial program that aims to achieve British Columbia's commitment on emissions reduction targets for 2030 and to reach net-zero by 2050 (British Columbia 2021g). This program includes initiatives to: adopt electric vehicles; encourages carbon neutral strategies for construction, oil and gas; to increase clean fuel requirements, and support innovation for hydrogen, bioeconomy, and negative emissions technology.
- The province committed in its StrongerBC report (British Columbia 2020a) to providing new resources for businesses to build their online presence, boost e-commerce, or increase digital marketing.
- For planned purchases to introduce new technologies to the workplace the Ministry of Jobs, Economic Recovery, and Innovation has created the Technology Assessment Program. Under this program technology assessments are completed and an action plan devised for companies that want to move forward with purchases, implementation, adoption, and training: https://cme-mec.ca/technology-assessment-program-tap-for-british-columbia/.
- The BC Tech Association offers two programs to help hire technology support. The first is the Digital Lift Internship that provides a 4-month paid internship along with hands-on experience to Indigenous Peoples, women, rural youth, and workers transitioning between industries. The second are 12 Indigenous internships that are designed to provide hand-on work experience for Indigenous youth.

**Funding programs best serve their purpose through broad eligibility criteria, rather than being narrowly focused. Application processes and subsequent reporting requirements should be user-friendly, rather than proving onerous for applicants.** These could help manufacturing SMEs to obtain and maintain important funding that can lead to adoption of new technologies.

## Findings

1. Funding programs for SME's are available to implement digital change within foreign companies. These funding programs need to be provided to a range of applicants, and need broad eligibility criteria to allow SME's to apply for needed funds.
2. Some countries have provided billions of dollars to incorporate new technology, Australia in particular is targeting their manufacturing industry to strengthen the industry given the amount it contributes to the Gross Domestic Product.
3. Equivalent funding programs in British Columbia and Canada are available to SME's; however, funding providers need to ensure that eligibility criteria, application, and reporting processes are easily navigated by applicants, which otherwise may present significant barriers to apply and receive funding.

## Innovations in Corporate Values

**Industries across British Columbia, Canada, and around the world are becoming more environmentally and socially conscious.** This has led to the establishment of guiding values to influence corporate behaviour and performance (Bennett Jones 2021). Corporate and Social Responsibility (CSR) has evolved into Environmental, Social, and Governance (ESG). **Companies are also incorporating equity, diversity, and inclusion (EDI) values into their businesses.** ESG and EDI are each closely linked, while being different enough that they offer different measures of performance outside of regular financial reporting.

In this section we provide information about the benefits, impacts, and costs of incorporating these standards into operations. Several industries have already begun to incorporate ESG and/or CSR, we will look to experts in at least oil and gas and mining (major project proponents) for cues for manufacturing, and determine whether the manufacturing sector in other jurisdictions have adopted ESG and/or CSR. We will also determine the importance of ESG to SME's in the manufacturing sector.

In addition, many other industries have identified the need to promote equity, diversity, and inclusion, especially among women, Indigenous, and other under-represented groups. Some of the barriers to under-represented groups have already been discussed; however, funding and strategies are available which could be incorporated into the manufacturing sector.

## Corporate and Social Responsibility

CSR was established to make a business accountable for its activities by developing a vision statement that demonstrated how a business would regulate its ethics and mitigate impacts on public values beyond simple economics. Benefits achieved by companies that shared a vision and incorporated CSR into their business models to demonstrate more environmental and social awareness often achieved better returns on investment than companies who had not established CSR values (Tzouvanas and Mamatzakis 2021).

The overall benefits of CSR are much like ESG, to demonstrate corporate responsibility and citizenship with communities. Ultimately, CSR values could help to reduce costs, increase employment, and to ensure sustainable and socially-responsible values through the supply chain. This last point involves much larger publicly-traded companies who need to show their investors and customers that the entire supply chain is aware of values that are held by society and that forethought will mitigate potential impacts.

## Environmental, Social, and Governance Values

The world is experiencing increased interest in carbon reduction, greater reliance on public input to projects, and green policies. The main difference between CSR and ESG is that the latter offers a way to evaluate and measure values, these include:

| Environmental | Social | Governance |
|---|---|---|
| • Climate change adaptation, response, and innovation<br>• GHG emissions, trading, and offsets<br>• Carbon tax<br>• Energy assessments<br>• Biodiversity<br>• Water management<br>• Environmental compliance and climate change litigation<br>• Waste management and circular economy<br>• Energy and clean technology<br>• Sustainable finance and impact investing | • Equity, diversity and inclusion (EDI)<br>• Employment and labour relations<br>• Human rights protection<br>• Indigenous rights and relations<br>• Community engagement<br>• Corporate reputation management<br>• Responsible procurement<br>• Supply chain advisory and management<br>• Product responsibility and stewardship<br>• Responsible tax | • Board governance, diversity, best practices and transparency<br>• Stakeholder engagement<br>• Shareholder activism, preparation and response<br>• Investor relations and public disclosure compliance<br>• Compliance and internal controls<br>• Proxy advisory firm vesting guidelines<br>• Securities disclosure<br>• Cybersecurity and data protection |

* Adapted from Bennett Jones (2021) and BDO Canada (2021)

ESG was first coined about a decade ago, but has become increasingly important as a result of the pandemic, reconciliation efforts, the impacts of climate change, and to alleviate demand by Millennial and Gen Z workers (BDO Canada 2021). As with CSR, publicly traded companies are incorporating ESG into their annual reporting to demonstrate responsibility. By including measures into corporate performance company executives can be held responsible not only financial performance, but also for sustainable values. Private companies may not need to show this level of responsibility, although there are several compelling reasons for such companies to demonstrate ESG values.

**Businesses are being increasingly evaluated on their values during the contract bid process, by potential investors (e.g., banks), and by future employees who are becoming more aware to the impacts of industry and by regulators. In short, companies are incorporating ESG values into their corporate structures to obtain contracts and to access funding.** In addition, large publicly-traded corporations that have their own ESG strategies defined may require SME's (employed as contractors and subcontractors) to also have their own ESG strategies in place. Especially as the majority of businesses in British Columbia and Canada are SME's.

BDO Canada (2021) outline several drivers for all (private and public) companies, these are summarized below:

- Banks and private equity firms are more frequently reviewing sustainability risks for loans and ESG strategies
- Supply chains are becoming more dependent on each link in the chain to have responsible procurement processes and to provide products and services under the auspices of ESG
- A growing proportion of workers (driven by Gen Z and Millennials) look for companies with an ESG program
- Companies use ESG to measure, maintain and create sustainable values that address global goals to combat climate change and social inclusion
- Social values held by mining companies ensured consultation and engagement with local communities eased concerns about potential impacts
- Environmental strategies outlined energy consumption reductions which resulted in lower bills
- Strategies to reduce pollution demonstrated increased responsibility to regulators, resulting in fewer inspections.

By incorporating ESG into the workplace, other companies have realized benefits and used ESG strategies to overcome issues. Examples of benefits include (McKinsey 2019):

- If a company can show strong environmental values, customers may be more willing to pay for their services. This is also true of large corporations who need subcontractors. A large company may look more favourably, or be required to, on a subcontractor who has an ESG policy.
- Companies that incorporate ESG to reduce resource costs could increase their operating profits by as much as 60%.
- A proven track record of environmental awareness can ease regulatory pressures, plus make finding employees easier.
- Can avoid long-term environmental effects that may lead to stranded investments. Instead, investments can be enhanced by looking to sustainable options like renewables, waste reduction, and scrubbers.

**The key to ESG is to demonstrate sustainable management efforts. ESG offers a way for companies to demonstrate and measure corporate responsibilities.** As such, global investment in 2019 was as high as $30 trillion (McKinsey 2019). Some countries have made ESG reporting mandatory for publicly listed com-

panies (Camus 2021). For example, Germany has made ESG reporting mandatory as part of its Sustainable Finance Strategy. While the UK has announced plans to introduce its own ESG framework and Europe has made it mandatory for some financial institutions to provide ESG credentials in reporting and on their websites (Camus 2021**). In Canada, many publicly owned companies have created and implemented ESG strategies, and report on the standards. However, there is not a single ESG framework in Canada or British Columbia.**

A framework logically leads to building a strategy and then to reporting. Five steps can be used to implement an ESG strategy (Camus 2021):

1) Complete a "materiality assessment" to identify sustainability issues: talk to clients, partners, and investors to determine key issues, and use that to define values and issues to overcome.
2) Identify relevant ESG frameworks. These can include (Business Council of British Columbia 2021):
    a. Global Reporting Initiative: used by 76% of the world's largest corporations
    b. Sustainable Accounting Standards Board: meant for financial stakeholders
    c. Task Force on Climate Disclosure: provides climate-centric standards to reduce greenhouse gas emissions
    d. Climate Disclosure Standards Board Framework: reports on environmental and natural capital.
3) Gather the required data: the previous steps provide issues and a framework on which to report against and examples of data to collect.
4) Report against data: produce a report that can be provided to clients and employees. Promote the report when talking with potential clients. Publish the report on a website to ensure full transparency.
5) The ESG process can be completed annually to determine how well issues are being addressed and may highlight additional challenges to overcome.

Examples of ESG strategies for manufacturers SME's can include (McKinsey 2019):

- Environmental: developing policies for recycling or waste material handling (e.g., for used oil or other industrial fluids), decreasing energy consumption, or reducing water intake
- Social: establish an EDI policy to determine how diversity in the workplace will be increased, boost employee motivation, and/or attract talent through greater social credibility
- Governance: Buy machinery that is built to last to provide long-term sustainability.

**While writing an ESG strategy may seem daunting, companies may have incorporated ESG without having written official policies or standards, or can already be regulated by municipal, provincial and/or federal requirements.** During interviews, many of the manufacturing SMEs mentioned initiatives they undertake as part of day-to-day business. Examples of values that fall under these standards include, but are not limited to:

- Employing women and Indigenous workers
- Agreements with local communities that aim to employ Indigenous people.
    - Two companies had established agreements with local First Nation's and are committed to diversity and inclusion
    - Another had tried to set up an employment program with Carrier-Sekani
- Adhering to British Columbia's environmental legislation

- Volunteering by providing funds to local schools and sports teams
- Recycling waste metal, oil, paper, cardboard, and other recyclables (e.g., cans and bottles) etc.
- Proper storage of chemicals and fuels, and reporting spills
- Reusing metal where possible to reduce the amount of waste
- Properly disposing of used industrial waste (e.g., oils or spent welding rods)
- Initiatives to collect and properly dispose of refuse dumped on backroads
- Working with local education institutions to support students by providing apprenticeships.

Once a strategy is developed, it then leads to reporting to demonstrate how a company is meeting requirements set out in the strategy. ESG reporting among SMEs can be challenging. Traditional reporting requirements, like safety and financials, take a lot of time each year. A burden that will be added to if additional ESG measurements and reporting are required, especially among companies that are trying to stay afloat during the COVID pandemic. Therefore, reporting needs to be user-friendly with standard reporting templates that reflect the values provided in the strategy to reduce any burden placed on manufacturing SME's. Completed reports (and the strategy) could be result in positive impacts on businesses, by providing a competitive advantage to companies who implement ESG strategies.

**During 2022 British Columbia will implement the establishment of an ESG Centre of Excellence to promote ESG principles for products and services. This will help British Columbians to develop, promote, and market environmentally and socially responsible goods and services.** The government is developing an ESG strategy that will include, but is not limited to: diversity and inclusion of under-represented workers and immigrants; value-added products; to promote, develop, and market "green" products (e.g., low carbon products). The new Centre will facilitate ESG investments in British Columbia, attract socially and environmentally conscious investors, and diversify markets for British Columbia's world-class goods and services under a respected and trustworthy ESG brand.

Of particular importance in Canada and northern British Columbia, manufacturing SME's need to be included in plans that are implemented by government. Their voices will give credit to plans that are made and to ensure the diversity of businesses from across the province are fully represented. Further to this, Indigenous values could be incorporated into ESG, which is currently lacking in many ESG strategies (Podlasly et al. 2021) and requires additional work to ensure Indigenous perspective can be measured or evaluated (Business Council of British Columbia 2021). Recent commitments by Canada to UNDRIP, the *Declaration of the Rights of Indigenous Peoples Act* in British Columbia, the Calls to Action by the Truth and Reconciliation Commission, and the adoption of Free, Prior and Informed Consent suggest that projects and businesses will not impose undue impacts on the environment or on social structures, and enable Indigenous governments to hold shared decision-making authority. ESG principles could be co-created with Indigenous input. By doing so increases the chance of project and business successes and reduces risks (Podlasly et al. 2021).

Several interviewees mentioned wanting to employ Indigenous workers or to form joint venture partnerships with Indigenous communities. Relationships could be built using the reconciliation model, whereby businesses and an Indigenous entity gain each other's trust and then determine how the partnership may work. From there they could define the needs of Indigenous employees (which may be different from non-Indigenous employees) and then provide employment. More information on relationship building is provided below in the section: Generating Social License.

## Equity Diversity and Inclusion

**Currently and historically, under-represented groups (e.g., Black, Indigenous, and People Of Colour (BIPOC); women; LGBTQIA2S+; immigrants; and, people living with visible and non-visible disabilities) have faced barriers when entering the workforce.** These barriers can be wide-ranging including (University of Victoria 2021):

- Unwelcoming experiences which leads to a lower sense of belonging, being pushed out, or otherwise marginalized
- Harrassment and/or assault due to their gender and race
- Social and economic challenges associated with colonialism and systemic racism
- Cultural messages, stereotypes, lack of role models, poor working conditions and environment
- Ageism
- Workplace inequalities for LGBTQIA2S+
- People with disabilities were discriminated against as employers were unsure how to employ disabled people or how to adequately source, train, and enable inclusion.

Other barriers facing underrepresented workers include, but are not limited to: lack of childcare (especially if required to work long days or camp shifts), remote geographic locations, lack of collateral for loans (if thinking of starting their own business), lack of drivers' licence, lack of reliable transportation, lower education levels and lack of essential skills, no or lower chance for career advancement, and lack of a safe space to learn new skills.

Some of these barriers can be addressed by employers providing physical changes in the workplace and also by changing the mindset of other employees. Making physical changes (e.g., equal pay or recognizing holidays of all cultures) can be easier to implement compared to changing the mindsets of employees who are not aware of their behaviour. A key solution will be to help employees and employers recognize their unconscious biases. These barriers prevent adequate integration in the workplace and if unaddressed will prolong stereotypes about underrepresented workers. A partial solution could involve writing and making available to all current and future staff, a diversity and inclusion policy. New workers are beginning to ask employers for diversity and inclusion policies (Glassdoor 2021). The policy demonstrates to prospective and existing employees that the employer is aware of issues facing underrepresented employees and that they are committed to hiring from these groups.

Other solutions could include:

- After employing underrepresented employees, to listen to those workers if they share concerns or if they are willing to share ideas, seeking their advice to implement positive changes in the workplace
- Mentoring in the workplace has proved successful, especially if the mentor belong to an underrepresented group. However, before a worker becomes a mentor they should undertake training to understand barriers
- If workplace training is undertaken, recognize that not all workers learn the same way, and that training delivery should be flexible
- Individual needs should be identified, some workers may require extra time to undertake some tasks. Build a relationship with workers to learn and understand their needs.

Work is being completed to overcome barriers, in particular reconciliation efforts for Indigenous people in Canada have gained traction recently. Employers may consider spending extra time with underrepresented employees or making changes to work around barriers.

**Overall, companies that provide barriers are missing out on skilled workers and by implementing solutions to encourage greater diversity and inclusion in their workplaces companies can experience better business outcomes (McKinsey 2015), increased revenues (Harvard Business Review 2018), and employees have improved job satisfaction and company culture (Glassdoor 2021).**

More information and advice to improve diversity and inclusion is available at: https://www.innovatebc.ca/dei-resources/

## Generating Social License

**Social license involves generating relationships with local communities and Indigenous people to support a project.** Government is required to consult and accommodate Indigenous communities for project developments. This is backed through several court cases, Delgamuukw vs. British Columbia and Haida Nation vs. British Columbia (Minister of Forests). The former defines the content and the extent of Aboriginal rights and title. The latter set the precedence for the Crown's duty to consult and accommodate. As such, government provides proponents with a list of Indigenous communities to communicate with (usually through the Indigenous elected government system). The proponent provides funding to support community, addresses concerns, provides information so the communities can determine potential impacts, and determine whether a project impacts Aboriginal interests. At the same time the proponent may engage with Indigenous economic development companies and joint venture partners. As reconciliation progresses, the United Nations Declaration on the Rights of Indigenous People, and in British Columbia the *Declaration on the Rights of Indigenous Peoples Act* (including Free, Prior, and Informed Consent) becomes more common place some proponents undertake additional work to go beyond standard consultation and accommodation.

Social license is not only limited to Indigenous communities, although has been focus in British Columbia leading up to and including the current day. Social license can provide local non-Indigenous communities with the chance to interact with proponents to learn about the potential impacts of projects and to understand benefits resulting from projects. This length of time this process takes will be dependent on the type and scale of the project, and the environment the proponent is looking to work in. It provides local people with the chance to gain confidence in the project as they interact with the proponent's representatives. Depending on the type and scale of the project it can take years to generate social license.

**One successful program initiated by the Canadian Council for Aboriginal Business is Progressive Aboriginal Relations (PAR) certification (Canadian Council for Aboriginal Business 2022). The program was first established in 2001 and is a form of CSR. One of the advantages is that PAR certification can be used to achieve a competitive advantage or could be used by a company as part of their ESG reporting. Furthermore, this certification is endorsed by Indigenous companies and communities.**

Through the program participants can indicate their corporate performance by achieving bronze, silver, or gold status. The level is judged by a committee of Indigenous business people. The certification informs communities that the business is a good partner; a great place to work; and, committed to prosperity in Indigenous communities. The certification is subject to independent and third-party verification of company reports (which could include ESG reporting).

Companies have to show a commitment to building relations with Indigenous communities, to achieving equitable representation within their workforce, to maintain Indigenous workers on staff, to develop business relations with Indigenous-owned businesses, and develop community relations through communications, information sharing, and involvement in events and activities.

Companies are able to include the PAR logo on communications to show their commitment. Companies that have achieved certification include, but are not limited to:

- Bronze: Tolko, MNP, Domcor, Hatch, and CN
- Silver: Allteck and Mosiac Forest Management
- Gold: BC Hydro, ATCO, and Civeo.

In addition to these certifications, PAR also acknowledges companies that have begun the certification process. There are companies who have committed to achieving PAR, and include: manufacturers, energy, environmental engineering consultants, forestry, wood products manufacturers, education institutions, and banks among others. They submit reports online for up to three years before being awarded one of the three levels of certification.

### *The Role of Manufacturing SME's in Social License*

The examples above provide context for how companies have and/or could work with communities near project sites. Project proponents often need to report on their social responsibilities as well as meet goals for equity, diversity and inclusion, and demonstrate reconciliation efforts (through engagement, consultation, and accommodation with Indigenous communities). As a result, **proponents may preferentially work with SME's that have established relationships with local communities prior to a project coming through. In return SME's will likely gain traction with proponents and generate greater revenue through contracts awarded to them or their joint venture partners.** Alternatively, local businesses can continue to take part in initiatives the proponent implements (e.g., working group meetings, attend open houses, etc.), employ local people, and support local initiatives.

## Findings

1. Standards to address environmental, social, and governance responsibilities have become increasingly popular in response to ongoing climate change impacts. Furthermore, standards are being established to encourage diversity and inclusion in the workplace.

2. In British Columbia templates for framework and standards are required for SME's to incorporate ESG values and to implement a strategy. A standard and easy-to-use approach will help SME's to incorporate ESG and lead to increased contract and investment opportunities. As well, part of ESG reporting could include SME's enrolling in certifications like PAR.

3. The province will establish an ESG Centre of Excellence along with a brand for ESG values and principles. These should involve input from SME's to ensure plans and outcomes are not prohibitive to these businesses taking advantage of ESG when manufacturing products or employing workers. In other words, ESG values and principles should be matched to the capacity of SME's.

4. In some cases, programs like ESG and PAR are required by potential workers, financial organizations, for SMEs to fulfill requirements when sub-contracting, and are a positive way for companies to demonstrate their commitment to communities to alleviate potential impacts from their operations.

5. Companies who demonstrate strong ESG values can also benefit from creating social license. Creating strong and trusting relationships among local communities can alleviate challenges throughout a project's lifecycle.

6. Some companies may have incorporated ESG and EDI standards into their daily operations already without making official policies. By documenting values companies will increase the transparency of their operations, which will build trust and relationships with community, supply chains, and customers. By reporting, SME's may gain a competitive advantage as well as experience increased profits, along with other benefits.

## Changes to Training and Education to Support Innovation

Funding, computing power, and establishing new systems in the digital evolution of manufacturing provide distinct barriers to technology adoption. Of the challenges presented, the largest is to generate confidence among existing workers in new technologies, provide them with the required skills, and bring in new workers with skills already in place to work with new technology (Price Waterhouse Cooper 2016a). To address these challenges training and education are required to help transform the knowledge and skills of everyone from the worker through to the CEO to be able to fully embrace new technologies and incorporate them into day-to-day processes.

Industrial development described above (culminating with Industry 4.0) describes how roles and tasks in the workplace have evolved overtime. **Manufacturing jobs have changed significantly overtime, in part because these jobs often follow well-defined procedures that can be easily programmed and performed by computers (Frey and Osbourne 2013). As such, it was predicted that about 47 percent of jobs in the United States were at risk of being replaced by technologies that did not require a worker to perform the same tasks (Frey and Osbourne 2013).**

**That being said, with the advent of the digital age, traditional jobs will still be required while companies catch up with digital advances. It is likely that rather than replacing workers, a greater diversity of skills will be required to work with new technologies (Royal Bank of Canada 2021).** For example, welding requires a person with skills and experience to construct items for clients. Advances in the industry now mean that welders run robots that do the welding, while the human element completes quality assurance and maintains the robots. Thus demonstrating that welders are not immediately replaceable in favour of robots, just that a welder's job and skills have changed and now incorporates new elements.

### New Technology in Canadian Occupations

Welding is one example of an occupation that has incorporated more technology over time. Other manufacturing jobs are also susceptible to increased computerization[21]. To understand which jobs are likely to become computerized a ranking system was used that was developed for occupations in the United States (Frey and Osbourne 2013) and then compared to occupations in Canada. These occupations were taken from the O*NET database which stores descriptions of occupations (similar to Canada's National Occupation Classification database) as well as information relevant to jobs, such as the type of technology skills a worker needs to possess for each occupation. Frey and Osbourne (2013) ranked occupations using a Gaussian process[22] clarifier that was run on technology skills requirements for each of the 702 occupations in the O*NET database. The process resulted in a ranking on a scale of 0 to 1, with 0 being the occupations least likely and 1 being the most likely to be computerized.

To determine the likelihood of increased computerization in Canadian occupations, the O*NET database records were compared to Canada's National Occupation Classification (NOC) codes. O*NET uses the Standard Occupational Classification (SOC) system, which uses a numerical identifier for occupations. While it is easy to translate some occupations from SOC to NOC, some are not intuitive. To overcome this Canada has developed a tool to cross-reference SOC codes (2018; US) to NOC codes (2016 v1.3; Statistics Canada 2020). Manufacturing jobs from Appendix 1 were compared to equivalent SOC codes, with only one occupation (NOC 8411: Underground mine service and support workers) not directly translated from NOC to SOC. Once the occupations were cross-referenced, rankings from Frey and Osbourne (2013) were applied to the NOC codes. Some NOC occupations were aligned with more than one SOC occupation without a way to directly determine which SOC job was most appropriate to use to determine a ranking. In these cases the rankings from the SOC occupations were averaged to produce a rank for the NOC occupation. As well as the average ranking, we also calculated the maximum and minimum ranking associated with each occupation (see Appendix 5) because some SOC occupations associated with an NOC code exhibited a wide range of rankings. The minimum and maximum enable the reader to determine whether an

21 Frey and Osbourne (2013) refer to computerization as job automation by means of computer-controlled equipment

22 A Gaussian process is a collection of random variables indexed by time and space to achieve a multivariate normal distribution whereby a function is considered a very long vector. Each entry in the vector specifies the functional value $f(x)$ at a particular input $x$. These are often used in statistical modelling as they provide consistent and tractable results (Rasmussen and Williams 2006).

occupation has a possibility of becoming computerized. An average score may not accurately represent whether an occupation could become computerized because one low score in the average will decrease the average. Equally one high ranking could inflate the ranking.

Frey and Osbourne (2013) found that after ranking the occupations in the O*NET database that jobs with the lowest likelihood of computerization were those that required higher level of education. The level of education for the NOC code occupations were determined from the British Columbia Labour Market Outlook: 2019 Edition (Table 13; British Columbia 2020b).

***Table 13: Average Gaussian ranking for each education level.***

| Required Education | Average Ranking |
|---|---|
| Degree | 0.059 |
| Diploma/Certificate | 0.626 |
| High School | 0.699 |

**The table indicates that our findings were similar to Frey and Osbourne (2013), occupations that require a high-level of education are associated with low levels of computerization.** Engineering jobs were notably ranked lower than other occupations (see Appendix 5). Whereas technical occupations could experience increased computerization potentially because those are associated with repetitive tasks and are more easily coded and undertaken by a computer. Rather than not requiring workers any longer technical jobs could instead require diversification of skills to enable workers to adapt to an increased technological component of their occupation.

## In-Demand Occupations and Skill Requirements

Traditional occupations are in high-demand across Canada. Increasing shortages are being experienced among skilled tradespeople. For example, in the manufacturing sector, several occupations are required, including: welders, millwrights (or industrial mechanic), automotive service technicians, and boiler makers (Royal Bank of Canada 2021). The British Columbia Labour Market Outlook: 2019 Edition (British Columbia 2020b) classifies high opportunity occupations; these are occupations that are expected to experience higher demand and pay compared with other occupations. The criteria used to identify high opportunity occupations are the number of job openings and the strength in employment growth; the current wage rate; the most recent unemployment and employment insurance rates; and, how easy it will be able to get that job in the future.

**For the manufacturing sector jobs identified in Appendix 1, 28 are high opportunity occupations. For the most part these occupations require either a degree or a college education, while two occupations require a high school education (longshore workers and transport truck drivers).**

**In addition to labour requirements, new skills to accommodate new technologies, "soft skills" will become critical to ensuring companies continue to effectively offer services and collaborate across sectors (Royal Bank of Canada 2021). The top 10 skills and competencies forecast to be required in British Columbia include: active listening, speaking, reading comprehension, critical thinking, social perceptiveness, judgement and decision making, writing, monitoring, complex problem solving, and coordination (British Columbia 2020b). Also, industries are being required to work with each other more frequently, so employee's ability to work across many sectors will become more important (Royal Bank of Canada 2021).**

The manufacturing industry will also need to attract and train workers to fill occupations that may be new to the industry and traditional occupations that may require different skill sets. New occupations that may be required in the manufacturing sector include: software engineers, computer scientists, data analysts, among others (Price Waterhouse Cooper 2016b).

### Other Sources for Workers

**Other than the under-represented groups (e.g., Indigenous, women, and immigrants) discussed earlier in the report, one possibility is for companies to hire highly educated people. Canada has an over-abundance of PhD's.** Traditionally, once a PhD is awarded the graduate then remains in academia and works their way up from researcher to professor over the course of several years. Currently, 20% of PhD graduates are employed as professors (Schein 2019). On their way to become a professor, graduates are employed as post-doctoral researchers and are typically poorly paid, sometimes without benefits and pensions. A post-doctoral researcher can expect to earn up to $45,000 a year (Schein 2019), and possibly supplement their income with additional consulting work or teaching. Under the publish or perish model PhD graduates are expected to, and need to, publish to be successful. This can result in high stress environments with little financial reward.

Companies can bring PhD graduates into industry, although there are several drawbacks: PhD graduates who entered the academic system from high school may have little to no industry experience, may not have networks built, and often considered over-qualified for industry positions (Schein 2019). However, the opportunities outweigh the drawbacks, a PhD graduate will possess many of the soft skills that are required in today's workforce. Most possess outside-of-the-box thinking, are highly analytical, have high level critical thinking and problem-solving skills, and are able to communicate effectively through written or oral means. Each of these skills is highly desired in the future workforce. PhD graduates also possess other highly developed skills and cutting-edge knowledge that could be beneficial as companies attempt to establish their niche. Drawbacks to employing PhD graduates can be overcome with on-the-job training and mentoring. There is also possibility to hire PhD graduates who have industry experience, who after working for a time returned to university to pursue further education.

## Findings

1. Many jobs are predicted to become more computerized over time. Jobs that are repetitive can be easily coded into a computer, which can perform some tasks. Workers may not become obsolete, but will be required to adopt new skills to work with new technology.
2. The occupations that are least likely to become computerized are those with higher levels of education (e.g., those that require a university education) and most engineering occupations.
3. Twenty-eight occupations in the manufacturing sector are categorized as high opportunity occupations, indicating that these occupations will offer employment opportunities and good wages. When considering hiring for these positions, and others, employers in the manufacturing sector should also consider people who demonstrate the ability to adapt to new technology and a combination of "soft skills".
4. The top three skill requirements in British Columbia are active listening, speaking, and reading comprehension, and also strong employees will be those who can work in or understand multiple industries.
5. Opportunities exist for Canadian business owners to hire highly educated workers and provide minimal mentoring to ensure their companies are successful and remain so. As well as hiring from under-represented groups, companies can hire from the pool of PhD graduates being produced by Canadian universities.

# Conclusions and Recommendations

The purpose of this project was to ensure that manufacturers in northern British Columbia can compete for service, supply, and construction contracts on major projects that require a high degree of specialization and efficiency. Northern manufacturers are actively engaged in building prosperous companies with a sustainable workforce to supply services to industrial projects in the north and to international clients.

Several barriers exist that prevent these companies from effectively competing for and winning contracts in the region. To overcome these barriers, the objectives of this research were to:

1. define the skill sets available within northern manufacturing SME's, and the barriers facing companies and workers in the north;
2. determine the upcoming capacity requirements of major projects and the skills and experience provided by manufacturing SME's in northern British Columbia;
3. define new technologies and innovations that could increase the competitive capacity of northern manufacturers; and,
4. provide solution-based recommendations for government, proponents, and employers to bolster capacity and competitiveness for companies in northern British Columbia.

To meet the objectives for this research the project was divided into phases with each phase representing an objective. Research was based on data analysis, with additional information gathered from subject matter expert interviews. The perspectives gathered during the research led to a number findings, which naturally lead to recommendations. For context, a summary of the findings that informed the recommendations is provided below. In this, suggestions are provided for the audience for the recommendations.

## Manufacturing Skills Gap Analysis

The manufacturing skills gap analysis examined the type of skills and training employers, government, and proponents could focus on strengthening the manufacturing industry for the future. To determine successful initiatives for British Columbia this analysis examined skills and training strategies from other jurisdictions.

During the COVID-19 pandemic, communications between groups have become more difficult. As a result, groups established between industry, government, and educators could be reestablished, thereby informing training programs with input from industry. The Program Advisory Committees and Sector Advisory Groups need to be reestablished following the pandemic. These groups need to communicate with each other as well as industry and government. These groups need to add a specific Indigenous element (and otherwise ensure a diversity of attendance) to ensure representative perspectives are captured.

This approach ensures that training programs are responsive to industry requirements and with government's involvement are endorsed and could be sponsored. Furthermore, these groups would benefit industry and educators in the north by providing training programs with input from employers from the region, leading to a supply of workers to the north. These groups need to be formally re-established especially given the different working environment following the pandemic and other impacts to British Columbia. Formalities like terms of references could be established by the Ministry of Advanced Education and Skills Training to ensure groups are provided with overall direction both within a group and among all the groups.

Equity, Diversity and Inclusion, as discussed in other sections, will hopefully create a working environment that will enable under-represented workers be successful in their careers. This encompasses many different aspects. One of which could specifically be establishing mentoring programs in the workplace. Apprenticeships are a form of mentoring, but direct mentoring through workplace partnerships between an experienced worker (the mentor) and a new worker (the mentee) will likely help to ensure success. An experienced worker can pass along lessons learned from years and bring realistic learning moments to

a mentee. However, both the mentor and the mentee require training in this situation. The mentor may need to understand how to communicate with the mentee, and equally the mentee needs tools to ensure they listen and have correctly understood the mentor.

Last, given the current worker shortage northern British Columbia needs skilled workers. Despite their being many workers among under-represented groups, training is required to bring these groups into industries. Temporary Foreign Workers and foreigners who want to live permanently in Canada bring skills with them that requires minimal effort by industry to ensure industrial standards are maintained. To this end, the Ministry of Jobs, Economic Recovery, and Innovation can help northern SME's by expediting programs to bring foreign workers to the region.

### Skills Gap Analysis Recommendations

1) Terms of Reference's for Program Advisory Committees (PACs) and Sector Advisory Groups (SAGs) need to be updated to define a clear framework to engage and participate in training and advisory programs. Any framework needs established objectives, with achievable and measurable outcomes to ensure training provides appropriate skills for now and the future to support the manufacturing industry.

2) All participants need consistent engagement to ensure the PACs and SAGs achieve their objectives (including government, industry, and Indigenous organizations).

3) Mentoring initiatives could be created to facilitate successful employment, with training provided equally for mentors as well as mentees.

4) Expedite applications for the Provincial Nominee Program and fast track certifications to support the manufacturing industry (and others).

## Manufacturing Capacity Analysis

Northern manufacturers have the capacity to service large projects in the oil and gas, mining, and utilities industries. Also, capacity provided by northern manufacturers will be in demand over at least the next decade. Without a home-grown skilled workforce an immigrant or transitory workforce will be required to fill the gaps, resulting in an influx of labour while required, and subsequent loss of expertise when projects are complete.

The capacity analysis identified a number of solutions that form the basis of several recommendations. The first being the formation of producer co-operatives. These have been proven in other jurisdictions to help a collective achieve a common goal. While an individual small or medium-sized companies may not have the workforce or financial capacity to service a major project, a collective of companies may be able to win contracts. A co-operative offers several other distinct advantages, other than increased size. It also has access to increased equipment and is increased administrative capacity to work with Indigenous people or search for and find Canadian or foreign workers.

Northern British Columbia is being increasingly considered for large industrial projects. As these projects go beyond the exploratory phase and into implementation, proponents have committed to employing local companies. However, many of these companies are not from the region and may not be aware of the talent or how to communicate effectively with northern SME's. A potential solution to this would be for proponents to work with the British Columbia Ministry of Jobs, Innovation, and Economic Recovery to fund a catalogue of local companies across the north. The website could be hosted through a government portal and rather than a promotional tool could be a place to store factual information about northern SME's. Part of the implementation of the website would be to gather information about northern SME's, and then promote the site to them and to proponents.

This website would be a database of SME's with information about services and products supplied; a summary of work history; office locations; and partnerships with Indigenous governments, organizations, and others (e.g., co-operatives). Furthermore, a website that was familiar to all northern companies could be

used to host a database of funding opportunities. Funding databases do exist, although it is necessary to research where these opportunities are housed (either with federal or provincial governments, or with other agencies). By placing all of these opportunities in one place SME's could keep track of programs and the website could be set up with an email service to inform SME's of new or renewed funding sources.

Last, the province has defined a number of plans to build a strong economy in British Columbia. Northern businesses need to be included in all phases of the plans as they are researched and implemented. There is a strong complement of businesses in the north who face unique challenges and have different requirements compared to their southern counterparts. This perspective needs to be understood to ensure plans and initiatives are fully informed. Furthermore, funding through agencies like the InBC Investment Corp should be equally shared throughout the province.

### Capacity Analysis Recommendations

1) SME's in northern British Columbia could form a cooperative to pool resources (raw materials, equipment, and skilled workers), share funding opportunities, and examine innovation collectively.

2) Industry has identified the need for a website for small and medium-sized businesses in the north, including projects completed, services offered, rates, location(s), partnerships that exist (add this to the Major Project Inventory).

3) The website should also contain a centralized database of funding sources available to manufacturing companies.

4) Ensure that manufacturing SME's are included in work to be implemented for the province's 2022 StrongerBC plan (e.g., northern manufacturers should be included in the Industrial and Manufacturing Action Plan; Goods Movement Strategy, and an ESG Centre of Excellence, among others) and receive a fair share of funds through the InBC Investment Corp.

## Manufacturing Innovation

Innovation among many industries is a driving factor, especially after the COVID-19 pandemic. The pandemic proved that if technology available today is used more widely that companies can still do business and through this continue to contribute to the economy. Technological innovations have led to a new evolution of industry, termed "Industry 4.0". This new phase of industry is leading to innovations to introduce efficiencies to manufacturing processes. A particular challenge for northern manufacturing SME's is becoming aware of and then navigating funding programs. Communication of provincial and federal programs require improvements to reach companies who have limited internet capacity.

Overall, British Columbia faces challenges to digital adoption (digitalization). However, this is especially pronounced in northern British Columbia due in part to the nature of the region. Specific challenges include access and infrastructure to rural and remote communities, long driving distances, impacts of adverse weather, remote worksites, and attracting residents to the north. In particular the lack of reliable and functional internet, which forms the basis of northern SME's adapting processes to new technologies. While this issue has been recognized by the federal and provincial governments, it requires greater emphasis to provide equal advantages to northern SME's as afforded to their southern counterparts. Specific programs could be designed and implemented to help bring new technology to northern manufacturers, including: the costs associated with incorporation into work processes, the capacities and capabilities required to adopt, and future proofing new technology to ensure it adds production efficiencies in the both the near and distant future. Furthermore, advances in internet capacity will create the need for additional training to help northern SME's to take full advantage of the benefits of advanced capabilities, but also in using that technology to its greatest potential. In support of training suggested in the Skills Capacity Analysis, the Ministry of Advanced Education, Skills and Training should provide training to improve skills in digital literacy.

Further to increased internet capability and training, the manufacturing industry needs supports to help them understand the new technologies that are available, which of them could be used, and how to incorporate technology into work processes. Funding is available to allow northern SME's to undertake this work, the funding agencies need to ensure that money is available to companies in the north and that northern SME's understand the full range of funding available to support digitalization. Available funding could be used to hire a digital adoption expert to assess existing processes and to help SME's understand where and how they can incorporate new technology. Part of a plan could be to identify specific digital processes that provide a competitive advantage to northern SME's.

As other industries (e.g., forestry) experience curtailments and job losses, manufacturing is poised to become an industry that can support the economy of British Columbia. This will require work to adopt new technologies. Government, industry, and private consultants can work together to support the manufacturing sector. Northern SME's could work with product development experts to determine niche products, to offer distinct services above those provided by competitors from elsewhere in the province or from out-of-province. An expert would provide a detailed market analysis which would include services offered by other northern manufacturing companies, examine which other companies are working in the north, determine why those companies were successful in their bids, and use the analysis to determine potential changes and adoptions that northern SME's could undertake to obtain contracts or changes to services that are currently offered. Funding is available for this with additional support provided by the Ministry of Jobs, Economic Recovery, and Innovation. The Ministry could play a greater role by providing access to economic development officers to assist northern SME's to develop products and provide updates related to funding programs, technological advances, and other initiatives available to northern SME's.

### Innovation Recommendations

1) Reliable internet is required in the north to ensure new technologies can be supported and grow. Internet should be provided to the same standard as in the southern part of the province (e.g., 5G fibre optic network) as well as the capacity to use the internet.

2) Industry wants appropriate supports to incentivize technology adoption and provide ongoing support to help manufacturing SMEs to achieve digital maturity.

3) Work with research and development specialists to determine which new technology to bring into local companies.

4) Linkages between tech companies and northern SME's are needed to help niche technology development.

5) SME's in the north could work with a business development expert to make a niche product or provide workers with specialized skills to meet niche requirements.

6) Opportunities could be created to help research and development in the manufacturing sector, specifically to determine high value/low volume products for SME's in northern British Columbia.

## Environmental, Social and Governance (ESG)

ESG responsibilities have become increasingly important for companies to meet corporate goals. The StrongerBC report also acknowledged the importance of ESG. The report announced the upcoming formation of an ESG Centre of Excellence along with a brand for ESG values and principles.

Accordingly, standards are required to ensure companies demonstrate and report on ESG values. Government, through the ESG Centre of Excellence, can help SME's by creating a framework and standards for SME's to incorporate ESG values and to implement an ESG strategy. A standard and easy-to-use approach will help SME's to incorporate ESG and could lead to increased contract and investment opportunities. As well, part of ESG reporting could include SME's enrolling in certifications like PAR (fulfilling in part the social of aspect of ESG).

As the ESG Centre of Excellence is established, input should be included from SME's to ensure plans and

outcomes are not prohibitive to these businesses. Also, that SME's can take advantage of ESG when manufacturing products or employing workers. In other words, while ESG is important to all companies in British Columbia, the ESG values and principles should be matched to the capacity of SME's.

SME's could incorporate ESG standards by documenting values that will increase the transparency of their operations. The objectives of which will build trust and relationships with community, supply chains, and customers. By reporting, SME's may gain a competitive advantage as well as experience increased profits, along with other benefits.

### ESG Recommendations

1) SME's could benefit by building stronger relationships with First Nations to increase workforce size and provide long-term local employees and require capacity development opportunities to encourage this work.
2) Supports in the workplace could be provided for under-represented groups (e.g., Indigenous, women, etc.)
3) Industry could support the creation of an ESG guide and report card that could be implemented in accordance with international and/or Canadian standards for ESG. This report card could include (but not be limited to):
    - Indigenous values
    - Community values
    - Workplace values for under-represented individuals (e.g., Indigenous, black or person of colour, 2SLGBTQQIA+, neuro-diverse, persons living with a visible or invisible disability, women, youth from care, non-binary, other)
    - Worker progression through training and education (beyond gaining experience)
    - Contract awards provided
    - Creation and sales of high-value products that reflect a green economy (e.g., low carbon).
4) Government could encourage relationship building by providing engagement funds and/or facilitating meetings between businesses and Indigenous organizations and governments.
5) SME's could consider applying for Progressive Aboriginal Relations (PAR) certification.
6) Industry needs increased administrative support from government that should be provided for SME's in northern British Columbia to find workers to fill high-demand positions and to increase equity, diversity, and inclusion.

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# APPENDIX 1: Labour Market Information for Manufacturing Occupations

| Occupation | Number of Industries | NOC | High Opportunity Occupation | Top Demand Trade | Cariboo | | | North Coast and Nechako | | | Northeast | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Employment in 2019 | Average annual growth 2019-2029 | Job openings | Employment in 2019 | Average annual growth 2019-2029 | Job openings | Employment in 2019 | Average annual growth 2019-2029 | Job openings |
| Senior Managers - construction, transportation, production and utilities | 9 | 0016 | Y | | 190 | -0.50% | 60 | 90 | 0.60% | 40 | 130 | 2.50% | 90 |
| Construction Trades Helpers and Labourers | 7 | 7611 | | Y | 780 | 0.20% | 110 | 570 | 0.40% | 100 | 670 | 2.60% | 320 |
| Transport truck drivers | 6 | 7511 | Y | | 2180 | 0.60% | 630 | 1390 | 1.00% | 490 | 1670 | 2.30% | 870 |
| Construction Managers | 5 | 0711 | Y | | 440 | 0.00% | 120 | 190 | 0.50% | 70 | 360 | 2.60% | 220 |
| Mechanical Engineers | 5 | 2132 | Y | | 160 | 0.00% | 20 | 60 | 0.10% | 10 | N/A | N/A | N/A |
| Construction Millwrights and Industrial Mechanics | 5 | 7311 | Y | Y | 1180 | -0.30% | 240 | 790 | -0.90% | 100 | 520 | 2.00% | 260 |
| Electrical and Electronics Engineers | 5 | 2133 | Y | | 90 | 0.70% | 20 | N/A | N/A | N/A | N/A | N/A | N/A |
| Facility Operation and Maintenance Managers | 5 | 0714 | Y | | 300 | 0.50% | 110 | 180 | 0.40% | 70 | 200 | 2.10% | 120 |
| Other labourers in processing, manufacturing and utilities | 4 | 9619 | | | 100 | 1.50% | 30 | 80 | -0.30% | 10 | 20 | 2.50% | 10 |
| Civil Engineers | 4 | 2131 | Y | | 140 | 0.90% | 40 | 100 | 0.90% | 30 | 70 | 2.90% | 40 |
| Information Systems analysts and consultants | 4 | 2171 | Y | | 170 | 1.60% | 60 | 100 | 0.00% | 20 | 70 | 2.30% | 30 |
| Heavy Equipment Operators (except crane) | 4 | 7521 | | Y | 1070 | 0.50% | 290 | 690 | 0.00% | 150 | 680 | 2.40% | 360 |
| Labourers in mineral and metal processing | 3 | 9611 | | | 50 | -0.50% | 10 | 100 | -1.20% | 10 | N/A | N/A | N/A |
| Engineering Managers | 3 | 0211 | Y | | 70 | 1.10% | 30 | 50 | -0.40% | 10 | 60 | 2.90% | 40 |
| Welders and Related Machine Operators | 3 | 7237 | | Y | 730 | 0.50% | 150 | 400 | -0.40% | 40 | 420 | 2.30% | 190 |
| Material Handlers | 3 | 7452 | | | 1160 | 0.00% | 180 | 470 | 0.00% | 80 | 360 | 2.10% | 150 |
| Manufacturing Managers | 3 | 0911 | Y | | 280 | 1.90% | 140 | 120 | -0.80% | 20 | 130 | 1.20% | 50 |
| Mining engineers | 2 | 2143 | Y | | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Structural metal and platework fabricators and fitters | 2 | 7235 | | | 60 | 0.50% | 10 | N/A | N/A | N/A | N/A | N/A | N/A |
| Oil and Gas well drilling and related workers and services operators | 2 | 8412 | | | N/A | N/A | N/A | N/A | N/A | N/A | 230 | 3.00% | 130 |
| Industrial Electricians | 2 | 7242 | | | 470 | -0.20% | 80 | 310 | -1.10% | 20 | 290 | 2.30% | 140 |
| Mine Labourers | 2 | 8614 | | | 60 | 2.10% | 20 | 70 | -1.60% | N/A | N/A | N/A | N/A |
| Labourers in metal fabrication | 2 | 9612 | | | 80 | 0.40% | 10 | 40 | -0.40% | 0 | 40 | 2.30% | 20 |
| Central Control and Process Operators, petroleum, gas and chemical processing | 2 | 9232 | Y | | 50 | 4.00% | 40 | 20 | -1.30% | 0 | 520 | 2.80% | 260 |
| Contractors and supervisors, oil and gas drilling and services | 2 | 8222 | | | 40 | 3.20% | 20 | 30 | -1.40% | 0 | 270 | 3.00% | 170 |

| Occupation | Number of Industries | NOC | High Opportunity Occupation | Top Demand Trade | Cariboo | | | North Coast and Nechako | | | Northeast | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Employment in 2019 | Average annual growth 2019-2029 | Job openings | Employment in 2019 | Average annual growth 2019-2029 | Job openings | Employment in 2019 | Average annual growth 2019-2029 | Job openings |
| Power Engineers and Power Systems Operators | 2 | 9241 | Y | | 540 | -0.40% | 90 | 110 | -0.10% | 20 | 300 | 2.30% | 160 |
| Machine operators, mineral and metal processing | 2 | 9411 | Y | | 50 | 3.40% | 40 | 270 | -1.30% | 20 | 30 | 0.40% | 10 |
| Supervisors, mining and quarrying | 2 | 8221 | Y | | 140 | 3.30% | 100 | 40 | -1.50% | 0 | N/A | N/A | N/A |
| Machinists and Machining and Tooling Inspectors | 2 | 7231 | | | 150 | 0.30% | 20 | 50 | -1.80% | 0 | 40 | 1.30% | 10 |
| Oil and gas drilling, servicing and related labourers | 2 | 8615 | | | N/A | N/A | N/A | 30 | -1.00% | 0 | 140 | 3.20% | 70 |
| Metalworking and forging machine operators | 2 | 9416 | | | 40 | 1.80% | 10 | 40 | -1.40% | 0 | N/A | N/A | N/A |
| Utilities Managers | 1 | 0912 | Y | | 90 | 1.00% | 50 | N/A | N/A | N/A | 40 | 2.30% | 30 |
| Sheet metal workers | 1 | 7233 | | | 70 | 2.00% | 30 | 30 | 0.90% | 10 | 60 | 2.10% | 20 |
| Carpenters | 1 | 7271 | | Y | 1050 | -0.40% | 110 | 780 | 0.30% | 150 | 670 | 2.60% | 320 |
| Managers in Transportation | 1 | 0731 | Y | | 170 | 0.50% | 60 | 130 | 1.50% | 60 | 160 | 2.20% | 90 |
| Supervisors, supply chain, tracking and scheduling coordination occupations | 1 | 1215 | Y | | 110 | 0.90% | 40 | 100 | 1.40% | 40 | 80 | 2.60% | 50 |
| Automotive service technicians, truck and bus mechanics and mechanical repair | 1 | 7321 | Y | Y | 1010 | 0.50% | 210 | 540 | 0.80% | 140 | 700 | 2.30% | 310 |
| Petroleum engineers | 1 | 2145 | Y | | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Contractors and supervisors, other construction trades, installers, repairers and services | 1 | 7205 | | | 250 | -0.40% | 50 | 90 | 0.30% | 30 | 50 | 2.70% | 30 |
| Residential and commercial installers and servicers | 1 | 7441 | | | 180 | 0.90% | 40 | 50 | 0.20% | 10 | 100 | 2.70% | 50 |
| Electrical and Electronics engineering technologists and technicians | 1 | 2241 | Y | | 200 | 1.00% | 50 | 130 | 1.30% | 40 | 90 | 2.80% | 50 |
| Supervisors, mineral and metal processing | 1 | 9211 | Y | | 30 | 3.80% | 20 | 200 | -1.00% | 30 | N/A | N/A | N/A |
| Underground mine service and support workers | 1 | 8411 | | | N/A | N/A | N/A | 30 | -0.70% | 0 | N/A | N/A | N/A |
| Foundry workers | 1 | 9412 | | | N/A | N/A | N/A | 80 | -1.20% | 10 | N/A | N/A | N/A |
| Industrial painters, coaters and metal finishing process operators | 1 | 9536 | | | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Plumbers | 1 | 7251 | | | 270 | -0.40% | 30 | 170 | 0.30% | 30 | 190 | 2.80% | 90 |
| Contractors and supervisors, machining, metal forming, shaping and erecting trades and related occupations | 1 | 7201 | | | 120 | 0.50% | 30 | 30 | -1.30% | 0 | 80 | 2.70% | 50 |
| Power Systems electricians | 1 | 7243 | | | 30 | 0.10% | 0 | N/A | N/A | N/A | 100 | 2.70% | 50 |
| Waterworks and gas maintenance workers | 1 | 7442 | | | 40 | 0.10% | 10 | 30 | -1.20% | 0 | 50 | 2.40% | 30 |

| Occupation | Number of Industries | NOC | High Opportunity Occupation | Top Demand Trade | Cariboo | | | North Coast and Nechako | | | Northeast | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Employment in 2019 | Average annual growth 2019-2029 | Job openings | Employment in 2019 | Average annual growth 2019-2029 | Job openings | Employment in 2019 | Average annual growth 2019-2029 | Job openings |
| Electrical power line and cable workers | 1 | 7244 | | | 80 | -0.20% | 10 | 60 | 0.30% | 10 | 40 | 2.70% | 20 |
| Labourers in chemical products processing and utilities | 1 | 9613 | | | N/A | N/A | N/A | 20 | -1.00% | 0 | 30 | 2.90% | 10 |
| Longshore Workers | 1 | 7451 | Y | | N/A | N/A | N/A | 390 | 2.80% | 220 | N/A | N/A | N/A |
| Heavy duty equipment mechanics | 1 | 7312 | Y | | 590 | 0.30% | 110 | 350 | -0.10% | 170 | 360 | 2.50% | 160 |
| Industrial and Manufacturing Engineers | 1 | 2141 | | | 40 | -1.70% | 0 | N/A | N/A | N/A | N/A | N/A | N/A |
| Computer and information systems managers | 1 | 0213 | Y | | 80 | 0.40% | 30 | 100 | 0.50% | 30 | 30 | 2.40% | 20 |
| Electricians (except industrial and power system) | 1 | 7241 | | Y | 510 | -0.30% | 30 | 280 | 0.50% | 40 | 470 | 2.70% | 200 |
| Other metal products machine operators | 1 | 9418 | | | 20 | 0.10% | 10 | N/A | N/A | N/A | N/A | N/A | N/A |
| Underground production and development miners | 1 | 8231 | Y | | 130 | 3.50% | 80 | 90 | -1.30% | 0 | N/A | N/A | N/A |
| Other product assemblers, finishers and inspectors | 1 | 9537 | | | 20 | 1.20% | 10 | 30 | -0.20% | 0 | 30 | 2.20% | 10 |
| Water and waste treatment plant operators | 1 | 9243 | | | 80 | 0.70% | 20 | 50 | -0.20% | 10 | 50 | 2.10% | 20 |
| Other trades helpers and labourers | 1 | 7612 | | | 30 | 0.10% | 0 | 100 | 0.20% | 10 | N/A | N/A | N/A |
| Painters and decorators (except interior decorators) | 1 | 7294 | | | 170 | -0.80% | 20 | 90 | 0.30% | 20 | 90 | 2.70% | 50 |
| Chemical Engineers | 1 | 2134 | Y | | 70 | -0.90% | 0 | 40 | -0.20% | 10 | 40 | 2.70% | 20 |
| Oil and gas well drillers, servicers, testers and related workers | 1 | 8232 | | | 60 | 2.70% | 20 | 20 | -1.20% | 0 | 130 | 2.90% | 60 |

# APPENDIX 2: Skills Importance and Frequency Rankings in Manufacturing Occupations

| Occupation | NOC | Hierarchy | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Senior Managers - construction, transportation, production and utilities | 0016 | Management | Speaking | Critical Thinking | Active Listening | Social Perceptiveness | Reading Comprehension | Coordination | Monitoring | Complex Problem Solving | Judgement and Decision-Making | Time Management |
| Engineering Managers | 0211 | Management | Reading Comprehension | Critical Thinking | Active Listening | Speaking | Writing | Judgement and Decision-Making | Complex Problem Solving | Monitoring | Coordination | Time Management |
| Computer and information systems managers | 0213 | Management | Critical Thinking | Active Listening | Reading Comprehension | Monitoring | Speaking | Judgement and Decision-Making | Writing | Complex Problem Solving | Coordination | Systems Evaluation |
| Construction Managers | 0711 | Management | Active Listening | Critical Thinking | Speaking | Coordination | Management of personnel resources | Reading Comprehension | Time Management | Complex Problem Solving | Monitoring | Negotiation |
| Facility Operation and Maintenance Managers | 0714 | Management | Speaking | Critical Thinking | Active Listening | Reading Comprehension | Coordination | Monitoring | Writing | Judgement and Decision-Making | Time Management | Social Perceptiveness |
| Managers in Transportation | 0731 | Management | Critical Thinking | Speaking | Monitoring | Reading Comprehension | Coordination | Active Listening | Complex Problem Solving | Writing | Management of Personnel Resources | Time Management |
| Manufacturing Managers | 0911 | Management | Critical Thinking | Reading Comprehension | Speaking | Monitoring | Active Listening | Judgement and Decision-Making | Time Management | Coordination | Management of Personnel Resources | Complex Problem Solving |
| Utilities Managers | 0912 | Management | Critical Thinking | Speaking | Reading Comprehension | Monitoring | Active Listening | Coordination | Judgement and Decision-Making | Complex Problem Solving | Time Management | Management of Personnel Resources |
| Supervisors, supply chain, tracking and scheduling coordination occupations | 1215 | Business, finance and administration occupations | Speaking | Active Listening | Reading Comprehension | Monitoring | Coordination | Critical Thinking | Social Perceptiveness | Judgement and Decision-Making | Time Management | Writing |
| Civil Engineers | 2131 | Natural and applied sciences and related occupations | Reading Comprehension | Critical Thinking | Complex Problem Solving | Speaking | Active Listening | Numeracy | Judgement and Decision-Making | Time Management | Writing | Systems Analysis |
| Mechanical Engineers | 2132 | Natural and applied sciences and related occupations | Critical Thinking | Reading Comprehension | Active Listening | Complex Problem Solving | Speaking | Judgement and Decision-Making | Writing | Numeracy | Science | Systems Analysis |
| Electrical and Electronics Engineers | 2133 | Natural and applied sciences and related occupations | Critical Thinking | Reading Comprehension | Active Listening | Speaking | Complex Problem Solving | Writing | Active Learning | Monitoring | Systems Analysis | Judgement and Decision-Making |
| Chemical Engineers | 2134 | Natural and applied sciences and related occupations | Critical Thinking | Reading Comprehension | Complex Problem Solving | Science | Judgement and Decision-Making | Speaking | Active Listening | Numeracy | Active Learning | Systems Analysis |

| Occupation | NOC | Hierarchy | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Industrial and Manufacturing Engineers | 2141 | Natural and applied sciences and related occupations | Critical Thinking | Reading Comprehension | Active Listening | Complex Problem Solving | Speaking | Writing | Judgement and Decision-Making | Monitoring | Active Learning | Numeracy |
| Mining engineers | 2143 | Natural and applied sciences and related occupations | Critical Thinking | Reading Comprehension | Active Listening | Complex Problem Solving | Speaking | Writing | Judgement and Decision-Making | Science | Monitoring | Numeracy |
| Petroleum engineers | 2145 | Natural and applied sciences and related occupations | Reading Comprehension | Critical Thinking | Speaking | Complex Problem Solving | Writing | Active Listening | Judgement and Decision-Making | Science | Monitoring | Numeracy |
| Information Systems analysts and consultants | 2171 | Natural and applied sciences and related occupations | Critical Thinking | Reading Comprehension | Active Listening | Complex Problem Solving | Speaking | Writing | Judgement and Decision-Making | Systems Analysis | Active Learning | Monitoring |
| Electrical and Electronics engineering technologists and technicians | 2241 | Natural and applied sciences and related occupations | Reading Comprehension | Critical Thinking | Complex Problem Solving | Active Listening | Monitoring | Troubleshooting | Operation Monitoring | Repairing | Speaking | Quality Control Analysis |
| Contractors and supervisors, machining, metal forming, shaping and erecting trades and related occupations | 7201 | Trades, transport and equipment operators and related occupations | Operation Monitoring | Critical Thinking | Operation and Control | Active Listening | Monitoring | Quality Control Analysis | Speaking | Reading Comprehension | Judgement and Decision-Making | Time Management |
| Contractors and supervisors, other construction trades, installers, repairers and services | 7205 | Trades, transport and equipment operators and related occupations | Critical Thinking | Active Listening | Speaking | Monitoring | Time Management | Reading Comprehension | Judgement and Decision-Making | Coordination | Quality Control Analysis | Social Perceptiveness |
| Machinists and Machining and Tooling Inspectors | 7231 | Trades, transport and equipment operators and related occupations | Quality Control Analysis | Operation Monitoring | Active Listening | Monitoring | Critical Thinking | Reading Comprehension | Speaking | Operation and Control | Judgement and Decision-Making | Coordination |
| Sheet metal workers | 7233 | Trades, transport and equipment operators and related occupations | Critical Thinking | Operation Monitoring | Monitoring | Operation and Control | Active Listening | Quality Control Analysis | Complex Problem Solving | Reading Comprehension | Speaking | Judgement and Decision-Making |
| Structural metal and platework fabricators and fitters | 7235 | Trades, transport and equipment operators and related occupations | Coordination | Critical Thinking | Operation and Control | Operation Monitoring | Active Listening | Monitoring | Speaking | Reading Comprehension | Judgement and Decision-Making | Social Perceptiveness |
| Welders and Related Machine Operators | 7237 | Trades, transport and equipment operators and related occupations | Operation Monitoring | Critical Thinking | Monitoring | Active Listening | Speaking | Operation and Control | Complex Problem Solving | Reading Comprehension | Judgement and Decision-Making | Time Management |

| Occupation | NOC | Hierarchy | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Electricians (except industrial and power system) | 7241 | Trades, transport and equipment operators and related occupations | Critical Thinking | Installation | Active Listening | Troubleshooting | Judgement and Decision-Making | Monitoring | Quality Control Analysis | Repairing | Active Learning | Speaking |
| Industrial Electricians | 7242 | Trades, transport and equipment operators and related occupations | Critical Thinking | Installation | Active Listening | Troubleshooting | Judgement and Decision-Making | Monitoring | Quality Control Analysis | Repairing | Active Learning | Speaking |
| Power Systems electricians | 7243 | Trades, transport and equipment operators and related occupations | Repairing | Critical Thinking | Troubleshooting | Quality Control Analysis | Operation Monitoring | Equipment Maintenance | Active Listening | Complex Problem Solving | Speaking | Reading Comprehension |
| Electrical power line and cable workers | 7244 | Trades, transport and equipment operators and related occupations | Monitoring | Critical Thinking | Active Listening | Management of Personnel Resources | Time Management | Coordination | Speaking | Judgement and Decision-Making | Quality Control Analysis | Operation Monitoring |
| Plumbers | 7251 | Trades, transport and equipment operators and related occupations | Critical Thinking | Active Listening | Operation Monitoring | Operation and Control | Quality Control Analysis | Coordination | Speaking | Reading Comprehension | Monitoring | Judgement and Decision-Making |
| Carpenters | 7271 | Trades, transport and equipment operators and related occupations | Active Listening | Monitoring | Speaking | Coordination | Critical Thinking | Judgement and Decision-Making | Reading Comprehension | Time Management | Operation Monitoring | Active Learning |
| Painters and decorators (except interior decorators) | 7294 | Trades, transport and equipment operators and related occupations | Active Listening | Coordination | Critical Thinking | Time Management | Monitoring | Judgement and Decision-Making | Social Perceptiveness | Speaking | Reading Comprehension | Complex Problem Solving |
| Construction Millwrights and Industrial Mechanics | 7311 | Trades, transport and equipment operators and related occupations | Operation Monitoring | Operation and Control | Critical Thinking | Equipment Maintenance | Quality Control Analysis | Repairing | Troubleshooting | Active Listening | Monitoring | Time Management |
| Heavy duty equipment mechanics | 7312 | Trades, transport and equipment operators and related occupations | Repairing | Equipment Maintenance | Troubleshooting | Operation Monitoring | Critical Thinking | Operation and Control | Quality Control Analysis | Monitoring | Active Listening | Judgement and Decision-Making |
| Automotive service technicians, truck and bus mechanics and mechanical repair | 7321 | Trades, transport and equipment operators and related occupations | Repairing | Troubleshooting | Critical Thinking | Active Listening | Operation Monitoring | Operation and Control | Speaking | Quality Control Analysis | Monitoring | Equipment Maintenance |

| Occupation | NOC | Hierarchy | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential and commercial installers and servicers | 7441 | Trades, transport and equipment operators and related occupations | Critical Thinking | Active Listening | Speaking | Monitoring | Time Management | Coordination | Judgement and Decision-Making | Reading Comprehension | Quality Control Analysis | Operation Monitoring |
| Waterworks and gas maintenance workers | 7442 | Trades, transport and equipment operators and related occupations | Critical Thinking | Active Listening | Operation Monitoring | Operation and Control | Quality Control Analysis | Coordination | Speaking | Reading Comprehension | Monitoring | Judgement and Decision-Making |
| Longshore Workers | 7451 | Trades, transport and equipment operators and related occupations | Critical Thinking | Coordination | Speaking | Monitoring | Active Listening | Time Management | Reading Comprehension | Management of Personnel Resources | Judgement and Decision-Making | Operation Monitoring |
| Material Handlers | 7452 | Trades, transport and equipment operators and related occupations | Monitoring | Active Listening | Coordination | Critical Thinking | Speaking | Reading Comprehension | Time Management | Judgement and Decision-Making | Social Perceptiveness | Operation and Control |
| Transport truck drivers | 7511 | Trades, transport and equipment operators and related occupations | Time Management | Speaking | Active Listening | Critical Thinking | Coordination | Reading Comprehension | Monitoring | Complex Problem Solving | Judgement and Decision-Making | Social Perceptiveness |
| Heavy Equipment Operators (except crane) | 7521 | Trades, transport and equipment operators and related occupations | Operation and Control | Operation Monitoring | Monitoring | Coordination | Critical Thinking | Active Listening | Judgement and Decision-Making | Troubleshooting | Speaking | Equipment Maintenance |
| Construction Trades Helpers and Labourers | 7611 | Trades, transport and equipment operators and related occupations | Operation Monitoring | Critical Thinking | Monitoring | Operation and Control | Active Listening | Coordination | Quality Control Analysis | Troubleshooting | Speaking | Judgement and Decision-Making |
| Other trades helpers and labourers | 7612 | Trades, transport and equipment operators and related occupations | Speaking | Active Listening | Service Orientation | Social Perceptiveness | Monitoring | Coordination | Critical Thinking | Reading Comprehension | Time Management | Judgement and Decision-Making |
| Supervisors, mining and quarrying | 8221 | Natural resources, agriculture and related production occupations | Coordination | Active Listening | Critical Thinking | Management of Personnel Resources | Time Management | Monitoring | Speaking | Reading Comprehension | Social Perceptiveness | Persuasion |
| Contractors and supervisors, oil and gas drilling and services | 8222 | Natural resources, agriculture and related production occupations | Coordination | Active Listening | Critical Thinking | Management of Personnel Resources | Time Management | Monitoring | Speaking | Reading Comprehension | Social Perceptiveness | Persuasion |
| Underground production and development miners | 8231 | Natural resources, agriculture and related production occupations | Operation Monitoring | Operation and Control | Critical Thinking | Monitoring | Active Listening | Judgement and Decision-Making | Speaking | Complex Problem Solving | Time Management | Coordination |

| Occupation | NOC | Hierarchy | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oil and gas well drillers, servicers, testers and related workers | 8232 | Natural resources, agriculture and related production occupations | Operation Monitoring | Operation and Control | Critical Thinking | Monitoring | Active Listening | Repairing | Speaking | Judgement and Decision-Making | Equipment Maintenance | Troubleshooting |
| xcUnderground mine service and support workers | 8411 | Natural resources, agriculture and related production occupations | Operation Monitoring | Monitoring | Equipment Maintenance | Repairing | Operation and Control | Troubleshooting | Critical Thinking | Quality Control Analysis | Active Listening | Complex Problem Solving |
| Oil and Gas well drilling and related workers and services operators | 8412 | Natural resources, agriculture and related production occupations | Operation Monitoring | Operation and Control | Critical Thinking | Monitoring | Active Listening | Repairing | Speaking | Judgement and Decision-Making | Equipment Maintenance | Troubleshooting |
| Mine Labourers | 8614 | Natural resources, agriculture and related production occupations | Operation Monitoring | Monitoring | Equipment Maintenance | Repairing | Operation and Control | Troubleshooting | Critical Thinking | Quality Control Analysis | Active Listening | Complex Problem Solving |
| Oil and gas drilling, servicing and related labourers | 8615 | Natural resources, agriculture and related production occupations | Operation Monitoring | Monitoring | Equipment Maintenance | Repairing | Operation and Control | Troubleshooting | Critical Thinking | Quality Control Analysis | Active Listening | Complex Problem Solving |
| Supervisors, mineral and metal processing | 9211 | Occupations in manufacturing and utilities | Speaking | Active Listening | Coordination | Critical Thinking | Management of personnel resources | Time Management | Reading Comprehension | Judgement and Decision-Making | Monitoring | Social Perceptiveness |
| Central Control and Process Operators, petroleum, gas and chemical processing | 9232 | Occupations in manufacturing and utilities | Operation Monitoring | Operation and Control | Monitoring | Critical Thinking | Quality Control Analysis | Active Listening | Reading Comprehension | Complex Problem Solving | Judgement and Decision-Making | Writing |
| Power Engineers and Power Systems Operators | 9241 | Occupations in manufacturing and utilities | Operation Monitoring | Critical Thinking | Active Listening | Monitoring | Operation and Control | Reading Comprehension | Speaking | Quality Control Analysis | Judgement and Decision-Making | Complex Problem Solving |
| Water and waste treatment plant operators | 9243 | Occupations in manufacturing and utilities | Operation Monitoring | Monitoring | Active Listening | Reading Comprehension | Critical Thinking | Speaking | Operation and Control | Quality Control Analysis | Coordination | Judgement and Decision-Making |
| Machine operators, mineral and metal processing | 9411 | Occupations in manufacturing and utilities | Operation Monitoring | Operation and Control | Monitoring | Critical Thinking | Active Listening | Quality Control Analysis | Speaking | Time Management | Judgement and Decision-Making | Reading Comprehension |
| Foundry workers | 9412 | Occupations in manufacturing and utilities | Monitoring | Operation Monitoring | Active Listening | Critical Thinking | Time Management | Judgement and Decision-Making | Operation and Control | Speaking | Quality Control Analysis | Complex Problem Solving |
| Metalworking and forging machine operators | 9416 | Occupations in manufacturing and utilities | Operation Monitoring | Operation and Control | Monitoring | Active Listening | Critical Thinking | Reading Comprehension | Speaking | Quality Control Analysis | Time Management | Judgement and Decision-Making |
| Other metal products machine operators | 9418 | Occupations in manufacturing and utilities | Operation Monitoring | Quality Control Analysis | Operation and Control | Monitoring | Critical Thinking | Active Listening | Reading Comprehension | Speaking | Judgement and Decision-Making | Complex Problem Solving |
| Industrial painters, coaters and metal finishing process operators | 9536 | Occupations in manufacturing and utilities | Operation Monitoring | Quality Control Analysis | Monitoring | Operation and Control | Critical Thinking | Time Management | Active Listening | Speaking | Coordination | Judgement and Decision-Making |
| Other product assemblers, finishers and inspectors | 9537 | Occupations in manufacturing and utilities | Active Listening | Speaking | Critical Thinking | Monitoring | Quality Control Analysis | Judgement and Decision-Making | Reading Comprehension | Time Management | Operation Monitoring | Coordination |

| Occupation | NOC | Hierarchy | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Labourers in mineral and metal processing | 9611 | Occupations in manufacturing and utilities | Operation Monitoring | Monitoring | Active Listening | Operation and Control | Speaking | Critical Thinking | Reading Comprehension | Coordination | Quality Control Analysis | Social Perceptiveness |
| Labourers in metal fabrication | 9612 | Occupations in manufacturing and utilities | Operation Monitoring | Operation and Control | Quality Control Analysis | Critical Thinking | Monitoring | Active Listening | Reading Comprehension | Speaking | Equipment Maintenance | Troubleshooting |
| Labourers in chemical products processing and utilities | 9613 | Occupations in manufacturing and utilities | Operation Monitoring | Monitoring | Active Listening | Operation and Control | Speaking | Critical Thinking | Reading Comprehension | Coordination | Quality Control Analysis | Social Perceptiveness |
| Other labourers in processing, manufacturing and utilities | 9619 | Occupations in manufacturing and utilities | Operation Monitoring | Operation and Control | Monitoring | Active Listening | Coordination | Critical Thinking | Speaking | Reading Comprehension | Social Perceptiveness | Time Management |

# APPENDIX 3: Frequency and Importance Rankings by NOC

***Management Jobs (NOC codes starting with 0)***

| Skill | Occurrence | Rank |
|---|---|---|
| Critical Thinking | 4 | 1 |
| Critical Thinking | 4 | 2 |
| Active Listening | 3 | 3 |
| Monitoring | 3 | 4 |
| Active Listening | 2 | 5* |
| Coordination | 2 | 5 |
| Judgement and Decision-Making | 3 | 6 |
| Complex Problem Solving | 2 | 7 |
| Time Management | 2 | 7 |
| Writing | 2 | 7 |
| Complex Problem Solving | 4 | 8 |
| Coordination | 2 | 9 |
| Management of Personnel Resources | 2 | 9 |
| Time Management | 2 | 9 |
| Time Management | 3 | 10 |

* Some skills were equally important

***Business, Finance and Administration Occupations (NOC codes starting with 1)***

| Skills | Occurrence | Rank |
|---|---|---|
| Speaking | 1 | 1 |
| Active Listening | 1 | 2 |
| Reading Comprehension | 1 | 3 |
| Monitoring | 1 | 4 |
| Coordination | 1 | 5 |
| Critical Thinking | 1 | 6 |
| Social Perceptiveness | 1 | 7 |
| Judgement and Decision-Making | 1 | 8 |
| Time Management | 1 | 9 |
| Writing | 1 | 10 |

### *Natural and Applied Sciences and Related Occupations (NOC codes starting with 2)*

| Skills | Occurrence | Rank |
|---|---|---|
| Critical Thinking | 6 | 1 |
| Reading Comprehension | 6 | 2 |
| Active Listening | 5 | 3 |
| Complex Problem Solving | 5 | 4 |
| Speaking | 4 | 5 |
| Writing | 4 | 6 |
| Judgement and Decision-Making | 5 | 7 |
| Monitoring | 2 | 8 |
| Numeracy | 2 | 8 |
| Science | 2 | 8 |
| Active Learning | 3 | 9 |
| Numeracy | 3 | 10 |
| Systems Analysis | 3 | 10 |

### *Trades, Transport and Equipment Operators and Related Occupations (NOC codes starting with 7)*

| Skills | Occurrence | Rank |
|---|---|---|
| Critical Thinking | 8 | 1 |
| Active Listening | 6 | 2 |
| Critical Thinking | 6 | 2 |
| Active Listening | 5 | 3 |
| Monitoring | 4 | 4 |
| Operation and Control | 4 | 4 |
| Active Listening | 4 | 5 |
| Critical Thinking | 4 | 5 |
| Coordination | 6 | 6 |
| Speaking | 7 | 7 |
| Reading Comprehension | 8 | 8 |
| Judgement and Decision-Making | 6 | 9 |
| Judgement and Decision-Making | 6 | 10 |

### *Natural Resources, Agriculture and Related Production Occupations (NOC codes starting with 8)*

| Skills | Occurrence | Rank |
|---|---|---|
| Operation Monitoring | 6 | 1 |
| Monitoring | 3 | 2 |
| Operation and Control | 3 | 2 |
| Critical Thinking | 5 | 3 |
| Monitoring | 3 | 4 |
| Repairing | 3 | 4 |
| Active Listening | 3 | 5 |
| Operation and Control | 3 | 5 |
| Troubleshooting | 3 | 6 |
| Speaking | 5 | 7 |
| Quality Control Analysis | 3 | 8 |
| Active Listening | 3 | 9 |
| Complex Problem Solving | 3 | 10 |

### *Occupations in Manufacturing and Utilities (NOC codes starting with 9)*

| Skills | Occurrence | Rank |
|---|---|---|
| Operation Monitoring | 11 | 1 |
| Operation and Control | 5 | 2 |
| Active Listening | 5 | 3 |
| Monitoring | 5 | 3 |
| Critical Thinking | 5 | 4 |
| Critical Thinking | 4 | 5 |
| Active Listening | 3 | 6 |
| Critical Thinking | 3 | 7 |
| Reading Comprehension | 7 | 8 |
| Speaking | 4 | 9 |
| Judgement and Decision-Making | 4 | 9 |
| Complex Problem Solving | 3 | 10 |
| Judgement and Decision-Making | 3 | 10 |
| Social Perceptiveness | 3 | 10 |

# APPENDIX 4: International Measures and Responses to COVID-19

The table in this appendix was adapted from University of Cambridge (2020). The entries are edited to provide examples beyond initiatives that British Columbia and Canada already have underway, to provide additional examples of responses that were offered in other countries. The aim is to provide a non-exhaustive list of examples that British Columbia or Canada could undertake to mitigate impacts to the COVID-19 for manufacturing SME's. Website links are provided for English-speaking countries.

| Country | Ensuring continuing operation of manufacturing businesses | Supporting post-crisis manufacturing growth |
|---|---|---|
| Australia | Financial incentive for AUD$17.6 billon including:<br>- SME support for salary payments (50% covered by the government over six months)<br>- SME Guarantee Scheme<br>Creation of the Coronavirus Business Liaison Unit<br>Advice for business continuity<br>Deferral of energy bills<br>Fiscal and balance sheet support for AUD$259 billon<br>Guidelines for workplaces (epidemic prevention and remote work) by industry and toolkits "to help business get back to work safely"<br>Subsidized infection control training for re-opening businesses | Subsidy of 50% of apprentice wages for up to 9 months<br>Time-limited 15-month incentive to invest by accelerating depreciation deductions<br>Increased threshold for tax deduction for capital investment<br>Technology Investment Roadmap to drive investment in low emissions technologies<br>Support for transforming and upgrading manufacturing operations for 200 projects worth $215 million through the Manufacturing Modernization Fund |
| China | Legal aid, consultation on business solutions and training on management technology for SMEs | Reduction of cargo port fees by 20%<br>Simplification of logistics procedures |

| Country | Ensuring continuing operation of manufacturing businesses | Supporting post-crisis manufacturing growth |
|---|---|---|
| European Commission | EC's Coordinate Response Instruments<br>- €65 billion for the Coronavirus Response Investment Initiative under European Structural Investment Fund<br>- €800 million in financial assistance through EU Solidarity Fund<br>- €1 billion guarantee to the European Investment Fund (EIF) mobilizing €8 billion for at least 100,000 SMEs (EIB Group)<br>- Credit holidays<br>- Flexibilities o state aid, liquidity to the banking sector, European fiscal framework<br>- Ensuring solidarity of the single market<br>Temporary framework to use full flexibility under state aid.<br>EIB Group proposes to mobilize up to €40 billion to fight crisis<br>€25 billion EIB Group Pan-European Guarantee Fund, which could support €200 billion of financing of companies<br>Coronavirus Response Investment Initiative Plus (CRII+) flexibility to mobilize non utilized ESIF<br>REACT-EU €55 billion of additional cohesion policy funding – Recovery Plan<br>€240 billion ESM Pandemic Crisis Support<br>€100 billion SURE Intitiative | Fiscal framework's general escape clause activated<br>New practical advice: continuous flow of goods across the EU, continuous operation of EU-wide supply chains<br>A strong EU-wide approach to foreign investment screening<br>An advisory panel on COVID-19 set up<br>€750 billion ECB Pandemic Emergency Purchase Program (PEPP)<br>COVID-19 Industrial Clusters Response Portal supports industrial clusters to address the challenges of the pandemic<br>A banking package to facilitate bank lending<br>Ensure supply chains remain intact via EU Global Response Package<br>Coronavirus Global Response<br>€2.4 trillion Recovery Plan for Europe; proposal of new recovery instrument, Next Generation EU and EC adjusted Work Programme 2020 |

| Country | Ensuring continuing operation of manufacturing businesses | Supporting post-crisis manufacturing growth |
|---|---|---|
| France | €300 billion for loan guarantees<br><br>€1,500 grants for all small businesses and the self-employed<br><br>Credit mediation (support to negotiate bank credits)<br><br>Suspension of penalties for delays in government contracts<br><br>Possibility of deferring social security contributions<br><br>Further relaxation of rules of the Solidarity Fund (€1,500 grants) | |
| Germany | Emergency aid: €50 billion for non-refundable grants for small businesses and the self employed<br><br>KfW Special Programme 2020 to cover short-term liquidity requirements of companies (including):<br>- ERP Start-Up Loan Universal<br>- KfW Entrepreneur Loan<br>- Direct Investing for Syndicated Financing<br><br>Short-term work benefits<br><br>The guarantees for securing loans to companies expanded in accordance with "Federal Guarantee 2020 Regulation"<br><br>Financial support to SMEs creating home-office working models<br><br>Short-term work benefits increased<br><br>KfW loans relaxed and conditions improved<br><br>€600 billion Economic Stabilization Fund of Federal Government<br><br>Funding up to €4,000 consulting costs without own contribution for SMEs and freelancers<br><br>€7.5 billion for social security | Extended possibilities for export credit guarantees<br><br>Export credit guarantees: state support in the private supplier credit insurance market<br><br>Federal contact point for securing supply chains<br><br>WG for measures to stimulate the economy<br><br>€130 billion Economic Stimulus Package |



| Country | Ensuring continuing operation of manufacturing businesses | Supporting post-crisis manufacturing growth |
|---|---|---|
| India | Financial regulatory package, including: three-month deferral of loan payments and easing of working capital financing<br><br>Loans for SMEs of up to Rs 50 lakh at 5% interest rate within 48 hours<br><br>Business Continuity Planning Toolkit and Webinar to contribute to SMEs resilience<br><br>Deferral of loan payments | |
| Ireland | Financial support for working capital, including:<br>- Credit Guarantee Scheme (up to €1 million)<br>- Microfinance Ireland (up to €50,000)<br>- SBCI COVID-19 Working Capital Scheme (€25,000 – €1.5 million)<br>- €200 million package for enterprise supports, including a rescue and restricting scheme<br>- COVID-19 wage subsidy scheme<br>- Sustaining Enterprise Fund (up to €800,000)<br>- COVID-19 Business Financial Planning Grant (up to €5,000 for external support from approved financial consultants to prepare a financial plan to secure the company in the short to medium term)<br>- Online database that allows the identification of spare capacity among logistics firms | Lean Business Continuity Voucher: up to €2,500 in training or advisory services support for crisis response, sustaining operations, including process re-engineering and planning for resilience post-crisis<br><br>COVID-19 Act on Support, providing access to two days consultancy engagement at no extra cost to asses financial management, strategic sourcing and transport and logistics advice.<br><br>eiLearn Online Learning Platform: over 450 pieces of customized content designed for Irish SMEs<br><br>Provision of information on existing support for market diversification |

| Country | Ensuring continuing operation of manufacturing businesses | Supporting post-crisis manufacturing growth |
|---|---|---|
| Italy | Government guaranteed loans to SMEs<br><br>Appointment of a special commissioner to manage the economic crisis | The Guarantee Fund for SMEs was strengthened to guarantee up to €100 billion on loans<br><br>€200 billion financial guarantee on loans to support exports<br><br>€55 billion to support businesses and families during the post-COVID-19 phase:<br>- €6 billion grant to businesses;<br>- €4 billion additional to the Guarantee Fund for SMEs;<br>- Industry 4.0: Extension of deadline to benefit the super-depreciation; |
| Japan | Emergency financing guarantee schemes for SMEs, up to ¥280 million<br><br>Over 1,000 consultation desks for SMEs affected, or likely to be affected, by the epidemic across the country<br><br>Emergency financing guarantee scheme for SMEs is extended to 738 from the original 40 designated industries<br><br>Subsidy for SMEs that suffer from decline in sales (up to ¥2 million for a corporation and ¥1 million for a sole proprietorship, and subsidy for preventive measures introduced as business resumes | Provision of overseas operations and market information<br><br>Priority access to subsidies for capital investment, sales channel development and the introduction of ICT tools<br><br>Subsidy of up over ¥240 billion to encourage firms to reshore their production and diversify their production bases in ASEAN<br><br>Subsidy that covers up to 75% of costs incurred by SMEs to repair damaged supply chains, shift to non-face-to-face business models, and invest in telework environment |
| New Zealand | NZ$2.8 billon business tax changes to free up cash flow: depreciation deduction; immediate deductions for low-value assets; fewer small businesses having to pay provisional tax.<br><br>Wage NZ$3.2 billon additional funding for wage subsidies<br><br>Wage Subsidy Extension to support employers who are still significantly impacted by Covid-19 after the Wage Subsidy ends<br><br>NZ$6.25 billon business finance guarantee scheme for SMEs. | NZ$50 billion Covid-19 Response and Recovery Fund (CRRF). Selected economic measures include:<br>- NZ$216 million to New Zealand Trade and Enterprise (NZTE) to support exports;<br>- NZ$10 million fund to incentive e-commerce in SMEs |



| Country | Ensuring continuing operation of manufacturing businesses | Supporting post-crisis manufacturing growth |
|---|---|---|
| Singapore | SG$4.0 billion Stabilisation and Support Package, including support for cash flow, retention and retraining of workers, and wage increases<br><br>Guide on business continuity planning for enterprises, especially SMEs.<br><br>Low-interest loan facility to financial institutions and temporary bridging loan programme to alleviate SMEs' immediate cash flow needs | SG Together Enhancing Enterprise Resilience (STEER) Programme – matching funds for industry-led activities supporting business growth and capability upgrading.<br><br>Under SG Together Enhancing Enterprise Resilience (STEER) programme, the government will match S$1 for every S$2 raised by industry-led initiatives (previously S$4)<br><br>Higher loan amounts and more flexible repayment terms for financing schemes that address the long-term growth needs of business<br><br>Funding support of up S$100,000 for business that expands internationally for the first time, with 200% tax deduction on expenses for eligible activities.<br><br>Information on business support measures in overseas markets that are offered by the respective governments, for reference of Singaporean business with international footprint. |
| South Korea | Guidelines for epidemic prevention and business continuity.<br><br>Financial/fiscal support for over £13.7billion, including:<br>- Income tax break to landlords (50%).<br>- VAT breaks to firms earning <60 million won/year.<br><br>Comprehensive economic policy package, which includes financial/fiscal support, increased to 349 trillion won (~£230bn)<br><br>Measures totaling 51.6 trillion won, including low-interest loans for small enterprises and preferential lending to leading SMEs, to provide liquidity to businesses<br><br>Support package totaling 41.8 trillion won, including the purchase of commercial bonds and investment in index funds, to stabilise financial markets | Tax cuts and financial aid of 4.5 trillion won, plus onsite support and advisory services, under GVCs Innovation Strategy to target reshoring of 100 Korean firms by 2022 |

| Country | Ensuring continuing operation of manufacturing businesses | Supporting post-crisis manufacturing growth |
|---|---|---|
| Taiwan | Increase or decrease custom duties (up to 1 year) to guarantee the supply of raw materials and intermediate goods<br><br>Deferral of tax payments (up to 12 months) and monthly installments (up to 36 months); and tax refunds of overpayments. | Training subsidies for industrial upgrading, up to 32 hours per employee;<br><br>Export promotion, including e-commerce |
| United States | US$2 trillion stimulus package (Coronavirus Aid, Relief, and Economy Security Act – CARES Act) will provide US$500 billion in loans to large companies, states and cities, and US$350 billion in aid to small businesses. It will also provide direct payments to most Americans and bolster unemployment insurance benefits.<br><br>Coronavirus Preparedness and Response Supplemental Appropriations Act: US$8.3 billion in emergency appropriations, including US$1 billion to provide low-interest loans of up to US$2 million.<br><br>Families First Coronavirus Response Act: US$3.4 billion package, including provisions for unemployment benefits, paid sick leave, medical leave and free testing.<br><br>US$483 billion Paycheck Protection Program and Health Care Enhancement Act (part of the CARES act), including US$321 billion for additional forgivable Small Business Administration loans and guarantees to help small businesses that retain workers;<br><br>US$62 billion for the Small Business Administration to provide grants and loans to assist small businesses; US$75 billion for hospitals; and US$25 billion for expanding virus testing. | Export-Import Bank supports the US exporting community: extended relief provisions for exporters and financial institutions.<br><br>NIST Manufacturing USA National Emergency Assistance Program: invites Manufacturing USA institutes to propose high-impact projects designed to respond to the COVID-19 pandemic. NIST anticipates funding individual projects at a level of approximately $250,000–$10 million that will have a performance period of 12–18 months. |

# APPENDIX 5: Computerization Ranking

| Manufacturing Occupation | NOC | Rank | Min | Max |
|---|---|---|---|---|
| Underground mine service and support workers | 8411 | NONE* | 0.000 | 0.000 |
| Other product assemblers, finishers and inspectors | 9537 | 0.980 | 0.000 | 0.000 |
| Supervisors, mining and quarrying | 8221 | 0.920 | 0.000 | 0.000 |
| Industrial painters, coaters and metal finishing process operators | 9536 | 0.915 | 0.910 | 0.920 |
| Heavy Equipment Operators (except crane) | 7521 | 0.910 | 0.830 | 0.950 |
| Other metal products machine operators | 9418 | 0.910 | 0.000 | 0.000 |
| Oil and Gas well drilling and related workers and services operators | 8412 | 0.857 | 0.800 | 0.930 |
| Material Handlers | 7452 | 0.856 | 0.720 | 0.930 |
| Power Engineers and Power Systems Operators | 9241 | 0.833 | 0.640 | 0.950 |
| Central Control and Process Operators, petroleum, gas and chemical processing | 9232 | 0.822 | 0.710 | 0.910 |
| Sheet metal workers | 7233 | 0.820 | 0.000 | 0.000 |
| Foundry workers | 9412 | 0.820 | 0.670 | 0.950 |
| Machinists and Machining and Tooling Inspectors | 7231 | 0.815 | 0.650 | 0.980 |
| Painters and decorators (except interior decorators) | 7294 | 0.810 | 0.750 | 0.870 |
| Machine operators, mineral and metal processing | 9411 | 0.795 | 0.370 | 0.910 |
| Transport truck drivers | 7511 | 0.790 | 0.000 | 0.000 |
| Welders and Related Machine Operators | 7237 | 0.775 | 0.610 | 0.940 |
| Construction Trades Helpers and Labourers | 7611 | 0.761 | 0.490 | 0.940 |
| Water and waste treatment plant operators | 9243 | 0.755 | 0.610 | 0.900 |
| Metalworking and forging machine operators | 9416 | 0.737 | 0.500 | 0.930 |
| Managers in Transportation | 0731 | 0.730 | 0.870 | 0.590 |
| Structural metal and platework fabricators and fitters | 7235 | 0.730 | 0.410 | 0.840 |
| Other labourers in processing, manufacturing and utilities | 9619 | 0.723 | 0.380 | 0.930 |
| Carpenters | 7271 | 0.720 | 0.000 | 0.000 |
| Electrical and Electronics engineering technologists and technicians | 2241 | 0.708 | 0.270 | 0.910 |
| Residential and commercial installers and servicers | 7441 | 0.703 | 0.180 | 0.920 |
| Oil and gas well drillers, servicers, testers and related workers | 8232 | 0.680 | 0.000 | 0.000 |
| Oil and gas drilling, servicing and related labourers | 8615 | 0.680 | 0.000 | 0.000 |
| Automotive service technicians, truck and bus mechanics and mechanical repair | 7321 | 0.660 | 0.590 | 0.730 |
| Industrial Electricians | 7242 | 0.655 | 0.410 | 0.900 |
| Construction Millwrights and Industrial Mechanics | 7311 | 0.630 | 0.590 | 0.670 |
| Other trades helpers and labourers | 7612 | 0.593 | 0.170 | 0.860 |
| Facility Operation and Maintenance Managers | 0714 | 0.590 | 0.000 | 0.000 |
| Heavy duty equipment mechanics | 7312 | 0.575 | 0.400 | 0.750 |
| Underground production and development miners | 8231 | 0.510 | 0.490 | 0.540 |

| Manufacturing Occupation | NOC | Rank | Min | Max |
|---|---|---|---|---|
| Longshore Workers | 7451 | 0.490 | 0.000 | 0.000 |
| Contractors and supervisors, machining, metal forming, shaping and erecting trades and related occupations | 7201 | 0.475 | 0.030 | 0.920 |
| Contractors and supervisors, other construction trades, installers, repairers and services | 7205 | 0.462 | 0.003 | 0.920 |
| Waterworks and gas maintenance workers | 7442 | 0.400 | 0.170 | 0.630 |
| Power Systems electricians | 7243 | 0.380 | 0.000 | 0.000 |
| Mine Labourers | 8614 | 0.370 | 0.000 | 0.000 |
| Labourers in mineral and metal processing | 9611 | 0.362 | 0.003 | 0.720 |
| Labourers in metal fabrication | 9612 | 0.362 | 0.003 | 0.720 |
| Labourers in chemical products processing and utilities | 9613 | 0.362 | 0.003 | 0.720 |
| Plumbers | 7251 | 0.350 | 0.000 | 0.000 |
| Contractors and supervisors, oil and gas drilling and services | 8222 | 0.170 | 0.000 | 0.000 |
| Petroleum engineers | 2145 | 0.160 | 0.000 | 0.000 |
| Electricians (except industrial and power system) | 7241 | 0.150 | 0.000 | 0.000 |
| Mining engineers | 2143 | 0.140 | 0.000 | 0.000 |
| Supervisors, supply chain, tracking and scheduling coordination occupations | 1215 | 0.132 | 0.014 | 0.420 |
| Information Systems analysts and consultants | 2171 | 0.108 | 0.007 | 0.210 |
| Electrical power line and cable workers | 7244 | 0.097 | 0.000 | 0.000 |
| Utilities Managers | 0912 | 0.087 | 0.014 | 0.160 |
| Construction Managers | 0711 | 0.071 | 0.000 | 0.000 |
| Electrical and Electronics Engineers | 2133 | 0.063 | 0.025 | 0.100 |
| Mechanical Engineers | 2132 | 0.041 | 0.070 | 0.011 |
| Computer and information systems managers | 0213 | 0.035 | 0.000 | 0.000 |
| Industrial and Manufacturing Engineers | 2141 | 0.028 | 0.028 | 0.029 |
| Chemical Engineers | 2134 | 0.027 | 0.017 | 0.037 |
| Manufacturing Managers | 0911 | 0.021 | 0.012 | 0.030 |
| Civil Engineers | 2131 | 0.018 | 0.018 | 0.019 |
| Engineering Managers | 0211 | 0.017 | 0.000 | 0.000 |
| Supervisors, mineral and metal processing | 9211 | 0.016 | 0.000 | 0.000 |
| Senior Managers - construction, transportation, production and utilities | 0016 | 0.015 | 0.000 | 0.000 |

* NONE signifies that a comparable NOC code was not available for this job and therefore no rank could be assigned.

Grey cells indicate jobs with a rank score of less than 0.5, meaning these jobs have lower likelihood of becoming computerized.