



ADVANCED MANUFACTURING SKILLS CATALOGUE



This project is funded in part by the Government of
Canada's Sectoral Workforce Solutions Program



OVERVIEW

OBJECTIVE

The objective of this analysis is to identify the key skills and competencies required in the manufacturing sector related to technologies which are driving advancements throughout the sector. The technological advancements in manufacturing are largely influenced by the integration of Artificial Intelligence (AI), the technologies of Industry 4.0, and the growing emphasis on decarbonization. These drivers are not only reshaping the production landscape of manufacturing, but are also impacting the set of current and future competencies and skills.

TECHNOLOGIES TRANSFORMING MANUFACTURING

AI stands at the forefront, revolutionizing manufacturing processes through predictive maintenance, quality control, and supply chain optimization. AI's ability to process vast amounts of data at unprecedented speeds allows for more efficient and precise operations, making it a key driver in the sector's evolution. By focusing on AI in skills scanning, industries can identify the necessity for workers proficient in AI technologies, data analysis, and machine learning, skills that are increasingly essential as manufacturing becomes more automated and data-driven.

Industry 4.0 represents the next wave of manufacturing, characterized by smart factories that integrates a set of emerging technologies which work together to achieve higher production efficiency through the digitization of the manufacturing process. This digital transformation demands a workforce skilled in digital literacy, system integration, and cybersecurity. Skills scanning within this technological category helps in pinpointing the growing need for talents who can navigate the complexities of interconnected manufacturing systems.

Decarbonization, driven by global sustainability goals, requires the adoption of green manufacturing practices and technologies. This shift towards eco-friendly operations necessitates skills in renewable energy technologies, waste management, and sustainable supply chain management. By including decarbonization in skills scanning, the manufacturing sector can identify the increasing demand for professionals who can implement and manage sustainable practices.

By not limiting the skills scanning to specific occupations but focusing on these broad technological categories, the approach ensures a comprehensive understanding of the skill sets that will be in demand across various manufacturing jobs. This holistic view is crucial for preparing the current and future workforce for the inevitable technological shifts and sustainability imperatives facing the manufacturing industry.



ARTIFICIAL INTELLIGENCE

BASIC SKILLS

Mathematics
Problem Solving
Curiosity
Self-Motivation
Writing

SOCIAL SKILLS

Communication
Management
Leadership
Mentorship
Customer Service
Presentations
Technical Leadership
Teamwork

TECHNOLOGY

Machine Learning
Computer Science
Deep Learning
Software Engineering
Software Development
Data Science
Data Analysis
Generative Artificial Intelligence
Artificial Neural Networks
Large Language Modeling
Natural Language Processing (NLP)
Automation
Manufacturing Processes

ARTIFICIAL INTELLIGENCE

TECHNICAL SKILLS

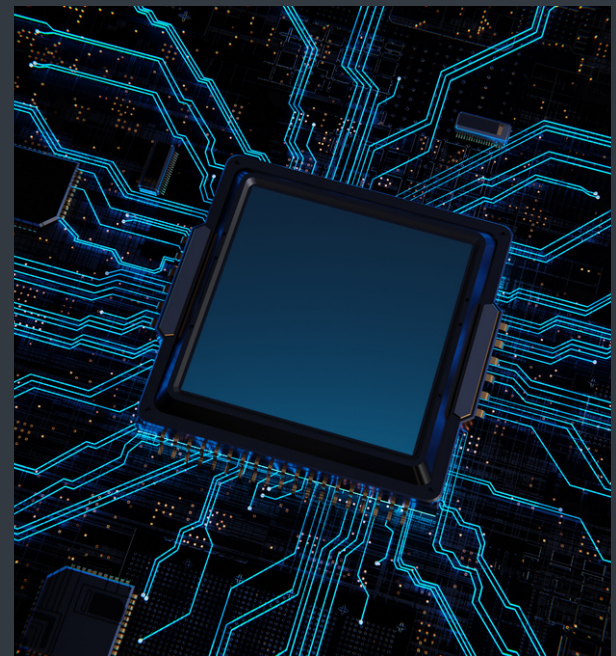
Python (Programming Language)
Algorithms
C/C++ (Programming Language)
TensorFlow
Apache Spark
PyTorch (Machine Learning Library)
Computer Vision
Java (Programming Language)
Microsoft Azure
Big Data
Continuous Improvement and Process-Optimization
MLOps (Machine Learning Operations)
R (Programming Language)
Amazon Web Services
SQL (Programming Language)
Apache Hadoop
Influencing Skills
Statistics
Scikit-Learn (Python Package)

PROBLEM SOLVING & RESOURCE MANAGEMENT

Research
Innovation
Agile Methodology
Operations
Scalability
Creativity

SKILLS HIGHLIGHT

Python plays a crucial role in the field of artificial intelligence (AI) due to its simplicity and versatility. Its extensive libraries and frameworks, such as TensorFlow, PyTorch, and Scikit-learn, provide robust tools for machine learning, deep learning, and data analysis, making the development of AI applications more accessible and efficient. Furthermore, Python's large community and wealth of documentation support innovation and collaboration among AI researchers and developers. This ease of use and strong ecosystem enable rapid prototyping and implementation of AI algorithms, solidifying Python's position as a leading language in AI research and development.





INDUSTRY 4.0

BASIC SKILLS

Analytical Skills
Self-Motivation
Curiosity

SOCIAL SKILLS

Leadership
Customer Service
Mentorship
Ethical Standards and Conduct
Management
Communication

TECHNOLOGY

Cyber Security
Computational Fluid Dynamics (CFD)
Simulations
Robotics
Automation
Security Engineering
Digital Forensics
Vulnerability
IT Security
Computer Science
Ethical Hacking
Software Engineering
CI/CD (Continuous Integration and Deployment)
Deep Learning
Artificial Intelligence

INDUSTRY 4.0

TECHNICAL SKILLS

Continuous Improvement and Process-Optimization

Software As A Service (SaaS)

Linux

MATLAB

Penetration Testing

Simulation Software

Ansys Simulation Software

C/C++ (Programming Language)

AWS CloudFormation

Infrastructure as Code (IaC)

Kubernetes

DevOps

Python (Programming Language)

PyTorch (Machine Learning Library)

Microsoft Azure

Amazon Web Services

Algorithms

Machine Learning

PROBLEM SOLVING & RESOURCE MANAGEMENT

Agile Methodology

Material Handling

Resourcefulness

Vulnerability Management

Operations

Engineering Design Process

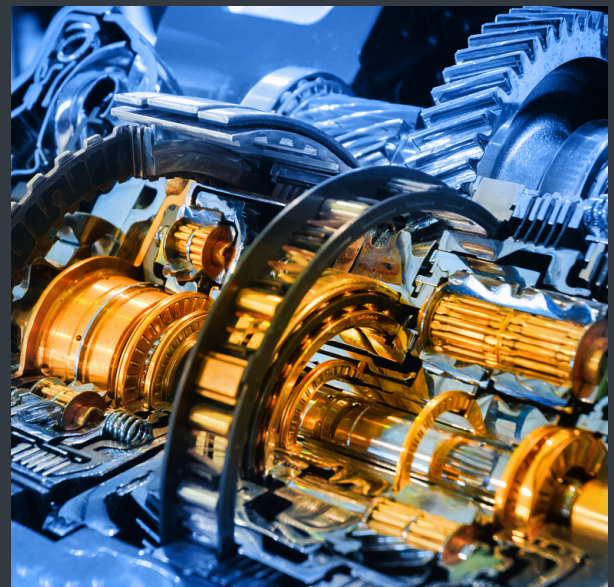
Innovation

Research

Planning

SKILLS HIGHLIGHT

In the context of Industry 4.0, continuous improvement and process optimization are essential for operational efficiency and quality. Proficiency in Lean Manufacturing and Six Sigma methodologies is crucial for identifying and eliminating inefficiencies, significantly reducing waste. Mastery of PDCA (Plan-Do-Check-Act) cycles enhances process adaptability, while expertise in Value Stream Mapping optimizes the flow of information and materials. These skills are vital for integrating digital technologies and boosting productivity within Industry 4.0 frameworks.





DECARBONIZATION

BASIC SKILLS

Problem Solving
Writing
Self-Motivation
Accountability
Analytical Skills

SOCIAL SKILLS

Communication
Management
Leadership
Consulting
Presenting
Teamwork
Mentorship
Negotiation
Ethical Standards and Conduct

TECHNOLOGY

Lean Manufacturing
Energy Management
Quality Control
Industrial Engineering
Renewable Energy
Automation
Net-Zero
Environmental Social and Corporate
Governance (ESG)
Emerging Technologies
Manufacturing Processes

DECARBONIZATION

TECHNICAL SKILLS

Six Sigma Methodology
Continuous Improvement and Process-
Optimization
Kaizen Methodology
Microsoft Office
Kanban Principles
Single-Minute Exchange of Die (SMED)
Process Failure Mode and Effects
Analysis (PFMA)
Power BI

PROBLEM SOLVING & RESOURCE MANAGEMENT

Energy System Transition
Innovation
Value Stream Mapping
Research
Energy Audits
Operations Management
Procurement
Energy Consumption
Prioritization
Employee Assistance Programs
Forecasting
Supply Chain
Troubleshooting (Problem Solving)
Business Development
Purchasing
Waste Minimization
Carbon Management

SKILLS HIGHLIGHT

Six Sigma methodology, with its emphasis on reducing waste and improving efficiency, plays a crucial role in decarbonization within the manufacturing industry. By applying Six Sigma's data-driven approach to identify and eliminate defects in manufacturing processes, companies can significantly reduce their carbon footprint. This reduction in waste not only leads to more sustainable operations but also aligns with global efforts towards environmental conservation, making Six Sigma an invaluable tool for achieving decarbonization goals in manufacturing.



FUTURE OF SKILLS IN MANUFACTURING

With the introduction of new technologies in the workplace, manufacturing workers will be presented with the opportunity to upskill and incorporate advanced technical skills into their repertoire, which can lead to enhanced job security, career growth, and the ability to work alongside cutting-edge technologies. The introduction of new roles in manufacturing will also be essential to integrating these new technologies into the workplace and on the production line, offering new and diverse career paths that merge traditional manufacturing practices with the innovations and technologies of the future. However, the introduction of these transformative technologies like AI, decarbonization and Industry 4.0, doesn't signal the end of traditional manufacturing roles, but rather their evolution and expansion. Existing roles and skills will remain key and essential to the growth of the sector, especially with the looming shortage in many production and skilled trades occupations in manufacturing. With the integration of new technologies in manufacturing, roles in the sector will combine traditional knowledge and new competencies, thereby enriching roles rather than replacing them.



METHODOLOGY

DATA COLLECTION

Research conducted as part of the Future Ready project was used to inform this analysis of the key trends and technologies transforming advanced manufacturing. A list of keywords, which includes the technologies, sub-technologies and techniques in advanced manufacturing was compiled and used to scan multiple platforms and sources for job postings in manufacturing across Canada and the United States.

Job description data were collected by systematically scraping the top matching job postings using the SerpAPI tool. Each job posting extracted includes details such as the job title, company name, location and job description.

To extract job skills from job descriptions, each post was fed through the Lightcast Open Skills API using python script. This step returned a list of skills found in the text, including contextual classification. The skills were then categorized into 6 different categories based on O*NET job skills categories, with two alterations. Technology Skills are related to an area of technology and indicate a broad knowledge based which includes many technical skills (e.g. computer science, machine learning, artificial intelligence). Technical Skills refer to a specific function or ability (e.g. Python, Java, Excel). The categories are as follows:

1. Basic (includes Content and Process Skills)
2. Technical
3. Technology
4. Complex Problem Solving
5. Resource Management
6. Social

It is important to note that O*NET does not provide an exhaustive list of categorized skills; therefore, the categorization of skills in this analysis was performed manually to ensure accuracy.

The Future Ready program is a \$19 million program funded in part by Employment and Social Development Canada's Sectoral Workforce Solutions Program to support companies in onboarding new and diverse workers to Canadian manufacturing. The initiative will also aid Canadian manufacturers in identifying their critical skills gaps to support the future profitability and growth of their organization through NGen's highly regarded Transformation Leadership Program. Through these approaches, the program aims to provide demand-driven solutions for the manufacturing sector, one of the sectors hardest hit by the pandemic, and a key to the recovery of the Canadian economy.

