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ABSTRACT

This curriculum guide was developed from a Technical Committee Report prepared with the assistance of industry personnel and containing a Task List which is the basis of the guide. It presents competency-based program standards for courses in precision machining technology and is part of the Idaho Vocational Curriculum Guide Project, a cooperative effort among secondary and postsecondary instructors and administrators and business representatives. The purpose of the program is to prepare students for employment as machinists, filers, grinders, buffers, lay out workers, mill operators, or computer numerically controlled machine operators, or to provide supplemental training for persons already employed in these occupations. Areas covered in the guide include communication skills, leadership skills, human relations and employability skills, safe and efficient work practices, shop mathematics and blueprints, shaping metal parts, bench work, precision measurement, layout, and inspection. The guide contains a task profile that outlines the curriculum and 13 task listings and performance standards that correspond to the 13 modules in the guide. The modules cover the following topics: employability skills, prerequisite machining, bench work, power saws, pedestal grinders, drill presses, lathes, milling machines, surface grinding machining, tool and cutter grinding machines, computerized numerical control, electric discharge machines, and heat and treat furnaces. Each module consists of an introduction and a list of tasks correlated to a performance objective and a list of enabling objectives. (KC)

VE#136

PRECISION MACHINING TECHNOLOGY

JUNE 1990

Division of Vocational Education
650 West State Street
Boise, Idaho 83720

Idaho State Board for Vocational Education

VE# 136

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ACKNOWLEDGEMENTS

Planning, developing and writing this publication required the coordinated efforts of many people involved in the occupational field of Precision Machining in the State of Idaho. Appreciation is expressed to the vocational Precision Machining instructors, their administrators and the Technical Committee members who provided their assistance to the development of this document.

The Idaho Division of Vocational Education obtained permission from the State of Alabama to use Alabama Curriculum Standards as a base document in 1984. This revision is based on a Technical Committee validation of the tasks in the occupational task list from the State of Florida and a subsequent development of performance objectives by a writing team.

The Technical Committee members were: Russ Ferguson, Hewlett Packard; Tom O'Brien, Hewlett Packard; Daniel Wenstrom, Precision Machine and Supply, Inc.; Robert J. Zweifel, Power Tool & Machine Company; Paul King, Hewlett Packard.

The curriculum committee responsible for reviewing and modifying the material included the following instructors: John Rudolph, Lewiston High School; Harvey Ward, Idaho Falls High school; Rolland Pywell, Nampa High School; Tom Price, North Idaho College; James Straub, North Idaho College; Don Wertman, Boise State University, Gary Fiege, Idaho State University. The Curriculum writer was Don Siplon. The Division sincerely appreciates the time and effort devoted by these people in completing this manual.

Don Eshelby
Director of Program Services

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Trades, Industrial and Technical Supervisor

State of Idaho
DIVISION OF VOCATIONAL EDUCATION

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Greetings:

The Division of Vocational Education is pleased to provide you with this State Curriculum Guide as a part of our commitment to your efforts in conducting quality educational programs for students who are preparing for employment in meaningful and rewarding occupations.

We know that a great deal of time and effort goes into the operation of a Vocational Education program, and we applaud your local efforts to make these programs available for students. This State Guide should assist you in these efforts.

The competency-based State Guide was developed from a Technical Committee Report prepared with the assistance of industry personnel. The Report includes a Task List which is the basis for the State Guide. The Tasks identified in the Technical Committee Report were representative of the competencies needed by a worker to be hired or employed in Idaho businesses.

Vocational Education has adopted the Competency-Based approach as the primary method of delivering Vocational Education skills to students. Competency Profiles are available for each student enrolled in programs as a means of recording student progress. The Profile is used as a student record when additional training is sought -- aiding in the program articulation process. The Profile also communicates to employers those skills the student has mastered.

We hope you find this document useful. Your comments are welcome!

Trudy Anderson, Ph.D.
Administrator

INTRODUCTION

The Idaho Vocational Curriculum Guide Project is a cooperative effort among secondary and postsecondary instructors and administrators to develop competency-based program standards for curriculum content for the Precision Machining Technology Program.

The Precision Machining Technology Curriculum was developed utilizing the Catalog of Performance Objectives, Criterion-Referenced Measures, and Performance Guides for Machining Technology compiled by the States of Alabama and Florida for the Vocational-Technical Education Consortium of States (V-TECS). V-TECS is a multi-state organization committed to curriculum research in specific occupational areas. The content of this document is directed toward the occupational area of Precision Machining Technology - not toward a specific institution in the State.

The benefits to students and institutions derived from the development of these curriculum competencies should be considerable. Articulation of students from secondary to postsecondary programs will be aided through a single set of curriculum standards. Local evaluation of programs and curricula can be accomplished using the standards as an objective measure. Institutions will be able to utilize the curriculum guide in a flexible manner to assure that vocational programs meet the needs of local business and industry.

TASK PROFILE

CURRICULUM FRAMEWORK PROGRAM AREA: Trade & Industrial Education

IDAHO DIVISION OF VOCATIONAL EDUCATION REVISION DATE: June 1990

PROGRAM TITLE: Precision Machining Technology

IDAHO CODE NUMBER: 6232 CIP#: 48.0503

I. MAJOR CONCEPTS/CONTENT: The purpose of this program is to prepare students for employment as machinists (600.280-022), filers (705.484-010), grinders (603.280-018), buffers (603.382-010), lay out workers (600.281-018), cut off saw operators (607.682-010), drill press operators (606.682-014), lathe operators (604.280-010), mill operators (605.685-030), C.N.C. machine operators (609.662-010), or to provide supplemental training for persons previously or currently employed in these occupations.

The content includes, but is not limited to, communication skills, leadership skills, human relations and employability skills, safe and efficient work practices, shop math and blueprints, shaping metal parts to required size, bench work, precision measurement, layout, and inspection.

II. LABORATORY ACTIVITIES: Machine shop laboratory activities are an integral part of this program and include the set-up and operation of grinders, buffers, cut off saws, drill presses, lathes, milling machines, and machines with computerized numerical controls.

III. SPECIAL NOTE: The Vocational Industrial Clubs of America, Inc., (VICA) is an appropriate vocational student organization for providing communications, leadership, human relations, and employability training experiences and for reinforcing specific vocational skills. When provided, these activities are considered an integral part of this program.

The cooperative method of instruction may be utilized for this program. Whenever the cooperative method is offered, the following is required for each student: a training plan, signed by the student, teacher, and employer which includes instructional objectives and a list of on-the-job and in-school learning experiences; a work station which reflects equipment, skills and tasks relevant to the occupation the student has chosen as a career goal. The student must receive compensation for work performed.

The typical length of the postsecondary program for the average achieving student is 1800 contact hours (2160 clock hours). The recommended length for secondary programs is 900 hours with multi period-blocks of instruction provided to accomplish a major portion of the listed competencies.

IV. INTENDED OUTCOMES: After successfully completing this program, the student will be able to:

1. Demonstrate employability skills and habits.
2. Perform prerequisite machining skills.
3. Demonstrate proficiency in performing bench work skills.
4. Demonstrate proficiency in setting up and operating power saws.
5. Demonstrate proficiency in setting up and operating pedestal grinders.
6. Demonstrate proficiency in setting up and operating drill presses.
7. Demonstrate proficiency in setting up and operating lathes.
8. Demonstrate proficiency in setting up and operating milling machines.
9. Demonstrate proficiency in setting up and operating surface grinding machines.
10. Demonstrate proficiency in setting up and operating tool and cutter grinding machines.
11. Demonstrate proficiency in applying computerized numerical control operations skills.
12. Describe and identify EDM machine functions and operations.
13. Demonstrate proficiency in setting up and operating heat treat furnaces.

- INSTRUCTIONAL LEVEL CODE -

E - Student is introduced to the concept and is familiar with basic operational functions. This level denotes basic instructional content necessary to enter the job market.

R - Student can perform the activity with minimum supervision. This level denotes instructional level necessary to retain a job after obtaining one and working for a short while.

A - Advanced level skills. The student is taught these skills only when the other tasks have been mastered. These are also used for short term training or upgrade training classes.

TASK LISTING

STUDENT PERFORMANCE STANDARDS — EFFECTIVE DATE: June 1990

PROGRAM AREA: Trade & Industrial Education

PROGRAM TITLE: Precision Machining Technology

01.0 DEMONSTRATE EMPLOYABILITY SKILLS - The student will be able to:

Level

E
- 01.01 Identify employment opportunities
- 01.02 Apply employment-seeking skills
- 01.03 Interpret employment capabilities
- 01.04 Demonstrate appropriate work behavior
- 01.05 Maintain a business-like image
- 01.06 Maintain working relationships with others
- 01.07 Communicate on the job
- 01.08 Adapt to change
- 01.09 Demonstrate a knowledge of business operation

02.0 PERFORM PREREQUISITE MACHINING SKILLS - The student will be able to:

Level

E
- 02.01 Demonstrate proficiency in maintaining immediate work area
- 02.02 Perform mathematical calculations
- 02.03 Demonstrate proficiency in blueprint reading and machine planning
- 02.04 Perform measuring operations
- 02.05 Perform maintenance on machines and tools

03.0 DEMONSTRATE PROFICIENCY IN PERFORMING BENCH WORK SKILLS
The student will be able to:

Level

E
- 03.01 Cut materials by using hand hacksaws
- 03.02 Cut threads by using hand taps and dies
- 03.03 Ream holes by using hand reamers
- 03.04 Hand-sharpen cutting tools by using abrasive stones
- 03.05 Hone and lap surfaces
- 03.06 Remove damaged screws and other hardware
- 03.07 Set up and use arbor press broaches
- 03.08 Deburr workpieces
- 03.09 Identify and use proper hand finishing tools

04.0 DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING POWER SAWS

Level The student will be able to:

04.01 Comply with safe and efficient work practices
04.02 Remove and replace saw blades
04.03 Select appropriate blades to perform given sawing operations
04.04 Select and set speeds and feeds for given sawing operations
04.05 Measure and cut off materials using power saws
04.06 Cut and weld band saw blades to insert for contour sawing
04.07 Set up and operate saws for angular cutting

05.0 DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING PEDESTAL GRINDERS - The student will be able to:

Level

05.01 Comply with safe and efficient work practices
05.02 Identify parts of the pedestal grinder
05.03 Mount grinding wheels
05.04 Set up support/tool rests
05.05 Dress grinding wheel
05.06 Grind lathe tools to required angles

06.0 DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING DRILL PRESSES

The student will be able to:

Level

06.01 Comply with safe and efficient work practices
06.02 Identify the parts of the drill press
06.03 Lubricate the drill press
06.04 Hand and machine sharpen drills
06.05 Center drill, drill and ream a hole in a workpiece.
06.06 Center-bore, spot-bore and countersink hold in workpiece.
06.07 Hand tap a hold in workpiece.
06.08 Power tap a hold in workpiece.

07.0 DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING LATHES

Level The student will be able to:

07.01 Identify the parts of the lathe
07.02 Comply with safe and efficient work practices
07.03 Measure stock
07.04 Set up an engine lathe
07.05 Secure tools, tool-holders and fixtures or attachments
07.06 Select and set feeds and speeds
07.07 Set up lathes and face workpieces held in chucks
07.08 Rough-cut and finish-cut with lathes
07.09 Perform lathe filing to deburr parts

07.10 Align lathe centers using accurate methods
07.11 Drill holes with lathes
07.12 Countersink hole with lathes
07.13 Ream holes with lathes
07.14 Tap threads with lathes
07.15 Die-cut threads with lathes
07.16 Counterbore holes with lathes
07.17 Bore holes with lathes
07.18 Knurl parts with lathes
07.19 Cut external threads with lathes
07.20 Re-chase threads with lathes
07.21 Cut internal threads with lathes
07.22 Set up and perform taper turning with taper attachments
07.23 Set up and perform taper turning with compound
07.24 Cut internal tapered surfaces
07.25 Set up and operate tool post grinders
07.26 Perform contour, angular or radial cuts with lathes
07.27 Set up and use follow and steady-rests
07.28 Set up face plates and dogs

08.0 DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING MILLING MACHINES - The student will be able to:

Level 08.01 Identify the parts of the horizontal and vertical milling machine
08.02 Lubricate milling machines.
08.03 True up the head and align milling machines fixtures
08.04 Select and set feeds and speeds for milling work
08.05 Square up workpieces with a table vise
08.06 Perform end milling
08.07 Perform fly-cutting operations
08.08 Drill holes with a milling machine
08.09 Perform reaming operations
08.10 Cut external keyways
08.11 Bore holes with milling machines
08.12 Perform form milling
08.13 Perform indexing operations using a dividing head
08.14 Set up and operate rotary tables
08.15 Mill cylindrical work
08.16 Mill an external radius
08.17 Mill an angle
08.18 Align milling machine attachments
08.19 Mill internal slots with a slotter and attachment
08.20 Perform cutting-off operations
08.21 Set up and perform slab mill operations
08.22 Use an edge finder and wiggler
08.23 Use digital readouts
A 08.24 Perform straddle milling operations on the horizontal mill
A 08.25 Set up and use a sine vise

09.0 DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING SURFACE GRINDING MACHINES - The student will be able to:

Level		
	09.01	Identify the parts of the machine
	09.02	Comply with safe and efficient work practices
	09.03	Clean and lubricate surface grinding machine
	09.04	Select the proper wheel
	09.05	Inspect, balance, dress, and true grinding wheels
	09.06	Attach and align workpieces for grinding operations
	09.07	Select and set feeds and speeds of grinders
	09.08	Set up and grind parallel flat surfaces
	09.09	Set up and grind four sides square
	09.10	Set up and use angle plates
A	09.11	Cut off or part workpieces with grinding machines
A	09.12	Set up grinders to run workpieces between centers
A	09.13	Measure, inspect, and rework workpieces on grinding machines
A	09.14	Set up, grind, and sharpen preshaped lathe tools
A	09.15	Set up and use radius dressers

10.0 DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING TOOL AND CUTTER GRINDING MACHINES - The student will be able to:

Level		
	10.01	Identify the parts of the machine
	10.02	Comply with safe and efficient work practices
	10.03	Identify and select proper machine controls
	10.04	Select proper wheels and work holding devices
	10.05	Perform truing, dressing, and forming operations to blueprint specifications
	10.06	Compute proper speeds
	10.07	Sharpen an end mill
	10.08	Sharpen a horizontal milling cutter
	10.09	Sharpen drills and countersinks

11.0 DEMONSTRATE PROFICIENCY IN APPLYING COMPUTERIZED NUMERICAL CONTROL OPERATIONS - The student will be able to:

Level

A
- 11.01 Identify the parts of the machine
- 11.02 Comply with safe and efficient work practices
- 11.03 Identify and select proper machine controls
- 11.04 Write a program and apply basic programming skills to a turning and/or a milling operation
- 11.05 Select proper work holders
- 11.06 Select proper cutting tools
- 11.07 Machine parts to blueprint tolerances
- 11.08 Demonstrate the use of CAD/CAM system for part program development

12.0 DESCRIBE EDM MACHINE, AND OTHER NEW PRECISION MACHINING TECHNOLOGY, FUNCTIONS AND OPERATING PRINCIPLES - The student will be able to:

Level

A
- 12.01 Describe the parts of the EDM machine
- 12.02 Describe EDM machine controls
- 12.03 Describe the functions of laser technology in precision machining
- 12.04 Describe the functions of robotics in precision machining

13.0 DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING HEAT TREAT FURNACES - The student will be able to:

Level

A
- 13.01 Comply with safe and efficient work practices
- 13.02 Identify proper machine controls
- 13.03 Select proper heat treatment processes
- 13.04 Perform a basic heat treatment process to blueprint specifications
- 13.05 Define stress relieving, annealing and normalizing

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 1

EMPLOYABILITY SKILLS

Division of Vocational Education
State of Idaho
Boise, Idaho
1990

MODULE 1 - EMPLOYABILITY SKILLS

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

01.01 TASK: Identify Employment Opportunities

LEVEL

E PERFORMANCE OBJECTIVE: Given the information resources of a library, obtain and compile the information needed to seek a job.

ENABLING OBJECTIVES:

1. Identify the requirements for a job.
2. Investigate educational opportunities.
3. Investigate occupational opportunities.
4. Locate resources for finding employment.
5. Confer with prospective employers.
6. Identify job trends.

01.02 TASK: Apply Employment-Seeking Skills

LEVEL

E PERFORMANCE OBJECTIVE: Given appropriate information, locate a job opportunity, prepare and take an interview for it, complete the required tests, forms and applications, and evaluate a response to the job opportunity.

ENABLING OBJECTIVES:

1. Locate a job opening.
2. Complete a resume.
3. Prepare for an interview.
4. Participate in an interview.
5. Complete tests required.
6. Complete forms required.
7. Complete an application letter.
8. Complete a follow-up letter.
9. Complete an acceptance letter.
10. Evaluate a job offer.
11. Evaluate a job rejection.

01.03 TASK: INTERPRET EMPLOYMENT CAPABILITIES

LEVEL

E PERFORMANCE OBJECTIVE: Given the assignment to explain how your capabilities make you employable, demonstrate how to match skills and experience to a job being sought.

ENABLING OBJECTIVES:

1. Match an interest to job area.
2. Match aptitudes to job area.
3. Verify abilities.
4. Identify immediate work goal.
5. Develop a career plan.

01.04 TASK: DEMONSTRATE APPROPRIATE WORK BEHAVIOR

LEVEL

E PERFORMANCE OBJECTIVE: Given the responsibility of an employee in a new job, demonstrate knowledge of appropriate behavior in the work place.

ENABLING OBJECTIVES:

1. Exhibit dependability.
2. Demonstrate punctuality.
3. Follow rules and regulations.
4. Explain the consequences of dishonesty.
5. Complete assignments accurately and on time.
6. Control emotions.
7. Take responsibility for decisions and actions
8. Take pride in work and be a loyal worker.
9. Learn to handle pressures and tensions.
10. Demonstrate ability to set priorities.
11. Demonstrate problem-solving skills.

01.05 TASK: MAINTAIN A BUSINESS-LIKE IMAGE

LEVEL

E PERFORMANCE OBJECTIVE: Given a responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of the actions and behaviors which will project a business-like image

ENABLING OBJECTIVES:

1. Participate in the institution's orientation.
2. Demonstrate knowledge of company or agency products and services.
3. Identify the requirements for a job.
4. Investigate educational opportunities.
5. Investigate occupational opportunities.
6. Locate resources for finding employment.
7. Confer with prospective employers.
8. Identify job trends.

01.06 TASK: MAINTAIN WORKING RELATIONSHIPS WITH OTHERS

LEVEL

E PERFORMANCE OBJECTIVE: Given the responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of how to successfully work with others.

ENABLING OBJECTIVES:

1. Work productively with others.
2. Show empathy, respect, and support for others.
3. Demonstrate procedures and assist others when necessary.
4. Recognize problems and work toward their solution.
5. Minimize the occurrence of problems.
6. Channel emotional reactions in positive ways.

01.07 TASK: COMMUNICATE ON THE JOB

LEVEL

E PERFORMANCE OBJECTIVE: Given the responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of how to communicate on the job.

ENABLING OBJECTIVES:

1. Read and comprehend written communications.
2. Use correct grammar.
3. Speak clearly when addressing others.
4. Use job-related terminology.
5. Listen attentively.
6. Write legibly.
7. Use telephone etiquette.
8. Follow written and oral directions.
9. Ask questions.
10. Locate information needed to complete the task.
11. Prepare written communication.
12. Demonstrate keyboarding skills.
13. Demonstrate computer skill.

01.08 TASK: ADAPT TO CHANGE

LEVEL

E PERFORMANCE OBJECTIVE: Given the responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of how to adapt to change.

ENABLING OBJECTIVES:

1. Recognize the need to change.
2. Demonstrate a willingness to learn.
3. Demonstrate flexibility.
4. Participate in continuing education.
5. Seek challenge in the work place.
6. Adjust goals and plans when necessary.

01.09 TASK: DEMONSTRATE A KNOWLEDGE OF BUSINESS OPERATION

LEVEL

E PERFORMANCE OBJECTIVE: Given the responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of the role of that business, its employees, and the free enterprise system.

ENABLING OBJECTIVES:

1. Explain the role of business in the enterprise system.
2. List the responsibilities of employees.
3. Identify the responsibilities of managers and employers.
4. Discuss the opportunities for business ownership or management.
5. Describe the planning required to start a business.
6. Discuss the importance of business meetings.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 2

PREREQUISITE MACHINING

Division of Vocational Education
State of Idaho
Boise, Idaho
1990

MODULE 2 - PREREQUISITE MACHINING

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

02.01 TASK: Demonstrate Proficiency In Maintaining Immediate Work Area
LEVEL
E PERFORMANCE OBJECTIVE: Given appropriate materials and supplies the student will be able to demonstrate proficiency to maintain work areas in a machine shop.

ENABLING OBJECTIVES:

1. Demonstrate the knowledge of shop safety rules and practices.
2. Describe procedures for the proper disposal of scrap metal chips, shavings, oil, andcoolant.
3. List shop operating rules and practices.
4. Demonstrate procedures to clean and maintain work areas affected by operations of work and shop areas.
5. Demonstrate knowledge of maintaining a clean and orderly shop.
6. Demonstrate knowledge of leaving work and shop area in a safe condition.

02.02 TASK: Perform Mathematical Calculation's
LEVEL
E PERFORMANCE OBJECTIVE: Given the appropriate tools, equipment and resource material, the student will demonstrate the ability to perform accurate mathematical calculations relating to machine set up, material, machine shop environment.

ENABLING OBJECTIVES:

1. Accurately perform job related decimal and fraction calculations.
2. Demonstrate proficiency solving job-related problems using basic formulas.
3. Demonstrate proficiency solving job-related problems using basic geometry.
4. Demonstrate proficiency measuring a workpiece and compare measurements with blueprint specifications.
5. Demonstrate proficiency calculating the amount of material that should be removed to obtain correct limits for secondary operations.
6. Demonstrate proficiency in solving job-related problems using mathematical handbooks, charts, and tables.
7. Demonstrate proficiency in converting measurements from English to metric and from metric to English units.
8. Demonstrate proficiency in determining the clearance, relief, and rake of cutting tools.
9. Demonstrate proficiency in calculating machine speeds and feeds using appropriate formulas.

02.03 TASK: Demonstrate Proficiency in Blueprint Reading and Machine Planning

LEVEL

E PERFORMANCE OBJECTIVE: Given the appropriate tools, materials, and prints, the student will demonstrate proficiency in reading blueprints to layout and prepare stock for machining operations.

ENABLING OBJECTIVES:

1. Interpret view concepts.
2. Read lines.
3. Read and interpret title blocks.
4. Read and interpret change orders on working and assembly prints.
5. Read and interpret abbreviations.
6. Make shop sketches.
7. Read and interpret blueprints, including geometric tolerancing.
8. Determine and interpret reference information used in performing machine work.
9. Perform layout for precision machine work by using layout instruments.
10. Lay out radial and bolt hole circles.
11. Select the most productive tool and tooling for a given operation.

02.04 TASK: Perform Measuring Operations

LEVEL

E PERFORMANCE OBJECTIVE: Given the appropriate tools and operation pieces, the student will accurately measure workpieces using the proper measuring instruments.

ENABLING OBJECTIVES:

1. Read and measure with rules and calipers.
2. Read and measure with micrometers.
3. Read and measure with vernier tools.
4. Read and measure with dial indicators.
5. Measure using as surface plate.
6. Read and interpret surface finish (ANSI Y14)

02.05 TASK: Perform Maintenance on Machines and Tools

LEVEL

E PERFORMANCE OBJECTIVE: Given the appropriate tools, equipment, and supplies, the student will be able to perform maintenance functions on machining equipment and tools to restore the equipment to full operating condition.

ENABLING OBJECTIVES:

1. Inspect work areas to assure a safe working environment.
2. Lubricate equipment parts.
3. Clean and store hand tools, cutters, fixtures, jigs, and attachments.
4. Inspect and repair hand tools.
5. Inspect drive pulleys or belts.
6. Select lubricants for machining operations.
7. Inspect equipment for safe operational conditions.
8. Store grinding wheels and precision tools

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 3

BENCH WORK

Division of Vocational Education
State of Idaho
Boise, Idaho
1990

MODULE 3 - BENCH WORK

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03.01 TASK: Cut materials by using hand hacksaws

Level

E PERFORMANCE OBJECTIVE: Given a dimensioned blueprint of a workpiece, raw material and a hand hacksaw, the student will be able to:

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for hand hacksawing.
2. Determine teeth per inch on various hacksaw blades.
3. Describe the applications for saw blades with different ratios of tooth pitch.
4. Demonstrate the correct method of sawing materials with a hand hacksaw.

03.02 TASK: Cut threads by using hand taps and dies

Level

E PERFORMANCE OBJECTIVE: Given a dimensioned blueprint, workpiece, tap, die, tap wrench, die stock, cutting fluids and measuring instruments, cut internal and external threads to a class #2 fit.

ENABLING OBJECTIVES:

1. Explain safety precautions/procedures for threading with taps and dies.
2. Identify and explain the use of the three taps used for threading a blind hole.
3. Select cutting fluids.
4. Describe the procedure for cutting internal and external threads with a tap or die.
5. Explain the correct procedure to align a tap with the hole.

03.03 TASK: Ream holes by using hand reamers

Level

E PERFORMANCE OBJECTIVE: Given a hand reamer, ream a series of previously drilled holes to a tolerance of $\pm$.001.

ENABLING OBJECTIVES:

1. Demonstrate the proper method of hand reaming holes using both adjustable and non-adjustable reamers.
2. Explain the types of lubricants and their applications to reaming.
3. Explain the correct drill sizes as they relate to the various sizes of reamers.

03.04 TASK: Hand sharpen cutting tools by using abrasive stones

Level

E PERFORMANCE OBJECTIVE: Given a bench stone and a variety of cutting tools, hone the cutting edges to remove burrs and smooth the surfaces.

ENABLING OBJECTIVES:

1. Determine and demonstrate how to correctly hold various cutting tools to the angles characteristic to that tool.
2. Explain why bench stones require lubricants.

03.05 TASK: Hone and lap surfaces

Level

E PERFORMANCE OBJECTIVE: Given lapping tables and honing stones, lap and hone various geometries to obtain microfinishes and close tolerances.

ENABLING OBJECTIVES:

1. Explain the finishes obtained from the different grit sizes for lapping.
2. Explain the system by which honing stones are classified.
3. Describe the lubricants involved in both operations.
4. Demonstrate the procedures of lapping and honing both rounds (inside, outside) and flats.

03.06 TASK: Remove damaged screws and other hardware

Level

E PERFORMANCE OBJECTIVE: Given a set of easy outs, a broken bolt in a piece of material, tap extractor and broken tap, remove these broken items from a variety of materials with a minimum of damage to the workpiece.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for using easy outs and tap extractors.
2. Explain the purpose of easy outs and tap extractors.
3. Determine the correct drill sizes used with various easy outs.
4. Determine the correct tap extractor for various taps.
5. Describe the procedures for using easy outs and tap extractors.
6. Remove damaged screws.

03.07 TASK: Set up and use arbor press broaches

Level

E PERFORMANCE OBJECTIVE: Given an arbor press, broaches and lubricant, cut internal spline and keyways to a tolerance of $\pm$.002.

ENABLING OBJECTIVES:

1. Explain why broaches have to be shimmed.
2. Explain why lubricant is required.
3. Cut splines and keyways utilizing broaches, bushings, shims and arbor presses.

3.08 TASK: Deburr workpieces

Level

E PERFORMANCE OBJECTIVE: Given a variety of internal and external geometries, files and scrapers, completely deburr these workpieces to required tolerances.

ENABLING OBJECTIVES:

1. Demonstrate how to properly hold files and three corner scrapers.
2. Demonstrate how to sharpen a three corner scraper.
3. Deburr workpieces to required tolerances.

03.09 TASK: Identify and use proper hand finishing tools

Level

E PERFORMANCE OBJECTIVE: Given a variety of files, abrasive stones, scrapers, abrasive cloth, prussian blue and indicators, hand finish a workpiece to print specifications.

ENABLING OBJECTIVES:

1. Describe the set up procedure for using level tasks for finishing a workpiece.
2. Explain the reason for the use of Prussian Blue in hand finishing a workpiece.
3. Demonstrate how to hand scrape a workpiece using prussian blue, a granite surface plate and scraper to a tolerance of $\pm$ .001

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 4

POWER SAWS

Division of Vocational Education
State of Idaho
Boise, Idaho
1990

MODULE 4 - POWER SAWS

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04.01 TASK: Comply with safe and efficient work practices
Level

PERFORMANCE OBJECTIVE: Given a band type or reciprocating type power saw, explain the specific safety precautions characteristic to each type.

ENABLING OBJECTIVES:

1. Explain what could be the possible injuries resulting from improper safety precautions.
2. Identify hazardous components of saws.

04.02 TASK: Remove and replace saw blades
Level

PERFORMANCE OBJECTIVE: Given a band type and reciprocating type power saw, demonstrate the correct procedure for removing and replacing the two types of blades.

ENABLING OBJECTIVES:

1. Explain why the teeth of the blade must point in the correct direction for each type of machine.
2. Explain why the blades of reciprocating saws must be elevated a certain distance above the workpiece before starting the machine.
3. Describe the procedures for replacing saw blades.
4. Replace blades in hand and reciprocating saws.

04.03 TASK: Select appropriate blades to perform given sawing operations
Level

PERFORMANCE OBJECTIVE: Given specifications for the size and type of material to be cut, and specification charts on saw blades, select the correct blade for the operation performed.

ENABLING OBJECTIVES:

1. Explain how the width of the blade and the radius desired in contour cutting have a direct effect on each other.
2. Explain how the number of teeth per inch and the thickness of the workpiece affect each other.
3. Describe a bi-metal saw blade for a reciprocating type machine.

04.04 Level TASK: Select and set speeds and feeds for given sawing operations

PERFORMANCE OBJECTIVE: Given a known hardness of a variety of materials, determine the correct speeds and feeds for power sawing.

ENABLING OBJECTIVES:

1. List the correct cutting speed and feed of the following materials:
   a. 1-1/2" cold rolled steel
   b. 1" aluminum
   c. 1" tool steel
   d. 1/6" aluminum.
2. Explain how coolant can affect speeds and feeds.
3. Calculate proper cutting speeds and feeds for specific material.

04.05 Level TASK: Measure and cut off materials using power saws

PERFORMANCE OBJECTIVE: Given the two types of power saws available, cut material either to a layout line or cut a pre-determined amount of material from the layout line.

ENABLING OBJECTIVES:

1. Determine the proper amount of material that must be left on a workpiece for machining.
2. Explain the safety precautions/procedures before operating power saws.
3. Describe the procedure to cut material to layout or scribed line.
4. Cut material to layout or scribed lines.

04.06 Level TASK: Cut and weld bandsaw blades to insert for contour sawing

PERFORMANCE OBJECTIVE: Given a butt welder, a variety of different width blades and a pre-drilled workpiece, cut and weld these blades for inside cutting.

ENABLING OBJECTIVES:

1. Describe the procedures for measuring and cutting saw blades to length.
2. Explain the reasons for annealing the saw blade after the welding operation.
3. Describe the procedures for grinding a saw blade before installation.
4. Describe the procedure for selecting the proper guides.
5. Cut and weld a sawblade for inside cutting.

04.07 TASK: Set up and operate saws for angular cutting
Level

PERFORMANCE OBJECTIVE: Given the two types of power saws, determine how to safely hold a workpiece for angular cutting and set up the saw for angular cutting.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures in sawing angles.
2. Explain the reasons for cutting as close to the layout lines as possible.
3. Explain the reasons for cutting angles on a bandsaw as opposed to using other machines.
4. Set up a saw for angular cutting.
5. Perform an angular cut on a workpiece.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 5

PEDESTAL GRINDERS

Division of Vocational Education
State of Idaho
Boise, Idaho
1990

MODULE 5 - PEDESTAL GRINDERS

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05.01 Level TASK: Comply with safe and efficient work practices

PERFORMANCE OBJECTIVE: Given a pedestal grinder, identify the specific safety precautions characteristic to grinders.

ENABLING OBJECTIVES:

1. Apply shop safety rules and procedures.
2. Demonstrate the operation of shop safety devices.
3. Demonstrate personal safety procedures.
4. Demonstrate first aid/emergency treatment procedures.
5. Apply fire safety rules and procedures.
6. Apply rules for electrical safety.

05.02 Level TASK: Identify parts of the pedestal grinder

PERFORMANCE OBJECTIVES: Given a pedestal grinder, manufacturer's manual or general textbook, identify major parts and function of a grinder.

ENABLING OBJECTIVES:

1. Identify types of pedestal grinders.
2. Identify major parts.
3. Explain the function of major parts.

05.03 TASK: Mount grinding wheels

PERFORMANCE OBJECTIVE: Given grinder, grinding wheels and access to necessary tools, inspect and mount wheel to meet requirements found in operator's manual and Machinery's Handbook.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for mounting grinding wheels.
2. Explain how to determine if a wheel is cracked before mounting.
3. Explain the importance of cleanliness when mounting wheel.
4. Explain the importance of the blotters on the wheel.
5. Explain the reasons for the manufacturer printing the operating speed on grinding wheels.
6. Explain the safety precautions in regard to the diameter of the flanges in relationship to the diameter of the wheel.
7. Explain procedure to determine how tight the wheel flanges should be.
8. Dress wheel and adjust wheel guard and tool rest.

05.04 TASK: Set up support tool rests
Level

PERFORMANCE OBJECTIVES: Given grinder, and the necessary tools, adjust the wheel guard and tool rest to within 1/16 inch of grinding wheel face.

ENABLING OBJECTIVES:

1. Explain the relevant safety precaution/procedures required for adjusting wheel guard and tool rest.
2. Explain the purpose of the wheel guard and tool rest.
3. Describe the procedures for adjusting the wheel guard and tool rest.
4. Set up a tool rest and adjust wheel guard.

05.05 TASK: Dress grinding wheel
Level

PERFORMANCE OBJECTIVE: Given grinder, wheel dresser and the necessary tools, true and dress grinding wheel in accordance with the procedures in the Machinery's Handbook. The wheel must run true and the grinding surface must not be loaded nor glazed.

ENABLING OBJECTIVES:

1. Explain the relevant safety precautions/procedures for dressing and truing a grinding wheel.
2. Identify the different types of wheel dressers.
3. Determine the type dresser to be used on different grinding wheels.
4. Explain the correct procedure to true and dress the grinding wheel.
5. Properly dress a grinding wheel.

05.06 TASK: Grind lathe tools to required angles
Level

PERFORMANCE OBJECTIVE: Given a tool blank, blueprint and measuring instruments, shape and sharpen cutting tool to a tolerance of $\pm$ 1 degree on clearance angles.

ENABLING OBJECTIVES:

1. Explain the relevant safety precautions/ procedures.
2. Describe the procedure for grinding cutting tool.
3. Describe the procedure for checking cutting tool clearances.
4. Explain positive and negative rake angles and their uses for machining different types of materials.
5. Properly sharpen three different cutting tools.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 6

DRILL PRESSES

Division of Vocational Education
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Boise, Idaho
1990

MODULE 6 - DRILL PRESSES

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MODULE 6 - SET UP AND OPERATE DRILL PRESSES

06.01 Level TASK: Comply with safe and efficient work practices

PERFORMANCE OBJECTIVE: Given a drill press, identify the specific safety precautions characteristic to grinders.

ENABLING OBJECTIVES:

1. Apply shop safety rules and procedures.
2. Demonstrate the operation of shop safety devices.
3. Demonstrate personal safety procedures.
4. Demonstrate first aid/emergency treatment procedures.
5. Apply fire safety rules and procedures.
6. Apply rules for electrical safety.

06.02 Level TASK: Identify the parts of the drill press and explain the uses

PERFORMANCE OBJECTIVE: Given parts breakdown sheet, identify the parts of the drill press.

ENABLING OBJECTIVES:

1. Explain the major parts of the drill press.
2. Explain the procedure for adjusting the table height.
3. Explain the different types of drill presses.
4. Explain the RPM settings and feed settings.
5. Explain the need to figure RPM and feed for various size drills and materials.
6. Explain safety precautions for operation of drill press.
7. Explain the use of the drill chuck and morse tapered spindle.

06.03 Level TASK: Lubricate the drill press

PERFORMANCE OBJECTIVE: Given service manual or lubrication chart and access of cleaning fluid, lubricants and lubrication tools, clean, inspect and lubricate drill press in accordance with service manual or lubrication chart. All lubrication points must be supplied with the correct type and amount of lubricant.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for cleaning, inspecting, and lubricating a drill press.
2. Explain the reasons for performing routine cleaning, inspection and lubrication of a drill press.
3. Identify the lubricants used in a drill press.
4. Locate the lubrication points on the drill press.
5. Describe the inspection procedures for a drill press.
6. Identify the materials and describe the procedure used for cleaning a drill press.
7. Perform lubrication service on a drill press.

06.04 TASK: Hand and machine sharpen drills
Level

PERFORMANCE OBJECTIVE: Given drills, drill gauge, pedestal grinder, drill grinder, cutting fluid, and precision measuring instruments, hand and machine sharpen drills. Sharpen drills on pedestal grinder and on drill grinding machine holding a tolerance of ± 1 degree. Each flute lip must correspond to the other flute lip in length to within ± .005 inch.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for hand and machine sharpening drill bits.
2. Describe the amount of lip clearance a drill must have to perform correctly.
3. Explain why a drill bit must have the same angle on both flutes and why both flutes must be the same length.
4. Discuss why different drill point angles are ground for different materials.
5. Define the following drill terms: (a) chisel edge (b) lip (c) flute (d) margin (e) land (f) body (g) shank (h) web
6. Describe the procedures for hand sharpening a drill bit.
7. Describe the procedures for correcting a thick web on a drill bit.
8. Describe the procedures for sharpening a drill using drill grinder.
9. Properly sharpen three drill bits using a pedestal grinder.
10. Properly sharpen three drill bits using a drill grinder.

06.05 TASK: Center drill, drill and ream hole in workpiece
Level

PERFORMANCE OBJECTIVE: Given a blueprint, workpiece, work holding device, combination square, combination drill and countersink, drills, reamers, cutting fluid, and precision measuring instruments, centerdrill, drill and ream a hole in the workpiece holding a tolerance of +.002 inch, -.000 for diameter, ± 1/64 inch for location.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for setting up and operating a drill press.
2. Describe the procedures for setting up a drill press.
3. Describe the uses of cutting fluids for drill press.
4. Calculate cutting speeds for centerdrilling, drilling and reaming operations (S.F.P.M.).
5. Calculate RPM for centerdrills, drills, reamers, etc.
6. Describe the procedures for center drilling and drilling holes.
7. Describe the procedures for reaming holes.
8. Identify the correct cutting fluids for drilling and reaming.
9. Centerdrill a hole in a workpiece to required tolerance.
10. Drill and ream hole in a workpiece to required tolerance.

06.06 TASK: Centerbore, spotface and countersink hole in workpiece
Level

PERFORMANCE OBJECTIVE: Given a blueprint, workpiece, work holding device, counterbore spotface and countersink tools, cutting fluid, and precision measuring instruments, counterbore, countersink, and spotface a hole in workpiece holding a tolerance of $\pm$ .010 inch.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for counterboring, countersinking and spotfacing operations.
2. Explain the purpose of counterboring, countersink and spotfacing a hole.
3. Define the difference between a counterbored, countersunk, and spotfaced hole.
4. Describe the procedures for counterboring, countersinking and spotfacing holes.
5. Identify the correct burring fluids for counterboring, countersinking and spotfacing.
6. Centerdrill a hole in a workpiece to required tolerance.
7. Spotface a hole in a workpiece to required tolerance.
8. Countersink a hole in a workpiece to required tolerance.

06.07 TASK: Hand tap a hole in workpiece
Level

PERFORMANCE OBJECTIVE: Given a blueprint, workpiece, work holding device, center taps, tap wrench, cutting fluids, and precision measuring instruments, hand tap a hole in the workpiece holding a tolerance of $\pm$ 1/2 degree for perpendicularity and $\pm$ 1/64 inch for location.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for hand tapping.
2. Describe the uses of threads.
3. List the taps in an American National/Unified 60 degree tap set and state the purpose of each tap.
4. Explain why a tapped hole must be countersunk.
5. Identify the uses of cutting fluids for tapping.
6. Describe the procedures for hand tapping a hole with a drill press to assure perpendicularity.
7. Hand tap a hole in a workpiece to required tolerance.

06.08 TASK: Power tap hole in workpiece
Level

PERFORMANCE OBJECTIVE: Given a blueprint, workpiece, work holding device, tapping head, taps, cutting fluid, and precision measuring instruments, power tap holes in workpiece holding a tolerance of ± 1/2 degree for perpendicularity and ± 1/64 inch for location.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for power tapping.
2. Distinguish between power and hand taps.
3. Calculate the R.P.M. for machine tapping in a drill press for the following: 1/4-20NC-2B, 1/2-13NC-2B, 5/8-11-NC-2B.
4. Describe the procedures for machine tapping holes.
5. Identify the correct cutting fluids for power tapping.
6. Power tap a hole in a workpiece to required tolerance.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 7

LATHES

Division of Vocational Education
State of Idaho
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MODULE 7 - LATHES

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MODULE 7 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING LATHES

07.01 TASK: Identify the parts of the lathe.
Level

PERFORMANCE OBJECTIVE: Given a parts breakdown sheet, identify the main parts of the lathe.

ENABLING OBJECTIVES:

1. Explain the major parts of the lathe.
2. Explain the function of the bed.
3. Explain the function of the carriage and the parts therein.
4. Explain the function of the head stock and the parts therein.
5. Explain the function of the tail stock and the parts therein.

07.02 TASK: Comply with general safe and efficient work practices.
Level

PERFORMANCE OBJECTIVE: Given an engine lathe, identify the major safety hazards characteristic to rotating workpieces.

ENABLING OBJECTIVES:

1. Explain the need for safety glasses.
2. Explain the hazards of chip handling.
3. Explain the set up hazards.
4. Explain the chuck removal and installation hazards.
5. Explain the hazards of work piece burrs.
6. Explain the proper housekeeping and tool hazards.
7. Demonstrate knowledge of safety by completing a written safety test

07.03 TASK: Measure stock
Level

PERFORMANCE OBJECTIVE: Given a cylindrical workpiece with external threads and a counterbored hole and a corresponding uni-dimensioned blueprint, outside, inside, and depth micrometers, telescope gauges, small hole gauge, vernier caliper, and surface plate, precision measure the workpiece. Measure the external diameters, pitch diameters, internal bores, hole depths, and linear measurements of a workpiece to a tolerance of $\pm$ .002 inches. Transpose dimensions onto blueprint in accordance with machine drafting procedures.

ENABLING OBJECTIVES:

1. Explain correct drafting standards for dimensioning blueprints.
2. Demonstrate the proper care, use, and calibrations of precision measuring instruments.

3. List accepted drafting abbreviations and/or symbols for the following terms:
   a. Outside diameter
   b. Inside diameter
   c. Threads per inch
   d. Inch
   e. Millimeter
   f. Counterbore
   g. Depth
4. Measure a cylindrical workpiece.

07.04 Level TASK: Set up an engine lathe

PERFORMANCE OBJECTIVE: Given independent, universal and collect chucks, lathe operation manual, and dial indicator, mount chucks on lathe in accordance with operation manual so that there is no horizontal or vertical movement of the chuck. Set up a lathe using follower and steady rests.

ENABLING OBJECTIVES:

1. Explain the relevant safety precautions/procedures for mounting chucks on lathes.
2. Explain the operation of lathe.
3. Describe the use of wood blocks as cradles between bedways and chuck.
4. Discuss the applications for independent, universal, and collect chucks.
5. Describe the procedures for mounting chucks on lathe.
6. Describe the procedures for mounting face plates.
7. Describe the procedures for mounting and using follower and steady rests.

07.05 Level TASK: Secure tools, tool-holders, and fixtures or attachments

PERFORMANCE OBJECTIVE: Given independent, universal and collet chucks, lathe operation manual, and dial indicator, mount chucks on lathe in accordance with operation manual so that there is no horizontal or vertical movement of the chuck. Mount tool bits, fixtures or attachments on lathe.

ENABLING OBJECTIVES:

1. Explain the relevant safety precautions/procedures for mounting chucks on lathes.
2. Explain the operation of lathe.
3. Describe the use of tool holders, fixtures and attachments.
4. Determine and discuss the applications for independent, universal and collect chucks.
5. Describe the mounting of tool bits.
6. Demonstrate mounting and use of steady and follower rests.

07.06 TASK: Select and set feeds and speeds
Level

PERFORMANCE OBJECTIVE: Given work sheet with check list, set assigned machines for each specified lathe spindle speed and feed.

ENABLING OBJECTIVES:

1. Explain lathe safety.
2. Locate, speed and feed chart on each machine.
3. List spindle speed formula and calculate RPM as per work sheet.
4. Identify lathe parts as listed on worksheet.
5. Adjust speed and feed settings for specified work sheet.

07.07 TASK: Set up lathes and face workpieces held in chucks
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, tool blanks, cutting fluids, and precision measuring instruments face the workpiece holding a tolerance of $\pm$ .005 inch and to a surface finish of 125 micro inches.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for facing.
2. Describe the uses of carbide, high speed, and ceramic cutting tools as applied to facing operations.
3. Define micro-inch.
4. Calculate cutting speeds and feeds for facing operations.
5. Describe the procedures for facing.
6. Identify the correct cutting fluids for facing.
7. Face a workpiece to specifications.

07.08 TASK: Rough-cut and finish-cut with lathes
Level

PERFORMANCE OBJECTIVE: Given bar stock and drawing, cutter bits, cutting fluids, measuring tools, make the required rough and finish cuts to required specifications.

ENABLING OBJECTIVES:

1. Explain safety for lathe operation.
2. Explain lathe feeds and describe the guideline
3. Select speeds and feeds and mount stock in work holding devices.
4. Explain tool position and tool geometry (angles).
5. Define trial cuts.
6. Make required trial cuts.
7. Using appropriate measuring tools, measure workpiece.
8. Perform required rough and finish cuts to specifications.

07.09 TASK: Perform lathe filing to deburr parts
Level

PERFORMANCE OBJECTIVE: Given work piece and work sheet; file, polish and deburr the workpiece.

ENABLING OBJECTIVES:

1. Explain lathe safety.
2. Select spindle speed and mount project in lathe.
3. Define micro-inch finishes.
4. List names of different deburr tools.
5. Explain grit size of abrasive clothes.
6. List and identify shape, cut and size of files as required by worksheet.
7. List other tools needed.
8. File, polish and deburr a workpiece.

07.10 TASK: Align lathe centers using accurate methods.
Level

PERFORMANCE OBJECTIVE: Given a live and dead center, show methods of aligning lathe centers.

ENABLING OBJECTIVES:

1. Describe the geometry of alignment of centers.
2. Align centers using the point to point method.
3. Align centers using a precision ground centered shaft.
4. Align centers using the cut and measuring method.

07.11 TASK: Drill holes with lathes.
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, drill, lathe attachments, and cutting fluid, drill hole in workpiece to a tolerance of $\pm$ .005 inch, - .000 for diameter.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for drilling operations.
2. Calculate speeds for drilling operations.
3. Describe the procedures for drilling on a lathe.
4. Identify the correct cutting fluid for drilling operations.
5. Drill a hole in a workpiece.

07.12 TASK: Countersink holes with lathes
Level

PERFORMANCE OBJECTIVES: Given blueprint, countersink took, workpiece, lathe attachments, cutting fluid, and measuring instruments, countersink hole in workpiece to a tolerance of + .010 inch, - .000 for diameter.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for countersinking operations.
2. Calculate speeds for countersinking operations.
3. Describe the procedures for countersinking on a lathe.
4. Identify the correct cutting fluid for countersinking.
5. Countersink a hole in a workpiece.

07.13 TASK: Ream holes with lathes
Level

PERFORMANCE OBJECTIVE: Given a blueprint, workpiece, reamer, lathe attachments, cutting fluid, and inside measuring instruments, ream hole in workpiece to a tolerance of + .002, - .000 for diameter.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for reaming operations.
2. Calculate speeds for reaming operations.
3. Describe the procedures for reaming.
4. Identify the correct cutting fluid for reaming.
5. Ream a hold in a workpiece.

07.14 TASK: Tap threads with lathes
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, tap, tap wrench, lathe attachments, cutting fluid, and thread plug gauge, tap hole in workpiece to a class 2 fit.

ENABLING OBJECTIVE:

1. Explain the safety precautions/procedures for tapping operations.
2. Determine tap drill size using the charts and formulas.
3. Describe the procedures for tapping on a lathe.
4. Identify the correct cutting fluid for tapping.
5. Describe the proper use of a plug gauge.
6. Tap threads in a workpiece.

07.15 TASK: Die-cut threads with lathes
Level

PERFORMANCE OBJECTIVE: Given blueprint, work piece and threading die and die stock, die cut external threads using a lathe.

ENABLING OBJECTIVES:

1. Explain safety requirements for cutting external threads.
2. Calculate lathe RPM.
3. Set up workpiece in chuck.
4. Remove tail stock center and explain how to follow the die with the tailstock spindle.
5. Describe procedures for cutting external threads.
6. Identify the proper cutting fluid.
7. Die cut external threads on a workpiece.

07.16 TASK: Counterbore holes with lathes
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, lathe attachments, boring bar, cutting fluid, and precision measuring instruments, counterbore hole in workpiece to a tolerance of $\pm$ .001 inch for diameter and depth.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for counter-boring operations.
2. Calculate speeds for counter-boring operations.
3. Describe the procedures for counter-boring.
4. Identify the correct cutting fluid for counter-boring operations.
5. Counterbore a hole in a workpiece.

07.17 TASK: Bore holes with lathes
Level

PERFORMANCE OBJECTIVES: Given blueprint, workpiece, boring bar, tool blank, boring bar holder, cutting fluid, and precision measuring instruments, bore hole with lathe to a tolerance of $\pm$ .001 inch for location, diameter, depth, and to print surface finish specifications.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for boring holes with a lathe.
2. Calculate speeds for boring operations on lathes.
3. Describe the procedures for boring holes.
4. Identify the correct cutting fluids for boring.
5. Bore a hole in a workpiece.

07.18 TASK: Knurl parts with lathes
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, diamond and/or straight knurling tools, cutting fluid, knurl workpiece in accordance with Machinery's Handbook specifications for knurling.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for knurling a workpiece.
2. Explain the proper use of knurling tools.
3. Calculate speeds and feeds for knurling operations.
4. Describe the procedures for knurling a workpiece.
5. Identify the correct cutting fluid for knurling.
6. Knurl a workpiece.

07.19 TASK: Cut external threads with lathes
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, tool holder, tool blank, center gauge, cutting fluids, and precision measuring instruments, cut external threads on workpiece to tolerances for class 2 fit for external threads and in accordance with Machinery's Handbook. Use thread micrometer and/or three wire system for checking threads.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for cutting external threads.
2. Explain the formulas used in the three wire system for measuring external threads.
3. Calculate proper speeds for cutting external threads.
4. Describe the procedures for cutting external threads.
5. Select the correct cutting fluid for threading operations.
6. Calculate thread depth.
7. Calculate total in feed of compound.
8. Determine depth per pass.
9. Determine compound off-set angle (right or left hand threads).
10. Cut external threads on a workpiece.

07.20 TASK: Rechase threads with lathes
Level

PERFORMANCE OBJECTIVE: Given a damaged thread, set up and catch thread to repair it.

ENABLING OBJECTIVES:

1. Explain safety precautions for rechasing threads.
2. Describe procedure for setting up a lathe to rechase threads.
3. Identify tools needed to rechase threads.
4. Select correct cutting fluid for rechasing threads.
5. Rechase threads on a workpiece.

07.21 TASK: Cut internal threads with lathes
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, tool holder, tool blank, thread center gauge, cutting fluids and precision measuring instruments, cut internal threads on workpieces to tolerances for class 2 fit for internal threads in accordance with Machinery's Handbook. Use threaded part or plug gauge for checking threads.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for chasing internal threads.
2. Calculate total in feed of compound for unified threading.
3. Calculate proper speeds and hole size for cutting internal threads.
4. Describe the procedures for cutting internal threads.
5. Select the correct cutting fluid for threading.
6. Determine depth of cut per pass.
7. Determine compound off-set angle.
8. Cut internal threads on a workpiece.

07.22 TASK: Set up and perform taper turning with taper attachments
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, turning tool, tool holder, dial indicator, micrometer carriage stop, cutting fluids, and precision measuring instruments, machine external taper on workpiece holding a tolerance of .001 per 4 inches in length and a surface finish as specified by the blueprint.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for machining an external taper.
2. Explain the use of taper attachments.
3. Describe the procedures for cutting external tapers.
4. Calculate speeds and feeds for external tapering operations.
5. Explain how to check taper over a 4.000 inch length.
6. Identify the correct cutting fluids for external tapering operations.
7. Turn an external taper on a workpiece.

07.23 TASK: Set up and perform taper turning with compound.
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, tool holder, cutting tool, cutting fluid, and precision measuring instruments, cut external angle with compound on workpiece holding a tolerance of $\pm$ 30 minutes for the angle, and a surface finish to print requirements.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures.
2. Calculate cutting speed for cutting external angle with compound.
3. Describe the procedures for cutting external angles.
4. Identify the correct cutting fluid for cutting external angles.
5. Cut an external taper with a compound on a workpiece.

07.24 Level TASK: Cut internal tapered surfaces

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, boring bar, tool blank, boring bar holder, cutting fluid, and precision measuring instruments, cut internal tapered surface on workpiece using taper attachment to a tolerance of ± .002 inch on the diameter, and ± .005 on the length, and to print surface finish requirements.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for cutting internal tapered surface.
2. Calculate speeds and feeds for internal tapering operations.
3. Describe the procedures for boring internal tapers with taper attachment.
4. Identify the correct cutting fluids for boring internal tapers.
5. Cut an internal taper on a workpiece.

07.25 Level TASK: Set up and operate tool post grinders

PERFORMANCE OBJECTIVE: Given blueprint, workpiece tool post grinder, tool post, diamond dresser, grinding wheel, coolant and precision measuring instruments, grind external diameter holding a tolerance of + .001 inch; - .000 and to a surface finish according to print specifications.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for grinding an external diameter.
2. Explain the proper set up and use of a tool post grinder on na lathe.
3. Identify grinding wheels for external diameter grinding operations.
4. Describe the procedures for grinding workpiece with tool post grinder.
5. Identify the correct coolant for grinding operations.
6. Define surface roughness, waviness, and lay and identify their symbols.
7. Demonstrate the use of a profilometer or surface roughness gauge for determining surface finish.
8. Grind an external diameter on a workpiece.

07.26 Level TASK: Perform contour, angular, or radial cuts with lathes

PERFORMANCE OBJECTIVE: Given blueprints, workpiece, tool blanks, tool holder, cutting fluid, radius guages, and precision measuring instruments, free hand form workpiece to concave and convex radii and angular into per blueprint and visual inspection.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for free hand forming a workpiece.
2. Describe the procedures for angular concave or contour cuts with lathes.
3. Explain the proper use of radius guages.
4. Calculate speeds for free hand forming operations.
5. Describe the procedures for free hand forming concave and convex radii.
6. Identify the correct cutting fluids.

07.27 TASK: Set up and use follow and steady-rests
Level

PERFORMANCE OBJECTIVE: Given blueprint, face plate, dog, steady rest and follower rest, turn long shaft between centers.

ENABLING OBJECTIVES:

1. Explain safety precautions for using follow and steady rests.
2. Install face plate.
3. Describe the procedure to install work with dogfit to faceplate.
4. Install steady rest or follower rest and adjust to part.
5. Turn work to size with proper follow and steady rest setup.

07.28 TASK: Set up face plates and dogs
Level

PERFORMANCE OBJECTIVE: Given blueprint, face plate, clamping tools, tool blanks, center drill, drill, boring bar, and workpiece, face, drill and bore workpiece holding a tolerance of $\pm$ .005 on all dimensions and to a surface finish as specified on print.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for facing, drilling, and boring operations.
2. Describe the use of the face plate and the importance of counter-balancing the workpiece.
3. Describe the procedure for clamping and aligning part to face plate.
4. Calculate cutting speeds for facing, drilling and boring.
5. Identify the correct fluid for facing, drilling and boring operations.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 8

MILLING MACHINES

Division of Vocational Education
State of Idaho
Boise, Idaho
1990

MODULE 8 - MILLING MACHINES

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

MODULE 8 - SET UP AND OPERATE MILLING MACHINES

08.01 Level TASK: Identify the parts of the Horizontal and Vertical Milling Machine

PERFORMANCE OBJECTIVE: Given a milling machine and service manual, identify major parts and their function.

ENABLING OBJECTIVES:

1. Identify types of milling machines.
2. Identify major parts of milling machines.
3. Describe the function of major parts.

08.02 Level TASK: Lubricate Milling Machines

PERFORMANCE OBJECTIVES: Given service manual and/or lubrication chart, lubricants and tools, clean, inspect and lubricate the milling machine in accordance with charts in operation manual. All lubrication points will be supplied with the correct amount and type of lubricant.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for cleaning, lubricating and inspecting the milling machine.
2. Explain the reasons for performing routine cleaning, inspection, and lubrication of milling machines.
3. Determine the proper lubricants to be used for milling machines.
4. Explain the meaning of the terms (a) climb; (b) conventional milling.
5. Describe the procedures for cleaning, lubricating and inspecting the milling machine.
6. Lubricate a milling machine.

08.03 Level TASK: True up the Head and Align Milling Machine Fixtures

PERFORMANCE OBJECTIVE: Given a milling machine with a swivel type head and dial indicator with attachments, align the table and must be aligned to within .001 inch T.I.R. at a 4 inch radius and align vise on milling machine table to within .001 inch T.I.R.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures in alignment of heads.
2. Explain the operation of a swivel head on a mill.
3. Explain the use of dial indicator for aligning swivel heads.
4. Describe the procedures for aligning the head of a milling machine.
5. Describe the procedures for aligning a vise on a milling table.
6. Align a vise on a milling table.
7. Align a head of a milling machine.

08.04 TASK: Select and Set Feeds and Speeds for Milling Work
Level

PERFORMANCE OBJECTIVE: Given a known hardness of a variety of materials, determine the correct speeds and feeds for milling using handbook.

ENABLING OBJECTIVES:

1. List the correct cutting speed and feed for the following materials:
   a. cold rolled steel, with 1/2" end mill.
   b. aluminum, with 1/4" end mill.
   c. tool steel, with 3/8" end mill.
2. Set correct feeds and speeds on a milling machine for selected material.

08.05 TASK: Square up Workpieces with a Table Vise
Level

PERFORMANCE OBJECTIVES: Given a blueprint, workpiece, end mill or face mill, cutting fluids, milling machine vise, parallels, soft face hammer, and precision measuring instruments, mill a block of metal square holding a tolerance of $\pm$ .001 inch for linear dimensions.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for milling operations.
2. Calculate the correct speed and feed for various cutters.
3. Describe the procedures for setting-up and machining a workpiece parallel and square.
4. Identify the correct cutting fluids for milling.
5. Mill a block of metal to square within required tolerances.

08.06 TASK: Perform End Milling
Level

PERFORMANCE OBJECTIVES: Given blueprint, workpiece holding device, end mill, cutting fluid, and precision measuring instrument, mill a flat surface to .001 T.I.R.

ENABLING OBJECTIVE:

1. Explain the safety precautions/procedures for end milling.
2. Calculate proper speeds, feeds and depth of cut with end milling.
3. Describe the procedures for setting up and end milling a flat surface.
4. Identify the correct cutting fluids for milling.
5. End mill a flat surface to .001 T.I.R.

08.07 TASK: Perform Fly-Cutting Operations
Level

PERFORMANCE OBJECTIVE: Given a blueprint, workpiece, fly-cutter, cutting tool blank, and precision measuring instruments, fly-cut workpiece surface to print requirements.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for fly-cutting a workpiece surface.
2. Define surface roughness, waviness, lay and identify their symbols.
3. Explain the purpose of fly-cutters.
4. Calculate speeds, feeds, and determine depth of cut for fly-cutting surfaces.
5. Describe the procedures for fly-cutting surfaces.
6. Fly-cut a workpiece surface to required tolerances.

08.08 TASK: Drill Holes with a Milling Machine
Level

PERFORMANCE OBJECTIVE: Given a blueprint, workpiece, center drill and drill, layout materials, and precision measuring instruments, drill equally spaced holes in workpiece holding a tolerance of $\pm$ .002 inch for location and diameter, and $\pm$ 1 degree for perpendicularity.

ENABLING OBJECTIVES:

1. Explain safety precautions/procedure for drilling holes.
2. Describe the procedures for using milling machine dials for accurate table positioning.
3. Calculate the amount of table movement for each position.
4. Describe the procedures for compensating for backlash out the lead screws.
5. Calculate the correct speed and feed.
6. Drill holes in a workpiece to specified tolerances using a milling machine.

08.09 TASK: Perform Reaming Operations
Level

PERFORMANCE OBJECTIVES: Given blueprint, workpiece, holding device, centerdrill, drill, reamer, cutting fluid, and precision measuring instruments, centerdrill, drill and ream a hole holding a tolerance of + .002, - .000 for diameter, and .002 for the hole's true position according to print specifications.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for centerdrilling and reaming a hole.
2. Explain the uses of centerdrills, drills, and reamers.
3. Calculate proper speeds and feeds for centerdrilling, drilling and reaming operations.
4. Describe the procedures for centerdrilling, drilling, and reaming on a milling machine.
5. Identify the correct cutting fluids for centerdrilling, drilling and reaming.
6. Determine the proper drill size for reaming.
7. Ream a hole in a workpiece holding required tolerances.

08.10 TASK: Cut External Keyways
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece holding device, end mill, cutting fluid, and precision measuring instruments, end mill keyseat in the workpiece holding a tolerance of + .001, - .000 inch for width, + .005, - .000 depth, ± 1/64 inch for length.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for end milling keyseats.
2. Calculating proper speeds, feeds and depth of cut when milling keyseats.
3. Describe the procedures for setting up and milling keyseats.
4. Identify the correct cutting fluids for milling keyseats.
5. Determine keyway depth.
6. End mill a keyseat in a workpiece holding required tolerances.

08.11 TASK: Bore Hole with Milling Machines
Level

PERFORMANCE OBJECTIVE: Given a blueprint with bore specifications, workpiece, work holding device, boring head, cutting fluid and precision measuring instruments, bore hole in workpiece with boring head holding print tolerances.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for boring and counterboring holes.
2. Explain the procedures for accurately adjusting a boring head.
3. Calculate speeds and feeds for boring operations.
4. Describe the procedures for setting up and completing boring operations.
5. Identify the correct cutting fluids for boring and counterboring.
6. Bore a hole in a workpiece using a boring head on a milling machine to required tolerances.

08.12 TASK: Perform Form Milling
Level

PERFORMANCE OBJECTIVE: Given a blueprint, workpiece, form cutter, cutting fluids, and precision measuring instruments, form mill workpiece holding print tolerances.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for form milling.
2. Define the terms concave and convex as they pertain to milling cutters.
3. Calculate speeds, feeds and depth of cut for milling cutter.
4. Describe the procedures for form milling.
5. Identify the correct cutting fluids.
6. Form mill a workpiece to required tolerances.

08.13 Level TASK: Perform Indexing Operations Using a Dividing Head

PERFORMANCE OBJECTIVE: Given blueprint, milling machine with an indexing head, Machinery's Handbook, change gears, cutting tools, cutting fluids, and precision measuring instruments, machine workpiece using differential indexing locating odd numbers of divisions over 40.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for machining using the differential indexing method.
2. Explain the calculations for the indexing head when performing differential indexing.
3. Explain the proper technique for assembling gears in gear train.
4. Define simple gearing and compound gearing.
5. Explain the use of an idler gear.
6. Describe the procedures for machining a workpiece using differential indexing.
7. Identify the correct cutting fluids.
8. Explain the use of wide range indexing.
9. Machine a workpiece with deferential indexing using a dividing head.

08.14 Level TASK: Set Up and Operate Rotary Tables

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, milling machine with rotary table, end mills, cutting fluids, and precision measuring instruments, machine an outside radius holding print tolerances.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for milling radii using a rotary table.
2. Describe set up and clamping procedures for a rotary table.
3. List the applications for a rotary table.
4. Explain the procedures for avoiding backlash of rotary table and milling machine screws.
5. Calculate the correct speeds for machining outside radius.
6. Describe the procedure for milling outside radius using a rotary table.
7. Identify the correct cutting fluids.
8. Describe the procedures for centering spindle with rotary table.
9. Mill an outside radius using a rotary table on a machining machine.

08.15 TASK: Mill Cylindrical Work
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, tap, tap wrench, lathe attachments, cutting fluid, and thread plug gauge, tap hole in workpiece to a class 2 fit.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for tapping operations.
2. Determine tap drill size using the charts and formulas.
3. Describe the procedures for tapping on the lathe.
4. Identify the correct cutting fluid for tapping.
5. Describe the proper use of a plug gauge.
6. Tap a hole in a workpiece using a lathe.

08.16 TASK: Mill an External Radius
Level

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, milling machine with rotary table, end mills, cutting fluids, and precision measuring instruments, machine an inside radius holding print tolerances.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for cutting radii using a rotary table.
2. Calculate the correct speeds for milling inside radius.
3. Describe the procedures for machining inside radii using a rotary table.
4. Identify the correct cutting fluids.
5. Machine an internal radius using a rotary table on a milling machine.

08.17 TASK: Mill an Angle
Level

PERFORMANCE OBJECTIVE: Give blueprint, milling machine, with an indexing head, drills, Machinery's Handbook, workpiece, cutting fluids, and precision measuring instruments, drill holes in workpiece to specified angles using the indexing head.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for milling holes using angular indexing.
2. Explain the calculations required for the indexing head when performing angular indexing.
3. Calculate speeds and feeds for angular indexing operations.
4. Describe the procedures for milling holes using angular indexing.
5. Identify the correct cutting fluids.
6. Drill holes in a workpiece to specified angles using an indexing head.

08.18 TASK: Align Milling Machine Attachments
Level

PERFORMANCE OBJECTIVE: Given a milling machine and a dial indicator with attachments, align milling machine attachments to within .001 inch T.I.R.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures in alignment of attachment.
2. Explain the use of dial indicator for aligning attachment.
3. Describe the procedures for aligning the milling attachment.
4. Align various milling machine attachments to within .001 T.I.R.

08.19 TASK: Mill Internal Slots with a slotting attachment
Level

PERFORMANCE OBJECTIVE: Given a blueprint, workpiece, milling machine with slotting attachment, cutting fluids, precision measuring instruments, and tool blanks, machine internal slots and keyway holding a tolerance as specified on blueprint.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for cutting internal slots and keyways.
2. Explain the ability to grind and sharpen cutting tools.
3. Determine the correct cutters for various applications.
4. Calculate depth and size of keyways and slots.
5. Describe set up procedures for the length of stroke.
6. Calculate speed in strokes per minute.
7. Describe procedures for machining internal slots and keyways.
8. Identify the correct cutting fluids.
9. Mill an internal slot to required tolerances.
10. Mill a keyway to required tolerances.

08.20 TASK: Perform Cutting-Off Operation
Level

PERFORMANCE OBJECTIVE: Given a milling machine, arbor and slitting saw, cut multiple workpieces to precision lengths and slot various shapes of workpieces.

ENABLING OBJECTIVES:

1. Explain how to calculate depths, speeds and feeds for slitting saws.
2. Explain how to set up workpieces with kickers to cut precision lengths.
3. Cut workpieces to precision lengths.
4. Slot various shapes of workpieces.

08.21 Level TASK: Set Up and Perform Slab Mill Operations

PERFORMANCE OBJECTIVE: Given blueprint, workpiece, horizontal milling machine, slab milling cutter, arbor with spacers, work holding device, cutting fluids, and precision measuring instruments, mill the workpiece. After rough and finish cut, parallelism must be within .002 inch per 6 inches of length.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for slab milling.
2. Explain the importance of maintaining a clean milling machine.
3. Describe procedures for mounting cutter and arbor in the milling machine.
4. Explain why the cutter should always be mounted on the arbor as close to the column of the milling machine as possible.
5. Describe the procedures for slab milling operations.
6. Identify the correct cutting fluid.
7. Explain the purpose of the applications for using climb milling and conventional milling.
8. Mill, rough and finish cut a workpiece to required tolerances.

08.22 Level TASK: Use an Edge Finder and Wiggler

PERFORMANCE OBJECTIVE: Given a workpiece and an edge finder or wiggler locate the center of the workpiece to within $\pm$ .001 inch.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures.
2. Explain the correct care and use of an edge finder or wiggler.
3. Describe the procedures for touching off with an edge finder and a wiggler.
4. Mark the center of a workpiece after locating it with a wiggler or edge finder.

08.23 Level TASK: Use Digital Readouts

PERFORMANCE OBJECTIVE: Given a blueprint, workpiece, center drill and drill, layout materials, digital read out, and precision measuring instruments, drill equally spaced holes in workpiece holding a tolerance of $\pm$ .0005 non-cumulative location.

ENABLING OBJECTIVES:

1. Explain the safety cutting precautions/procedures for drilling holes.
2. Describe the procedures for using digital read out for accurate table positioning.
3. Calculate the amount of table movement for each position.
4. Describe the procedures for keeping backlash out of lead screws.
5. Calculate the correct cutting speed and feed.
6. Describe the procedures for drilling equally spaced holes.
7. Identify the correct cutting fluids for drilling.
8. Drill equally spaced holes in a workpiece using digital read outs to locate centers.

08.24 Level TASK: Perform Straddle Milling Operations on the Horizontal Mill

PERFORMANCE OBJECTIVE: Given a blueprint, workpiece, work holding device, milling cutter, arbor spacer, cutting fluids, and precision measuring instruments, gang mill workpieces holding a tolerance of ± .005 on depth, width and spacing.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures.
2. Explain the purpose of and applications for gang milling operations.
3. Describe the procedures for mounting cutters and arbor in machine.
4. Explain why a key is needed in the arbor.
5. Calculate speed, feed and depth of cut for gang milling operations.
6. Describe the procedures for gang milling.
7. Identify the correct cutting fluid for milling operations.
8. Gang mill workpieces on a horizontal mill to required tolerances.

08.25 Level TASK: Set Up and Use a Sine Vise

PERFORMANCE OBJECTIVE: Given a milling sine vise, workpiece, parallels, soft face hammer, and precision measuring instruments, seat workpiece in vise to within .003 T.I.R. per 4 inches.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures.
2. Describe the care and use of parallels.
3. Describe the procedures for seating a part in a milling sine vise.
4. Set up and seat a workpiece in a sine vise.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 9

SURFACE GRINDING MACHINING

Division of Vocational Education
State of Idaho
Boise, Idaho
1990

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MODULE 9 - SURFACE GRINDING MACHINING

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Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

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It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

09.01 Level TASK: Identify the parts of the Machine and explain their use

PERFORMANCE OBJECTIVES: Given a surface grinder, service manual, identify major parts and function.

ENABLING OBJECTIVES:
1. Identify types of surface grinders.
2. Identify major parts.
3. Describe the function of major parts.

09.02 Level TASK: Comply with Safe and Efficient Work Practices

PERFORMANCE OBJECTIVE: Given a tool and cutter grinder and a selection of grinding wheels, explain the safety hazards associated with grinders and grinding wheels.

ENABLING OBJECTIVES:
1. Explain the safety precautions/procedures for mounting grinding wheels.
2. Explain how to determine if a wheel is cracked before mounting.
3. Explain the importance of cleanliness when mounting a wheel.
4. Explain the importance of the blotters on the wheel.
5. Describe the procedure for determining how tight the flanges should be.

09.03 Level TASK: Clean, inspect, and lubricate surface grinding machine

PERFORMANCE OBJECTIVE: Given service manual and/or lubrication charts, and access to cleaning fluid, lubricants, and lubrication tools for the surface grinder, clean, inspect, and lubricate the grinder in accordance with service manual and lubrication charts. All lubrication points will be supplied with the required type and amount of lubricant.

ENABLING OBJECTIVES:
1. Explain the safety precautions/procedures for cleaning, inspecting, and lubricating.
2. Explain the reasons for performing routine cleaning, inspection, and lubrication.
3. List the applications for lubricants used.
4. Locate the lubrication points on the grinder using the manual.
5. Describe the inspection procedures.
6. Identify the materials and describe the procedures used for cleaning surface grinders.
7. Lubricate a surface grinding machine.

09.04 TASK: Select the Proper Wheel
Level

PERFORMANCE OBJECTIVE: Given grinder, grinding wheel and access to necessary tools and precision measuring instruments, select, inspect, and mount wheel to meet requirements found in operator's manual and the Machinery's Handbook.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for mounting grinding wheels.
2. State type of grit, structure, grade, bond, and grit size for grinding the following materials: a) machine steel, b) hardened tool steel, c) carbide, d) cast iron.
3. Explain how to determine if a wheel is cracked before mounting.
4. Explain the importance of cleanliness when mounting a wheel.
5. Explain the importance of the blotters on the wheel.
6. Explain the reasons for the manufacturer printing the operating wheel speed on grinding wheels.
7. Explain the relevant safety precautions/procedures in regard to the diameter of the flanges in relationship to the diameter of the wheel.
8. Describe the procedures for mounting and balancing a grinding wheel.
9. Mount and balance a grinding wheel.

09.05 TASK: Inspect, Balance, Dress, and True, Grinding Wheel
Level

PERFORMANCE OBJECTIVE: Given grinder and diamond dresser, true and dress the grinding wheel in accordance with the procedures stated in the Machinery's Handbook and so that the wheel runs true and the grinding surface is neither loaded nor glazed.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for truing and dressing a grinding wheel.
2. Identify the different types of wheel dresser.
3. Determine the types of dresser to be used on different grinding wheels.
4. Explain the reasons for truing and dressing grinding wheels.
5. Describe procedures for truing, dressing, and balancing, a grinding wheel.
6. Explain the safety precautions/procedures for using a diamond wheel dresser.
7. True and dress a grinding wheel using a diamond wheel dresser.

09.06 TASK: Attach and Align Workpieces for Grinding Operations
Level

PERFORMANCE OBJECTIVE: Given a surface grinder and a dial indicator with attachments, align surface grinding attachments to within .0005 inch T.I.R.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures in alignment or attachment.
2. Explain the use of dial indicator for aligning attachment.
3. Describe the procedures for aligning the grinding attachment.
4. Align grinding attachments to required tolerances.

09.07 TASK: Select and Set Feeds and Speeds of Grinders
Level

PERFORMANCE OBJECTIVE: Given a known hardness of a variety of materials, determine the correct speeds and feeds for surface grinding.

ENABLING OBJECTIVES:

1. List the correct cutting speeds and feed for the following materials:
   a. cold rolled steel.
   b. aluminum.
   c. tool steel.
2. Describe the procedure for setting speeds and feeds of grinders.

09.08 TASK: Set Up and Grind Parallel Flat Surfaces
Level

PERFORMANCE OBJECTIVE: Given grinding specifications, workpiece, diamond wheel dresser, coolant, and precision measuring instruments, grind flat surface holding a tolerance of $\pm$ .0005 inch without warpage or distortion.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for surface grinding flat surfaces.
2. Describe the dressing procedures for grinding flat surfaces.
3. Explain the reason for using a coolant.
4. Describe the procedures for grinding flat surfaces.
5. Identify the correct coolant.
6. Discuss safe wheel mounting procedures.
7. Grind parallel flat surfaces to required tolerances.

09.09 TASK: Set Up and Grind Four Sides Square
Level

PERFORMANCE OBJECTIVE: Given grinding specifications, workpiece, diamond wheel dresser, angle plate, clamps, coolant, and precision measuring instruments, grind workpiece square holding a tolerance for squareness as specified on blueprint.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for grinding square.
2. Define square in relation to surface grinding.
3. Describe the procedures for grinding square.
4. Grind four sides of a workpiece square.

09.10 TASK: Set Up and Use Angle Plates

Level

PERFORMANCE OBJECTIVE: Given grinding specifications, grinder, three workpieces, diamond wheel dresser, angle vise, coolant, sine plate, and precision measuring instruments, grind angular surfaces holding a tolerance of $\pm$ 3 minutes for angle vise grinding and
$\pm$ 2 minutes for sine plate grinding.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for grinding angular surfaces.
2. Define the term "wringing" in relation to the use of gage blocks.
3. Describe the correct care and use of guage blocks.
4. Describe the use of guage blocks for setting up angles.
5. Describe the correct care and use of angle vises and sine plates.
6. Describe the procedure for grinding angular surfaces using dressed angular wheel, angle vise, and sine plate.
7. Grind angular surfaces on three workpieces to required tolerances.

09.11 TASK: Cut Off or Part Workpieces with Grinding Machines

Level

A PERFORMANCE OBJECTIVE: Given a surface grinder and a hot saw wheel, inspect, and mount wheel to meet requirements found in operator's manual and Machinery's Handbook and cut off or part workpieces.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for mounting hot saw wheel.
2. List type of grit, structure, grade, bond, and grit size for grinding the following materials: a) machine steel, b) hardened tool steel, c) carbide, d) cast iron.
3. Explain how to determine if a wheel is cracked before mounting.
4. Explain the reasons for the manufacturer printing the operating wheel speed on grinding wheels.
5. Explain the relevant safety precautions/procedures in regard to the diameter of the flanges in relationship to the diameter of the wheel.
6. Describe the procedures for mounting and balancing a grinding wheel.
7. Cut off and part workpieces using a grinding machine.

09.12 Level A TASK: Set Up Grinders to Run Workpieces between Centers

PERFORMANCE OBJECTIVE: Given blueprint, a workpiece at least 6" long, index centers and a precision measuring instruments, grind shaft between centers to a tolerance of ± .0002 inch in diameter.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for grinding shafts between centers.
2. Calculate speeds and feeds for grinding.
3. Describe the procedures for grinding a shaft between centers and setting index centers.
4. Grind a shaft between two centers to required tolerances.

09.13 Level A TASK: Measure, inspect and rework workpieces on grinding machines

PERFORMANCE OBJECTIVE: Given a grinder, flat workpiece, outside micrometer, vernier caliper, and surface plate, precision measure the workpiece.

ENABLING OBJECTIVES:

1. Explain correct drafting standards for dimensioning blueprints.
2. Demonstrate the proper care, use and calibrations of precision measuring instruments.
3. List accepted drafting abbreviations and/or symbols for the following terms:
   a. Outside diameter
   b. Inside diameter
   c. Threads per inch
   d. Inch
   e. Millimeter
   f. Counterbore
   g. Depth
4. Measure and grind a workpiece to blueprint specification.

09.14 Level A TASK: Set Up, Grind, and Sharpen Pre-shaped Lathe Tools

PERFORMANCE OBJECTIVE: Given a form relieved cutter, cutter grinding attachment, wheel dressing equipment, wrenches, grinding charts, coolant, and precision measuring instruments, sharpen a form relieved cutter to chart specifications in Machinery's Handbook.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for grinding form relieved cutters.
2. Explain three methods of sharpening a clearance on cutting tools.
3. Explain how a form relieved cutter is ground in order not to destroy the form while sharpening.
4. Sharpen a form relieved cutter to required specifications.

09.15 TASK: Set Up and Use Radius Dressers

Level

A PERFORMANCE OBJECTIVE: **Given wheel dressing specifications, radius dresser, coolant, radius guages, and precision measuring instruments, dress concave/convex radius on wheel holding print tolerances.**

ENABLING OBJECTIVES:

1. **Explain the safety precautions/procedures for dressing radii on grinding wheels.**
2. **Describe the situations that require dressing a radius on the wheel.**
3. **Describe the procedures for dressing concave/convex radii on grinding wheels.**
4. **Dress a concave radius on a grinding wheel to required specifications.**
5. **Dress a convex radius on a grinding wheel to required specifications.**

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 10

TOOL AND CUTTER GRINDING MACHINES

Division of Vocational Education
State of Idaho
Boise, Idaho
1989

MODULE 10 - TOOL AND CUTTER GRINDING MACHINES

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

MODULE 10 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING TOOL AND CUTTER GRINDING MACHINES

10.01 TASK: Identify the parts of the machine and explain their use

Level

A PERFORMANCE OBJECTIVE: Given service manual or nomenclature chart, demonstrate complete familiarization of the machine parts and explain their function.

ENABLING OBJECTIVES:

1. List the parts of a cutter grinding machine.
2. Explain the function of the parts on a cutting grinding machine.

10.02 TASK: Comply with safe and efficient work practices

Level

A PERFORMANCE OBJECTIVE: Given a tool and cutter grinder and a selection of grinding wheels, explain the safety hazards associated with grinders and grinding wheels.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for mounting grinding wheels.
2. Explain how to determine if a wheel is cracked before mounting.
3. Explain the importance of cleanliness when mounting a wheel.
4. Explain the importance of the blotters on the wheel.

10.03 TASK: Identify and select proper machine controls

Level

A PERFORMANCE OBJECTIVE: Given service manual or nomenclature chart, demonstrate complete familiarization of the machine controls and explain their function.

ENABLING OBJECTIVES:

1. List the controls of a cutter grinding machine.
2. Explain the function of the controls on a cutting grinding machine.

10.04 TASK: Select proper wheels and work holding devices

Level

A PERFORMANCE OBJECTIVE: Given grinder, various grinding wheels and work holding devices, determine the correct wheel and proper holding method for sharpening all types of cutters, taps and reamers.

ENABLING OBJECTIVES:

1. Explain the reasons for the manufacturer printing the operating wheel speed on the blotters of all wheels.
2. Explain the correct procedure for using work holding devices.
3. Describe how these devices are used for grinding the numerous geometries involved in sharpening all cutters.

10.05 TASK: Perform truing, dressing, and forming operations to blueprint level specifications

A

PERFORMANCE OBJECTIVE: Given wheels, diamond wheel dressers and balancing devices, true and dress grinding wheels in accordance with the procedures stated in the Machinery's Handbook.

ENABLING OBJECTIVES:

1. Identify the types of wheel dressers.
2. Determine the type dresser to be used for different grinding wheels.
3. Explain the reasons for truing and dressing a grinding wheel.
4. Demonstrate the procedures for forming, truing and dressing a grinding wheel.

10.06 TASK: Compute proper speeds

Level

A PERFORMANCE OBJECTIVE: Given a variety of cutters made of high speed steel and carbide, determine the correct R.P.M. range the wheel operates under and verify with manufacturer's maximum R.P.M. listing on wheel blotter.

ENABLING OBJECTIVES:

1. Explain how manually controlling depths and feed rates can have a detrimental effect of annealing the cutter.
2. Select proper speeds for various cutters according to the type of cutter.

10.07 TASK: Sharpen an end mill

Level

A PERFORMANCE OBJECTIVE: Given fluted end mills, end mill grinding attachment, diamond dresser or a carborundum stone, charts for grinding end mills, and precision measuring tools, grind the face and primary/secondary relief on the face and sides of the fluted end mill.

ENABLING OBJECTIVES:

1. Describe the safety precautions or procedures for sharpening end mills.
2. Define primary and secondary relief on an end mill.
3. Explain why the face of an end mill should not be flat.
4. Calculate the primary and secondary relief on the face and sides of end mills.
5. Describe the procedures for setting up an end mill grinding fixture.
6. Describe the methods by which centers of cutters are found.
7. Identify the types of tool rests and their applications.
8. Demonstrate the use of a floating spindle.
9. Explain how tool rest height can effect clearance angles.
10. Grind the face and reliefs of fluted end mills.

10.08 TASK: Sharpen a horizontal milling cutter

Level

A PERFORMANCE OBJECTIVE: Given grinder, correctly dressed grinding wheel, and a wide variety of cutters suitable to the horizontal milling machine, grind the correct clearances necessary for the different types of materials.

ENABLING OBJECTIVES:

1. Describe the precautions or procedures for sharpening a horizontal milling cutter.
2. Demonstrate tool rest application to fluted type cutters versus stagger-tooth cutters.
3. Demonstrate how cutter can be held to obtain proper relief angles.
4. Demonstrate proper hand/eye coordination for sharpening cutters.
5. Sharpen a horizontal milling cutter.

10.09 TASK: Sharpen drills and Counter Sinks

Level

A PERFORMANCE OBJECTIVE: Given drills, pedestal grinder, and drill guage, sharpen drills to proper clearance and drill point angle.

ENABLING OBJECTIVES:

1. Describe the precautions or procedures for sharpening drills and counter sinks.
2. Demonstrate how to hold a drill correctly on grinding wheel.
3. Determine the proper angles for specific types of materials.
4. Sharpen a drill by hand and demonstrate its ability to drill a hole no larger than .010" more than its diameter.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 11

COMPUTERIZED NUMERICAL CONTROL

Division of Vocational Education
State of Idaho
Boise, Idaho
1990

MODULE 11 - COMPUTERIZED NUMERICAL CONTROL

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11.01 TASK: Perform Preventive Maintenance on NC/CNC Machines

Level A

PERFORMANCE OBJECTIVE: The student will perform preventive maintenance on NC/CNC Machines as required by the manufacturers' lubrication charts and procedures and complete assignments and tests with a minimum score of eighty-five percent (85%).

ENABLING OBJECTIVES:

1. Match terms associated with preventive maintenance to their correct definitions.
2. Match types of lubricants used in machines to their correct descriptions.
3. Determine required lubricants and coolants.
4. Demonstrate the ability to perform routine inspection and maintenance.
5. Make appropriate adjustments to machine components.

11.02 TASK: Identify the Parts of the Machine and Explain their use

Level A

PERFORMANCE OBJECTIVE: The student will identify and apply NC/CNC safety requirements on assignments, quizzes and daily operations with 100% accuracy, and identify NC-CNC development parts, functions, axes and coordinates with 85% accuracy.

ENABLING OBJECTIVES:

1. Select from a list, facts concerning numerical control.
2. Label work areas of NC/CNC Machines.
3. Label major parts of NC/CNC Machines.
4. Select from a list, facts concerning the Cartesian coordinate System.
5. Label the axes on an NC/CNC Machine.
6. Label coordinate points.

11.03 TASK: Identify and Select Proper Machine Controls

Level A

PERFORMANCE OBJECTIVE: The student will be able to bring the machine from an inactive to an active mode. The student will show this knowledge by completing an assignment sheet and the unit test on machine powering up with a minimum score of 85 percent, and a safety test with a minimum score of 100 percent. Further, evidence of this knowledge will be indicated by accurately and completely powering up and shutting down a NC/CNC machine.

ENABLING OBJECTIVES:

1. Complete an NC/CNC safety test.
2. Match terms associated with machine and control power-up to their correct definitions.
3. Identify controls and indicators used to power up, check, and shut down the machine.
4. Match controls and indicators used to power up, check, and shut down the machine to their correct functions.

5. State functions of mode select switch positions used to power up, check, and shut down the machine.
6. Describe the types of programming used in an NC/CNC Machine.
7. Match letter addresses to their correct meanings.
8. Match selected G codes to their correct functions.
9. Match selected M codes to their correct functions.
10. Identify types of CRT displays.
11. State meanings of status display codes.
12. Match alarm codes to their correct descriptions.
13. Complete statements about the operation of the joystick/axes controls.
14. Describe the purpose of emergency stops and power switches.
15. Trouble shoot alarm indications during power up.
16. Demonstrate the ability to:
    a. Power up, check, and shut down NC/CNC Machines.
    b. Perform axes accuracy checks.

11.04 Level A TASK: Write a Program and Apply Basic Programming Skills to a Turning Operation and/or a Milling Machine

PERFORMANCE OBJECTIVE: The students will be able to write a program. The student will show this knowledge by completing program, tooling, coordinated dimensions, and written set up procedures to produce parts to print specifications on the CNC Lathe Machine.

ENABLING OBJECTIVES:

1. Match terms associated with writing a program to their correct definitions.
2. State purpose of the program.
3. Match program letters to their basic functions.
4. Match G codes to their modes of operation.
5. Match M codes to their functions.
6. Modify blueprint dimensions to fit NC/CNC Program Planning.
7. Calculate axes values using absolute method.
8. Calculate axes values using incremental method.
9. Calculate axes values using tool radius compensation.
10. Calculate I, J and K values.
11. Write a Lathe program for turning, contouring and threading.
12. Write a mill program for drilling, milling and continuous path contouring.
13. Select from a list, steps to determine threading passes.
14. Select from a list, factors to consider when selecting tooling required for turning, milling and drilling procedures.
15. Select from a list, guidelines for planning procedures.
16. Calculate speeds and feeds.
17. Arrange in order, steps in writing a program utilizing appropriate canned cycles.
18. Select from a list, steps in writing a program to set dwell.
19. Plan procedure.
20. Complete a setup sheet.
21. Write a program to set dwell.

11.05 Level A TASK: Select Proper Work Holders for a Production Run

PERFORMANCE OBJECTIVE: The student will be able to perform a production run. The student will show this knowledge by completing assignment sheets and a unit test with a minimum score of 85 percent and by performing a production run with a minimum of a 90 percent efficiency rating and a maximum rejection rate of 5 percent.

ENABLING OBJECTIVES:

1. Match terms associated with production runs to their correct definitions.
2. Calculate efficiency.
3. Calculate productivity.
4. State guidelines to follow in monitoring tool life.
5. Select from a list, guidelines to follow in monitoring dimensional accuracy during a production run.
6. Demonstrate the ability to perform production run to required efficiency and productivity standards.
   a. Monitor dimensional accuracy and change offsets as required.
   b. Monitor tool life and change tools as required.

11.06 Level A TASK: Select Proper Cutting Tools

PERFORMANCE OBJECTIVE: The student will determine the correct type of cutter suitable to the operation performed.

ENABLING OBJECTIVES:

1. Select the best cutter geometry from the cutter inventory available.
2. Describe why this cutter is the best for the many operations these machines can perform.

11.07 Level A TASK: Machine Parts to Blueprint Tolerances

PERFORMANCE OBJECTIVE: The student will be able to evaluate a NC/CNC produced part in terms of design requirements. The student will show this knowledge by completing assignment sheets and a unit test with a minimum score of 85 percent and by producing a part within all tolerances on the second run.

ENABLING OBJECTIVES:

1. Match terms associated with machining evaluation to their correct definitions.
2. Select from a list, items to check during a visual inspection of first run.
3. Match blueprint symbols to their correct meanings.
4. Match inspection equipment to their correct descriptions.
5. Select from a list items to check during a dimensional inspection of first run.
6. Identify three indications that program editing may be necessary.
7. List actions to take for setup flaws.
8. Compare finished part to blueprint.
9. Calculate revised offset values.

10. Determine required program and setup changes.
11. Demonstrate the ability to:
    a. Run first part.
    b. Evaluate first run.
    c. Edit program and change setup as required.
    d. Run and evaluate second part.

11.08 TASK: Demonstrate the Use of CAD/CAM Systems for Part Program Development

Level A

PERFORMANCE OBJECTIVE: Each student will complete the exercises assigned under projects and submit the assigned, completed projects for evaluation.

ENABLING OBJECTIVES:

1. Develop an understanding of computer aided drafting.
2. Develop a beginning level of AUTOCAD usage.
3. Define terms and equipment used with CAD systems.
4. Demonstrate knowledge of and use of AUTOCAD setting commands.
5. Utilize DOS computer commands to: a) format, b) copy, c) delete, d) erase, e) directory, f) make a directory, g) path, h) change i) directory and j) remove a directory.
6. Demonstrate knowledge of and use of AUTOCAD drawing commands.
7. Demonstrate knowledge of and use of AUTOCAD editing commands.
8. Demonstrate knowledge of and use of AUTOCAD display commands.
9. Demonstrate knowledge of and use of AUTOCAD layer commands.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 12

E.D.M. MACHINE

Division of Vocational Education
State of Idaho
Boise, Idaho
1990

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MODULE 12 - E.D.M. MACHINE

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

MODULE 12 - E.D.M. MACHINE

12.01 Level TASK: Describe the parts of the EDM machine

PERFORMANCE OBJECTIVE: Given an operators manual or maintenance manual, identify the major parts and functions of an Electric Discharge Machine.

ENABLING OBJECTIVES:

1. Identify the generator unit and explain its function.
2. Identify the machine base, dielectric tank and the head/ram unit.
3. Identify the dielectric flushing system and explain its function during machining.

12.02 Level TASK: Describe EDM machine controls

PERFORMANCE OBJECTIVE: Given operators manual, identify the E.D.M. controls and describe their functions.

ENABLING OBJECTIVES:

1. Identify the power level and spark time on/off controls and explain how they affect the erosion process.
2. Identify the servo control and explain its function.
3. Identify the polarity selector and explain the difference between positive and reverse polarity and how each affects the erosion process.

12.03 Level TASK: Describe the functions of laser technology in precision machining

PERFORMANCE OBJECTIVE: Given an operators manual and laser cutting machine describe the concepts behind Light Amplication by Stimulated Emission of Radiation (LASER).

ENABLING OBJECTIVES:

1. Identify the components of the machine and describe how to concentrate the light beam.
2. Describe how the light beam can be used to measure precision dimensions and to what tolerances.
3. Identify the industries that utilize these machines.

12.04 Level TASK: Describe the functions of robotics in precision machining

PERFORMANCE OBJECTIVE: Given an industrial robot and service manual describe how to power up and explain the various multi-axis movements.

ENABLING OBJECTIVES:

1. Describe the differences between pick and place vs. jointed wrist designs.
2. Describe F.M.S. and give its robotic advantages.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 13

HEAT AND TREAT FURNACES

Division of Vocational Education
State of Idaho
Boise, Idaho
1990

MODULE 13 - HEAT AND TREAT FURNACES

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

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It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

MODULE 13 - SET UP AND OPERATE HEAT TREAT FURNACES

13.01 TASK: Identify the Parts of the Machine

Level A

PERFORMANCE OBJECTIVE: Given an operators manual for either an electric or gas fired furnace describe the controls and explain the concepts of the Thermocouple.

ENABLING OBJECTIVE:

1. Explain why the temperature control and critical temperature must be controlled with the Thermocouple.
2. Explain why it is important to be prepared whenever you open the furnace door.
3. Describe the operation of a thermocouple.

13.02 TASK: Identify Proper Machine Controls

Level A

PERFORMANCE OBJECTIVE: Given a heat treat furnace and operator's manual, identify the controls for operating the machine and describe their function.

ENABLING OBJECTIVES:

1. List the main operating controls of a heat treat machine.
2. Describe the function of each of the main operating controls of a heat treat machine.

13.03 TASK: Set Up and Operate Heat Treat Furnaces

Level A

PERFORMANCE OBJECTIVE: Given a heat treat furnace and an operator's manual, set up and operate the furnace.

ENABLING OBJECTIVES:

1. Explain the safety precaution for operating a heat treat furnace.
2. Describe the proper procedure to set up and operate a heat treat furnace.
3. Set up and operate a heat treat furnace.

13.04 TASK: Select Proper Heat Treatment Process

Level A

PERFORMANCE OBJECTIVE: Given a hardened and tempered workpiece, chart of S.A.E./AISI heat treating specifications and a heat treat furnace, test to within $\pm$ 5 of predetermined harness in accordance with the Rockwell Brinell scales.

ENABLING OBJECTIVES:

1. Identify the parts of furnace and explain controls.
2. Explain the difference between ferrous and non-ferrous alloys.
3. Explain the difference between machine steel and carbon tool steel.
4. Define the following:
   a. ferrite
   b. cementite
   c. pearlite

d. martinsite
e. austinite

5. Describe the effects of under-heating and overheating steel.
6. Identify the numbers in the S.A.E. numbering system for the following steels:
   a. 1020
   b. 2340
   c. 4330
   d. 10120
7. Explain the reasons for tempering hardened steel.
8. Describe how to test steel for hardness with a file and a hardness tester.
9. Explain the use of the B and C scales on a Rockwell tester.
10. Explain the uses of the scleroscope.

13.05 TASK: Perform a Basic Heat Treatment Process to Blueprint Specifications

Level A

PERFORMANCE OBJECTIVE: Given S.A.E. or AISI specifications for hardening and tempering operations, three pieces of steel with different alloying composition, quenching solutions, hardness tester, and a file, harden temper, and a heat treat furnace, test one piece of oil hardening material, one piece of air hardening material, and one piece of water hardening material to S.A.E. or AISI specifications with + 5 on hardness tester in accordance with the Rockwell "C" or Brinell scale.

ENABLING OBJECTIVES:

1. Explain the safety procedures for heat treating.
2. Explain the operation of various types of heat treating furnaces, controlled atmosphere, liquid and non-airtight.
3. Explain the various temperature setting required for different types of steel.
4. Explain the different types of quenching media and the quenching process.
5. Explain the use of the oxy-acetylene torch to heat treat steel.
6. Explain the use of a magnet to guage the proper critical temperature.
7. Explain the color method of tempering, citing the proper colors for different tools.
8. Heat treat three different pieces of material.

13.06 TASK: Define Stress, Relieving, Annealing and Normalizing

Level A

PERFORMANCE OBJECTIVE: Given S.A.E. or AISI specifications for an annealing and normalizing operation, piece of steel, and S.A.E. charts or Machinery's Handbook, anneal workpiece to its original state of hardness.

ENABLING OBJECTIVES:

1. Explain the safety precautions/procedures for annealing steel.
2. Define annealing, stress relieving and normalizing.
3. Describe how steel is cooled after annealing.
4. Describe the procedures for annealing steels.
5. Anneal a workpiece to its original state of hardness.