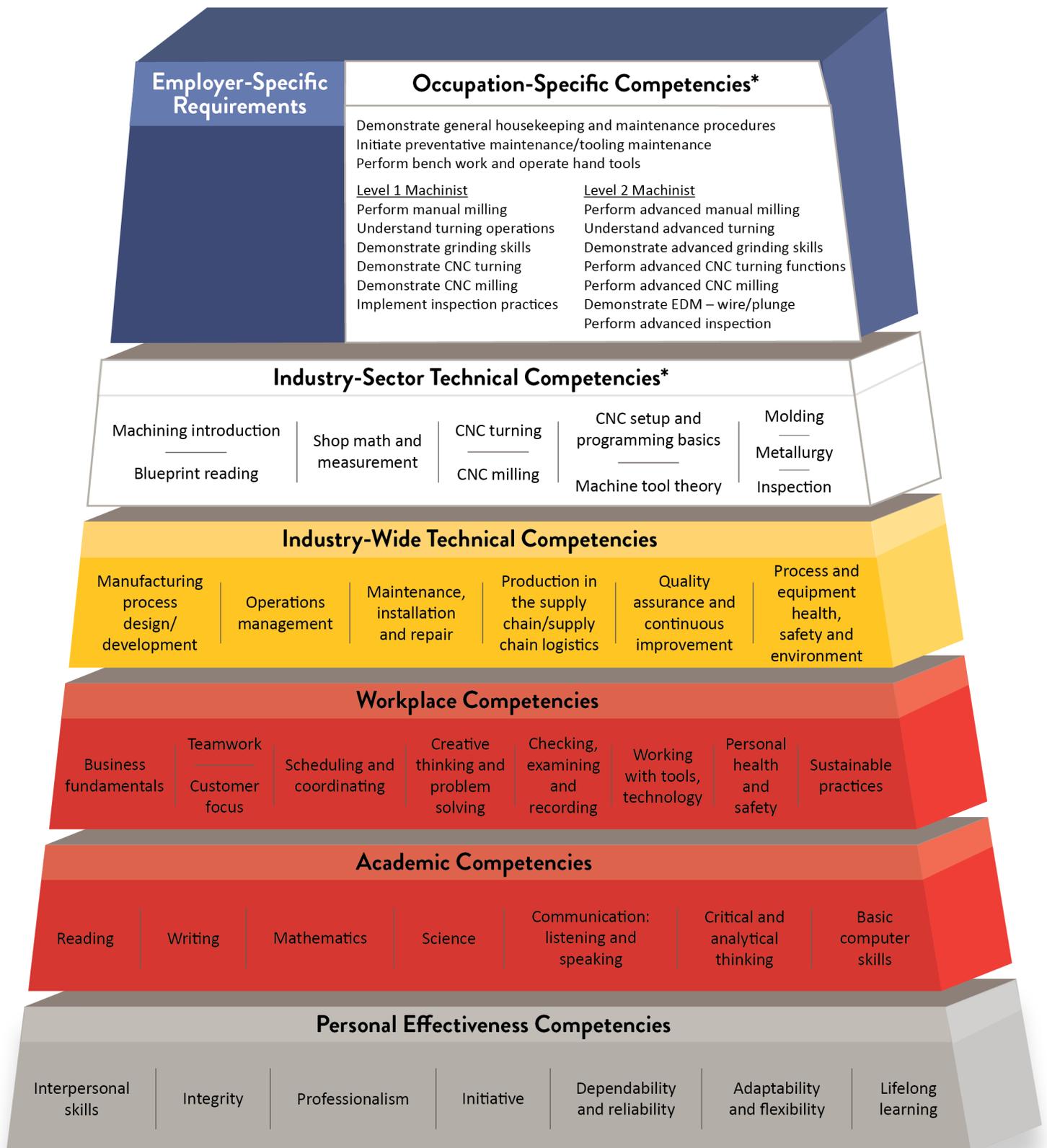


Minnesota Dual-Training Pipeline

Competency Model for Advanced Manufacturing

Occupation: Machinist/Computer Numerical Control (CNC) Operator



Based on: Advanced Manufacturing Competency Model, Employment and Training Administration, United States Department of Labor, February 2025. For more detailed information about competency model creation and sources, visit dli.mn.gov/business/workforce/advanced-manufacturing.

Competency Model for Machinist/ Computer Numerical Control (CNC) Operator

Machinist/Computer Numerical Control (CNC) Operator – An individual who operates CNC machines to shape metal or plastic parts. Responsibilities include interpreting blueprints and manuals, setting up equipment, selecting and loading cutting tools, and inspecting parts during production. They measure and mark materials, perform basic machine maintenance, and ensure safety by wearing protective gear. They also check tool sharpness and detect malfunctions using precision instruments like micrometers and calipers.

*Pipeline recommends the Industry-Sector Technical Competencies as formal training opportunities (provided through related instruction) and the Occupation-Specific Competencies as on-the-job (OJT) training opportunities.

Industry-Sector Technical Competencies

Related Instruction for dual training means the organized and systematic form of education resulting in the enhancement of skills and competencies related to the dual trainee's current or intended occupation.

- **Machining introduction** – Learn basic machining operations including safety, MSDS, measuring tools and use of drill presses and band saws.
- **Blueprint reading** – Knowledge in reading and understanding industrial prints.
- **Shop math and measurement** – Training in basic math including linear measurement, metrics and beginning algebra.
- **CNC turning** – Training in how to operate a lathe including types of chucks, cutting tools, speeds and feeds, tool care, threads, part production and general inspection.
- **CNC milling** – Learn mill operation including clamping, tools and holders, speeds, and feeds, cutting depths/width along with direction.
- **CNC setup and programming basics** – Exposure to manual programming of Computer Numerical Control (CNC) machine tools. Learn types of CNC controls, machinery, programming formats and basic terminology.

- **Machine tool theory** – Learn to complete the processes required for manufacturing a precision part, use standard shop safety practices, set-up and operate standard manufacturing machines, complete accurate layouts, explain applications of hand tools and use correctly and use basic measuring tools.
- **Molding** – Understand the fundamentals of injection molding technology.
- **Metallurgy** – Know the basic principles of metals, the behavior of metals and the processes which affect them, as well as the most common metals used in industrial processes.
- **Inspection** – Know the proper methods and instruments used to effectively inspect parts in the shop, including using instruments such as the caliper, micrometer, and CMM.

Occupation-Specific Competencies

On-the-Job Training is hands-on instruction completed at work to learn the core competencies necessary to succeed in an occupation. Common types of OJT include job shadowing, mentorship, cohort-based training, assignment-based project evaluation and discussion-based training.

- **Demonstrate general housekeeping and maintenance procedures** – Demonstrate the ability to maintain tools and machinery with basic cleaning and maintenance procedures.
- **Initiate preventative maintenance /tooling maintenance** – Practice industry approved procedures for conducting preventative maintenance on machines and tools.
- **Perform bench work and operate hand tools** – Knowledge of the various tools, methods, and procedures for common machine shop benchwork and hand tool work.

Level 1 Machinist

- **Perform manual milling** – Display basic operation of the vertical and horizontal milling machines and the ability to use cutting tools and holders, setups, spindles and arbors, work holding methods.
- **Understand turning operations** – Demonstrate basic lathe applications such as understanding turning safety, calculating speeds and feeds, using various tools and tool holders, identifying basic tool geometry, and the use of common lathe spindle tooling.
- **Demonstrate grinding skills** – Use surface grinders with proper set up techniques and grinding processes.

- **Demonstrate CNC turning** – Demonstrate CNC lathe operations, control functions, the letter address system, the program format, and machine setup.
- **Demonstrate CNC milling** – Demonstrates the fundamentals of CNC machining processes with skills in work holding, speeds and feeds for various materials and functions and understanding of capabilities of CNC machining tools.
- **Implement inspection practices** – Demonstrate the proper methods and instruments used to effectively inspect parts in the shop, including using instruments such as the caliper, micrometer, and CMM.

Level 2 Machinist

- **Perform advanced manual milling** – Use mill for advanced techniques such as squaring a block, perform angle layouts with various methods including a sign bar. Perform simple keyset and slotting operations.
- **Understand advanced turning** – Ability to operate lathe for advanced processes such as form radius, single-point isometric threads, turn spherical radius, use a radius gauge, as well as advanced taper techniques and work support devices.
- **Demonstrate advanced grinding skills** – Demonstrate advanced techniques of grinding including use of sine bars and chucks, sine bars, gage blocks, wheel balancers, various grinding wheels and diamond dressers.
- **Perform advanced CNC turning functions** – Able to perform advanced techniques of CNC lathe including turning with an offset talk stock and boring functions.
- **Perform advanced CNC milling** – Use advanced techniques of setting-up and operating CNC milling machines including principles of clamping and locating work piece, selection of cutting tools and holders along with use of rotary tables. Demonstrate pocketing slotting and key seat techniques as well as edging techniques.
- **Demonstrate EDM – wire/plunge** – Know how to prepare, operate, and maintain the wire EDM machine. Create basic G-code without the use of CAM software.
- **Perform advanced inspection** – Able to use measuring instruments relating to state-of-the-art manufacturing environments, such as coordinate measuring machine and calibration. Understanding of quality control, total quality management (TQM), and statistical process control (SPC) as they relate to manufacturing environments.

Updated December 2025