Automation Risk in the Labor Market

A Workforce Analysis of the Far North Subregion

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North Far North Center of Excellence for Labor Market Research



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Executive Summary

The "2024 Automation Risk in the Labor Market Report" prepared by the North Far North Center of Excellence provides data analysis on the potential impact of automation, a term which encompasses advances in robotics, machine learning, and artificial intelligence (Al), on the Far North subregion's workforce through several different lenses: pay level, required education, gender, race and ethnicity, and industry. Additionally, this report expands upon the "Automation Risk for Jobs in the Capital Region Report" published in 2020 by the North Far North Center of Excellence. Due to the time that has elapsed between the two studies and the fact that this study utilizes a slightly different approach than the 2020 report, some of its key findings differ, as do some of the recommendations informed by those findings.

An occupational analysis was conducted to identify minimal-risk and high-risk jobs in the 10 sectors designated by the California Community Colleges Chancellor's Office that are also deemed critical to the subregion's overall economy. The occupations at minimal risk of automation identified in each of the sectors provide a roadmap for community colleges as they create and expand pathways leading to careers that are more resilient and adaptive to the impacts of automation. Important data insights are highlighted below with further details included in the body of this report.



Jobs Of the more than 359,000 jobs in the Far North labor market, 42% have high or above-average automation risk.

Wages Higher-wage jobs have less automation risk. Minimal-risk jobs pay an average entrylevel wage of \$32.82/hour while high-risk jobs pay substantially less, \$17.28/hour.

Education High automation-risk jobs have lower educational needs than minimal-risk jobs, most of which require a bachelor's degree or higher.

Gender Among high-risk jobs, male workers make up a greater percentage, 65% of the workforce, compared to female workers, 35%.

Industries More than 157,000 jobs are concentrated in industries with an above-average automation risk.

Automation Impact by the Numbers ⁻

Introduction

In the 1990s, the adoption of desktop computers was heralded as a transformative innovation that would forever change the workforce. These days automation involving generative artificial intelligence (AI), robotics, and other forms of advanced technology are reshaping every sector of the economy and eliminating process-oriented, repetitive, and physically demanding tasks in nearly every aspect of the workforce, from the production line to the supply chain and back office.¹

In recent years, technology companies have been striving to integrate AI with automation/robotics to augment and assist human labor in the workforce. In 2023, this work was greatly advanced by the rollout of generative AI, specifically tools such as ChatGPT and Gemini (formerly Google Bard), which are a form of machine learning that incorporates large language models (LLMs) to create new content and data that is promptly available, complex, based on a sizable amount of information, and offers a wide range of applications.²

Generative AI has garnered significant attention due to growing concerns about its potential to uproot traditional roles in the workforce. One theory is that occupations that rely on knowledge-specific work, such as software developers and marketing professionals,³ and occupations that rely on creative work,⁴ may be most susceptible to disruption. As the adoption of generative AI has widened, McKinsey reported that cognitive and social-emotional skills are being rated as more highly valued than technological skills.⁵

With the speed that these advancements have been introduced, the concern about the potential for job displacement at all levels of the workforce has emerged among policy, education, and industry stakeholders. To understand the potential impact of automation and AI (which includes many forms of advanced technology, such as robotics and data mining) on the Far North subregion's workforce, the following analysis was conducted. This report aims to help community college leaders make decisions about areas of investment, skills training areas, and career pathways to equip students with resiliency in the face of many technological changes. The analysis in this report can guide decision makers as they consider the following questions:

- * How is automation changing the workforce landscape?
- * How can community colleges adapt training programs to keep pace with this transformation?
- * How can colleges direct students toward careers that are resilient to automation?
- What risks and opportunities will career education (CE) programs face as these changes take hold in the workforce?

¹ "Jobs of Tomorrow: Large Language Models and Jobs," World Economic Forum, Jobs of Tomorrow Series, September 2023, accessed April 9, 2024, https://www3.weforum.org/docs/WEF_Jobs_of_Tomorrow_Generative_Al_2023.pdf.

² Adam Zewe. "Explained: Generative AI," MIT News, November 9, 2023, <u>https://news.mit.edu/2023/explained-generative-ai-1109</u>.

³ McKinsey & Company, "The Economic Potential of Generative Al: The Next Productivity Frontier," *McKinsey Digital Insights*, July 14, 2023, accessed April 9, 2024, <u>https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier#key-insights</u>.

⁴ David De Cremer, Nicola Morini Bianzino, and Ben Falk, "How Generative AI Could Disrupt Creative Work," *Harvard Business Review*, April 13, 2023, accessed April 13, 2023, <u>https://hbr.org/2023/04/how-generative-ai-could-disrupt-creative-work</u>.

⁵ McKinsey & Company, "The State of Al in 2023: Generative Al's Breakout Year," McKinsey Digital Insights, August 1, 2023, accessed April 9, 2024, https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai-in-2023-generative-ais-breakout-year.

Defining automation risk

More than a decade ago, researchers Carl Benedikt Frey and Michael Osborne anticipated the extensive changes the labor market might undergo with breakthroughs in automation. In response to concerns about unemployment resulting from these advancements, Frey and Osborne developed a methodology that can be applied to assessing the impact of computerization (machine learning and mobile robotics) on occupations in the labor market.

By analyzing fields related to mobile robotics and machine learning, including data mining, machine vision, computational statistics and other sub-fields of artificial intelligence, the methodology was first used by Frey and Osborne in 2013 to estimate that 47% of U.S. jobs could be replaced by automation in just 20 years.⁶ This methodology is still in use today, and this study utilizes Lightcast's adaptation of Frey and Osborne's "Automation Risk Index."⁷ While much attention has been directed toward job loss resulting from automation, an important caveat noted by Frey and Osborne is that certain skills are not easy for Al and robotics to carry out. These skills represent opportunity areas in preparing students to thrive in an evolving labor market: social intelligence, creativity, and perception and manipulation.⁸

Automation risk analysis

This report presents an analysis of the Far North subregion which comprises 15-counties: Butte, Colusa, Del Norte, Glenn, Humboldt, Lake, Lassen, Mendocino, Modoc, Plumas, Shasta, Sierra, Siskiyou, Tehama, and Trinity.

Automation risk is analyzed in terms of the overall workforce in the Far North subregion and by educational attainment, gender, and race and ethnicity. In addition, an analysis of industries employing the greatest concentration of high-risk jobs was conducted. Lastly, the most and least at-risk jobs were identified for each of the 10 sectors designated by the California Community Colleges Chancellor's Office. Using Lightcast's Automation Risk Index,⁹ which has an average score of 100, the following categories were developed to measure the automation risk of occupations in the labor market:



⁶ Carl Benedikt Frey and Michael A. Osborne, "The Future of Employment: How Susceptible Are Jobs to Computerisation?" Oxford Martin Programme on Technology and Employment, September 17, 2013, accessed June 26, 2024, <u>https://oms-www.files.svdcdn.com/production/downloads/academic/future-of-employment.pdf</u>.

<u>of-employment.pdf</u>. ⁷ "Automation Index Methodology," Lightcast, Accessed September 1, 2024, <u>https://kb.lightcast.io/en/articles/6957638-automation-index-methodology</u>. ⁸ Ibid.

⁹ Appendix A contains information on the automation index methodology. Appendix B contains the top 50 occupations selected for this study's occupational risk assessment. Appendix C contains the list of occupations that were excluded from the analysis due to low employment (10 or fewer jobs), or that were missing an Automation Index Score.

Overall Automation Risk

There were about 360,000 jobs in the Far North subregion in 2020, excluding occupations with fewer than 10 jobs and occupations without an assigned Automation Index Score.¹⁰

Based on the definition of automation:

- 57% were at below-average or minimal risk of automation,
- 44% were at high or above-average risk for automation,
- And 1% were average risk (Exhibit 1).

KEY FINDING

Only 1% of jobs are at average risk of automation. The majority of jobs fall within two main categories: belowaverage and minimal risk (57%), and above-average and high risk (44%).



Exhibit 1. Automation risk for jobs in the Far North, 2020

¹⁰ These occupations included: Legislators; Military-only occupations; and Unclassified Occupation. For the 102 occupations that were excluded, the total number of jobs were 1,204 jobs in 2020. See Appendix C for the detailed list of excluded occupations.

Automation Risk By Wage Level

The jobs at high risk of displacement due to automation tend to pay less, on average, when compared to the wages of the jobs with a minimal risk of automation. For jobs with above-average automation risk, workers earn entry-level wages of \$19.18 per hour, whereas workers in high-risk jobs earn entry-level wages of \$17.28 per hour (Exhibit 2). As the risk of automation decreases, wages tend to increase: average entry-level wages for workers in below-average automation risk jobs pay \$9.54 more per hour than high-risk jobs, and jobs with minimal risk pay \$15.54 more per hour.

KEY FINDING

Low paid jobs are most at risk of automation.

Exhibit 2. Automation risk by wage level in the Far North, 2020

Automation Risk	Average Entry-level Wage	Average Median Wage	Average Experienced Wage
High Risk	\$17.28	\$21.17	\$26.38
Above-Average Risk	\$19.18	\$23.65	\$30.39
Below-Average Risk	\$26.82	\$35.11	\$46.09
Minimal Risk	\$32.82	\$45.43	\$61.07
Overall Average	\$24.03	\$31.34	\$40.98



Automation Risk By Education Level

To understand the relationship between automation and education in the Far North subregion, it is important to understand how jobs are concentrated in terms of educational requirements. Across the subregion, 13% require less than a high school diploma, 41% require a high school diploma or equivalent, 13% require some college or an associate degree, and 33% require a bachelor's degree or higher.

KEY FINDING

Jobs requiring lower levels of education are most at risk of automation.

Among workers in the Far North subregion, jobs with the highest automation risk are those that require the lowest levels of education, i.e., a high school diploma or equivalent or less, 99%, compared to 81% of jobs with an above-average automation risk (Exhibit 3). For below-average automation risk jobs, only 3% require less than a high school diploma or equivalent, while 63% require some college up to a bachelor's degree or higher.

For jobs with minimal risk, the majority of jobs require a bachelor's degree or higher, 89%, and none require less than a high school diploma. These findings suggest that level of education is an important factor when assessing automation risk since jobs with a high automation risk have lower educational requirements than jobs with minimal automation risk.





Less than a High School Diploma High School Diploma or Equivalent Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Automation Risk By Gender

There are some gender differences when assessing the automation risk of jobs in the Far North. Occupations with a high risk of automation in the subregion disproportionately employ male workers, 65%, compared to female workers, 35% (Exhibit 4). Several occupations that are at high risk of automation and employ a greater proportion of male workers than female workers are in the construction industry. Examples include:

KEY FINDING

Jobs that traditionally employ male workers at more at risk of automation.

- Construction laborers Of 3,530 jobs, men account for 96% of workers compared to 4% who were women.
- Carpenters Of 3,380 jobs, men account for 98% of workers compared to 2% who were women.
- Landscaping and groundskeeping workers Of 4,334 jobs, men account for 91% of workers compared to 9% who were women.
- Operating engineers and other construction equipment operators Of 1,528 jobs, men account for 96% of workers compared to 4% who were women.



Exhibit 4. Automation risk by gender in the Far North

■ Share of Female Workers ■ Share of Male Workers

Automation Risk By Race And Ethnicity

In the Far North subregion, certain race and ethnicity groups are more concentrated in jobs that are more at risk of automation. Across all race and ethnicity groups, 20% of workers are employed in high-risk occupations (based on occupations for which race and ethnicity data is available). While all race and ethnicity groups share similarities in the proportion of workers in jobs that have above-average risk of automation (20% to 26%), there are greater differences between particular groups employed in high-risk automation jobs (12% to 27%) (Exhibit 5).

KEY FINDING

Several race and ethnicity groups are concentrated in jobs more at risk.

For instance, the highest proportion of workers that are employed in high-risk occupations are workers who identify as Hispanic or Latino; American Indian or Alaskan Native; and Native Hawaiian or Pacific Islander.¹¹ In contrast, Black and Asian workers have the lowest proportion of workers in these jobs. In terms of representation within occupations that have minimal automation risk, Asian workers, 17%, and workers who are two or more races, 15%, have the highest percentages.



Exhibit 5. Automation risk by race and ethnicity in the Far North¹²

¹¹ Lightcast utilizes data collected by the U.S. Census Bureau through the American Community Survey and data from the California Economic Development Department. The race and ethnicity terms in this section adhere to the terms and definitions the Census Bureau uses in collecting its data. For definitions, please refer to: <u>https://www.census.gov/topics/population/race/about.html</u>.

¹² Jobs with average risk represented less than 1% of workers within each race and ethnicity group.

Automation Risk: Industry Overview

This study examined industries by share of jobs in the Far North subregion to determine which areas of the labor market are at higher risk of automation.

Please note that Lightcast does not provide industry-based Automation Risk Index scores. The following industry analysis is based on a methodology used in a 2017 McKinsey & Company report that examined which industries in the U.S. were most susceptible to being automated (e.g., automation potential). As a result, categories regarding automation risk are based on their methodology and analysis.

KEY FINDING

A substantial proportion of jobs in the Far North are concentrated in industries that have a higher-thanaverage automation score. Nearly 44% of jobs are in these industries.

Using work activities as the basis for estimates of automation risk, McKinsey & Company calculated the "automation potential" of each industry at a national level. Analyzing these scores as proportions, we calculated a national average automation score of 0.46 (Exhibit 6).¹³ Industries with a score above 0.46 are at an above-average risk of automation, while industries below that number are at a below-average risk. When focusing on the sectors with above-average automation potential scores, this amounted to more than 157,000 jobs in the Far North in 2020, while industries with below-average automation potential amounted to 203,383 jobs, or nearly 57% of all jobs. Jobs in the sectors with above-average risk are projected to undergo moderate growth, 7.1%, adding about 11,000 jobs by 2030, whereas below-average potential industries are projected to grow by 14.6%, or by nearly 30,000 jobs.

¹³ James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst, "A Future that Works: Automation, Employment, and Productivity," McKinsey Global Institute, January 2017, accessed October 1, 2024, <u>https://www.mckinsey.com/~/media/mckinsey/featured%20insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%</u> <u>20works/MGI-A-future-that-works-Full-report.ashx</u>.

Exhibit 6. Share of jobs and National Automation Potential scores by industry in the Far North, 2020-2030

Industry Sector	2020 Jobs	Share of 2020 Jobs	2030 Jobs	Share of 2030 Jobs	National Automation Potential ¹⁴
Accommodation and Food Services	26,294	7.3%	31,270	7.8%	.73
Manufacturing	17,947	5.0%	20,827	5.2%	.60
Agriculture, Forestry, Fishing and Hunting	20,348	5.6%	19,447	4.8%	.58
Transportation and Warehousing	8,198	2.3%	9,529	2.4%	.57
Retail Trade	42,548	11.8%	43,329	10.8%	.53
Mining, Quarrying, and Oil and Gas Extraction	359	0.1%	341	0.1%	.51
Other Services	18,797	5.2%	20,090	5.0%	.49
Construction	22,690	6.3%	23,514	5.9%	.47
	٢	lational Avera	age Automatic	on Risk Score	.46
Wholesale Trade	8,014	2.2%	8,137	2.0%	.44
Utilities	2,290	0.6%	2,859	0.7%	.44
Finance and Insurance	7,544	2.1%	6,560	1.6%	.43
Arts, Entertainment, and Recreation	4,182	1.2%	5,675	1.4%	.41
Real Estate and Rental and Leasing	5,293	1.5%	5,834	1.5%	.40
Administrative and Support and Waste Management and Remediation Services	14,093	3.9%	14,203	3.5%	.39
Health Care and Social Assistance	62,699	17.4%	78,611	19.6%	.36
Information	2,525	0.7%	2,771	0.7%	.36
Professional, Scientific, and Technical Services	11,470	3.2%	11,235	2.8%	.35
Management of Companies and Enterprises	1,780	0.5%	1,806	0.4%	.35
Educational Services	4,477	1.2%	5,365	1.3%	.27
Other industry sectors ¹⁵	79,016	21.9%	90,092	22.4%	N/A
Total	360,564	100%	401,495	100%	-

¹⁴ The national "automation potential" calculated by McKinsey and Company are reflected as proportions in order to calculate an average score across all industries, which allowed for "above-average" and "below-average" automation potential scores. For more information about automation potential scores, please reference the McKinsey and Company report. James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst, "A Future that Works: Automation, Employment, and Productivity," McKinsey Global Institute, January 2017, accessed October 1, 2024, https://www.mckinsey.com/~/media/mckinsey/featured%20insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that% 20works/MGI-A-future-that-works-Full-report.ashx. ¹⁵ Note: Other industry sectors include government (NAICS 90) and unclassified industries (NAICS 99).

The industry with the highest automation potential score (.73), which we categorized as "high risk," was accommodation and food services, which made up 7.3% of jobs in 2020. The industry education services had the lowest automation potential score (.27), which we categorized as "minimal risk," and made up 1.2% of jobs in the Far North in 2020.



Exhibit 6. Share of jobs by industry sector in the Far North, 2020¹⁶

¹⁶ Note: Other industry sectors include government (NAICS 90) and unclassified industries (NAICS 99). These sectors did not have automation scores and were excluded from the McKinsey report and are excluded from the graph.

Automation Risk By Sector

The following section contains an analysis of the 10 sectors critical to the economy of the Far North subregion. For each sector, occupations at high and low risk of automation were identified. These occupations are presented along with their current employment numbers, projected employment, entry-level wages, and required education.

In general, occupations most at risk tend to involve repetitive, routine, and/or physical tasks which are more likely to be automated, with AI and robotics increasingly being used in combination to carry out these activities. In contrast, jobs at lower risk tend to rely on activities involving high-level cognitive and emotional abilities, such as interpersonal skills, critical thinking, leadership, collaboration, creativity, dexterity, and problem solving.¹⁷ These skills appear to be transferable across industries/sectors and are also knowledge and experience based whereas the skills of high-risk occupations seem to be more oriented around discrete tasks and activities.

Advanced manufacturing¹⁸

In the early 1990s, advancements in automation began to remake the manufacturing sector, eliminating repetitive or physically taxing tasks that were unsafe for human workers.¹⁹ Today, computer-controlled robotics is currently used for manufacturing processes, assembly, and packaging.²⁰

New developments in cobots and robots, machine learning-powered predictive analytics, and generative AI have further reshaped the industry. Industries with the highest exposure for automation and augmentation include production of consumer goods, electronics manufacturing, automotive and aerospace, advanced manufacturing, and chemical and advanced materials.²¹

The factories of the future, often referred to as "smart factories," are seen as combining AI, the Internet of Things (interconnected devices and systems that exchange data), and data analytics to optimize predictive maintenance.²² These technological advances are expected to impact the workforce. A 2023 survey found that 40% of business respondents expect a decrease in the manufacturing workforce due to the use of generative AI.²³ However, even with further adoption of AI and robotics, human oversight is expected to be needed for decision making, critical thinking, problem solving, monitoring, and intervention.²⁴

¹⁷ Austine O. Unuriode, Stanley C. Okoro, Osariemen T. Afolabi, Olalekan B. Durojaiye, Alexander Lopez, Babatunde Y. Yusuf, and Mayowa J. Akinwande, "The Impact of Al on US Labor Markets," Department of Computer Science, Austin Peay State University, Vol. 14, 10.5121/csit.2024.140403 (February 2024): pp. 33-48, <u>https://aircconline.com/csit/papers/vol14/csit140403.pdf</u>.

¹⁸ Occupations that aligned with the sectors designated by the California Community Colleges Chancellor's Office have been identified by risk level: high, above-average, below-average, and minimal. They have been sorted by risk level.

¹⁹ "Generative AI in the Workplace: Research Findings," Society for Human Resource Management (SHRM) and The Burning Glass Institute, February 2024, accessed April 9, 2024, <u>https://shrm-res.cloudinary.com/image/upload/v1706729099/AI/CPR-230956 Research Gen-AI-Workplace FINAL 1.pdf.</u> ²⁰ Bernard Marr, "Artificial Intelligence In Manufacturing: Four Use Cases You Need To Know In 2023," *Forbes.* July 7, 2023, accessed April 9, 2024, <u>https://www.forbes.com/sites/bernardmarr/2023/07/07/artificial-intelligence-in-manufacturing-four-use-cases-you-need-to-know-in-</u> 2023/?sh=198994ca3bd8.

²¹ "Jobs of Tomorrow: Large Language Models and Jobs," World Economic Forum, Jobs of Tomorrow Series, September 2023, accessed April 9, 2024, https://www3.weforum.org/docs/WEF_Jobs_of_Tomorrow_Generative_Al_2023.pdf.

²² Unmudl Skills Team, "How AI is Reshaping Manufacturing Jobs," Unmudl, March 12, 2024, accessed April 9, 2024, <u>https://unmudl.com/blog/ai-manufacturing-jobs</u>.

²³ McKinsey & Company, "The State of Al in 2023: Generative Al's Breakout Year," McKinsey Digital Insights, August 1, 2023, accessed April 9, 2024, https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai-in-2023-generative-ais-breakout-year.

²⁴ NAM Newsroom, "How Will Al Impact the Manufacturing Workforce?" National Association of Manufacturers, blog post, January 12, 2023, accessed April 9, 2024, <u>https://nam.org/how-will-ai-impact-the-manufacturing-workforce-20315/</u>.

When evaluating jobs in advanced manufacturing in the Far North, Exhibits 8 and 9 show occupations that are most and least at risk of automation.

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Structural Iron and Steel Workers	124	123	-0.7%	\$22.97	HS or equivalent
٠	Structural Metal Fabricators and Fitters	74	43	-41.3%	\$16.10	HS or equivalent
٠	Slaughterers and Meat Packers	182	148	-18.4%	\$18.71	No formal credential
٠	Production Workers, All Other	411	531	29.2%	\$15.85	HS or equivalent
•	Cabinetmakers and Bench Carpenters	421	484	14.9%	\$16.86	HS or equivalent
•	High Risk Automation Index Score					

Exhibit 8. Top five jobs with above-average and high automation risk in the Far North

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Exhibit 9. Top five jobs with below-average and minimal automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
٠	Aerospace Engineers	24	38	60.9%	\$47.59	Bachelor's
•	Industrial Production Managers	302	418	38.4%	\$36.86	Bachelor's
•	Civil Engineers	971	1,113	14.6%	\$37.90	Bachelor's
٠	Computer Hardware Engineers	76	308	305.4%	\$45.41	Bachelor's
٠	Mechanical Engineers	200	208	3.8%	\$34.84	Bachelor's

Minimal Risk Automation Index Score

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Advanced transportation & logistics

Automation is revolutionizing the advanced transportation and logistics sector at many different levels. Autonomous vehicles, including trucks, are in the testing stage, with numerous successes and failures demonstrated over the past two years. Proposed legislation in California may delay the testing of autonomous trucks over 10,001 pounds.²⁵ Automotive businesses are experimenting at every stage of the value chain from production to post-sale services to improve production, reduce equipment costs, and assist with developing autonomous vehicles.²⁶ For example, the company Applied Intuition, which is valued at \$6 billion, is working to develop AI vehicle software for the automotive, defense, construction, and agriculture sectors.²⁷

²⁶ "Early Generative AI and its impact on automotive industry, 2023 summary," Deloitte, accessed April 9, 2024,

https://www2.deloitte.com/cz/en/pages/technology/articles/early-generative-ai-and-its-impact-on-automotive-industry.html. ²⁷ Sean O'Kane, "Applied Intuition Iands \$6B valuation for AI-powered autonomous vehicle software," TechCrunch, March 12, 2024, accessed April 9,

²⁵ Rebecca Bellen, "Self-Driving Truck Companies Face a Potential Roadblock in California," *TechCrunch*, February 9, 2023, accessed April 9, 2024, <u>https://techcrunch.com/2023/02/09/self-driving-truck-companies-face-a-potential-roadblock-in-california/</u>.

^{2024,} https://techcrunch.com/2024/03/12/applied-intuition-series-e-raise-funding-andreessen-lux/.

In the logistics industry, robotic technology combined with powerful AI is being deployed in warehouses to eliminate physically demanding tasks for human workers by companies such as GrayOrange.²⁸ Amazon has invested heavily in drones and these technologies. According to a recent article by Yahoo! Finance, Amazon has reduced its workforce by 100,000 people after integrating 750,000 robots into its workplace settings, including fulfillment centers.²⁹ When evaluating jobs in advanced transportation and logistics in the Far North, Exhibits 10 and 11 show occupations that are most and least at risk of automation.

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Risk	Occupation		2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
٠	Dredge Operators		49	18	-62.6%	\$24.78	HS or equivalent
٠	Crane and Tower Operators		62	43	-31.2%	\$24.18	HS or equivalent
٠	Automotive Glass Installers and R	epairers	86	93	7.7%	\$19.97	HS or equivalent
٠	Industrial Truck and Tractor Open	rators	1,501	1,588	5.8%	\$18.40	No formal credential
٠	Automotive Body and Related Re	epairers	356	334	-6.3%	\$18.53	HS or equivalent
•	High Risk Automation Index Score						

Exhibit 10. Top five jobs with above-average and high automation risk in the Far North

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Exhibit 11. Top five jobs with below-average and minimal automation risk in the Far North

Risk	Occupation		2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
٠	Logisticians		351	254	-27.5%	\$29.42	Bachelor's
•	Transportation, Storage, and Distribution Managers		298	408	37.2%	\$31.58	HS or equivalent
•	Captains, Mates, and Pilots of Water Vesse	els	33	40	20.8%	\$30.11	Postsecondary
•	Commercial Pilots		180	159	-12.1%	\$33.48	HS or equivalent
•	Air Traffic Controllers		83	67	-19.5%	\$39.45	Associate
•	Below-Average Automation Index Score	•	Minimal A	utomation Ind	ex Score		

²⁸ Brian Heater, "Warehouse robotics firm GreyOrange raises \$110M via growth financing," TechCrunch, May 17, 2022, accessed April 9, 2024,

https://techcrunch.com/2022/05/17/warehouse-robotics-firm-greyorange-raises-110m-via-growth-financing/. ²⁹ Caleb Naysmith, "Amazon Grows To Over 750,000 Robots As World's Second-Largest Private Employer Replaces Over 100,000 Humans," Yahoo! *Finance*, April 11, 2024, accessed April 12, 204, <u>https://finance.yahoo.com/news/amazon-grows-over-750-000-153000967.html</u>.

Agriculture, water & environmental technologies

Precision agriculture is a term frequently associated with Al/automation in this sector and involves collecting data for data-driven decision making, sometimes involving Al, to track many different aspects of crop farming, including soil composition, pests, weather, crop productivity, and water usage. Precision agriculture is also being applied to livestock management, with sensors being used to monitor animal health. Tractor and farming equipment companies have introduced numerous technologies, such as farming equipment that uses GPS technology in conjunction with highly sensitive sensors and cameras.³⁰ Tractor company John Deere has developed an herbicide sprayer combined with cameras that target "weeds specifically, allowing for more precise use of chemicals."³¹ This type of technology has been used in conjunction with GPS for seed placement, fertilizer applications, and irrigation. Due to the cost of adoption, deployment, and maintenance, the technology being rolled out appears to favor large-scale industrial farming, and it is unclear if the cost and hardware upgrades appeal to smaller farmers. When evaluating jobs in in this sector in the Far North, Exhibits 12 and 13 show occupations that are most and least at risk of automation.

Exhibit 12. Top five jobs with above-average and high automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
٠	Landscaping and Groundskeeping Workers	4,217	4,560	8.1%	\$14.39	No formal credential
•	Pesticide Handlers, Sprayers, and Applicators, Vegetation	78	52	-33.3%	\$17.04	HS or equivalent
٠	Tree Trimmers and Pruners	232	247	6.3%	\$16.38	HS or equivalent
٠	Graders and Sorters, Agricultural Products	366	266	-27.5%	\$14.15	No formal credential
•	Grounds Maintenance Workers, All Other	141	119	-15.6%	\$18.19	No formal credential
•	High Risk Automation Index Score					

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Exhibit 13. Top five jobs with below-average and minimal automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
٠	Environmental Scientists and Specialists, Including Health	452	481	6.6%	\$32.70	Bachelor's
•	Forest and Conservation Technicians	1,891	1,388	-26.6%	\$16.07	Associate
•	Foresters	195	205	5.0%	\$29.40	Bachelor's
•	Environmental Engineers	98	100	1.7%	\$40.62	Bachelor's
•	Geoscientists, Except Hydrologists and Geographers	114	158	39.2%	\$31.61	Bachelor's
	Minimal Automation Index Score					

Minimal Automation Index Score

³⁰ Tim Sprinkle, "5 Ways How Digital Farm Technology Is Transforming Agriculture," ASME, January 17, 2019, accessed April 9, 2024,

https://www.asme.org/topics-resources/content/5-ways-digital-farm-technology-transforming.

³¹ Jordyn Holman and Jeanna Smialek, "Will A.I. Boost Productivity? Companies Sure Hope So," *The New York Times*, April 1, 2024, accessed April 9, 2024, https://www.nytimes.com/2024/04/01/business/economy/artificial-intelligence-productivity.html.

Business & entrepreneurship

A 2024 survey by Tech.co finds that the tasks businesses are most likely to use Al for in the office are data entry and analysis, writing, scheduling and calendar management, and quality control, suggesting that middle-skill occupations (those requiring education and training more than a high school diploma but less than a bachelor's degree) that engage in these tasks may be disrupted by the adoption of generative Al.³²

Additionally, several studies have found that automation propelled by the adoption of Al will affect industries (such as financial services and business, legal, and professional services) that employ occupations within the business and entrepreneurship sector. The most commonly reported business functions that are adopting new generative Al technologies are the same as those in which Al is commonly used: marketing and sales, product and service development, and service operations, such as customer care and back-office support³³



Jobs that perform routine tasks, such as administrative or clerical activities, record keeping and managing information, or elementary analysis, data analysis, or referencing databases, appear to be most at risk.³⁴ Jobs that are less exposed tend to require interaction and collaboration. When evaluating jobs in business and entrepreneurship in the Far North, Exhibits 14 and 15 show occupations that are most and least at risk of automation.

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Mail Clerks and Mail Machine Operators, Except Postal Service	82	42	-48.7%	\$15.19	HS or equivalent
•	Office Machine Operators, Except Computer	57	3	-95.4%	\$16.00	HS or equivalent
•	Barbers	110	114	3.4%	\$7.45	Postsecondary
•	Telemarketers	102	39	-62.2%	\$14.00	No formal credential
•	Bookkeeping, Accounting, and Auditing Clerks	4,220	4,016	-4.8%	\$18.50	Some college
•	Above-Average Automation Index Score					

Exhibit 14. Top five jobs with above-average and high automation risk in the Far North

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

³³ McKinsey & Company, "The State of AI in 2023: Generative AI's Breakout Year," McKinsey Digital Insights, August 1, 2023, accessed April 9, 2024, <u>https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai-in-2023-generative-ais-breakout-year</u>. ³⁴ Ibid.

³² "The Impact of Technology on the Workplace," Tech.co, 2024, accessed April 9, 2024, p.12, <u>https://images.tech.co/wp-content/uploads/techco-impact-of-tech-workplace-report-2024.pdf</u>.

Exhibit	15.	Тор	five	jobs	with	below-a	verage	and	minimal	autom	ation	risk	in	the	Far	Nor	rth
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Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Marketing Managers	267	348	30.0%	\$35.23	Bachelor's
•	Administrative Services Managers	463	596	28.8%	\$31.35	Bachelor's
٠	Facilities Managers	263	370	40.7%	\$30.51	Bachelor's
٠	Lawyers	1,167	1,199	2.8%	\$38.77	Doctoral or professional
•	Chief Executives	742	800	7.9%	\$42.04	Bachelor's
•	Minimal Automation Index Score					

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Education & human development

Of all the sectors examined, the technical feasibility of automation appears to be lowest in education since generative Al does not yet have the ability to replace teachers, given the reliance of the occupation on interpersonal interaction and collaboration. ³⁵ However, an area that generative Al may prove impactful is in the automation of administrative tasks—ranging from grading assignments to managing student data, and creating specialized lesson plans.

The report "Jobs of Tomorrow" predicts that teachers could rely on Al for assistance in lesson planning and correcting student work, which could free up time that would allow teachers to focus more on direct student engagement.³⁶ While Al can handle certain tasks more efficiently than traditional methods, experts note that Al cannot replicate the human qualities that make good teachers—the ability to inspire, motivate, and understand the emotional and social needs of their students.³⁷

An Optimistic Employment Outlook

Based on the analysis in this report, there are no occupations in the education sector at aboveaverage or high risk of automation. As a result, occupations in this section focus on jobs that are below-average risk and minimal risk of automation. These occupations were included to demonstrate the scope of career opportunities at low risk of automation in this sector and because these occupations represent a bright spot in the overall labor market. Additionally, the community colleges may choose to consider increased program investments in these occupations, especially given that some show very strong projected in growth. It should also be noted that these occupations typically require a bachelor's degree or higher, which may necessitate the expansion of transfer agreements between community colleges and four-year postsecondary institutions.

³⁵ Michael Chui, James Manyika, and Mehdi Miremadi, "Where machines could replace humans—and where they can't (yet)," McKinsey & Co., McKinsey *Digital*, July 8, 2016, accessed April 9, 2024, <u>https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/where-machines-could-replace-humans-and-where-they-cant-yet</u>.

³⁶ "Jobs of Tomorrow: Large Language Models and Jobs," World Economic Forum, Jobs of Tomorrow Series, September 2023, accessed April 9, 2024, https://www3.weforum.org/docs/WEF Jobs of Tomorrow Generative Al 2023.pdf.

³⁷ Claire Chen, "AI Will Transform Teaching and Learning. Let's Get It Right," Stanford Institute for Human-Centered Artificial Intelligence (HAI), May 9, 2023, accessed April 9, 2024, https://hai.stanford.edu/news/ai-will-transform-teaching-and-learning-lets-get-it-right.

The human services sector is poised to be augmented by automation. According to a report by Deloitte, Al can assist with case management, "to help lessen caseworkers' workload by prepopulating data from paper applications, automating system actions, sending reminders and other communications to clients, and recommending interventions."³⁸ When evaluating jobs in education and human development in the Far North, Exhibits 16 and 17 show occupations that are below-average and least at risk of automation.

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Middle School Teachers, Except Special and Career/Technical Education	1,414	1,502	6.2%	\$30.37	Bachelor's
•	Secondary School Teachers, Except Special and Career/Technical Education	2,476	2,479	0.2%	\$29.33	Bachelor's
٠	Tutors	808	957	18.5%	\$14.17	Bachelor's
•	Teachers and Instructors, All Other	558	452	-19.1%	\$23.70	Bachelor's
•	School Psychologists	199	272	37.1%	\$38.94	Doctoral or professional
•	Below-Average Automation Index Score					

Exhibit 16. Top five jobs with below-average risk in the Far North

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Exhibit 17. Top five jobs with minimal automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Health Education Specialists	242	284	17.3%	\$20.55	Bachelor's
٠	Special Education Teachers, All Other	101	194	92.3%	\$30.62	Bachelor's
•	Education and Childcare Administrators, Preschool and Daycare	184	215	16.9%	\$21.27	Bachelor's
٠	Education Administrators, Kindergarten through Secondary	766	861	12.5%	\$51.08	Master's
٠	Education Administrators, Postsecondary	289	387	33.8%	\$39.97	Master's

Minimal Automation Index Score

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Energy, construction & utilities

Due to the hands-on nature of many construction jobs, AI, as opposed to robotics, appears to be steadily making strides in the industry. A Goldman Sachs research analysis estimates that only 6% of construction tasks currently utilize AI, yet the technology's potential to revolutionize the industry is substantial.³⁹ In the renewable energy sector, solar photovoltaic installers are experiencing a surge in

³⁸ Tiffany Fishman, Jamia McDonald, Hariharan Murthy, Naman Chaurasia, Joe Mariani, and Pankaj Kamleshkumar Kishnani, "Realizing the potential of generative AI in human services: Use cases to transform program delivery," Deloitte Center for Government Insights, Deloitte, accessed April 9, 2024, <u>https://www2.deloitte.com/us/en/insights/industry/public-sector/automation-and-generative-ai-in-government/generative-ai-in-public-health.html.</u> ³⁹ Karen Briggs and Nisha Kodnani, "Global Economics Analyst: The Potentially Large Effects of Artificial Intelligence on Economic Growth," Economic Research, Goldman Sachs, March 26, 2023, accessed April 7, 2024, <u>https://www.key4biz.it/wp-content/uploads/2023/03/Global-Economics-Analyst -</u> The-Potentially-Large-Effects-of-Artificial-Intelligence-on-Economic-Growth-Briggs Kodnani.pdf.

job opportunities, thanks to Al's advancements in site analysis and performance monitoring. The Solar Energy Industries Association has reported a record number of installations, supported by Al's precision in optimizing designs.⁴⁰

Other industry professions, such as engineering technicians, are experiencing a shift toward roles that require proficiency in Al-driven software and digital tools for design optimization, simulation, and data analysis.⁴¹ The utilities industry is undergoing a technological transformation driven by Al, promising significant changes in energy production and consumption. Al tools offer solutions by optimizing energy usage, forecasting demand and supply for better grid management, and facilitating the integration of renewable energy sources. This technological paradigm shift is changing the occupational landscape across the industry.⁴² When evaluating jobs in energy, construction, and utilities in the Far North, Exhibits 18 and 19 show occupations that are most and least at risk of automation.

Exhibit 18. Top five jobs with above-average and high automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
٠	Floor Layers, Except Carpet, Wood, and Hard Tiles	83	113	35.6%	\$17.81	No formal credential
٠	HelpersPipelayers, Plumbers, Pipefitters, and Steamfitters	173	114	-33.9%	\$15.61	HS or equivalent
•	Painters, Construction and Maintenance	1,209	1,143	-5.5%	\$16.01	No formal credential
•	HelpersPainters, Paperhangers, Plasterers, and Stucco Masons	54	94	74.2%	\$18.70	No formal credential
٠	HelpersElectricians	58	63	9.8%	\$17.00	HS or equivalent

High Risk Automation Index Score

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Exhibit 19. Top five jobs with below-average and minimal automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Architects, Except Landscape and Naval	200	236	18.4%	\$27.04	Bachelor's
•	Architectural and Engineering Managers	244	255	4.6%	\$51.48	Bachelor's
•	Petroleum Engineers	43	6	-86.6%	\$41.09	Bachelor's
•	Landscape Architects	51	47	-7.9%	\$22.44	Bachelor's
•	Construction Managers	1,369	1,509	10.3%	\$20.50	Bachelor's
•	Below-Average Automation Index Score	•	Minimal Auto	mation Inde	x Score	

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

https://www.cognizant.com/en_us/industries/documents/unlock-value-using-generative-ai-in-utilities-industry.pdf.

⁴⁰ "US Solar Market Insight," Solar Energy Industries Association, March 6, 2024, accessed April 9, 2024, <u>https://www.seia.org/us-solar-market-insight</u>. ⁴¹ "Unlock Value Using Generative AI in Utilities Industry," Cognizant, 2023, accessed April 7, 2024,

⁴² "The Al-Enabled Utility: Rewiring to Win in the Energy Transition," McKinsey & Company, August 2023, accessed April 11, 2024, <u>https://www.mckinsey.com/~/media/mckinsey/industries/electric%20power%20and%20natural%20gas/our%20insights/the%20ai%20enabled%20utility%20rewiring%20to%20win%20in%20the%20energy%20transition/mck_utility_compendium.pdf</u>.

Health

Since the delivery of patient care often requires human interaction, the health sector does not appear slated for as great a workforce shakeup as other industries. Many of the jobs within the health sector that involve direct patient care, such as the jobs held by nurses, home health aides, dental assistants, and dental hygienists, are perceived as difficult to automate. For example, according to the World Economic Forum's "Jobs of Tomorrow" report, home health aides spend 75% of time on tasks with low exposure to automation and augmentation.⁴³

Although generative Al is viewed as potentially augmenting the work of doctors or nurse practitioners in diagnosing patients or identifying potential harmful drug interactions, these jobs will continue to rely on human decision making and critical thinking.⁴⁴ Some occupations do, however, appear to be more susceptible, particularly jobs with lower educational requirements.⁴⁵ When evaluating jobs in health in the Far North, Exhibits 20 and 21 show occupations that are most and least at risk of automation.

Exhibit 20. Top five jobs with above-average and high automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Dental Laboratory Technicians	59	15	-75.4%	\$16.09	HS or equivalent
٠	Orderlies	109	82	-24.4%	\$16.91	HS or equivalent
•	Pharmacy Aides	205	178	-12.9%	\$15.23	HS or equivalent
•	Medical Equipment Preparers	178	224	25.9%	\$19.27	HS or equivalent
•	Pharmacy Technicians	809	907	12.1%	\$18.37	HS or equivalent
•	Above-Average Automation Index Score	•	High Risk A	Automation Ir	ndex Score	

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Exhibit 21. Top five jobs with below-average and minimal automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Medical and Health Services Managers	1,005	1,590	58.2%	\$37.56	Bachelor's
٠	Medical Scientists, Except Epidemiologists	221	176	-20.2%	\$46.49	Doctoral or professional
٠	Marriage and Family Therapists	664	587	-11.5%	\$22.77	Master's
٠	Psychiatric Technicians	121	189	56.8%	\$22.15	Postsecondary
٠	Rehabilitation Counselors	500	436	-12.8%	\$15.26	Master's
•	Minimal Automation Index Score					

⁴³ "Jobs of Tomorrow: Large Language Models and Jobs," World Economic Forum, Jobs of Tomorrow Series, September 2023, accessed April 9, 2024, https://www3.weforum.org/docs/WEF_Jobs_of_Tomorrow_Generative_Al_2023.pdf.

⁴⁴ Steve Lohr, "How one tech skeptic decided A.A. might benefit the middle class," *The New York Times*, April 1, 2024, accessed April 9, 2024, <u>https://www.nytimes.com/2024/04/01/business/ai-tech-economy.html</u>.

⁴⁵ McKinsey & Company, "The State of AI in 2023: Generative AI's Breakout Year," McKinsey Digital Insights, August 1, 2023, accessed April 9, 2024, https://www.mckinsey.com/capabilities/guantumblack/our-insights/the-state-of-ai-in-2023-generative-ais-breakout-year.

ICT/digital media

The field of ICT/digital media is expected to be largely impacted by automation. Businesses in the technology, media, and telecom industry have the highest percentage reporting regular use of generative Al.⁴⁶ Hiring demand has increased for data engineers, machine learning engineers, and Al data scientists by businesses that use Al, with diminishing demand reported for Al-related software engineers.

The World Economic Forum's report "Jobs of Tomorrow" predicts that large language models (LLMs) will lead to new roles among Al developers, interface and interaction designers, Al content creators, data curators, and Al ethics and governance specialists.⁴⁷ The report notes that information technology ranks as one of the top industries planning to adopt Al technologies and has the greatest exposure to LLMs.⁴⁸

Graphic design, typically a stalwart ICT/digital media occupation for community college students, has undergone a rapid transformation due to generative Al's ability to create complex visual designs without the need for much human input except prompts. ⁴⁹ Similarly, software developers is an occupation that is highly exposed. When evaluating jobs in ICT/digital media in the Far North, Exhibits 22 and 23 show occupations that are most and least at risk of automation.



⁴⁶ Ibid.

⁴⁷ "Jobs of Tomorrow: Large Language Models and Jobs," World Economic Forum, Jobs of Tomorrow Series, September 2023, accessed April 9, 2024, <u>https://www3.weforum.org/docs/WEF_Jobs_of_Tomorrow_Generative_Al_2023.pdf</u>.

⁴⁸ lbid. ⁴⁹ lbid.

Exhibit 22. Top five jobs with above-average and high automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Telecommunications Line Installers and Repairers	405	372	-8.2%	\$25.94	HS or equivalent
•	Electrical Power-Line Installers and Repairers	260	397	53.0%	\$36.70	HS or equivalent
•	Telecommunications Equipment Installers and Repairers, Except Line Installers	346	351	1.5%	\$23.38	Postsecondary
•	Sound Engineering Technicians	31	28	-10.1%	\$18.65	Postsecondary
•	Word Processors and Typists	127	55	-56.7%	\$17.57	HS or equivalent
•	Above-Average Automation Index Score	٠	High Risk Au	tomation Inc	lex Score	

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Exhibit 23. Top five jobs with below-average and minimal automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Special Effects Artists and Animators	104	124	19.2%	\$13.37	Bachelor's
•	Computer and Information Systems Managers	369	468	26.9%	\$48.22	Bachelor's
•	Software Developers	538	696	29.4%	\$42.56	Bachelor's
•	Software Quality Assurance Analysts and Testers	80	169	112.5%	\$40.30	Bachelor's
٠	Graphic Designers	419	369	-11.9%	\$18.60	Bachelor's
	Minimal Automation Index Score					

Minimal Automation Index Score

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Public safety

Perhaps due to the public-facing nature of many public safety occupations such as police officers, security guards, emergency medical technicians, and firefighters, the impact of automation on this sector's workforce was largely absent from the reports identified for this literature review. However, it has been documented that technology is changing work functions and tasks within the public safety sectors. For example, police departments have adopted the use of robots for bomb defusing and in other high-risk situations to minimize threats to law enforcement officers. ⁵⁰

As with Al in other sectors of the economy, this technology can assist by improving efficiency and productivity, providing greater accuracy for decision making through data collection and management, and expanding human capabilities in forensics, crime mapping, surveillance, and facial recognition.

⁵⁰ "Police robots are on patrol. Now the questions about them are piling up." USAToday, November 7, 2023, accessed April 11, 2024, <u>https://www.usatoday.com/story/news/nation/2023/10/31/nyc-police-robots-privacy-safety-concerns/71218199007/</u>.

An article published by the industry news website Police1 details how Al can be applied in police work, such as cross-referencing disparate databases, identifying suspects from incomplete fingerprints, auditing bodycam footage, assisting with report writing, and using LLMs to retrieve text and summarize documents and answer questions.⁵¹ When evaluating jobs in public safety in the Far North, Exhibits 24 and 25 show occupations that are most and least at risk of automation.



Exhibit 24. Top five jobs with above-average and high automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Postal Service Mail Carriers	697	845	21.2%	\$18.98	HS or equivalent
•	Postal Service Mail Sorters, Processors, and Processing Machine Operators	142	71	-49.9%	\$20.55	HS or equivalent
•	Security Guards	1,275	1,584	24.2%	\$14.58	HS or equivalent
•	Postal Service Clerks	385	397	3.1%	\$21.21	HS or equivalent
•	Firefighters	1,975	3,068	55.3%	\$20.44	Postsecondary
•	Above-Average Automation Index Score					

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Exhibit 25. Top five jobs with below-average and minimal automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
٠	Probation Officers and Correctional Treatment Specialists	465	494	6.4%	\$25.96	Bachelor's
٠	Postmasters and Mail Superintendents	64	81	25.3%	\$33.15	HS or equivalent
•	First-Line Supervisors of Firefighting and Prevention Workers	248	438	76.3%	\$34.44	Postsecondary
٠	First-Line Supervisors of Police and Detectives	261	336	28.9%	\$47.59	HS or equivalent
•	Arbitrators, Mediators, and Conciliators	50	79	57.5%	\$30.91	Bachelor's
٠	Below-Average Automation Index Score	•	Minimal Au	tomation Inc	lex Score	

⁵¹ Paul Goldenberg and Michael Gips. "Al is set to revolutionize policing: Are we ready?" Police1, March 4, 2024, accessed April 11, 2024, https://www.police1.com/tech-pulse/ai-is-set-to-revolutionize-policing-are-we-ready.

Retail, hospitality & tourism

In 2016, McKinsey Quarterly issued a report examining how machines could replace humans, noting that retail was an industry sector with a high potential for automation. The report estimated that 53% of activities were automatable, such as maintaining records of sales, gathering customer or product information, and other data-collection activities.⁵² Since then, automation within the retail, hospitality, and tourism sector has greatly accelerated and was greatly impacted by changing consumer habits resulting from the Covid-19 pandemic. Currently, Al can be applied to specific roles in the hospitality industry by streamlining operations, automating routine tasks, predicting demand patterns by customers and adjusting staffing accordingly, and providing customer service through chatbots or robotic concierge services, such as cleaning and room service.⁵³

Al may also transform how work is conducted in restaurants in the retail, hospitality, and tourism sector. California startup Bear Robotics is developing Al robots that can be used as waiters and servers.⁵⁴ Chef Robotics in San Francisco announced raising additional funds in January for robots that assist with food assembly.⁵⁵

The firm Botinkit announced fundraising in 2023 to launch robots that could automate cooking in chain restaurants by stir-frying, stewing, and adding ingredients to dishes.⁵⁶



Even the work conducted by hairstylists and barbers may be transformed. Several companies are experimenting with ways of automating haircuts through the use of robots and drones.⁵⁷ When evaluating jobs in retail, hospitality, and tourism in the Far North, Exhibits 26 and 27 show occupations that are most and least at risk of automation.

https://techcrunch.com/2024/01/26/chef-robotics-eyes-commercial-kitchens-with-a-14-75m-raise/.

⁵² Michael Chui, James Manyika, and Mehdi Miremadi, "Where machines could replace humans—and

where they can't (yet) ," McKinsey Quarterly, July 2016, accessed April 11, 2024.

 $[\]frac{https://www.mckinsey.com/~/media/mckinsey/business\%20 functions/mckinsey\%20 digital/our\%20 insights/where\%20 machines\%20 could\%20 replace\%20 humans\%20 and\%20 where \%20 they\%20 could where machines - could-replace humans - and - where - they-cant-yet.pdf.$

⁵³ "Exploring innovative AI use cases in hospitality," LeewayHertz, 2024, accessed April 11, 2024, <u>https://www.leewayHertz.com/ai-use-cases-in-hospitality/#:~:text=How%20can%20AI%20improve%20guest,the%20overall%20stay%20more%20convenient.</u>

⁵⁴ Kate Park, "Bear Robotics, a robot waiter startup, just picked up \$60M from LG," TechCrunch, March 12, 2024, accessed April 11, 2024, https://techcrunch.com/2024/03/12/bear-robotics-a-robot-waiter-startup-just-picked-up-60m-from-lg/.

⁵⁵ Brian Heater, "Chef Robotics eyes commercial kitchens with \$14.75M raise," TechCrunch, January 26, 2024, accessed April 11, 2024.

⁵⁶ Rita Liao, "Kitchen robot Botinkit raises \$13M from DJI angel and others," TechCrunch, July 19, 2023, accessed April 11, 2024,

https://techcrunch.com/2023/07/19/kitchen-robot-botinkit-raises-13m-from-dji-angel-and-others/. ⁵⁷ Bonnie Burton, "This robot will give you a new haircut...if you dare," CNET, July 22, 2020, accessed September 3, 2024,

https://www.cnet.com/science/this-robot-will-give-you-a-new-haircut-if-you-dare/.

Exhibit 26. Top five jobs with above-average and high automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Dishwashers	1,127	1,286	14.2%	\$14.27	No formal credential
•	Cooks, Fast Food	2,292	2,360	3.0%	\$14.57	No formal credential
•	Fast Food and Counter Workers	8,058	8,145	1.1%	\$14.43	No formal credential
•	Dining Room and Cafeteria Attendants and Bartender Helpers	985	1,179	19.7%	\$14.03	No formal credential
•	Waiters and Waitresses	3,916	4,096	4.6%	\$14.04	No formal credential
•	Above-Average Automation Index Score					

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Exhibit 27. Top five jobs with below-average and minimal automation risk in the Far North

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Music Directors and Composers	92	104	13.4%	\$18.75	Bachelor's
•	Coaches and Scouts	456	643	41.1%	\$18.79	Bachelor's
•	First-Line Supervisors of Non-Retail Sales Workers	581	504	-13.2%	\$18.63	HS or equivalent
•	Art Directors	136	187	37.2%	\$13.03	Bachelor's
•	General and Operations Managers	4,153	5,754	38.6%	\$31.24	Bachelor's
•	Minimal Automation Index Score					



Automation Risk: Skills

The following section highlights the specific skills that may be valuable for tomorrow's workforce and that could be incorporated into training geared toward "upskilling" workers. The skills associated with minimal-risk occupations appear to be highly valued by employers and may warrant continued attention by community college programs. By mapping skills shared between high-risk and minimal-risk occupations, community colleges can develop pathways leading to careers that are more resilient to the impacts of automation.

The COE conducted an analysis of more than 5 million unique online job postings to determine the common, specialized, and software skills most requested by employers for the 111 occupations that are classified at minimal risk of automation.⁵⁸ To obtain a more comprehensive picture of the skills that are associated with these occupations, the analysis included skills for occupations listed nationally by employers in job postings in the last 12 months.

The analysis also examined the skills requested by employers in online job postings for the 140 occupations classified at high risk of automation. In nearly 4 million unique online job postings across the United States in the last 12 months, the top common, specialized, and software skills are highlighted below. Finally, it is worth noting that the findings in this section are similar to a report by McKinsey & Company, which found that manual skills will decline, while the demand for workers with social, technological, and cognitive skills will increase.⁵⁹



Please note:

The COE is not suggesting that the skills associated with highrisk occupations identified in this section will become irrelevant for the workforce. This is because some skills overlap exists between highand minimal-risk occupations. As a result, this section is intended to highlight the importance of shared skills and to encourage discussions about ways in which occupations may evolve as skills are impacted by automation.

⁵⁸ Common skills are typically related to employability. These are skills that are prevalent across many occupations and include both interpersonal attributes and learned skills (also referred to as "soft skills"). Specialized skills are those primarily required to perform specific tasks in an occupation. Software skills are specific to any software tool or programming component used to support a job.

⁵⁹ Marco Dondi, Julia Klier, Frédéric Panier, and Jörg Schubert, "McKinsey: These are the skills you will need for the future of work," World Economic Forum and McKinsey & Company, June 2021, accessed June 2, 2024, <u>https://www.weforum.org/agenda/2021/06/defining-the-skills-citizens-will-need-in-thefuture-world-of-work/</u>.

Patterns among common skills

Skills analysis can be valuable in revealing the top skills most in-demand for minimal-risk occupations. Additionally, analysis of occupations with shared skills can reveal how to direct incumbent workers from high-risk jobs toward minimal-risk careers. Further analysis of occupations within specific community college program areas may also prove valuable.

This study's analysis shows that minimal- and high-risk occupations share several common skills:

- Communication
- Management
- Operations

Among minimal-risk occupations, other top skills are management of personnel and leadership, skills commonly associated with occupations requiring advanced education or training (Exhibit 28). In comparison, among high-risk occupations, other top skills were customer service and lifting ability. For many occupations within the retail, hospitality, and tourism sector, the adoption of chatbots or robotic concierge services is likely to transform the need for live or in-person customer service. Lifting ability is another skill area in which mobile robots are replacing human workers, as evidenced by Amazon's widespread adoption of robots in its warehouses and logistics hubs.

Some skills—such as communication, project management, management and leadership—fall in areas where AI has been slow to advance. These skills are foundational to minimal-risk occupations. This is because communication and project management involve complex cognitive abilities while management and leadership are associated with interpersonal relationships and social perceptiveness—all areas in which AI, at the moment, is lacking.

Minimal Risk	High Risk
 Communication* Management* Leadership Operations* Customer Service Planning Problem Solving Writing Sales Research 	 Customer Service Communication* Lifting Ability Cleanliness Management* Detail Oriented Sanitation Operations* English Language Loading And Unloading

Exhibit 28. Top common skills for occupations with minimal and high automation risk in online job postings

* denotes a shared skill.

Patterns among specialized skills

Among the top specialized skills identified by this study, none were shared between minimal- and highrisk occupations. Among minimal-risk occupations, the top specialized skills include project management, marketing, and computer science (Exhibit 29). As with the top common skills, many of the minimal-risk skills involve higher-level cognitive abilities, such as critical thinking (project management, data analysis), problem solving (workflow management), and social perceptiveness (marketing, social work).

Top specialized skills associated with high-risk occupations include restaurant operation, warehousing, and food safety and sanitation. Many of these skills are associated with tasks that are being impacted by robots/cobots and AI. The demand for these high-risk skills may wane as processes become more streamlined through automation in the future.

Exhibit 29. Top specialized skills for occupations with minimal and high automation risk in online job postings

Minimal Risk	High Risk
 Project Management Marketing Computer Science Data Analysis Auditing Agile Methodology Social Work SQL (Programming Language) Workflow Management Nursing 	 Restaurant Operation Warehousing Food Safety and Sanitation Housekeeping Mopping Forklift Truck Food Services General Mathematics Food Preparation Cooking

* denotes a shared skill.



Patterns among software skills

In terms of Microsoft software programs, there is a great deal of overlap between the software skills required for minimal-risk and high-risk occupations (Exhibit 30). These software skills account for half of the top software skills identified for bother minimal- and high-risk occupations. This shows that Microsoft Office software programs are in-demand for a broad spectrum of occupations. However, an important difference may exist in terms of how these occupations utilize these software programs and the tasks that can be completed by human workers as opposed to Al or robots.

In this instance, a closer occupational analysis of skills associated with high-risk and minimal-risk jobs in specific program areas may be warranted. For example, Al is expected to continue to make advances in areas such as data reporting and data analysis which may reduce the need for workers with the ability to use Microsoft Excel. Occupations that are predicted to be impacted include financial analysts, actuaries and accountants; auditors, compliance officers and lawyers, and administrative roles that involve data entry, appointment scheduling, documentation management, and customer communication.⁶⁰

Additionally, Al advances in computer programming are greatly changing the demand for software developers. However, as mentioned earlier, the rise of Al is spurring demand for Al model and prompt engineers, interface and interaction designers, Al content creators, data curators and trainers, and ethics and governance specialists. More research into the occupations that may shift to meet the needs created by Al and automation is needed to identify employment opportunities in the labor market.

Exhibit 30. Top software skills for occupations with minimal and high automation risk in online job postings

Minimal Risk	High Risk
 Microsoft Office* Microsoft Excel* Microsoft PowerPoint* Microsoft Outlook* SQL (Programming Language) Python (Programming Language) Java (Programming Language) Microsoft Word* Amazon Web Services Application Programming Interface (API) 	 Microsoft Excel* Microsoft Office* Microsoft Outlook* Warehouse Management Systems Operating Systems SAP Applications Microsoft Word* Inventory Management System Microsoft PowerPoint* Spreadsheets

* denotes a shared skill.

Conclusion & Recommendations

Overall, a general takeaway from this and other studies is that automation is in the process of impacting nearly every corner of the workforce. This report illustrates how at every level (earnings, education, gender, and race and ethnicity) and within each of the 10 sectors critical to the Far North economy, the forces of automation are at work.

Given these findings, it is imperative for students entering the workforce to be equipped with skills that will allow them to be resilient and adaptable in the labor market. Analytical judgement, flexibility, and emotional intelligence have yet to be mastered by technologies associated with automation.⁶¹

Weaknesses in automation and Al—such as deficits in abstract reasoning, problem solving, factual accuracy, and critical thinking—may provide opportunity areas for student training and may present promising career prospects for students as educators and training providers look ahead to what is needed to thrive in a rapidly changing workforce.⁶² Furthermore, attention to the limitations of automation can lend insight into what career-training assets students will need to succeed in workplaces where technological advances are being integrated.

Key Finding: Low-wage jobs are most at risk.

Recommendation: The occupations identified in this study's sector analysis can provide a starting point for developing pathways toward rewarding and sustainable careers for students that pay well and that are at lower risk of automation. The identified minimal-risk occupations may be helpful for transitioning workers away from jobs that are at high or above-average risk of automation. By mapping skills associated with high-risk occupations that co-occur with minimal-risk occupations, workers can be retrained or upskilled to enter jobs less susceptible to disruption.

Key Finding: Jobs requiring lower levels of education or little to no work experience are most at risk. These jobs also are typically low-wage jobs.

Recommendation: Colleges should focus on occupations requiring higher levels of education and training as these occupations tend to be well-paid and less at risk of automation. These occupations tend to engage in tasks that require skillsets that are unique to humans. Workers in jobs that spend time in tasks involving managing and supervising others, social interactions, and content expertise are less likely to be displaced due to automation.⁶³ Community colleges may

⁶¹ Goh Chiew Tong, "Here are the top skills you will need for an 'A.I.-powered future,' according to new Microsoft data," CNBC, May 9, 2023, accessed June 26, 2024, <u>https://www.cnbc.com/2023/05/09/top-skills-you-will-need-for-an-ai-powered-future-according-to-microsoft-.html</u>. ⁶² Ibid.

⁶³ Carl Benedikt Frey and Michael A. Osborne, "The Future of Employment: How Susceptible Are Jobs to Computerisation?" Oxford Martin Programme on Technology and Employment, September 17, 2013, accessed June 26, 2024, <u>https://oms-www.files.svdcdn.com/production/downloads/academic/future-of-employment.pdf.</u>

choose to emphasize these types of skillsets in program delivery and expand pathways leading to managerial or supervisory careers for students.

Key Finding: The study analyzed automation risk through the lens of several different demographic characteristics. Jobs that have traditionally employed male workers are found to be more at risk. In addition, a higher proportion of workers that are employed in high-risk occupations identify as Hispanic or Latino; American Indian or Alaskan Native; and Native Hawaiian or Pacific Islander.

Recommendation: Community colleges can use these findings to market training programs to demographic groups with low representation in minimal-risk occupations by communicating that these careers are less susceptible to automation. The community colleges are uniquely poised to address this need as they have a track record of delivering specialized supports to positively impact underrepresented groups and populations.

Key Finding: A large proportion of jobs in the Far North are concentrated in industries that have a higher-than-average automation score. Nearly 44% of jobs are in these industries.

Recommendation: The industry analysis provided in this report presents a dilemma for education and training providers. The industries identified as having above-average risk of automation also employ a large percentage of the subregion's workforce. As a result, these industries cannot be written off as not offering employment opportunities to workers in the region. A nuanced training approach is needed that develops and enhances pathways leading to promising occupations in these industries.

Given how the workforce is rapidly changing, a proactive strategy that addresses anticipated changes may be warranted by the community colleges. The impact of automation and AI as identified by this study will evolve over time. Prioritizing communication between community colleges and industry to assess how quickly Far North employers are implementing AI and automation may be needed as new practices are more widely adopted.

Key Finding: A substantial number of skills are shared between minimal-risk and high-risk occupations.

Recommendation: Future research into skills shared between minimal- and high-risk occupations should be conducted. This analysis can inform the development of pathways for incumbent workers from high-risk toward minimal-risk careers. Education and training providers should consider investments in workforce training opportunities that build upon the skills associated with occupations at low risk of automation. Skills such as interpersonal communication, critical thinking,

problem solving, and creativity are not easily replaced by robotic technology and Al. These are skills that will most likely play a protective role in deferring automation potential of certain occupations and that can help workers remain relevant in the workplace.

Key Finding: Most of the occupations with high employment and low automation risk in the subregion require a bachelor's degree or higher as entry-level education (Exhibit 31).

Recommendation: Community colleges may choose to develop pathways and transfer agreements to four-year colleges and universities that lead into occupations shown in Exhibit 31. Only one occupation falls within the top 10 and requires an associate degree: forest and conservation technicians. General and operations managers, on the other hand, have the highest number of jobs, require a bachelor's degree or higher, and are minimal risk. A staffing patterns analysis indicated that this occupation is most concentrated in the retail trade industry with job titles that include shift supervisors, general managers, and operations managers. In healthcare, medical and health services managers are minimal risk, while numerous occupations in education are also minimal risk: secondary school teachers, except special and career/technical education; middle school teachers, except special and career/technical education; administrators, kindergarten through secondary.

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	General and Operations Managers	4,153	5,754	38.6%	\$31.24	Bachelor's
•	Secondary School Teachers, Except Special and Career/Technical Education	2,476	2,479	0.2%	\$29.33	Bachelor's
•	Forest and Conservation Technicians	1,891	1,388	-26.6%	\$16.07	Associate
•	Middle School Teachers, Except Special and Career/Technical Education	1,414	1,502	6.2%	\$30.37	Bachelor's
•	Construction Managers	1,369	1,509	10.3%	\$20.50	Bachelor's
•	Lawyers	1,167	1,199	2.8%	\$38.77	Doctoral or professional
•	Medical and Health Services Managers	1,005	1,590	58.2%	\$37.56	Bachelor's
•	Civil Engineers	971	1,113	14.6%	\$37.90	Bachelor's
•	Education Administrators, Kindergarten through Secondary	766	861	12.5%	\$51.08	Master's
•	Chief Executives	742	800	7.9%	\$42.04	Bachelor's
•	Below-Average Automation Index Score	•	Minimal A	utomation In	dex Score	

Exhibit 31. Top 10 occupations with the highest employment in 2020 and below-average or minimal automation risk in the Far North subregion

Appendix A: Automation Risk Methodology

Automation Risk Index

The Automation Risk Index used in this study was calculated by Lightcast and measures the susceptibility of an occupation's risk of automation. Using Frey and Osborne's methodology as a framework, Lightcast calculates the risk of automation for an occupation by considering occupational work tasks and time spent on tasks, work activities listed in O*NET, Frey and Osborne's published "computerization probabilities" for each occupation, the risk of similar roles using compatibility scores, and the occupation's share in an industry's risk using staffing patterns. Specifically, the Automation Risk Index measures an occupation's risk of being affected by automation using four measures:

- Percent of time spent on high-risk work
- Percent of time spent on low-risk work
- Number of high-risk jobs in compatible occupations
- Overall industry automation risk

The automation index calculates standardized scores with a base of 100 and a standard deviation of 15. Occupations with a score above 100 have a greater-than-average risk of automation, and occupations with a score below 100 have a lower-than-average risk of automation. Note that the share of time spent on low-risk work is a negative contributor to an occupation's index score (making the index score lower) while the other three measures are positive contributors (making the index score higher). Using the standard deviation, we calculated the following categories to capture the most extreme occupational groupings of automation risk:



Appendix B: Occupational Automation Risk

Automation risk for top 50 occupations in the Far North

There were 359,057 jobs in the Far North in 2020. When focusing on the top 50 occupations based on the number of jobs, these 50 jobs made up over half of all workers, a total of 193,819 in 2020. The following sections focus on these 50 occupations and specify the occupations that are most and least at risk of automation. There are 11 occupations out of the 50 that are above-average automation risk and 11 are high risk (Exhibit B1).

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
•	Cashiers	11,106	10,496	-5.5%	\$14.60	No formal credential
•	Fast Food and Counter Workers	8,058	8,145	1.1%	\$14.43	No formal credential
•	Farmworkers and Laborers, Crop, Nursery, and Greenhouse	7,207	6,411	-11.0%	\$14.13	No formal credential
•	Office Clerks, General	6,335	6,238	-1.5%	\$15.41	HS or equivalent
•	Stockers and Order Fillers	4,610	6,451	40.0%	\$15.68	HS or equivalent
•	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	4,460	5,024	12.7%	\$14.72	No formal credential
•	Heavy and Tractor-Trailer Truck Drivers	4,292	4,518	5.3%	\$20.29	Postsecondary
•	Bookkeeping, Accounting, and Auditing Clerks	4,220	4,016	-4.8%	\$18.50	Some college
•	Landscaping and Groundskeeping Workers	4,217	4,560	8.1%	\$14.39	No formal credential
٠	Laborers and Freight, Stock, and Material Movers, Hand	4,115	4,389	6.7%	\$15.55	No formal credential
•	Maids and Housekeeping Cleaners	4,096	4,042	-1.3%	\$14.24	No formal credential
•	Waiters and Waitresses	3,916	4,096	4.6%	\$14.04	No formal credential
•	Construction Laborers	3,725	3,628	-2.6%	\$16.67	No formal credential
٠	Maintenance and Repair Workers, General	3,628	4,211	16.1%	\$17.31	HS or equivalent
•	Carpenters	3,433	3,274	-4.7%	\$19.58	HS or equivalent
•	Cooks, Restaurant	2,315	3,077	32.9%	\$15.77	No formal credential
•	Cooks, Fast Food	2,292	2,360	3.0%	\$14.57	No formal credential
•	Light Truck Drivers	2,105	2,625	24.7%	\$16.27	HS or equivalent
•	Firefighters	1,975	3,068	55.3%	\$20.44	Postsecondary
•	Automotive Service Technicians and Mechanics	1,942	1,999	3.0%	\$16.87	Postsecondary
•	First-Line Supervisors of Food Preparation and Serving Workers	1,889	3,091	63.6%	\$16.69	HS or equivalent
•	Food Preparation Workers	1,870	2,475	32.4%	\$14.17	No formal credential
	TOTAL	91,80 <u>6</u>	98,194	7.0%		

Exhibit B1. Jobs with above-average and high automation risk in the Far North

There are 25 occupations that are below-average risk, and three that are minimal risk (Exhibit B2).

Risk	Occupation	2020 Jobs	2030 Jobs	% Change	Entry- Level Wage	Typical Entry-Level Education
٠	Home Health and Personal Care Aides	18,430	28,052	52.2%	\$14.03	HS or equivalent
•	Retail Salespersons	8,234	7,662	-6.9%	\$14.90	No formal credential
•	Registered Nurses	6,540	7,848	20.0%	\$49.11	Bachelor's
•	Postsecondary Teachers	4,492	5,844	30.1%	\$41.23	Doctoral or professional
•	Elementary School Teachers, Except Special Education	4,472	5,855	30.9%	\$28.34	Bachelor's
•	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	4,362	4,294	-1.5%	\$17.66	HS or equivalent
•	Teaching Assistants, Except Postsecondary	4,227	4,961	17.4%	\$16.51	Some college
•	General and Operations Managers	4,153	5,754	38.6%	\$31.24	Bachelor's
•	First-Line Supervisors of Retail Sales Workers	3,568	3,413	-4.3%	\$17.22	HS or equivalent
•	Farmers, Ranchers, and Other Agricultural Managers	3,526	3,247	-7.9%	\$14.01	HS or equivalent
•	First-Line Supervisors of Office and Administrative Support Workers	3,065	2,981	-2.8%	\$23.09	HS or equivalent
•	Customer Service Representatives	2,871	2,812	-2.0%	\$16.13	HS or equivalent
•	Childcare Workers	2,780	2,343	-15.7%	\$14.00	HS or equivalent
•	Nursing Assistants	2,533	3,068	21.1%	\$17.48	Postsecondary
•	Correctional Officers and Jailers	2,513	2,417	-3.8%	\$29.33	HS or equivalent
•	Secondary School Teachers, Except Special and Career/Technical Education	2,476	2,479	0.2%	\$29.33	Bachelor's
•	Business Operations Specialists, All Other	2,406	3,102	29.0%	\$22.04	Bachelor's
•	Managers, All Other	2,281	2,575	12.9%	\$19.23	Bachelor's
•	Medical Assistants	2,192	2,473	12.8%	\$17.75	Postsecondary
•	Police and Sheriff's Patrol Officers	2,060	2,390	16.0%	\$31.25	HS or equivalent
•	Accountants and Auditors	2,022	2,299	13.7%	\$27.26	Bachelor's
•	Medical Secretaries and Administrative Assistants	1,978	2,267	14.6%	\$17.14	HS or equivalent
•	Social and Human Service Assistants	1,968	2,006	1.9%	\$17.37	HS or equivalent
•	Sales Representatives, Wholesale and Manufacturing	1,946	2,065	6.1%	\$22.09	HS or equivalent
•	Forest and Conservation Technicians	1,891	1,388	-26.6%	\$16.07	Associate
•	Receptionists and Information Clerks	1,821	1,891	3.9%	\$15.38	HS or equivalent
•	Licensed Practical and Licensed Vocational Nurses	1,664	1,779	6.9%	\$26.90	Postsecondary
•	Management Analysts	1,542	1,831	18.7%	\$29.15	Bachelor's
	TOTAL	102,013	119,096	16.7%		

xhibit B2. Jobs with below-average ar	d minimal autom	ation risk in t	the Far Nortl
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Appendix C: Occupations with 10 or Fewer Jobs or Missing Automation Index Score

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SOC	Description	Automation	2020 Jobs
47-2053	Terrazzo Workers and Finishers	137	0
51-7031	Model Makers, Wood	128	3
51-4071	Foundry Mold and Coremakers	127	2
51-9031	Cutters and Trimmers, Hand	126	2
51-6042	Shoe Machine Operators and Tenders	125	1
49-9045	Refractory Materials Repairers, Except Brickmasons	124	0
47-5071	Roustabouts, Oil and Gas	124	6
51-2021	Coil Winders, Tapers, and Finishers	123	0
51-7032	Patternmakers, Wood	122	1
51-4022	Forging Machine Setters, Operators, and Tenders, Metal and Plastic	122	3
51-4034	Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic	121	5
51-4052	Pourers and Casters, Metal	121	2
51-2051	Fiberglass Laminators and Fabricators	121	5
51-4192	Layout Workers, Metal and Plastic	120	3
51-2011	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	119	0
51-2031	Engine and Other Machine Assemblers	119	8
47-5081	HelpersExtraction Workers	119	1
47-5044	Loading and Moving Machine Operators, Underground Mining	118	0
49-9095	Manufactured Building and Mobile Home Installers	118	2
51-4035	Milling and Planning Machine Setters, Operators, and Tenders, Metal and Plastic	118	5
51-9193	Cooling and Freezing Equipment Operators and Tenders	118	9
51-4051	Metal-Refining Furnace Operators and Tenders	117	0
51-2061	Timing Device Assemblers and Adjusters	117	2
47-5043	Roof Bolters, Mining	117	0
51-6063	Textile Knitting and Weaving Machine Setters, Operators, and Tenders	117	5
51-4061	Model Makers, Metal and Plastic	116	0
51-4062	Patternmakers, Metal and Plastic	116	0
53-7073	Wellhead Pumpers	115	2

soc	Description	Automation Index	2020 J <u>obs</u>
47-5099	Extraction Workers, All Other	115	3
47-5049	Underground Mining Machine Operators, All Other	115	6
47-5051	Rock Splitters, Quarry	115	0
51-4191	Heat Treating Equipment Setters, Operators, and Tenders, Metal and Plastic	114	1
51-6061	Textile Bleaching and Dyeing Machine Operators and Tenders	114	4
51-9194	Etchers and Engravers	113	7
51-6092	Fabric and Apparel Patternmakers	113	1
51-6064	Textile Winding, Twisting, and Drawing Out Machine Setters, Operators, and Tenders	113	6
47-5012	Rotary Drill Operators, Oil and Gas	111	0
49-3052	Motorcycle Mechanics	110	4
49-9092	Commercial Divers	110	2
49-9069	Precision Instrument and Equipment Repairers, All Other	109	8
53-6099	Transportation Workers, All Other	109	6
53-6032	Aircraft Service Attendants	109	6
53-6011	Bridge and Lock Tenders	107	6
29-2092	Hearing Aid Specialists	107	2
39-3099	Entertainment Attendants and Related Workers, All Other	107	7
47-5011	Derrick Operators, Oil and Gas	107	1
33-3041	Parking Enforcement Workers	106	1
53-5022	Motorboat Operators	106	4
45-2021	Animal Breeders	106	5
53-7072	Pump Operators, Except Wellhead Pumpers	106	6
53-4099	Rail Transportation Workers, All Other	106	4
19-3093	Historians	105	7
35-2013	Cooks, Private Household	103	2
51-9162	Computer Numerically Controlled Tool Programmers	102	2
53-7071	Gas Compressor and Gas Pumping Station Operators	98	3
43-4041	Credit Authorizers, Checkers, and Clerks	98	6
39-5091	Makeup Artists, Theatrical and Performance	98	6
43-2099	Communications Equipment Operators, All Other	97	9
53-2031	Flight Attendants	97	4
27-4015	Lighting Technicians	96	2

soc	Description	Automation Index	2020 Jobs
43-9081	Proofreaders and Copy Markers	95	4
43-9031	Desktop Publishers	95	4
29-1024	Prosthodontists	94	0
51-8011	Nuclear Power Reactor Operators	93	0
13-2081	Tax Examiners and Collectors, and Revenue Agents	93	1
33-3052	Transit and Railroad Police	92	5
17-3028	Calibration Technologists and Technicians	92	1
29-1023	Orthodontists	92	7
25-4011	Archivists	92	5
19-4051	Nuclear Technicians	91	0
29-2091	Orthotists and Prosthetists	91	3
15-2021	Mathematicians	90	0
25-9021	Farm and Home Management Educators	90	8
19-3094	Political Scientists	89	9
29-1213	Dermatologists	89	4
29-1029	Dentists, All Other Specialists	88	9
19-4043	Geological Technicians, Except Hydrologic Technicians	88	0
17-2131	Materials Engineers	87	4
27-2032	Choreographers	87	5
29-9092	Genetic Counselors	86	1
17-2121	Marine Engineers and Naval Architects	85	4
17-2021	Agricultural Engineers	85	0
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	85	6
33-3031	Fish and Game Wardens	84	2
29-1243	Pediatric Surgeons	84	0
11-9171	Funeral Home Managers	84	5
19-1099	Life Scientists, All Other	84	4
15-2099	Mathematical Science Occupations, All Other	83	0
19-2021	Atmospheric and Space Scientists	83	9
19-3092	Geographers	82	2
19-3022	Survey Researchers	82	5
17-2031	Bioengineers and Biomedical Engineers	82	1
53-1041	Aircraft Cargo Handling Supervisors	82	4

soc	Description	Automation Index	2020 Jobs
17-2151	Mining and Geological Engineers, Including Mining Safety Engineers	81	0
29-1022	Oral and Maxillofacial Surgeons	75	1
15-2011	Actuaries	75	7
19-1041	Epidemiologists	75	9
19-2032	Materials Scientists	74	0
13-1074	Farm Labor Contractors	73	0
19-1011	Animal Scientists	73	2
19-2011	Astronomers	73	0
11-1031	Legislators	N/A	N/A
55-9999	Military-only occupations	N/A	870
99-9999	Unclassified Occupation	N/A	-
		TOTAL	1,204

Source: Lightcast 2024.1, QCEW Employees, Non-QCEW Employees, and Self-Employed.

Exhibit C2. Fewer than 10 jobs and/or missing Automation Index Score in the North

soc	Description	Automation Index	2020 Jobs
51-7031	Model Makers, Wood	128	4
51-6042	Shoe Machine Operators and Tenders	125	4
49-9045	Refractory Materials Repairers, Except Brickmasons	124	4
51-7032	Patternmakers, Wood	122	1
51-4052	Pourers and Casters, Metal	121	1
47-5044	Loading and Moving Machine Operators, Underground Mining	118	1
49-9095	Manufactured Building and Mobile Home Installers	118	7
51-4051	Metal-Refining Furnace Operators and Tenders	117	8
51-2061	Timing Device Assemblers and Adjusters	117	0
47-5043	Roof Bolters, Mining	117	0
51-6063	Textile Knitting and Weaving Machine Setters, Operators, and Tenders	117	9
51-4061	Model Makers, Metal and Plastic	116	1
51-4062	Patternmakers, Metal and Plastic	116	0
47-5049	Underground Mining Machine Operators, All Other	115	4
53-7073	Wellhead Pumpers	115	7
51-6061	Textile Bleaching and Dyeing Machine Operators and Tenders	114	4
47-5011	Derrick Operators, Oil and Gas	107	0
53-4099	Rail Transportation Workers, All Other	106	4

soc	Description	Automation Index	2020 Jobs
35-2013	Cooks, Private Household	103	4
53-7071	Gas Compressor and Gas Pumping Station Operators	98	4
29-1024	Prosthodontists	94	1
39-4012	Crematory Operators	92	9
19-4051	Nuclear Technicians	91	9
29-1243	Pediatric Surgeons	84	3
13-1074	Farm Labor Contractors	73	0
11-1031	Legislators	N/A	457
55-9999	Military-only occupations	N/A	4,440
99-9999	Unclassified Occupation	N/A	0
		TOTAL	4,988

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