



The Manufacturers Association

TRAINING PLAN – CNC Machinist (YEAR 2)

Total Related Training Instruction (RTI) Hours: 144

Learning Unit	Hrs. of Instruction
Unit 1: Benchwork and Layout <ul style="list-style-type: none"> ➤ Layout tools ➤ Tapping ➤ Reaming ➤ Filing ➤ Engraving ➤ Stamping 	5
Unit 2: Cutting and Drilling <ul style="list-style-type: none"> ➤ Cutting Operations ➤ Drilling Operations ➤ Workholding ➤ Tool Materials ➤ Tool Geometry 	33
Unit 3: Grinding Operations <ul style="list-style-type: none"> ➤ Surface Grinding ➤ Cylindrical Grinding ➤ Centerless Grinding ➤ Grinding Variables ➤ Grinding Wheel Selection and Geometry 	38
Unit 4: Manual Mill <ul style="list-style-type: none"> ➤ Set Up ➤ Operation ➤ Speeds and Feeds 	26.5
Unit 5: Manual Lathe <ul style="list-style-type: none"> ➤ Set Up ➤ Operation ➤ Speeds and Feeds 	26.5
Unit 6: Basic Metrology and Inspection <ul style="list-style-type: none"> ➤ Hole Standards ➤ Thread Standards ➤ Texture Standards 	15.5



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Unit 1: Benchwork and Layout

The learning unit instructs the worker in various aspects of benchwork and layout. Layout is the process of marking a workpiece prior to cutting in order to have a visual guideline during cutting operations. Benchwork includes various cutting processes that machinists complete by hand rather than on a machine when creating part features that require less power and force. Common benchwork operations include hand tapping, hand reaming, hand filing, and engraving.

Learning Outcomes and Content

1. Describe benchwork and layout.
2. Explain the importance of layout.
3. Identify common layout tools.
4. Describe hand tapping and identify the three basic types of hand taps.
5. Identify common hand tapping tools.
6. Describe hand reaming and identify basic types of hand reamers.
7. Describe hand filing
8. Describe engraving and hand stamping

Learning Modules

Module	Hrs. of Instruction	Provider
Benchwork and Layout Operations - This learning module provides a detailed overview of the various benchwork and layout processes that operators often need to perform during manual machining.	1.5	ToolingU-SME
Benchwork and Layout Practical – This learning module will teach a worker how complete various benchwork and layout activities commonly associated with manual machining. Workers will gain hands on experience with hand tapping, hand reaming, hand filing, engraving, and hand stamping.	3.5	Facility

Unit 2: Cutting and Drilling

The learning unit introduces a worker to various cutting and drilling operations. Instruction covers basic cutting theory, metal cutting fluids, workholding devices, clamping basics, and tool selection.

Learning Outcomes and Content

1. Identify the most common cutting processes, as well as the machines used to perform them.
2. Identify the types of machine tools used in metal cutting operations and describe their function.
3. Describe chip formation and how it affects surface finish, part quality, and tool life.
4. Identify optimal band sawing variables and conditions.
5. Identify the common types of cutting fluids and describe their optimal use.
6. Describe how the tool material dictates the material removal rate, surface finish and tolerance, and expense to the manufacturer in the form of reduced scrap, extended tool life, production rates, and part quality.
7. Identify the different carbide grades and select the proper grade for a particular cutting operation.
8. Identify clamping components and describe their relative advantages.
9. Identify common types of tool wear and strategies to reduce or prevent them from occurring.
10. Describe how optimizing cutting conditions leads to better products, higher output, and reduced manufacturing costs.



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11. Demonstrate the ability to safely setup and operate machine tools to perform routine sawing operations.
12. Demonstrate the ability to safely setup and operate machine tools to perform routine drilling operations.

Learning Modules

Module	Hrs. of Instruction	Provider
Cutting Processes – This learning module provides an introductory overview of the common metal cutting operations.	1.5	ToolingU-SME
Overview of Machine Tools – This learning module provides an overview of the basic machine tools used in metal cutting operations.	1.5	ToolingU-SME
Basic Cutting Theory – This learning module provides an introductory overview of metal cutting theory and chip formation.	1.5	ToolingU-SME
Band Saw Operation – This learning module gives an in-depth description of the considerations required for band sawing operations.	1.5	ToolingU-SME
Introduction to Metal Cutting Fluids – This learning module provides an overview of the use of cutting fluids in machining operations, including basic fluid safety and maintenance.	1.5	ToolingU-SME
Introduction to Workholding – This learning module introduces the role of a workholding device during the manufacturing process and identifies common groups of these devices.	1.5	ToolingU-SME
Cutting Tool Materials – This learning module provides an in-depth discussion of various cutting tool materials and their properties.	1.5	ToolingU-SME
Carbide Grade Selection – This learning module describes the different carbide tool grades and explains how to select the proper grade for a cutting operation.	1.5	ToolingU-SME
Clamping Basics – This learning module covers the most common types of clamping components and explains their relative advantages and applications.	1.5	ToolingU-SME
ANSI Insert Selection – This learning module provides information on how to identify the qualities and properties of a carbide cutting insert based on its ANSI insert number.	1.5	ToolingU-SME
Advanced Tool Materials – This learning module describes advanced metal-cutting tool materials: how they are made and how they are used.	1.5	ToolingU-SME
Drill Tool Geometry – This learning module provides an overview of each tool angle for a drill, including point angle and helix angle, and details the impact that each angle has on a cutting operation.	1.5	ToolingU-SME



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Optimizing Tool Life and Process – This learning module provides a detailed overview of the various considerations necessary for prolonging cutting tool life.	1.5	ToolingU-SME
Impact of Workpiece Materials - This learning module gives a detailed overview of the various types of workpiece materials, how they can be processed, and the challenges posed by each.	1.5	ToolingU-SME
Sawing Practical - This learning module will teach a worker how to plan for a sawing project and develop the skills required to use sawing equipment. Safe working procedures and standard work will be emphasized when setting up and operating the sawing equipment. The session will also discuss routine maintenance responsibilities required on sawing equipment.	6	Facility
Drilling Practical - This learning module will teach a worker how to plan for a drilling project and develop the skills required to use drilling equipment. Safe working procedures and standard work will be emphasized when setting up and operating the drill. The session will also discuss routine maintenance responsibilities required on drilling equipment.	6	Facility

Unit 3: Grinding Operations

The learning unit introduces a worker to various grinding processes. Instruction includes topics such as grinding theory, grinding variables, and grind wheel materials and selection. The instruction will also teach a worker how to set up and operate different types of grinding machines.

Learning Outcomes and Content

1. Identify and describe the various types of grinding processes.
2. Describe safe grinding practices that prevent workplace injury.
3. Identify the components of a surface grinder.
4. Identify the components of a cylindrical grinder
5. Identify the components of a centerless grinder.
6. Demonstrate the ability to safely setup and operate a surface grinder
7. Demonstrate the ability to safely setup and operate a cylindrical grinder
8. Demonstrate the ability to safely setup and operate a centerless grinder
9. Explain how proper coolant application can optimize wheel performance and improve finished parts, reducing scrap and tool cost.
10. Describe how an awareness of grinding fluid hazards and maintenance can increase workplace safety and reduce coolant costs.
11. Understand grinding variables and their impact on reducing manufacturing costs and increasing quality.
12. Describe how to grind ferrous metals successfully, and explain what potential problems to anticipate and check for within the grinding operation.
13. Describe how to grind nonferrous metals successfully, and explain what potential problems to anticipate and check for within the grinding operation.
14. Describe how knowledge of grinding wheel materials will help to ensure high quality, high productivity, and low scrap rates.
15. Describe how improper dressing or truing can lead to poor surface finish, improper tolerances, scrapped parts, and wheel failure.
16. Explain how an incorrect or incompatible grinding wheel can lead to scrapped parts, damaged wheels or machines, and wasted time and money.
17. Describe common wheel geometries and the applications appropriate for each.

Learning Module



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Module	Hrs. of Instruction	Provider
<u>Grinding Processes</u> – This learning module provides a comprehensive overview of the various types of grinding used in modern manufacturing environments.	1.5	ToolingU-SME
<u>Grinding Safety</u> – This learning module provides an overview of safety concerns and precautions for grinding operations.	1.5	ToolingU-SME
<u>Basic Grinding Theory</u> – This learning module provides an overview of the general process of grinding.	1.5	ToolingU-SME
<u>Basics of the Surface Grinder</u> – This learning module provides an overview of the components, considerations, and varieties of the surface grinding machine.	1.5	ToolingU-SME
<u>Basics of the Cylindrical Grinder</u> – This learning module provides a comprehensive introduction to different types and components of cylindrical grinding machines.	1.5	ToolingU-SME
<u>Basics of the Centerless Grinder</u> – This learning module provides a comprehensive introduction to centerless grinding.	1.5	ToolingU-SME
<u>Setup for the Surface Grinder</u> - This learning module provides a comprehensive overview of the steps and considerations involved in setting up a surface grinding machine.	1.5	ToolingU-SME
<u>Setup for the Cylindrical Grinder</u> - This learning module provides a comprehensive overview of the steps and considerations involved in setting up a cylindrical grinding machine.	1.5	ToolingU-SME
<u>Setup of the Centerless Grinder</u> - This learning module explains how to set up a centerless grinder for typical outer diameter (OD) operations.	1.5	ToolingU-SME
<u>Surface Grinder Operation</u> - This learning module provides step-by-step guidelines on how to grind a rectangular workpiece.	1.5	ToolingU-SME
<u>Cylindrical Grinder Operation</u> - This learning module provides a detailed overview of the steps needed to perform the various types of operations possible on a cylindrical grinder.	1.5	ToolingU-SME
<u>Centerless Grinder Operation</u> - This learning module explains the basic procedures required to properly operate a centerless grinder.	1.5	ToolingU-SME
<u>Introduction to Grinding Fluids</u> - This learning module provides an overview of the uses, types, and selection considerations of grinding fluids, or coolants, used in various machining operations.	1.5	ToolingU-SME
<u>Grinding Variables</u> - This learning module provides a detailed overview of the different variables involved in any given grinding operation.	1.5	ToolingU-SME



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Grinding Ferrous Metals - This learning module provides an in-depth overview of the considerations involved with grinding various ferrous metal workpiece materials.	1.5	ToolingU-SME
Grinding Nonferrous Metals - This learning module provides an in-depth overview of the considerations for grinding nonferrous workpiece materials.	1.5	ToolingU-SME
Grinding Wheel Materials - This learning module provides a detailed overview of the various abrasive and bond materials used in grinding wheels.	1.5	ToolingU-SME
Dressing and Truing - This learning module provides a guide to performing necessary grinding wheel preparations.	1.5	ToolingU-SME
Grinding Wheel Selection - This learning module provides a guide on selecting the ideal grinding wheel from a grinding wheel manufacturer's catalog.	1.5	ToolingU-SME
Grinding Wheel Geometry - This learning module provides an overview of common grinding wheel geometries according to American National Standards Institute (ANSI) standards.	1.5	ToolingU-SME
Grinding Practical – This learning module will teach a worker how to plan for a grinding operation and develop the skills required to use various grinding equipment, including a surface grinder, cylindrical grinder, and a pedestal/tool & cutter machine grinder. Safe working procedures and standard work will be emphasized when setting up and operating the grinder. The session will also discuss routine maintenance responsibilities required on grinding equipment.	8	Facility

Unit 4: Manual Mill

The learning unit introduces the worker to the manual milling process. Instruction includes an overview of workholding devices, mill set up, operation, and adjusting speeds and feeds.

Learning Outcomes and Content

1. Describe standard workholding devices
2. Identify the groups of workholding devices.
3. Identify the workholding devices used for mill and lathe operations.
4. List the steps an operator must follow to ensure proper manual mill setup.
5. Describe the steps to operate a manual mill.
6. Describe the cutting variables for milling operations.
7. Identify the various angles involved in mill tool geometry and implement the proper tool geometry for mill cutting processes.
8. Under the supervision of a journeyworker, demonstrate the ability to safely setup and operate a manual mill to perform routine milling operations.

Learning Modules

Module	Hrs. of Instruction	Provider
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Workholding Devices – This learning module identifies the standard workholding devices used for both the mill and the lathe.	1.5	ToolingU-SME
Manual Mill Basics - This learning module introduces the manual vertical and horizontal milling machines.	1.5	ToolingU-SME
Manual Mill Set Up – This learning module introduces important considerations that a mill operator must make before starting any cutting process as well as the steps an operator must follow to ensure proper manual mill setup.	1.5	ToolingU-SME
Manual Mill Operation – This learning module serves as a guide for manually machining various features onto a workpiece. The class takes the users through the steps of creating a part on the manual mill, including determining the order of operations, squaring the six sides, creating a step, grooving, center drilling, and drilling.	1.5	ToolingU-SME
Holemaking on the Manual Mill – This learning module provides information on the principles and processes for various holemaking operations that the manual milling machine can perform.	1.5	ToolingU-SME
Speed and Feed for the Mill – This learning module provides a thorough explanation of cutting variables for mill operations, including how these variables are measured, selected, and set.	1.5	ToolingU-SME
Mill Tool Geometry - This learning module provides an overview of the possible tool angles and insert features for a multi-point milling cutter, detailing the affect each angle has on a cutting operation.	1.5	ToolingU-SME
Manual Milling Practical -This learning module will teach a worker how to plan for milling and develop the skills required to use a mill. This includes application of determining the order of operations, squaring the six sides, creating a step, grooving, center drilling, and drilling through hands-on instruction. Safe working procedures and standard work will be emphasized when setting up and operating the mill. The session will also discuss routine maintenance responsibilities required on mill equipment	16	Facility

Unit 5: Engine Lathe

The learning unit introduces the worker to the manual lathe process. Instruction includes an overview of lathe set up, operation, and adjusting speeds and feeds.

Learning Outcomes and Content

1. List the steps an operator must follow to ensure proper engine lathe setup.
2. Describe the steps to operate an engine lathe.
3. Describe the cutting variables for lathe operations.
4. Under the supervision of a journeyworker, demonstrate the ability to safely setup and operate an engine lathe to perform routine turning operations.

Learning Modules



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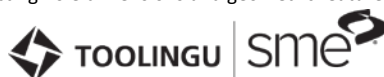
Module	Hrs. of Instruction	Provider
Engine Lathe Basics - This learning module introduces the components and controls used on a manual lathe.	1.5	ToolingU-SME
Engine Lath Set Up – This learning module introduces important considerations that a lathe operator must take before starting any cutting process as well as the steps to ensure proper engine lathe setup.	1.5	ToolingU-SME
Engine Lathe Operation – This learning module guides you through the machining of a cylindrical part using inner- and outer-diameter cutting operations as well as explains general principles surrounding each operation.	1.5	ToolingU-SME
Taper Turning on the Engine Lathe – This learning module is an introductory class covering methods for turning basic tapered parts on an engine lathe.	1.5	ToolingU-SME
Threading on the Engine Lathe – This learning module describes the manual lathe components used for threading and explains how to cut and inspect an external and internal thread.	1.5	ToolingU-SME
Speed and Feed for the Lathe – This learning module provides a thorough explanation of cutting variables for lathe operations, including how these variables are measured, selected, and set.	1.5	ToolingU-SME
Lathe Tool Geometry – This learning module provides a description of single-point lathe tool angles, detailing the effect these angles have on a cutting operation.	1.5	ToolingU-SME
Turning Practical - This learning module will teach a worker how to plan for turning and develop the skills required to use a lathe to parallel turn and face; center drill; parallel turn to a shoulder; turn external tapers or angles; cut chamfers and external screw threads; drill and ream workpieces through hands-on instruction. Safe working procedures and standard work will be emphasized when setting up and operating the lathe. The session will also discuss routine maintenance responsibilities required on lathe equipment.	16	Facility

Unit 6: Basic Metrology and Inspection

The learning unit instructs the worker in advanced metrology and inspection of CNC machined parts using equipment such as optical comparators and CMMs.

Learning Outcomes and Content

1. Explain how to measure common hole features with plug gages, pin gages, and calipers and verify they are within tolerance.
2. Explain how to measure common threaded features with internal and external thread gages and verify the features are within tolerance.
3. Describe commonly used methods for tolerancing a part's surface roughness in a production environment.
4. Describe best practices for inspecting the complete layout of a prismatic part.
5. Describe best practices for inspecting the complete layout of a cylindrical part.
6. Describe advanced methods for inspecting hole dimensions and geometric features in a lab setting.





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7. Describe best practices for using the optical comparator to inspect parts.
8. Describe best practices for using the CMM to inspect parts
9. Describe best practices for instrument and gage calibration, along with correct documentation of calibration efforts.
10. Describe the various methods for incorporating in-line inspection into an established production process.
11. Demonstrate how to use an Optical Comparator to inspect a part.
12. Demonstrate how to use a CMM to inspect a part.

Learning Modules

Module	Hrs. of Instruction	Provider
<u>Hole Standards and Inspection</u> - This learning module provides a comprehensive introduction to hole inspection using contact instruments.	1.5	ToolingU-SME
<u>Thread Standards and Inspection</u> - This learning module explains the various parts of threads and how to inspect them.	1.5	ToolingU-SME
<u>Surface Texture and Inspection</u> - This learning module provides information on surface finish and methods involved for its inspection.	1.5	ToolingU-SME
<u>Inspecting a Prismatic Part</u> - This learning module explains the measurements, methods, and inspection tools necessary to confirm that a prismatic part meets its specifications.	1.5	ToolingU-SME
<u>Inspecting a Cylindrical Part</u> - This learning module explains the measurements, methods, and inspection tools necessary to confirm that a cylindrical part meets its specifications.	1.5	ToolingU-SME
<u>Inspection Practical</u> – This hands-on learning module teaches a worker the step by step procedures for conducting basic part inspections.	7.5	Facility