TECH CRAFTSMAN CAREER BUILDING TECHNICAL TRADE SCHOOL

CURRICULUM GUIDE for

PRECISION MACHINING TECHNOLOGY

2016

Interim Director, Proprietary School Certification
Missouri Department of Higher Education
PO Box 1469
Jefferson City, MO 65102-1469

Tech Craftsman Career Building Technical Trade School

Certified State of Missouri Proprietary School Trade School/University

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ACKNOWLEDGMENTS

I, as the creator of Tech Craftsman Career Building Technical Trade School (TCCBTTS) designed to develop and offer needed careers to advance graduate interns in a lifelong job. Also creator of Advance Technology Career University designed for advanced graduate interns to move on and earn AA and Bachelor Degrees.

TCCBTTS is using two different terms, **"Internship" and "Apprenticeship"** those two terms fit the many different programs we offer

✓ **Internship** is (a job) training for white collar and professional careers. Internships for professional careers are similar in some ways to apprenticeships for trade and vocational jobs. The Internship's lack of standardization and oversight leaves the term open to broad interpretation.

✓ **Apprenticeship** is a person who works for another in order to learn a trade

Tech Craftsman Career Building Technical Trade School interns/apprentices can go through TCCBTTS's 24 month, 8 hour days, 5 days weeks and then find a job as a master in their field, or advance with college degrees through Advance Technology Career University. While I was planning, developing, and writing this curriculum for automotive technology, I realized several more curriculum's need to be developed to fit all the other programs which in the future will be offered to fit several different fields, so now I'm adding: "Precision Machine Technology", hope the following will encourage future TCCBTTS interns/apprentices or even college interns/apprentices.

I admit I begged and borrowed many of different published curriculums to put together this plan to be turned into over to the Interim Director, Proprietary School Certification Missouri Department of Higher Education. It was explained to me once turned over to higher education, then at any time once, directors, master, in any program offered, then TCCBTTS's committee and instructors in each department can revise this curriculum at any time. I realized the final revised curriculum will require the coordinated efforts of many people involved in TCCBTTS field of Automotive Technology. Automotive Technology will be the first program Tech Craftsman Career Building Technical Trade School will offer on startup. Now TCCBTTS is in a new phase with adding several new technologies, this too will be an exciting program and a high paying career.

Appreciation is expressed to the many machine shop experts who have worked in the machining industry for decades, which now have years of experience and know what is lacking from instruction from community colleges or other machine shop technology school which only instruct what's called, "Basic" knowledge. Those professionals who provided their assistance to the development of this document are greatly appreciated.

Tech Craftsman Career Building Technical Trade School, has adopted Missouri NATEF Standards as the base document for instructional content in this curriculum. If for any revisions will be required in the future on this Machining Technology Curriculum Guide will be based on a Technical Committee set up by Tech Craftsman Career Building Technical Trade School for review of the tasks in TCCBTTS Instruction and a subsequent development of performance objectives by a writing team.

As President of TCCBTTS, I reviewed several curricula's from different states, two such states as being Idaho and Florida and different community colleges across the nation. I adapted several parts from both states to fit Tech Craftsman Career Building Technical Trade School, including the State of Missouri's needs and requirements.

Thank you,

James E. Grow, President/CEO

INTRODUCTION

This *Vocational Trade School Program Curriculum Project* was specially designed for Tech Craftsman Career Building Technical Trade School with a cooperative effort among machinist professionals, and machinist shop owners, of anyone of the three categories:

1. Tool and die makers
2. Precision Machining
3. Auto Machine Shop

Including, car dealership shop managers, industry representatives, to develop competency based program standards for curriculum content.

The Machinist Standards were developed utilizing documents the creator and developer of Tech Craftsman Career Building Technical Trade School compiled from the State of Idaho, the State of Florida, and Missouri, including several other sources.

Tech Craftsman Career Building Technical Trade School will use the standards used by; The National Institute for Metalworking Skills (NIMS) – Apprenticeship and Southern Florida's Apprenticeship Training Standards (FEAT) and General Machinist and Computer Numerically Controlled (CNC) Machinist. These national research standards will be directed in specific occupational areas. The content of this document is directed toward the occupational area of Automotive Technician - not toward a specific institution or level of instruction in the State of Missouri.

The benefits to TCCBTTS interns/apprentices and institutions derived from the development of these curriculum standards should be considerable. Articulation of TCCBTTS interns/apprentices from Tech Craftsman Career Building Technical Trade School Proprietary School programs will be aided through a single set of curriculum standards. Local evaluation of programs and curricula can be accomplished using the (NIMS) Standards as an objective measure. Institutions will be able to utilize the curriculum standards in a flexible manner to assure that vocational programs meet the needs of local business and industry.

The Curriculum Guide is organized in the same manner as the (NIMS) Standards with eight instructional areas. Previous standards will be revised to be aligned with the (NIMS) groupings. Instructors will be able to use the (NIMS) Standards as the base for curriculum development at the local level, and follow that process with the State of Missouri's objectives as the instructional component for each group. The Competency Profiles will be revised to reflect the content of the (NIMS) tasks. Programs will also have the capability to scan the competencies with bar coding equipment as the profiles will have bar codes assigned to each task.

Each program is designed to contact and work with local car dealerships, private owned auto repair shops and Auto Manufacturers to establish a partnership with Tech Craftsman Career Building Technical Trade School to incorporate not only any new technology into this curriculum but will review all suggested parts to be added by recommendations from partners. This curriculum guide format can be shared with all the mentioned partners to encourage them to participate in Tech Craftsman Career Building Technical Trade School programs.

Machinists Categories:

4. **Tool and die makers**
5. **Precision Machining**
6. **Auto Machine Shop**

How Machinists Learn:

- Machinists learn in apprenticeship programs, informally on the job, in vocational high schools, vocational trade school, and in community or technical colleges.
- Many entrants, (Entrants is a person or group that enters, joins, or takes part in something) or has previously having worked as machine setters, operators, or tenders.
- Although employment is projected to decline, job opportunities are expected to be good in all three fields.

Machinists and Tool and Die Makers

There are currently 8,060 jobs for machinists in Missouri and this is projected to grow by 4% to 8,410 jobs by 2016.

Overall employment of machinists and tool and die makers is projected to grow 6 percent from 2014 to 2024, about as fast as the average for all occupations. Employment growth will vary by specialty.

Employment of machinists is projected to grow 10 percent from 2014 to 2024, faster than the average for all occupations. Despite improvements in technologies, such as computer numerically controlled (CNC) machine tools, autoloaders, high-speed machining, and lights-out manufacturing, machinists will still be required to set up, monitor, and maintain these automated systems.

In addition, employers will continue to need machinists, who have a wide range of skills and are capable of using modern production techniques in a machine shop. As manufacturers invest in new equipment, modify production techniques, and implement product design changes more rapidly, they will continue to rely heavily on experienced machinists.

Employment of tool and die makers is projected to decline 13 percent from 2014 to 2024. Foreign competition in manufacturing and advances in automation, including CNC machine tools and computer-aided design (CAD), should reduce employment of tool and die makers.

Job Prospects for Machinists and Tool and Die Makers:
Machinists and tool and die makers should be very good, as employers continue to value the wide-ranging skills of these workers. Also, many young people with the education and skills needed to become machinists and tool and die makers prefer to attend college or may not wish to enter production occupations. Therefore, the number of workers learning to be machinists and tool and die makers is expected to be smaller than the number of job openings arising each year from the need to replace experienced machinists who retire or leave the occupation for other reasons.

Job Outlook Tool and die makers
Employment of machinists and tool and die makers is projected to grow 6 percent from 2014 to 2024, about as fast as the average for all occupations. Workers familiar with computer software applications and who can perform multiple tasks in a machine shop will have the best job opportunities.

- Tool and die makers are a class of machinists in the manufacturing industries who make jigs, fixtures, dies, molds, machine tools, cutting tools, gauges, and other tools used in manufacturing processes. Depending on which area of concentration a particular person works in, he or she may be called by variations on the name, including tool maker (toolmaker), die maker (diemaker), mold maker (moldmaker), tool fitter (toolfitter), etc.

  Tool and die makers work primarily in toolroom environments, (A toolroom is a room where tools are stored)—sometimes literally in one room but more often in an environment with flexible, semipermeable boundaries from production work. They are skilled artisans (craftspeople) who typically learn their trade through a combination of academic coursework and hands-on- instruction, with a substantial period of on-the-job training that is functionally an apprenticeship (although usually not nominally today).

Auto Machine Shop:
A facility within a factory with equipment and skilled labor to manufacture and/or repair parts on engine blocks, cylinder heads, crankshafts, camshafts or any engine component, bring each piece back to auto makers or auto manufacturers original specifications.

Precision Machining
Precision machining is what produces a huge number of both large and small objects that we use in daily life. Each intricate piece which makes up an object requires one level or another of a machinists skills. Likewise, a tool or machine that has been worn down will often require machine tool calibration, welding or grooving by a precision machinist. From the production of aircraft aluminum

alloys to surgical bone drilling devices and custom automotive tools, precision machining reaches into every technology and industry. In other words, if an object contains parts, it required precision machining.

Tech Craftsman Career Building Technical Trade School understand we need to provide not only to TCCBTTS' interns/apprentices the opportunity to choose between each program, but to provide each industry the opportunity for TCCBTTS to provide well trained master technician employees to serve all 3 of those industries, such as, Tool and Die Maker Technicians, Precision Machinist Technicians, Auto Machine Shop Technicians.

TASK PROFILE

PROGRAM TITLE: Precision Machining Technology

MAJOR CONCEPTS/CONTENT: The purpose of this program is to prepare TCCBTTS interns/apprentices for employment as:

1. Machinists (600.280-022)
2. Filers (705.484-010)
3. Grinders (603.280-018)
4. Buffers (603.382-010)
5. Lay out workers (600.281-018)
6. Cut off saw operators (607.682-010)
7. Drill press operators (606.682-014)
8. Lathe operators (604.280-010)
9. Mill operators (605.685-030)
10. C.N.C. machine operators (609.662-010)

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.

Machine shop/laboratory activities are an integral part of this program and include the instructors and TCCBTTS interns/apprentices set-up and operation of grinders, buffers, cut off saws, drill presses, lathes, milling machines, and machines with computerized numerical controls.

The cooperative method of instruction may be utilized for this program. Whenever the cooperative method is offered, the following is required for each intern/apprentices: a training plan, signed by the intern/apprentices, 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 interns/apprentices has chosen as a career goal. The intern/apprentices must receive compensation for work performed.

The typical length of the TCCBTTS program for the average achieving intern/apprentices is a 24 month program, 8 hour days, 5 day week

(**See code descriptions on next following page**)

- TITLE(s): MACHINIST (machine shop)
  Alternate titles: machinist, first-class; machinist, general.
  DOT CODE (600.280-022)

Sets up and operates conventional, special-purpose, and numerical control (NC) machines and machining centers to fabricate metallic and nonmetallic parts, and fits and assembles machined parts into complete units, applying knowledge of machine shop theory and procedures, shop mathematics, machinability of materials, and layout techniques: Studies blueprints, sketches, drawings, manuals, specifications, or sample part to determine dimensions and tolerances of finished workpiece, sequence of operations, and setup requirements.

Measures, marks, and scribes dimensions and reference points on material or workpiece as guides for subsequent machining [LAY-OUT WORKER (machine shop) 600.281-018]

Selects, aligns, and secures holding fixtures, cutting tools, attachments, accessories, and materials on machines, such as mills, lathes, jig borers, grinders, and shapers.

Calculates and sets controls to regulate machining factors, such as speed, feed, coolant flow, and depth and angle of cut, or enters commands to retrieve, input, or edit computerized machine control media.

Starts and observes machine operation to detect malfunctions or out-of-tolerance machining, and adjusts machine controls or control media as required. Verifies conformance of finished workpiece to specifications, using precision measuring instruments, sets up and operates machine on trial run to verify accuracy of machine settings or programmed control data.

TCCBTTS Interns/Apprentices fits and assembles parts into complete assembly, using jigs, fixtures, surface plate, surface table, hand-tools, and power tools. TCCBTTS Interns/Apprentices verify dimensions and alignment of assembly, using measuring instruments, such as micrometers, height gauges, and gauge blocks.

May install machined replacement parts in mechanisms, machines, and equipment, and test operation of unit to ensure functionality and performance. May operate welding equipment to cut or weld parts. May develop specifications from general description and draw sketch of part or product to be fabricated.

May confer with engineers, production personnel, programmers, or others to resolve machining or assembly problems, may specialize in setting up and operating NC machines and machining centers and be designated Numerical Control Machine Machinist (machine shop); or set up and operate NC machines linked to automated

storage, retrieval, and moving devices and be designated Flexible Machining System Machinist (machine shop).

- **TITLE(s): FILER, HAND, TOOL (machine shop)**
  DOT CODE 705.484-010

Alternate titles: precision filer, hand; tool filer, hand Files grooved, contoured, and irregular surfaces of metal objects, such as metalworking dies and machine parts, to conform to templates, other parts, layout, or blueprint specifications: Studies blueprint or layout on workpiece, and selects files according to material, size and shape of work, and amount of stock to be removed, applying knowledge of filing procedures.

TCCBTTS Interns/Apprentices files workpiece surface to layout lines, and inspects with magnifying glass. Verifies conformity of finished workpiece by positioning workpiece against template or other part, or by measuring dimensions, using instruments, such as Vernier Calipers, micrometers, and surface gauges

Smooths and polishes workpiece with emery cloth or power buffer, and feels surface with fingers for smoothness. May lay out workpiece [LAY-OUT WORKER (machine shop)] or saw out template or layout [CONTOUR-BAND-SAW OPERATOR, VERTICAL (machine shop)].

May functionally test workpiece by mounting workpiece in press or with other parts and operating press or machine, may specialize according to product as Die Filer (machine tools).

- **TITLE(s): GRINDER OPERATOR, TOOL (machine shop)**
  Alternate titles: precision grinder
  DOT CODE: 603.280-018

TCCBTTS Interns/Apprentices will sets up and operates variety of grinding machines, such as external, internal, and surface grinders, to grind metal workpieces, such as machine parts, dies, or tools, according to knowledge of grinding procedures: Studies blueprint or layout on workpiece to visualize grinding to be done, and plans sequence of operations. Selects grinding wheel, applying knowledge of abrasives and metal properties, and secures it on spindle, using wrench. Dresses wheel with dressing device.

Lifts workpiece manually or with hoist, and positions and secures workpiece to holding device, using wrenches and clamps. Selects feed rates, grinding speeds, depth of cuts, and grinding wheel of size, shape, and grade for each operation, applying knowledge of metal properties, abrasives, product specifications, and shop mathematics. Positions and tightens stops to limit travel of workpieces or grinding wheel. TCCBTTS TCCBTTS

Interns/Apprentices moves controls to position wheel and workpiece in relation to each other, and to set feed, speed, and depth of cut.

Starts machine, turns hand-wheel to feed grinding wheel to workpiece or vice versa, and engages power feeding device. Turns valve handle and directs flow of coolant against wheel and workpiece. Observes operation and adjusts position and action of wheel and workpiece. Verifies dimensions of ground workpieces for conformance to specifications, using measuring instruments, such as templates, micrometers, dial indicators, and gauge blocks.

Works to tolerances of plus or minus 0.0001 inch, and may measure, mark, and scribe workpiece to lay it out for grinding [LAY-OUT WORKER (machine shop) 600.281-018].

May dress grinding wheels to complex profiles, using special fixtures and tools, and may grind nonmetallic materials, such as plastics, including operate tracer attachment to duplicate contours from templates or models or may be required to have specialized experience with particular materials, product, or precision level or with machine of particular size, type, or trade name.

- **Buffing-Machine Operator**
  DOT Code: 603.382-010

TCCBTTS Interns/Apprentices will sets up and operates semiautomatic buffing machine to buff parts, such as automobile trim or hardware to specified finish: Reads work order to determine parts to be buffed and setup procedure.

- Selects holding fixture and bolts it to feed arm.
- Slides spacers between buffs on spindle to set spacing.
- Measures and sets angle of feed arm to control position of workpiece against buff, according to specifications or using knowledge of machine operation.
- Sets length of traverse and stroke of feed arm by adjusting air cylinder and setting stops. Starts buff revolving and clamps workpiece in fixture. Presses button to feed workpiece against buff. Removes buffed part from fixture and examines it to ensure that surface coloration meets specifications.
- Adjusts angle, feed, or traverse of machine to achieve specified finish.

- **Lay-Out Worker**
  DOT Code: 600.281-018

TCCBTTS Interns/Apprentices will lay out metal stock or workpieces, such as castings, plates, or machine parts, to indicate location, dimensions, and tolerances necessary for further processing, such as machining, welding, or assembly, analyzing specifications and computing dimensions according to knowledge of product, subsequent processing, shop mathematics, and layout procedures.

TCCBTTS Interns/Apprentices will learn and studies blueprint, sketch, model, or other specifications and plans layout. Examines workpiece and verifies such requirements as dimensions and squareness, using rule, square, and straightedge. Lifts and positions workpiece in relation to surface plate manually or with hoist, using such work aids as shims, parallel blocks, and angle plates.

TCCBTTS Interns/Apprentices will verify position with measuring instruments, such as gauge blocks, height gauges, and dial indicators. Determines reference points and computes layout dimensions. Sets indicators on height gauge, protractor, or layout machine to computed dimensions, or projects dimensions by setting indicators to specified locations on model and moving instrument or machine so that indicators bear on corresponding locations on workpiece. Indents layout points, using prick punch, center punch, and hammer.

TCCBTTS Interns/Apprentices will mark or scribes layout lines, using hand-tools and work aids, such as surface gauge, straightedge, compasses, templates, and scriber and mark such data as dimensions, instructions, and part identification on workpiece.

TCCBTTS Interns/Apprentices will work to tolerances as close as plus 0.001 inch and may position model in parallel relationship to workpiece which may apply pigment to layout surfaces, using paint brush and may inspect machined parts to verify conformance to specifications.

TCCBTTS Interns/Apprentices will may add dimensional details to blueprints or prepare dimensional drawings to be followed by other workers may layout sheet metal or plate steel, applying specialized knowledge of sheet metal layout geometry [Sheet-Metal Lay-Out Worker (any industry)].

- **TITLE(s): CUT-OFF-SAW OPERATOR, METAL (machine shop)**
  Alternate titles: band-saw operator;
  DOT CODE: 607.682-010

TCCBTTS Interns/Apprentices circular-saw operator; hack-saw operator; power-saw operator Sets up and operates metal-sawing machines, such as hacksaw, band-saw, circular saw, friction saw, and rubber-disk saw to cut metal stock to dimensions: Reads job order for specifications, such as material, type, and size of stock, and dimensions to be cut. Obtains and transfers stock to machine, manually or with hoist. Installs saw blade and sets blade tension and cutting speed for specified operation. Sets saw blade angle to obtain desired angle cuts, using wrench. TCCBTTS Interns/Apprentices will sets stops and guides to control dimension of cut, using steel rule and wrenches.

Positions and secures stock against stops or in feeding device. Turns valve to start flow of coolant against cutting area. Starts machine and observes operation. Measures work for conformance to specifications, using rule. TCCBTTS Interns/Apprentices will mark and identifying data on workpiece. TCCBTTS Interns/Apprentices will replaces defective cutting blade or wheel, using hand-tools and may be required to have experience with custom or production work or with particular material, product, size of workpiece, or type or trade name of machine and be designated accordingly.

- **TITLE(s): DRILL-PRESS OPERATOR (machine shop)**
  Alternate titles: production-drilling-machine
  DOT CODE: 606.682-014

Interns/Apprentices operator operates previously set up drilling machines, such as single- or multiple-spindle drill presses to drill, ream, countersink, spot face, or tap holes in metal or nonmetal workpieces according to specifications: Lifts workpiece manually or with hoist, and positions and secures it on machine table in drilling jig or holding fixture. Moves machine controls to feed tools into workpiece, and engages automatic feed. Observes machine operation, and verifies conformance of drilled workpiece to specifications, using fixed gauges, calipers, and micrometers, changes worn cutting tools, using wrenches.

Interns/Apprentices will move controls to adjust cutting speeds, feed rates, and depth of cut. Interns/Apprentices may assist MACHINE SETTER (machine shop) 600.360-014 in setting up machine. Interns/Apprentices may sharpen cutting tools, using bench grinder and may perform minor assembly, such as fastening parts with nuts, bolts, and screws, using power tools and hand-tools. Interns/Apprentices may be designated according to product as Barrel Reamer (ordnance); or function of machine as Reamer Operator (machine shop); Tapper Operator (machine shop).

- **TITLE(s): ENGINE-LATHE SET-UP OPERATOR, TOOL**
  Alternate titles: precision-lathe
  DOT CODE: 604.280-010

TCCBTTS Interns/Apprentices operator; tool-room-lathe operator; tracer-lathe set-up operator Sets up and operates engine lathe to perform machining, such as turning, facing, boring, and threading on rotating metal castings, forgings, and bar stock, to machine tool, die, or machine parts, analyzing specifications and deciding on tooling according to knowledge of metal properties and lathe operation: Studies blueprint or layout on workpiece to visualize machining to be done, and plans sequence of operations.

TCCBTTS Interns/Apprentices will selects method of holding workpiece according to its size and shape and installs holding fixtures, such as chuck jaws, collets, arbors, and mandrels, to headstock or tailstock, using clamps or wrenches. Lifts workpiece manually or with hoist, and positions and secures it in holding fixture or between centers, using clamps and wrenches, and verifying position with measuring instruments, such as calipers, height gauges, and dial indicators. Selects feed rate, cutting speed, depth of cut, and cutting tool for each operation, according to knowledge of metal properties and shop mathematics. Positions and secures cutting tool in tool holder on cross-slide or tailstock. Moves controls to set cutting speed and feed rate and to position tool in relation to workpiece.

TCCBTTS Interns/Apprentices will start machine and turns hand-wheels to feed tool to and along workpiece, or engages automatic feed. Turns valve handle and directs flow of coolant against tool and workpiece. Verifies conformance of machined workpiece to specifications, using measuring instruments, such as micrometer, calipers, and depth gauges and may operate large engine lathe to machine large objects, such as ship propeller shafts, and be designated Lathe Set-Up Operator, Large (machine shop) and may offset position of tailstock to machine tapered surfaces.

TCCBTTS Interns/Apprentices may mount gears, move levers, and engage threading dial to machine threads, using knowledge of thread cutting. May machine teeth on cutting tools, or duplicate contours from templates or models, using relieving or tracing attachments and may operate bench grinder to sharpen tools, including working on nonmetallic materials, such as plastics. Interns/Apprentices may be required to have specialized experience with particular materials, product, precision level, machining process or size, type, or trade name of machine.

- **TITLE(s): MILLING-MACHINE TENDER**
  DOT CODE: 605.685-030

Tends milling machines that mill surfaces of metal workpieces according to specifications: Positions and secures workpiece in fixture or feeding device. Starts machine, and turns hand-wheel to feed workpiece to cutter or vice versa, or engages automatic feeding mechanism. Turns valve handle to direct flow of coolant against cutter and workpiece. Observes machine operation, and removes and inspects machined workpiece to verify conformance to specifications, using instruments, such as gauges, calipers, micrometers, and templates and may change worn cutters, using wrenches and records production output.

TCCBTTS Interns/Apprentices may tend machine that mills workpiece according to programmed cycle and may turn controls to adjust feed rate of workpiece or speed of cutting tool and may mill nonmetallic materials.

- **TITLE(s): NUMERICAL CONTROL MACHINE OPERATOR**
  DOT CODE: 609.362-010

TCCBTTS Interns/Apprentices will set up and operates numerical control machine to cut, shape, or form metal workpieces to specifications: Reviews setup sheet and specifications to determine setup procedure, machining sequence, and dimensions of finished workpiece. Attaches fixture to machine bed and positions and secures workpiece in fixture according to setup instructions, using clamps, bolts, hand-tools, power tools, and measuring instruments, such as rule and calipers. Assembles cutting tools in tool-holders and positions tool-holders in machine spindles as specified, using hand-tools, or inserts cutting tools in specified machine magazines.

TCCBTTS Interns/Apprentices will load control media, such as disk, tape, or punch card, in machine control console or enters commands to retrieve preprogrammed machine instructions from data base. Manipulates controls and enters commands to index cutting tool to specified set point and to start machine. Observes and listens to machine operation to detect malfunctions, such as worn or damaged cutting tools. Changes cutting tools and location of workpiece during machining process as specified in setup instructions.

Measures workpiece for conformance to specifications, using measuring instruments, such as micrometers, dial indicators, and gauges. TCCBTTS Interns/Apprentices will notifies supervisor of discrepancies and may adjust machine feed and speed and change cutters to machine parts according to specifications when automatic programming is

faulty or machine malfunctions and may machine materials other than metal, such as composites, plastic, and rubber.

Introducing the Metal Working Skills Standards Project

Machining Skills-Level I Tech Craftsman Career Building Technical Trade School Standards

TCCBTTS is pleased to present the first of a series of 24 voluntary National Skill Standards for the metalworking industry. The goal of this project has been to establish world-class standards reflecting industry skill requirements. The standards will provide a method through certification and training for individual workers to receive recognition and reward for their abilities. The standards at the same time will help TCCBTTS's employers identify intern/apprentice training needs and evaluate intern/apprentice job applicants fairly.

Machining Skills Level I has been developed and validated to incorporate the basic requirements for the majority of skilled positions in the metalworking trades. This set of standards has been designed to allow selection of individual skills or groups of skills to be used as a foundation for perfecting skills called for in many of the more specialized metalworking disciplines.

Machining Skills-Level I-II-III

TCCBTTS has determined general machining area each of the three skill level standards have been developed. Each has addressed similar skills with a graduated level of required precision or with newer and more complex technologies. Since the standards are entirely performance-based, individuals can advance at their own pace, and be recognized for the skills they possess. The standards also provide employers with an objective assessment tool for worker performance and training needs.

Precision Machining Technology

COURSE DESCRIPTION:

TCCBTTS's Precision Machining is a program designed to prepare TCCBTTS interns/apprentices with skills to shape metal parts on machines such as lathes, grinders, drill presses, milling machines, and shapers.

Programs may also train individuals in the use of one machine tool. Includes instruction in making computations related to work dimensions, CNC and EDM machines, testing feeds and speeds of machines using precision measuring instruments such as layout tools, micrometers, and gauges; machining and heat-treating various metals; and in laying out machine parts. The course also includes training in applied communications, and employability skills including leadership, human relations, and safe efficient work practices.

INTENDED OUTCOMES:

After TCCBTTS interns/apprentices have successfully completing this 24 month program the TCCBTTS interns/apprentices will be able to:

- Demonstrate employability skills and habits.
- Perform prerequisite machining skills.
- Demonstrate proficiency in performing bench work skills.
- Demonstrate proficiency in setting up and operating power saws.
- Demonstrate proficiency in setting up and operating pedestal grinders.
- Demonstrate proficiency in setting up and operating drill presses.
- Demonstrate proficiency in setting up and operating lathes.
- Demonstrate proficiency in setting up and operating milling machines.
- Demonstrate proficiency in setting up and operating surface grinding machines.
- Demonstrate proficiency in applying computerized numerical control operations skills.
- Describe and identify EDM machine functions and operations.

PRECISION MACHINING
LEVEL I

TCCBTTS's course designed to introduce our TCCBTTS interns/apprentices to basic precision machining and automated computerized manufacturing.

TCCBTTS INTERNS/APPRENTICES'S TASK LIST

TCCBTTS Interns/Apprentices will demonstrate employment skills- TCCBTTS interns/apprentices will be able to:

Level I

- Identify employment opportunities
- Apply employment-seeking skills
- Interpret employment capabilities
- Demonstrate appropriate work behavior
- Maintain a business-like image
- Maintain working relationships with others
- Communicate on the job
- Adapt to change
- Demonstrate knowledge of business operation

TCCBTTS Interns/Apprentices will demonstrate proficiency in performing bench work skills - TCCBTTS interns/apprentices during will be able to:

Level I

- Cut materials by using hand hacksaws
- Cut threads by using hand taps and dies
- Ream holes by using hand reamers
- Hand-sharpen cutting tools by using abrasive stones
- Remove damaged screws and other hardware
- Set up and use arbor press broaches
- Deburr work pieces
- Identify and use proper hand finishing tools

TCCBTTS Interns/Apprentices will demonstrate proficiency in setting up and operating power saws- TCCBTTS interns/apprentices will be able to:

Level I

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

TCCBTTS Interns/Apprentices will demonstrate proficiency setting up and operating pedestal grinders-TCCBTTS interns/apprentices will be able to in:

Level I:

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

TCCBTTS Interns/Apprentices will demonstrate proficiency setting up and operation drill presses-TCCBTTS interns/apprentices will be able to:

Level I

- Comply with safe and efficient work practices
- Identify the parts of the drill press
- Lubricate the drill press
- Sharpen drills
- Center drill, drill and ream a hole in a work piece.
- Center-bore, spot-bore and countersink hole in work piece.
- Hand tap a hole in work piece.
- Power tap a hole in work piece.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 1

EMPLOYABILITY SKILLS

This is one of a series of TCCBTTS's modules which comprise the Missouri Proprietary School Certification of Higher Education Curriculum Guide for Precision Machining.

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in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each TCCBTTS intern/apprentice 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 1 - EMPLOYABILITY SKILLS

TASK: Identify Employment Opportunities

Level I

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

ENABLING OBJECTIVES:

- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

TASK: Apply Employment-Seeking Skills

Level I

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:

- Locate a job opening.
- Complete a resume.
- Prepare for an interview.
- Participate in an interview.
- Complete tests required.
- Complete forms required.
- Complete an application letter.
- Complete a follow-up letter.
- Complete an acceptance letter.
- Evaluate a job offer.
- Evaluate a job rejection.

TASK: INTERPRET EMPLOYMENT CAPABILITIES

Level I

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:

- Match an interest to job area.
- Match aptitudes to job area.
- Verify abilities.
- Identify immediate work goal.
- Develop a career plan.

TASK: DEMONSTRATE APPROPRIATE WORK BEHAVIOR

Level I

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

ENABLING OBJECTIVES:

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

TASK: MAINTAIN A BUSINESS-LIKE IMAGE

Level I

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:

- Participate in the institution's orientation.
- Demonstrate knowledge of company or agency products and services.
- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

TASK: MAINTAIN WORKING RELATIONSHIPS WITH OTHERS

Level I

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

ENABLING OBJECTIVES:

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

TASK: COMMUNICATE ON THE JOB

Level I

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

ENABLING OBJECTIVES:

- Read and comprehend written communications.
- Use correct grammar.
- Speak clearly when addressing others.
- Use job-related terminology.
- Listen attentively.
- Write legibly.
- Use telephone etiquette.
- Follow written and oral directions.
- Ask questions.
- Locate information needed to complete the task.
- Prepare written communication.
- Demonstrate keyboarding skills.
- Demonstrate computer skill.

TASK: ADAPT TO CHANGE

Level I

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

ENABLING OBJECTIVES:

- Recognize the need to change.
- Demonstrate a willingness to learn.
- Demonstrate flexibility.
- Participate in continuing education.
- Seek challenge in the work place.
- Adjust goals and plans when necessary.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 2 - PREREQUISITE MACHINING

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TASK: Demonstrate Proficiency in Maintaining Immediate Work Area Level I

PERFORMANCE OBJECTIVE: Given appropriate materials and supplies the TCCBTTS interns/apprentices will be able to demonstrate proficiency to maintain work areas in a machine shop.

ENABLING OBJECTIVES:

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

TASK: Perform Mathematical Calculation's

Level I

PERFORMANCE OBJECTIVE: Given the appropriate tools, equipment and resource material, TCCBTTS interns/apprentices will demonstrate the ability to perform accurate mathematical calculations relating to machine set up, material, and machine shop environment.

ENABLING OBJECTIVES:

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

TASK: Demonstrate Proficiency in Blueprint Reading and Machine Planning

Level I

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

ENABLING OBJECTIVES:

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

TASK: Perform Measuring Operations

Level I

PERFORMANCE OBJECTIVE: Given the appropriate tools and operation pieces, TCCBTTS interns/apprentices will accurately measure work pieces using the proper measuring instruments.

ENABLING OBJECTIVES:

- Read and measure with rules and calipers.
- Read and measure with micrometers.
- Read and measure with Vernier tools.
- Read and measure with dial indicators.
- Measure using as surface plate.
- Read and interpret surface finish (ANSI Y14)

TASK: Perform Maintenance on Machines and Tools

Level I

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

ENABLING OBJECTIVES:

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

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 3

BENCH WORK

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MODULE 3 - PERFORM BENCH WORK SKILLS

TASK: Cut materials by using hand hacksaws

Level I

PERFORMANCE OBJECTIVE: Given a dimensioned blueprint of a work piece, raw material, and a hand hacksaw, TCCBTTS interns/apprentices will be able to:

ENABLING OBJECTIVES:

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

TASK: Cut threads by using hand taps and dies

Level I

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

ENABLING OBJECTIVES:

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

TASK: Ream holes by using hand reamers

Level I

PERFORMANCE OBJECTIVE: Given a hand reamer, ream a series of previously drilled holes to a tolerance of +.001.

ENABLING OBJECTIVES:

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

TASK: Hand sharpen cutting tools by using abrasive stones

Level I

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:

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

TASK: Remove damaged screws and other hardware

Level I

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 work piece.

ENABLING OBJECTIVES:

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

TASK: Set up and use arbor press broaches

Level I

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

ENABLING OBJECTIVES:

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

TASK: Deburr work pieces

Level I

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

ENABLING OBJECTIVES:

- Demonstrate how to properly hold files and three corner scrapers.
- Demonstrate how to sharpen a three corner scraper.
- Deburr work pieces to required tolerances.

CURRICULUM STANDARDS FOR PRECISION MACHINING
MODULE 4 - POWER SAWS

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MODULE 4 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING POWER SAWS

TASK: Comply with safe and efficient work practices

Level I

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

ENABLING OBJECTIVES:

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

TASK: Remove and replace saw blades

Level I

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:

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

TASK: Select appropriate blades to perform given sawing operations

Level I

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:

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

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

Level I

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

ENABLING OBJECTIVES:

List the correct cutting speed and feed of the following materials:

- 1-1/2" cold rolled steel
- 1" aluminum
- 1" tool steel
- 1/6" aluminum.

Explain how coolant can affect speeds and feeds.

Calculate proper cutting speeds and feeds for specific material.

TASK: Measure and cut off materials using power saws

Level I

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:

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

TASK: Cut and weld band saw blades to insert for contour sawing

Level I

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

ENABLING OBJECTIVES:

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

TASK: Set up and operate saws for angular cutting

Level I

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures in sawing angles.
- Explain the reasons for cutting as close to the layout lines as possible.
- Explain the reasons for cutting angles on a band-saw as opposed to using other machines.
- Set up a saw for angular cutting.
- Perform an angular cut on a work piece.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 5 - PEDESTAL GRINDERS

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MODULE 5 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING PEDESTAL GRINDERS

TASK: Comply with safe and efficient work practices

Level I

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

ENABLING OBJECTIVES:

- Apply shop safety rules and procedures.
- Demonstrate the operation of shop safety devices.
- Demonstrate personal safety procedures.
- Demonstrate first aid/emergency treatment procedures.
- Apply fire safety rules and procedures.
- Apply rules for electrical safety.

TASK: Identify parts of the pedestal grinder

Level I

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

ENABLING OBJECTIVES:

- Identify types of pedestal grinders.
- Identify major parts.
- Explain the function of major parts.

TASK: Mount grinding wheels

Level I

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:

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

TASK: Set up support tool rests

Level I

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:

Explain the relevant safety precaution/procedures required for adjusting wheel guard and tool rest.

Explain the purpose of the wheel guard and tool rest.

Describe the procedures for adjusting the wheel guard and tool rest.

Set up a tool rest and adjust wheel guard.

TASK: Dress grinding wheel

Level I

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:

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

TASK: Grind lathe tools to required angles

Level I

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

ENABLING OBJECTIVES:

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

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 6 - DRILL PRESSES

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MODULE 6 – Demonstrate Proficiency in Setting up And Operation Drill Presses

TASK: Comply with safe and efficient work practices

Level I

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

ENABLING OBJECTIVES:

- Apply shop safety rules and procedures.
- Demonstrate the operation of shop safety devices.
- Demonstrate personal safety procedures.
- Demonstrate first aid/emergency treatment procedures.
- Apply fire safety rules and procedures.
- Apply rules for electrical safety.

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

Level I

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

ENABLING OBJECTIVES:

- Explain the major parts of the drill press.
- Explain the procedure for adjusting the table height.
- Explain the different types of drill presses.
- Explain the RPM settings and feed settings.
- Explain the need to figure RPM and feed for various size drills and materials.
- Explain safety precautions for operation of drill press.
- Explain the use of the drill chuck and Morse tapered spindle.

TASK: Lubricate the drill press

Level I

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:

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

TASK: Hand and machine sharpen drills

Level I

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for sharpening twist drills and sing off hand procedures.
- Describe the amount of lip clearance a drill must have to perform correctly.
- Explain why a drill bit must have the same angle on both flutes and why both flutes must be the same length.
- Discuss why different drill point angles are ground for different materials.
- Define the following drill terms:
    - ✓ Chisel edge
    - ✓ Lip
    - ✓ Flute
    - ✓ Margin
    - ✓ Land
    - ✓ Body
    - ✓ Shank
    - ✓ Web.
- Describe the procedures for hand sharpening a drill bit.
- Describe the procedures for correcting a thick web on a drill bit.
- Properly sharpen three drill bits using a pedestal grinder.

TASK: Center drill, drill and ream hole in work piece

Level I

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for setting up and operating a drill press.
- Describe the procedures for setting up a drill press.
- Describe the uses of cutting fluids for drill press.
- Calculate cutting speeds for center-drilling, drilling and reaming operations (S.F.P.M.).
- Calculate RPM for center-drills, drills, reamers, etc.
- Describe the procedures for center drilling and drilling holes.
- Describe the procedures for reaming holes.
- Identify the correct cutting fluids for drilling and reaming.
- Center-drill a hole in a work piece to required tolerance.
- Drill and ream hole in a work piece to required tolerance.

TASK: Center-bore, spot-face and countersink hole in work piece

Level I

PERFORMANCE OBJECTIVE: Given a blueprint, work piece, work holding device, counter-bore spot-face and countersink tools, cutting fluid, and precision measuring instruments, counter-bore, countersink, and spot-face a hole in work piece holding a tolerance of + .010 inch.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for counter-boring, countersinking and spot-facing operations.
- Explain the purpose of counter-boring, countersink and spot-facing a hole.
- Define the difference between a counter-bored, countersunk, and spot-faced hole.
- Describe the procedures for counter-boring, countersinking and spot-facing holes.
- Identify the correct burring fluids for counter-boring, countersinking and Spot-facing.
- Center-drill a hole in a work piece to required tolerance.
- Spot-face a hole in a work piece to required tolerance.
- Countersink a hole in a work piece to required tolerance.

TASK: Hand-tap a hole in work piece

Level I

PERFORMANCE OBJECTIVE: Given a blueprint, work piece, work holding device, Center-taps, tap wrench, cutting fluids, and precision measuring instruments, hand tap a hole in the work piece holding a tolerance of + 1/2 degree for perpendicularity and + 1/64 inch for location.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for hand tapping.
- Describe the uses of threads.
- List the taps in an American National/Unified 60 degree tap set and state the purpose of each tap.
- Explain why a tapped hole must be countersunk.
- Identify the uses of cutting fluids for tapping.
- Describe the procedures for hand tapping a hole with a drill press to assure perpendicularity.

- Hand-tap a hole in a work piece to required tolerance.

TASK: Power tap hole in work piece

Level I

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for power tapping.
- Distinguish between power and hand taps.
- 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
- Describe the procedures for machine tapping holes.
- Identify the correct cutting fluids for power tapping.
- Power-tap a hole in a work piece to required tolerance.

PRECISION MACHINING
LEVEL II
Prerequisite: Level I

A course designed to provide TCCBTTS interns/apprentices with precision machining and automated manufacturing applications.

TASK LISTING

TCCBTTS Interns/Apprentices Performance Standards Effective Date: June 2016

PROGRAM AREA: Trade & Industrial Education

PROGRAM TITLE: Precision Machining Technology

DEMONSTRATE EMPLOYABILITY SKILLS – TCCBTTS interns/apprentices will be able to:

Level II

- Identify employment opportunities
- Apply employment-seeking skills
- Interpret employment capabilities
- Demonstrate appropriate work behavior
- Maintain a business-like image
- Maintain working relationships with others
- Communicate on the job
- Adapt to change
- Demonstrate a knowledge of business operation

Perform Prerequisite Machining Skills - The interns/apprentices will be able to:

Level II

- Demonstrate proficiency in maintaining immediate work area
- Perform mathematical calculations

- Demonstrate proficiency in blueprint reading and machine planning
- Perform measuring operations
- Perform maintenance on machines and tools

Demonstrate Proficiency In Performing Bench Work Skills TCCBTTS interns/apprentices will be able to:

Level II

- Cut materials by using hand hacksaws
- Cut threads by using hand taps and dies
- Ream holes by using hand reamers
- Hand-sharpen cutting tools by using abrasive stones
- Remove damaged screws and other hardware
- Set up and use arbor press broaches
- De-burr work pieces
- Identify and use proper hand finishing tools

Demonstrate Proficiency in Setting up and Operation Power-Saws- TCCBTTS interns/apprentices will be able to:

Level II

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

Demonstrate Proficiency in Setting up and Operating Pedestal Grinders- TCCBTTS interns/apprentices will be able to:

Level II

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

Demonstrate Proficiency in Setting up and Operating Drill Presses- TCCBTTS interns/apprentices will be able to:

Level II

- Comply with safe and efficient work practices
- Identify the parts of the drill press
- Lubricate the drill press
- Sharpen drills
- Center drill, drill and ream a hole in a work piece.
- Center-bore, spot-bore and countersink hole in work piece.
- Hand-tap a hole in work piece.
- Power-tap a hole in work piece.

Demonstrate Proficiency in Setting up And Operating Lathes- TCCBTTS interns/apprentices will be able to:

Level II

- Identify the parts of the lathe
- Comply with safe and efficient work practices
- Measure stock
- Set up an engine lathe
- Secure tools, tool-holders and fixtures or attachments
- Select and set feeds and speeds
- Set up lathes and face work pieces held in chucks
- Rough-cut and finish-cut with lathes
- Deburr parts using filing procedures
- Align lathe centers using accurate methods
- Drill holes with lathes
- Countersink holes with lathes
- Ream holes with lathes
- Tap threads with lathes
- Die-cut threads with lathes
- Counter bore holes with lathes
- Bore holes with lathes
- Knurl parts with lathes
- Cut external threads with lathes

- Re-chase threads with lathes
- Cut internal threads with lathes
- Set up and perform taper turning with taper attachments
- Set up and perform taper turning with compound
- Cut internal tapered surfaces
- Set up and operate tool post grinders
- Perform contour, angular or radial cuts with lathes
- Set up and use follow and steady-rests
- Set up face plates and dogs

Demonstrate Proficiency in Setting up and Operating Machines-TCCBTTS interns/apprentices will be able to:

Level II

- Identify the parts of the horizontal and vertical milling machine
- Lubricate milling machines.
- True up the head and align milling machines fixtures
- Select and set feeds and speeds for milling work
- Square up work pieces with a table vise
- Perform end milling
- Perform fly-cutting operations
- Drill holes with a milling machine
- Perform reaming operations
- Cut external keyways
- Bore holes with milling machines
- Perform form milling
- Perform indexing operations using a dividing head
- Set up and operate rotary tables
- Mill cylindrical work
- Mill an external radius
- Mill an angle
- Align milling machine attachments
- Mill internal slots with a slotter and attachment
- Perform cutting-off operations
- Set up and perform slab mill operations
- Use an edge finder and wiggler
- Use digital readouts
- Set up and use a sine vise

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 1

EMPLOYABILITY SKILLS

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MODULE 1 - EMPLOYABILITY SKILLS

TASK: Identify Employment Opportunities

Level II

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

ENABLING OBJECTIVES:

- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

TASK: Apply Employment-Seeking Skills

Level II

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:

- Locate a job opening.
- Complete a resume.
- Prepare for an interview.
- Participate in an interview.
- Complete tests required.
- Complete forms required.
- Complete an application letter.
- Complete a follow-up letter.
- Complete an acceptance letter.
- Evaluate a job offer.
- Evaluate a job rejection.

TASK: INTERPRET EMPLOYMENT CAPABILITIES

Level II

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:

- Match an interest to job area.
- Match aptitudes to job area.
- Verify abilities.
- Identify immediate work goal.
- Develop a career plan.

TASK: DEMONSTRATE APPROPRIATE WORK BEHAVIOR

Level II

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

ENABLING OBJECTIVES:

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

TASK: MAINTAIN A BUSINESS-LIKE IMAGE

Level II

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:

- Participate in the institution's orientation.
- Demonstrate knowledge of company or agency products and services.
- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

TASK: MAINTAIN WORKING RELATIONSHIPS WITH OTHERS

Level II

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

ENABLING OBJECTIVES:

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

TASK: COMMUNICATE ON THE JOB

Level II

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

ENABLING OBJECTIVES:

- Read and comprehend written communications.
- Use correct grammar.
- Speak clearly when addressing others.
- Use job-related terminology.
- Listen attentively.
- Write legibly.
- Use telephone etiquette.
- Follow written and oral directions.
- Ask questions.
- Locate information needed to complete the task.
- Prepare written communication.
- Demonstrate keyboarding skills.
- Demonstrate computer skill.

TASK: ADAPT TO CHANGE

Level II

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

ENABLING OBJECTIVES:

- Recognize the need to change.
- Demonstrate a willingness to learn.
- Demonstrate flexibility.
- Participate in continuing education.
- Seek challenge in the work place.

- Adjust goals and plans when necessary.

Curriculum Standards for Precision Machining

MODULE 2-PREREQUISITE MACHINING

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MODULE 2 - PREREQUISITE MACHINING SKILLS

TASK: Demonstrate Proficiency in Maintaining Immediate Work Area

Level II

PERFORMANCE OBJECTIVE: Given appropriate materials and supplies TCCBTTS interns/apprentices will be able to demonstrate proficiency to maintain work areas in a machine shop.

ENABLING OBJECTIVES:

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

TASK: Perform Mathematical Calculation's

Level II

PERFORMANCE OBJECTIVE: Given the appropriate tools, equipment and resource material, TCCBTTS interns/apprentices will demonstrate the ability to perform accurate mathematical calculations relating to machine set up, material, and machine shop environment.

ENABLING OBJECTIVES:

- Accurately perform job related decimal and fraction calculations.
- Demonstrate proficiency solving job-related problems using basic formulas.

- Demonstrate proficiency solving job-related problems using basic geometry.
- Demonstrate proficiency measuring a work piece and compare measurements with blueprint specifications.
- Demonstrate proficiency calculating the amount of material that should be removed to obtain correct limits for secondary operations.
- Demonstrate proficiency in solving job-related problems using mathematical handbooks, charts, and tables.
- Demonstrate proficiency in converting measurements from English to metric and from metric to English units.
- Demonstrate proficiency in determining the clearance, relief, and rake of cutting tools.
- Demonstrate proficiency in calculating machine speeds and feeds using appropriate formulas.

TASK: Demonstrate Proficiency in Blueprint Reading and Machine Planning

Level II

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

ENABLING OBJECTIVES:

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

TASK: Perform Measuring Operations

Level II

PERFORMANCE OBJECTIVE: Given the appropriate tools and operation pieces, TCCBTTS interns/apprentices will accurately measure work pieces using the proper measuring instruments.

ENABLING OBJECTIVES:

- Read and measure with rules and calipers.
- Read and measure with micrometers.
- Read and measure with vernier tools.
- Read and measure with dial indicators.
- Measure using as surface plate.
- Read and interpret surface finish (ANSI Y14)

TASK: Perform Maintenance on Machines and Tools

Level II

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

ENABLING OBJECTIVES:

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

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 3 - BENCH WORK

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MODULE 3 - PERFORM BENCH WORK SKILLS

TASK: Cut materials by using hand hacksaws

Level II

PERFORMANCE OBJECTIVE: Given a dimensioned blueprint of a work piece, raw material, and a hand hacksaw, TCCBTTS interns/apprentices will be able to:

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for use of a hand hacksaw.

- Determine teeth per inch on various hacksaw blades.
- Describe the applications for saw blades with different ratios of tooth pitch.
- Demonstrate the correct method of sawing materials with a hand hacksaw.

TASK: Cut threads by using hand taps and dies

Level II

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

ENABLING OBJECTIVES:

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

TASK: Ream holes by using hand reamers

Level II

PERFORMANCE OBJECTIVE: Given a hand reamer, ream a series of previously drilled holes to a tolerance of +.001.

ENABLING OBJECTIVES:

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

TASK: Hand sharpen cutting tools by using abrasive stones

Level II

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:

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

TASK: Remove damaged screws and other hardware

Level II

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 work piece.

ENABLING OBJECTIVES:

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

TASK: Set up and use arbor press broaches

Level II

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

ENABLING OBJECTIVES:

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

TASK: Deburr work pieces

Level II

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

ENABLING OBJECTIVES:

- Demonstrate how to properly hold files and three corner scrapers.
- Demonstrate how to sharpen a three corner scraper.
- Deburr work pieces to required tolerances.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 4- POWER SAWS

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MODULE 4 – Demonstration Proficiency In Setting UP and Operating Power-Saws

TASK: Comply with safe and efficient work practices

Level II

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

ENABLING OBJECTIVES:

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

TASK: Remove and replace saw blades

Level II

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:

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

TASK: Select appropriate blades to perform given sawing operations

Level II

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:

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

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

Level II

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

ENABLING OBJECTIVES:

- List the correct cutting speed and feed of the following materials:
- 1-1/2" cold rolled steel
- 1" aluminum
- 1" tool steel
- 1/6" aluminum.

Explain how coolant can affect speeds and feeds.
Calculate proper cutting speeds and feeds for specific material.

TASK: Measure and cut off materials using power saws

Level II

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:

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

TASK: Cut and weld band saw blades to insert for contour sawing

Level II

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

ENABLING OBJECTIVES:

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

TASK: Set up and operate saws for angular cutting

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures in sawing angles.
- Explain the reasons for cutting as close to the layout lines as possible.
- Explain the reasons for cutting angles on a band-saw as opposed to using other machines.
- Set up a saw for angular cutting.
- Perform an angular cut on a work piece

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 5 - PEDESTAL GRINDERS

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MODULE 5 – Demonstrate Proficiency In Setting Up and Operating Pedestal Grinders

TASK: Comply with safe and efficient work practices

Level II

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

ENABLING OBJECTIVES:

- Apply shop safety rules and procedures.
- Demonstrate the operation of shop safety devices.
- Demonstrate personal safety procedures.
- Demonstrate first aid/emergency treatment procedures.
- Apply fire safety rules and procedures.
- Apply rules for electrical safety.

TASK: Identify parts of the pedestal grinder

Level II

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

ENABLING OBJECTIVES:

- Identify types of pedestal grinders.
- Identify major parts.
- Explain the function of major parts.

TASK: Mount grinding wheels

Level II

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:

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

TASK: Set up support tool rests

Level II

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:

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

TASK: Dress grinding wheel

Level II

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:

- Explain the relevant safety precautions/procedures for dressing and truing a grinding wheel.
- Identify the different types of wheel dressers.

- Determine the type dresser to be used on different grinding wheels.
- Explain the correct procedure to true and dress the grinding wheel.
- Properly dress a grinding wheel.

TASK: Grind lathe tools to required angles

Level II

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

ENABLING OBJECTIVES:

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

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 6 - DRILL PRESSES

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MODULE 6 – Demonstrate Proficiency in Setting Up and Operation Drill Presses

TASK: Comply with safe and efficient work practices

Level II

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

ENABLING OBJECTIVES:

- Apply shop safety rules and procedures.
- Demonstrate the operation of shop safety devices.
- Demonstrate personal safety procedures.
- Demonstrate first aid/emergency treatment procedures.
- Apply fire safety rules and procedures.
- Apply rules for electrical safety.

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

Level II

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

ENABLING OBJECTIVES:

- Explain the major parts of the drill press.
- Explain the procedure for adjusting the table height.
- Explain the different types of drill presses.
- Explain the RPM settings and feed settings.
- Explain the need to figure RPM and feed for various size drills and materials.
- Explain safety precautions for operation of drill press.

- Explain the use of the drill chuck and Morse tapered spindle.

TASK: Lubricate the drill press

Level II

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:

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

TASK: Hand and machine sharpen drills

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for sharpening twist drills and sing off hand procedures.
- Describe the amount of lip clearance a drill must have to perform correctly.
- Explain why a drill bit must have the same angle on both flutes and why both flutes must be the same length.
- Discuss why different drill point angles are ground for different materials.
- Define the following drill terms:
  - (a) Chisel edge
  - (b) Lip
  - (c) Flute
  - (d) Margin
  - (e) Land
  - (f) Body
  - (g) Shank
  - (h) Web.
- Describe the procedures for hand sharpening a drill bit.
- Describe the procedures for correcting a thick web on a drill bit.
- Properly sharpen three drill bits using a pedestal grinder.

TASK: Center drill, drill and ream hole in work piece

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for setting up and operating a drill press.
- Describe the procedures for setting up a drill press.
- Describe the uses of cutting fluids for drill press.
- Calculate cutting speeds for center-drilling, drilling and reaming operations (S.F.P.M.).
- Calculate RPM for center-drills, drills, reamers, etc.
- Describe the procedures for center drilling and drilling holes.
- Describe the procedures for reaming holes.
- Identify the correct cutting fluids for drilling and reaming.
- Center-drill a hole in a work piece to required tolerance.
- Drill and ream hole in a work piece to required tolerance.

TASK: Center-bore, spot-face and countersink hole in work piece

Level II

PERFORMANCE OBJECTIVE: Given a blueprint, work piece, work holding device, Counter-bore spot-face and countersink tools, cutting fluid, and precision measuring instruments, counter-bore, countersink, and spot-face a hole in work piece holding a tolerance of + .010 inch.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for counter-boring, countersinking and spot-facing operations.
- Explain the purpose of counter-boring, countersink and spot-facing a hole.
- Define the difference between a counter-bored, countersunk, and spot-faced hole.
- Describe the procedures for counter-boring, countersinking and spot-facing holes.
- Identify the correct burring fluids for counter-boring, countersinking and Spot-facing.
- Center-drill a hole in a work piece to required tolerance.
- Spot-face a hole in a work piece to required tolerance.
- Countersink a hole in a work piece to required tolerance.

TASK: Hand tap a hole in work piece

Level II

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

ENABLING OBJECTIVES:

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

TASK: Power tap hole in work piece

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for power tapping.
- Distinguish between power and hand taps.

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.
- Describe the procedures for machine tapping holes.
- Identify the correct cutting fluids for power tapping.
- Power-tap a hole in a work piece to required tolerance.

CURRICULUM STANDARDS FOR PRECISION MACHINING
MODULE 7 Demonstrate Proficiency in Setting up and Operating- LATHES

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MODULE 7 – Demonstrate Proficiency in Setting Up and Operating - LATHES

TASK: Identify the parts of the lathe.

Level II

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

ENABLING OBJECTIVES:

- Explain the major parts of the lathe.
- Explain the function of the bed.
- Explain the function of the carriage and the parts therein.
- Explain the function of the head stock and the parts therein.
- Explain the function of the tail stock and the parts therein.

TASK: Comply with general safe and efficient work practices.

Level II

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

ENABLING OBJECTIVES:

- Explain the need for safety glasses.
- Explain the hazards of chip handling.
- Explain the set up hazards.
- Explain the chuck removal and installation hazards.
- Explain the hazards of work piece burrs.
- Explain the proper housekeeping and tool hazards.

- Demonstrate knowledge of safety by completing a written safety test

TASK: Measure stock

Level II

PERFORMANCE OBJECTIVE: Given a cylindrical work piece with external threads and a counter-bored hole and a corresponding unidimensional blueprint, outside, inside, and depth micrometers, telescope work piece, small hole gauge, Vernier caliper, and surface plate, precision measure the work piece. Measure the external diameters, pitch diameters, internal bores, hole depths, and linear measurements of a work piece to a tolerance of + .002 inches. Transpose dimensions onto blueprint in accordance with machine drafting procedures.

ENABLING OBJECTIVES:

- Explain correct drafting standards for dimensioning blueprints.
- Demonstrate the proper care, use, and calibrations of precision measuring instruments.
- List accepted drafting abbreviations and/or symbols for the following terms:
- Outside diameter
- Inside diameter
- Threads per inch
- Inch
- Millimeter
- Counter-bore
- Depth
- Measure a cylindrical work piece.

TASK: Set up an engine lathe

Level II

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:

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

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

Level II

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:

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

TASK: Select and set feeds and speeds

Level II

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

ENABLING OBJECTIVES:

- Explain lathe safety.
- Locate, speed and feed chart on each machine.

- List spindle speed formula and calculate RPM as per work sheet.
- Identify lathe parts as listed on worksheet.
- Adjust speed and feed settings for specified work sheet.

TASK: Set up lathes and face work pieces held in chucks

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for facing.
- Describe the uses of carbide, high speed, and cutting tools as applied to facing operations.
- Define micro-inch.
- Calculate cutting speeds and feeds for facing operations.
- Describe the procedures for facing.
- Identify the correct cutting fluids for facing.
- Face a work piece to specifications.

TASK: Rough-cut and finish-cut with lathes

Level II

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:

- Explain safety for lathe operation.
- Explain lathe feeds and describe the guideline

- Select speeds and feeds and mount stock in work holding devices.
- Explain tool position and tool geometry (angles).
- Define trial cuts.
- Make required trial cuts.
- Using appropriate measuring tools, measure work piece.
- Perform required rough and finish cuts to specifications.

TASK: Perform lathe filing to deburr parts

Level II

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

ENABLING OBJECTIVES:

- Explain lathe safety.
- Select spindle speed and mount project in lathe.
- Define micro-inch finishes.
- List names of different deburr tools.
- Explain grit size of abrasive clothes.
- List and identify shape, cut and size of files as required by worksheet.
- List other tools needed.
- File, polish and deburr a work piece.

TASK: Align lathe centers using accurate methods.

Level II

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

ENABLING OBJECTIVES:

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

TASK: Drill holes with lathes.

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, drill, lathe attachments, and cutting fluid, drill hole in work piece to a tolerance of + .005 inch, -.000 for diameter.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for drilling operations.
- Calculate speeds for drilling operations.
- Describe the procedures for drilling on a lathe.
- Identify the correct cutting fluid for drilling operations.
- Drill a hole in a work piece.

TASK: Countersink holes with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for countersinking operations.
- Calculate speeds for countersinking operations.
- Describe the procedures for countersinking on a lathe.
- Identify the correct cutting fluid for countersinking.
- Countersink a hole in a work piece.

TASK: Ream holes with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for reaming operations.
- Calculate speeds for reaming operations.
- Describe the procedures for reaming.
- Identify the correct cutting fluid for reaming.
- Ream a hold in a work piece.

TASK: Tap threads with lathes

Level II

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

ENABLING OBJECTIVE:

- Explain the safety precautions/procedures for tapping operations.
- Determine tap drill size using the charts and formulas.
- Describe the procedures for tapping on a lathe.
- Identify the correct cutting fluid for tapping.
- Describe the proper use of a plug gauge.
- Tap threads in a work piece.

TASK: Die-cut threads with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain safety requirements for cutting external threads.
- Calculate lathe RPM.
- Set up work piece in chuck.
- Remove tail stock center and explain how to follow the die with the tailstock spindle.
- Describe procedures for cutting external threads.
- Identify the proper cutting fluid.
- Die cut external threads on a work piece.

TASK: Counter-bore holes with lathes

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, lathe attachments, boring bar, cutting fluid, and precision measuring instruments, counter-bore hole in work piece to a tolerance of + .001 inch for diameter and depth.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for counter-boring operations.
- Calculate speeds for counter-boring operations.

- Describe the procedures for counter-boring.
- Identify the correct cutting fluid for counter-boring operations.
- Counter-bore a hole in a work piece.

TASK: Bore holes with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for boring holes with a lathe.
- Calculate speeds for boring operations on lathes.
- Describe the procedures for boring holes.
- Identify the correct cutting fluids for boring.
- Bore a hole in a work piece.

TASK: Knurl parts with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for knurling a work piece.
- Explain the proper use of knurling tools.
- Calculate speeds and feeds for knurling operations.
- Describe the procedures for knurling a work piece.

- Identify the correct cutting fluid for knurling.
- Knurl a work piece.

TASK: Cut external threads with lathes

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, tool holder, tool blank, center gauge, cutting fluids, and precision measuring instruments, cut external threads on work piece 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:

- Explain the safety precautions/procedures for cutting external threads.
- Explain the formulas used in the three wire system for measuring external threads.
- Calculate proper speeds for cutting external threads.
- Describe the procedures for cutting external threads.
- Select the correct cutting fluid for threading operations.
- Calculate thread depth.
- Calculate total in feed of compound.
- Determine depth per pass.
- Determine compound off-set angle (right or left hand threads).
- Cut external threads on a work piece.

TASK: Re-chase threads with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain safety precautions for re-chasing threads.
- Describe procedure for setting up a lathe to re-chase threads.
- Identify tools needed to re-chase threads.
- Select correct cutting fluid for re-chasing threads.
- Re-chase threads on a work piece.

TASK: Cut internal threads with lathes

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, tool holder, tool blank, thread center gauge, cutting fluids and precision measuring instruments, cut internal threads on work pieces 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:

- Explain the safety precautions/procedures for chasing internal threads.
- Calculate total in feed of compound for unified threading.
- Calculate proper speeds and hole size for cutting internal threads.
- Describe the procedures for cutting internal threads.
- Select the correct cutting fluid for threading.
- Determine depth of cut per pass.
- Determine compound off-set angle.
- Cut internal threads on a work piece.

TASK: Set up and perform taper turning with taper attachments

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, turning tool, tool holder, dial indicator, micrometer carriage stop, cutting fluids, and precision measuring instruments, machine external taper on work piece holding a

tolerance of .00l per 4 inches in length and a surface finish as specified by the blueprint.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for machining an external taper.
- Explain the use of taper attachments.
- Describe the procedures for cutting external tapers.
- Calculate speeds and feeds for external tapering operations.
- Explain how to check taper over a 4.000 inch length.
- Identify the correct cutting fluids for external tapering operations.
- Turn an external taper on a work piece.

TASK: Set up and perform taper turning with compound.

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures.
- Calculate cutting speed for cutting external angle with compound.
- Describe the procedures for cutting external angles.
- Identify the correct cutting fluid for cutting external angles.
- Cut an external taper with a compound on a work piece.

TASK: Cut internal tapered surfaces

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, boring bar, tool blank, boring bar holder, cutting fluid, and precision measuring instruments, cut internal tapered surface on work piece 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:

- Explain the safety precautions/procedures for cutting internal tapered surface.
- Calculate speeds and feeds for internal tapering operations.
- Describe the procedures for boring internal tapers with taper attachment.
- Identify the correct cutting fluids for boring internal tapers.
- Cut an internal taper on a work piece.

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

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for free hand forming a work piece.
- Describe the procedures for angular concave or contour cuts with lathes.
- Explain the proper use of radius gauges.
- Calculate speeds for free hand forming operations.
- Describe the procedures for free hand forming concave and convex radii.
- Identify the correct cutting fluids.
- Cut contour, concave and angular surfaces on a work piece.

TASK: Set up and use follower and steady-rests

Level II

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

ENABLING OBJECTIVES:

- Explain safety precautions for using follow and steady rests.

- Install face plate.
- Describe the procedure to install work using a lathe dog and faceplate.
- Install steady rest or follower rest and adjust to part.
- Turn work to size with proper follow and steady rest setup.

TASK: Set up face plates and lathe dogs

Level II

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

ENABLING OBJECTIVES:

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

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 8 - MILLING MACHINES

This is one of a series of modules which comprise TCCBTTS Proprietary School Certification Missouri Higher Education Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a intern/apprentice 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 s intern/apprentice to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of intern/apprentice 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 intern/apprentice. 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 intern/apprentice and institutions derived from these curriculum standards should be considerable. Articulation of intern/apprentice 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. Intern/Apprentice 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 intern/apprentice 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 – Demonstrate Proficiency in Setting Up Operating Milling Machines

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

Level II

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

ENABLING OBJECTIVES:

- Identify types of milling machines.
- Identify major parts of milling machines.
- Describe the function of major parts.

TASK: Lubricate Milling Machines

Level II

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:

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

TASK: True up the Head and Align Milling Machine Fixtures

Level II

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:

- Explain the safety precautions/procedures in alignment of heads.
- Explain the operation of a swivel head on a mill.
- Explain the use of dial indicator for aligning swivel heads.
- Describe the procedures for aligning the head of a milling machine.
- Describe the procedures for aligning a vise on a milling table.
- Align a vise on a milling table.
- Align a head of a milling machine.

TASK: Select and Set Feeds and Speeds for Milling Work

Level II

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

ENABLING OBJECTIVES:

- List the correct cutting speed and feed for the following materials:
  - Cold rolled steel, with 1/2" end mill.
  - Aluminum, with 1/4" end mill.
  - Tool steel, with 3/8" end mill.
- Set correct feeds and speeds on a milling machine for selected material.

TASK: Square up Work pieces with a Table Vise

Level II

PERFORMANCE OBJECTIVES: Given a blueprint, work piece, 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 + .001 inch for linear dimensions.

ENABLING OBJECTIVES:

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

TASK: Perform End Milling

Level II

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

ENABLING OBJECTIVE:

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

TASK: Perform Fly-Cutting Operations

Level II

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

ENABLING OBJECTIVES:

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

TASK: Drill Holes with a Milling Machine

Level II

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

ENABLING OBJECTIVES:

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

TASK: Perform Reaming Operations

Level II

PERFORMANCE OBJECTIVES: Given blueprint, work piece, holding device, Center-drill, drill, reamer, cutting fluid, and precision measuring instruments, Center-drill, 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:

- Explain the safety precautions/procedures for center-drilling and reaming a hole.
- Explain the uses of center-drills, drills, and reamers.
- Calculate proper speeds and feeds for center-drilling, drilling, and reaming operations.
- Describe the procedures for center-drilling, drilling, and reaming on a milling machine.
- Identify the correct cutting fluids for center-drilling, drilling and reaming.
- Determine the proper drill size for reaming.
- Ream a hole in a work piece holding required tolerances.

TASK: Cut External Keyways

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for end milling key-seats.
- Calculating proper speeds, feeds, and depth of cut when milling key-seats.
- Describe the procedures for setting up and milling key-seats.
- Identify the correct cutting fluids for milling key-seats.
- Determine keyway depth.
- End mill a key-seat in a work piece holding required tolerances.

TASK: Bore Hole with Milling Machines

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for boring and counter-boring holes.
- Explain the procedures for accurately adjusting a boring head.
- Calculate speeds and feeds for boring operations.
- Describe the procedures for setting up and completing boring operations.
- Identify the correct cutting fluids for boring and counter-boring.
- Bore a hole in a work piece using a boring head on a milling machine to required tolerances.

TASK: Perform Form Milling

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for form milling.
- Define the terms concave and convex as they pertain to milling cutters.
- Calculate speeds, feeds, and depth of cut for milling cutter.
- Describe the procedures for form milling.
- Identify the correct cutting fluids.
- Form mill a work piece to required tolerances.

TASK: Perform Indexing Operations Using a Dividing Head

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for machining using the differential indexing method.
- Explain the calculations for the indexing head when performing differential indexing.
- Explain the proper technique for assembling gears in gear train.
- Define simple gearing and compound gearing.
- Explain the use of an idler gear.
- Describe the procedures for machining a work piece using differential indexing.
- Identify the correct cutting fluids.
- Explain the use of wide range indexing.

- Machine a work piece with deferential indexing using a dividing head.

TASK: Set Up and Operate Rotary Tables

Level II

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

ENABLING OBJECTIVES:

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

TASK: Mill an External Radius

Level II

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

ENABLING OBJECTIVES:

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

TASK: Mill an Angle

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for milling holes using angular indexing.
- Explain the calculations required for the indexing head when performing angular indexing.
- Calculate speeds and feeds for angular indexing operations.
- Describe the procedures for milling holes using angular indexing.
- Identify the correct cutting fluids.
- Drill holes in a work piece to specified angles using an indexing head.

TASK: Align Milling Machine Attachments

Level II

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:

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

TASK: Mill Internal Slots with a slotting attachment

Level II

PERFORMANCE OBJECTIVE: Given a blueprint, work piece, 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:

- Explain the safety precautions/procedures for cutting internal slots and Key-ways.
- Explain the ability to grind and sharpen cutting tools.
- Determine the correct cutters for various applications.
- Calculate depth and size of keyways and slots.
- Describe set up procedures for the length of stroke.
- Calculate speed in strokes per minute.
- Describe procedures for machining internal slots and keyways.

TASK: Perform Cutting-Off Operation

Level II

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

ENABLING OBJECTIVES:

- Explain how to calculate depths, speeds and feeds for slitting saws.
- Explain how to set up work pieces with kickers to cut precision lengths.
- Cut work pieces to precision lengths.
- Slot various shapes of work pieces.

TASK: Set Up and Perform Slab Mill Operations

Level II

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

ENABLING OBJECTIVES:

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

TASK: Use an Edge Finder and Wiggler

Level II

PERFORMANCE OBJECTIVE: Given a work piece and an edge finder or wiggler locate the center of the work piece to within + .001 inch.

ENABLING OBJECTIVES:

Explain the safety precautions/procedures.

Explain the correct care and use of an edge finder or wiggler.

Describe the procedures for touching off with an edge finder and a wiggler.

Mark the center of a work piece after locating it with a wiggler or edge finder.

TASK: Use Digital Readouts

Level II

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

ENABLING OBJECTIVES:

- Explain the safety cutting precautions/procedures for drilling holes.
- Describe the procedures for using digital read out for accurate table positioning.
- Calculate the amount of table movement for each position.
- Describe the procedures for keeping backlash out of lead screws.
- Calculate the correct cutting speed and feed.
- Describe the procedures for drilling equally spaced holes.
- Identify the correct cutting fluids for drilling.
- Drill equally spaced holes in a work piece using digital read outs to locate centers.

TASK: Perform Straddle Milling Operations on the Horizontal Mill

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures.
- Explain the purpose of and applications for gang milling operations.
- Describe the procedures for mounting cutters and arbor in machine.
- Explain why a key is needed in the arbor.
- Calculate speed, feed, and depth of cut for gang milling operations.
- Describe the procedures for gang milling.

TASK: Set Up and Use a Sine Vise

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures.
- Describe the care and use of parallels.
- Describe the procedures for seating a part in a milling sine vise.
- Set up and seat a work piece in a sine vise.

PRECISION MACHINING-LEVEL III
Prerequisite: Level II

A course designed to provide TCCBTTS interns/apprentices with team work, critical thinking, problem solving, diagnostics, and repairing/producing to industry standards

TASK LISTING

- TCCBTTS Interns/Apprentices Performance Standards Effective Date: June 2016
- PROGRAM AREA: Trade & Industrial Education
- PROGRAM TITLE: Precision Machining Technology

DEMONSTRATE EMPLOYABILITY SKILLS

TCCBTTS interns/apprentices will be able to: Level III

- Identify employment opportunities
- Apply employment-seeking skills
- Interpret employment capabilities
- Demonstrate appropriate work behavior
- Maintain a business-like image
- Maintain working relationships with others
- Communicate on the job
- Adapt to change
- Demonstrate knowledge of business operation

PERFORM PREREQUISITE MACHINING SKILLS

TCCBTTS interns/apprentices will be able to: Level I II

- Demonstrate proficiency in maintaining immediate work area
- Perform mathematical calculations
- Demonstrate proficiency in blueprint reading and machine planning
- Perform measuring operations
- Perform maintenance on machines and tools

Demonstrate Proficiency in Performing Bench Work Skills

TCCBTTS interns/apprentices will be able to: Level I II

- Cut materials by using hand hacksaws
- Cut threads by using hand taps and dies
- Ream holes by using hand reamers
- Hand-sharpen cutting tools by using abrasive stones
- Remove damaged screws and other hardware
- Set up and use arbor press broaches
- Deburr work pieces
- Identify and use proper hand finishing tools

Demonstrate Proficiency in Setting UP and Operating: LATHES

TCCBTTS interns/apprentices will be able to: Level III

- Identify the parts of the lathe
- Comply with safe and efficient work practices
- Measure stock
- Set up an engine lathe
- Secure tools, tool-holders and fixtures or attachments
- Select and set feeds and speeds
- Set up lathes and face work pieces held in chucks
- Rough-cut and finish-cut with lathes
- Deburr parts using filing procedures
- Align lathe centers using accurate methods
- Drill holes with lathes
- Countersink holes with lathes
- Ream holes with lathes
- Tap threads with lathes
- Die-cut threads with lathes
- Counter bore holes with lathes
- Bore holes with lathes
- Knurl parts with lathes
- Cut external threads with lathes
- Re-chase threads with lathes

- Cut internal threads with lathes
- Set up and perform taper turning with taper attachments
- Set up and perform taper turning with compound
- Cut internal tapered surfaces
- Set up and operate tool post grinders
- Perform contour, angular or radial cuts with lathes
- Set up and use follow and steady-rests
- Set up face plates and dogs

Demonstrate Proficiency in Setting Up and Operating Milling Machines

TCCBTTS interns/apprentices will be able to: Level I II

- Identify the parts of the horizontal and vertical milling machine
- Lubricate milling machines.
- True up the head and align milling machines fixtures
- Select and set feeds and speeds for milling work
- Square up work pieces with a table vise
- Perform end milling
- Perform fly-cutting operations
- Drill holes with a milling machine
- Perform reaming operations
- Cut external keyways
- Bore holes with milling machines
- Perform form milling
- Perform indexing operations using a dividing head
- Set up and operate rotary tables
- Mill cylindrical work
- Mill an external radius
- Mill an angle
- Align milling machine attachments
- Mill internal slots with a slotter and attachment

- Perform cutting-off operations
- Set up and perform slab mill operations
- Use an edge finder and wiggler
- Use digital readouts
- Set up and use a sine vise

Demonstrate Proficiency in Setting Up and Operating Surface Grinding Machines

TCCBTTS interns/apprentices will be able to: Level III

- Identify the parts of the machine
- Comply with safe and efficient work practices
- Clean and lubricate surface grinding machine
- Select the proper wheel
- Inspect, balance, dress, and true grinding wheels
- Attach and align work pieces for grinding operations
- Set up and grind parallel flat surfaces
- Set up and grind four sides square
- Set up and use angle plates
- Cut off or part work pieces with grinding machines
- Measure, inspect, and rework work pieces on grinding machines
- Set up, grind, and sharpen pre-shaped lathe tools
- Set up and use radius dressers

Demonstrate Proficiency in Applying Computerized Numerical Control Operations

TCCBTTS interns/apprentices will be able to: Level III

- Identify the parts of the machine
- Comply with safe and efficient work practices

- Identify and select proper machine controls
- Write a program and apply basic programming skills to a turning and/or a milling operation
- Select proper work holders
- Select proper cutting tools
- Machine parts to blueprint tolerances
- Demonstrate the use of CAD/CAM system for part program development

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 1 - EMPLOYABILITY SKILLS

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MODULE 1 - EMPLOYABILITY SKILLS

TASK: Identify Employment Opportunities

Level III

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

ENABLING OBJECTIVES:

- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

TASK: Apply Employment-Seeking Skills

Level III

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:

- Locate a job opening.
- Complete a resume.
- Prepare for an interview.
- Participate in an interview.
- Complete tests required.
- Complete forms required.
- Complete an application letter.
- Complete a follow-up letter.
- Complete an acceptance letter.
- Evaluate a job offer.
- Evaluate a job rejection.

TASK: INTERPRET EMPLOYMENT CAPABILITIES

Level III

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:

- Match an interest to job area.
- Match aptitudes to job area.
- Verify abilities.
- Identify immediate work goal.
- Develop a career plan.

TASK: DEMONSTRATE APPROPRIATE WORK BEHAVIOR

Level III

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

ENABLING OBJECTIVES:

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

TASK: MAINTAIN A BUSINESS-LIKE IMAGE

Level III

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:

- Participate in the institution's orientation.
- Demonstrate knowledge of company or agency products and services.
- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

TASK: MAINTAIN WORKING RELATIONSHIPS WITH OTHERS

Level III

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

ENABLING OBJECTIVES:

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

TASK: COMMUNICATE ON THE JOB

Level III

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

ENABLING OBJECTIVES:

- Read and comprehend written communications.
- Use correct grammar.
- Speak clearly when addressing others.
- Use job-related terminology.
- Listen attentively.
- Write legibly.
- Use telephone etiquette.
- Follow written and oral directions.
- Ask questions.
- Locate information needed to complete the task.
- Prepare written communication.
- Demonstrate keyboarding skills.
- Demonstrate computer skill.

TASK: ADAPT TO CHANGE

Level III

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

ENABLING OBJECTIVES:

- Recognize the need to change.
- Demonstrate a willingness to learn.
- Demonstrate flexibility.
- Participate in continuing education.
- Seek challenge in the work place.
- Adjust goals and plans when necessary.

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 2 - PREREQUISITE MACHINING

This is one of a series of modules which comprise TCCBTTS Proprietary School Certification Missouri Higher Education Curriculum Guide for Precision Machining.

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MODULE 2 - PREREQUISITE MACHINING SKILLS

TASK: Demonstrate Proficiency in Maintaining Immediate Work Area Level III

PERFORMANCE OBJECTIVE: Given appropriate materials and supplies the interns/apprentices will be able to demonstrate proficiency to maintain work areas in a machine shop.

ENABLING OBJECTIVES:

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

TASK: Perform Mathematical Calculation's

Level III

PERFORMANCE OBJECTIVE: Given the appropriate tools, equipment and resource material, the interns/apprentices will demonstrate the ability to perform

accurate mathematical calculations relating to machine set up, material, and machine shop environment.

ENABLING OBJECTIVES:

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

TASK: Demonstrate Proficiency in Blueprint Reading and Machine Planning

Level III

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

ENABLING OBJECTIVES:

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

TASK: Perform Measuring Operations

Level III

PERFORMANCE OBJECTIVE: Given the appropriate tools and operation pieces, the interns/apprentices will accurately measure work pieces using the proper measuring instruments.

ENABLING OBJECTIVES:

- Read and measure with rules and calipers.
- Read and measure with micrometers.
- Read and measure with Vernier tools.
- Read and measure with dial indicators.
- Measure using as surface plate.
- Read and interpret surface finish (ANSI Y14)

TASK: Perform Maintenance on Machines and Tools

Level III

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

ENABLING OBJECTIVES:

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

MODULE 3 - BENCH WORK

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MODULE 3 - PERFORM BENCH WORK SKILLS

TASK: Cut materials by using hand hacksaws

Level III

PERFORMANCE OBJECTIVE: Given a dimensioned blueprint of a work piece, raw material, and a hand hacksaw, the interns/apprentices will be able to:

ENABLING OBJECTIVES:

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

TASK: Cut threads by using hand taps and dies

Level III

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

ENABLING OBJECTIVES:

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

TASK: Ream holes by using hand reamers

Level III

PERFORMANCE OBJECTIVE: Given a hand reamer, ream a series of previously drilled holes to a tolerance of +.001.

ENABLING OBJECTIVES:

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

TASK: Hand sharpen cutting tools by using abrasive stones

Level III

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:

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

TASK: Remove damaged screws and other hardware

Level III

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 work piece.

ENABLING OBJECTIVES:

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

TASK: Set up and use arbor press broaches

Level III

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

ENABLING OBJECTIVES:

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

TASK: Deburr work pieces

Level III

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

ENABLING OBJECTIVES:

- Demonstrate how to properly hold files and three corner scrapers.
- Demonstrate how to sharpen a three corner scraper.
- Deburr work pieces to required tolerances.

MODULE 7 – Demonstrate Proficiency in Setting Up and Operating - LATHES

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TASK: Identify the parts of the lathe.

Level II

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

ENABLING OBJECTIVES:

- Explain the major parts of the lathe.
- Explain the function of the bed.
- Explain the function of the carriage and the parts therein.
- Explain the function of the head stock and the parts therein.
- Explain the function of the tail stock and the parts therein.

TASK: Comply with general safe and efficient work practices.

Level II

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

ENABLING OBJECTIVES:

- Explain the need for safety glasses.
- Explain the hazards of chip handling.
- Explain the set up hazards.
- Explain the chuck removal and installation hazards.
- Explain the hazards of work piece burrs.
- Explain the proper housekeeping and tool hazards.
- Demonstrate knowledge of safety by completing a written safety test

TASK: Measure stock

Level II

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

ENABLING OBJECTIVES:

- Explain correct drafting standards for dimensioning blueprints.
- Demonstrate the proper care, use, and calibrations of precision measuring instruments.
- List accepted drafting abbreviations and/or symbols for the following terms:
    - Outside diameter
    - Inside diameter
    - Threads per inch
    - Inch
    - Millimeter
    - Counter-bore
    - Depth
    - Measure a cylindrical work piece.

TASK: Set up an engine lathe

Level II

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:

- Explain the relevant safety precautions/procedures for mounting chucks on lathes.
- Explain the operation of lathe.
- Describe the use of wood blocks as cradles between bed-ways and chuck.
- Discuss the applications for independent, universal, and collect chucks.
- Describe the procedures for mounting chucks on lathe.
- Describe the procedures for mounting face plates.
- Describe the procedures for mounting and using follower and steady rests.

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

Level II

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:

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

TASK: Select and set feeds and speeds

Level II

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

ENABLING OBJECTIVES:

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

TASK: Set up lathes and face work pieces held in chucks

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for facing.
- Describe the uses of carbide, high speed, and cutting tools as applied to facing operations.
- Define micro-inch.
- Calculate cutting speeds and feeds for facing operations.
- Describe the procedures for facing.
- Identify the correct cutting fluids for facing.
- Face a work piece to specifications.

TASK: Rough-cut and finish-cut with lathes

Level II

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:

- Explain safety for lathe operation.
- Explain lathe feeds and describe the guideline
- Select speeds and feeds and mount stock in work holding devices.
- Explain tool position and tool geometry (angles).
- Define trial cuts.
- Make required trial cuts.
- Using appropriate measuring tools, measure work piece.
- Perform required rough and finish cuts to specifications.

TASK: Perform lathe filing to deburr parts

Level II

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

ENABLING OBJECTIVES:

- Explain lathe safety.
- Select spindle speed and mount project in lathe.
- Define micro-inch finishes.
- List names of different deburr tools.
- Explain grit size of abrasive clothes.
- List and identify shape, cut and size of files as required by worksheet.
- List other tools needed.
- File, polish and deburr a work piece.

TASK: Align lathe centers using accurate methods.

Level II

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

ENABLING OBJECTIVES:

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

TASK: Drill holes with lathes.

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, drill, lathe attachments, and cutting fluid, drill hole in work piece to a tolerance of + .005 inch, - .000 for diameter.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for drilling operations.
- Calculate speeds for drilling operations.
- Describe the procedures for drilling on a lathe.
- Identify the correct cutting fluid for drilling operations.
- Drill a hole in a work piece.

TASK: Countersink holes with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for countersinking operations.
- Calculate speeds for countersinking operations.
- Describe the procedures for countersinking on a lathe.
- Identify the correct cutting fluid for countersinking.
- Countersink a hole in a work piece.

TASK: Ream holes with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for reaming operations.
- Calculate speeds for reaming operations.
- Describe the procedures for reaming.
- Identify the correct cutting fluid for reaming.
- Ream a hold in a work piece.

TASK: Tap threads with lathes

Level II

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

ENABLING OBJECTIVE:

- Explain the safety precautions/procedures for tapping operations.
- Determine tap drill size using the charts and formulas.
- Describe the procedures for tapping on a lathe.
- Identify the correct cutting fluid for tapping.
- Describe the proper use of a plug gauge.
- Tap threads in a work piece.

TASK: Die-cut threads with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain safety requirements for cutting external threads.
- Calculate lathe RPM.
- Set up work piece in chuck.
- Remove tail stock center and explain how to follow the die with the tailstock spindle.
- Describe procedures for cutting external threads.
- Identify the proper cutting fluid.
- Die cut external threads on a work piece.

TASK: Counter-bore holes with lathes

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, lathe attachments, boring bar, cutting fluid, and precision measuring instruments, counter-bore hole in work piece to a tolerance of + .001 inch for diameter and depth.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for counter-boring operations.
- Calculate speeds for counter-boring operations.
- Describe the procedures for counter-boring.
- Identify the correct cutting fluid for counter-boring operations.
- Counter-bore a hole in a work piece.

TASK: Bore holes with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for boring holes with a lathe.
- Calculate speeds for boring operations on lathes.
- Describe the procedures for boring holes.
- Identify the correct cutting fluids for boring.
- Bore a hole in a work piece.

TASK: Knurl parts with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for knurling a work piece.
- Explain the proper use of knurling tools.
- Calculate speeds and feeds for knurling operations.
- Describe the procedures for knurling a work piece.
- Identify the correct cutting fluid for knurling.
- Knurl a work piece.

TASK: Cut external threads with lathes

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, tool holder, tool blank, center gauge, cutting fluids, and precision measuring instruments, cut external threads on work piece 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:

- Explain the safety precautions/procedures for cutting external threads.
- Explain the formulas used in the three wire system for measuring external threads.
- Calculate proper speeds for cutting external threads.
- Describe the procedures for cutting external threads.
- Select the correct cutting fluid for threading operations.
- Calculate thread depth.
- Calculate total in feed of compound.
- Determine depth per pass.
- Determine compound off-set angle (right or left hand threads).
- Cut external threads on a work piece.

TASK: Re-chase threads with lathes

Level II

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

ENABLING OBJECTIVES:

- Explain safety precautions for re-chasing threads.
- Describe procedure for setting up a lathe to re-chase threads.
- Identify tools needed to re-chase threads.
- Select correct cutting fluid for re-chasing threads.
- Re-chase threads on a work piece.

TASK: Cut internal threads with lathes

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, tool holder, tool blank, thread center gauge, cutting fluids and precision measuring instruments, cut internal threads on work pieces 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:

- Explain the safety precautions/procedures for chasing internal threads.
- Calculate total in feed of compound for unified threading.
- Calculate proper speeds and hole size for cutting internal threads.
- Describe the procedures for cutting internal threads.
- Select the correct cutting fluid for threading.
- Determine depth of cut per pass.
- Determine compound off-set angle.
- Cut internal threads on a work piece.

TASK: Set up and perform taper turning with taper attachments

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, turning tool, tool holder, dial indicator, micrometer carriage stop, cutting fluids, and precision measuring instruments, machine external taper on work piece holding a tolerance of .00l per 4 inches in length and a surface finish as specified by the blueprint.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for machining an external taper.
- Explain the use of taper attachments.
- Describe the procedures for cutting external tapers.
- Calculate speeds and feeds for external tapering operations.
- Explain how to check taper over a 4.000 inch length.
- Identify the correct cutting fluids for external tapering operations.
- Turn an external taper on a work piece.

TASK: Set up and perform taper turning with compound.

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures.
- Calculate cutting speed for cutting external angle with compound.
- Describe the procedures for cutting external angles.
- Identify the correct cutting fluid for cutting external angles.
- Cut an external taper with a compound on a work piece.

TASK: Cut internal tapered surfaces

Level II

PERFORMANCE OBJECTIVE: Given blueprint, work piece, boring bar, tool blank, boring bar holder, cutting fluid, and precision measuring instruments, cut internal tapered surface on work piece 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:

- Explain the safety precautions/procedures for cutting internal tapered surface.
- Calculate speeds and feeds for internal tapering operations.
- Describe the procedures for boring internal tapers with taper attachment.
- Identify the correct cutting fluids for boring internal tapers.
- Cut an internal taper on a work piece.

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

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for free hand forming a work piece.
- Describe the procedures for angular concave or contour cuts with lathes.
- Explain the proper use of radius gauges.
- Calculate speeds for free hand forming operations.
- Describe the procedures for free hand forming concave and convex radii.
- Identify the correct cutting fluids.
- Cut contour, concave and angular surfaces on a work piece.

TASK: Set up and use follower and steady-rests

Level II

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

ENABLING OBJECTIVES:

- Explain safety precautions for using follow and steady rests.
- Install face plate.
- Describe the procedure to install work using a lathe dog and faceplate.
- Install steady rest or follower rest and adjust to part.
- Turn work to size with proper follow and steady rest setup.

TASK: Set up face plates and lathe dogs

Level II

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

ENABLING OBJECTIVES:

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

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 interns/apprentices 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 interns/apprentices to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of interns/apprentices 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 interns/apprentices. 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 interns/apprentices and institutions derived from these curriculum standards should be considerable. Articulation of interns/apprentices 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. Interns/Apprentices 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 interns/apprentices 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 – Demonstrate Proficiency in Setting Up and Operating – Milling Machines

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

Level II

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

ENABLING OBJECTIVES:

- Identify types of milling machines.
- Identify major parts of milling machines.
- Describe the function of major parts.

TASK: Lubricate Milling Machines

Level II

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:

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

TASK: True up the Head and Align Milling Machine Fixtures

Level II

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:

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

TASK: Select and Set Feeds and Speeds for Milling Work

Level II

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

ENABLING OBJECTIVES:

- List the correct cutting speed and feed for the following materials:
  - Cold rolled steel, with 1/2" end mill.
  - Aluminum, with 1/4" end mill.
  - Tool steel, with 3/8" end mill.
- Set correct feeds and speeds on a milling machine for selected material.

TASK: Square up Work pieces with a Table Vise

Level II

PERFORMANCE OBJECTIVES: Given a blueprint, work piece, 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 + .001 inch for linear dimensions.

ENABLING OBJECTIVES:

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

TASK: Perform End Milling

Level II

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

ENABLING OBJECTIVE:

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

TASK: Perform Fly-Cutting Operations

Level II

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

ENABLING OBJECTIVES:

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

TASK: Drill Holes with a Milling Machine

Level II

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

ENABLING OBJECTIVES:

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

TASK: Perform Reaming Operations

Level II

PERFORMANCE OBJECTIVES: Given blueprint, work piece, holding device, Center-drill, drill, reamer, cutting fluid and precision measuring instruments, Center-drill, 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:

- Explain the safety precautions/procedures for center-drilling and reaming a hole.
- Explain the uses of center-drills, drills, and reamers.
- Calculate proper speeds and feeds for center-drilling, drilling, and reaming operations.
- Describe the procedures for center-drilling, drilling, and reaming on a milling machine.
- Identify the correct cutting fluids for center-drilling, drilling and reaming.
- Determine the proper drill size for reaming.
- Ream a hole in a work piece holding required tolerances.

TASK: Cut External Keyways

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for end milling key-seats.
- Calculating proper speeds, feeds, and depth of cut when milling key-seats.
- Describe the procedures for setting up and milling key-seats.
- Identify the correct cutting fluids for milling key-seats.
- Determine keyway depth.
- End mill a key-seat in a work piece holding required tolerances.

TASK: Bore Hole with Milling Machines

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for boring and counter-boring holes.
- Explain the procedures for accurately adjusting a boring head.
- Calculate speeds and feeds for boring operations.
- Describe the procedures for setting up and completing boring operations.
- Identify the correct cutting fluids for boring and counter-boring.
- Bore a hole in a work piece using a boring head on a milling machine to required tolerances.

TASK: Perform Form Milling

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for form milling.
- Define the terms concave and convex as they pertain to milling cutters.
- Calculate speeds, feeds, and depth of cut for milling cutter.
- Describe the procedures for form milling.
- Identify the correct cutting fluids.
- Form mill a work piece to required tolerances.

TASK: Perform Indexing Operations Using a Dividing Head

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for machining using the differential indexing method.
- Explain the calculations for the indexing head when performing differential indexing.
- Explain the proper technique for assembling gears in gear train.
- Define simple gearing and compound gearing.
- Explain the use of an idler gear.
- Describe the procedures for machining a work piece using differential indexing.
- Identify the correct cutting fluids.
- Explain the use of wide range indexing.
- Machine a work piece with deferential indexing using a dividing head.

TASK: Set Up and Operate Rotary Tables

Level II

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

ENABLING OBJECTIVES:

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

TASK: Mill an External Radius

Level II

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

ENABLING OBJECTIVES:

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

TASK: Mill an Angle

Level II

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for milling holes using angular indexing.
- Explain the calculations required for the indexing head when performing angular indexing.
- Calculate speeds and feeds for angular indexing operations.
- Describe the procedures for milling holes using angular indexing.
- Identify the correct cutting fluids.
- Drill holes in a work piece to specified angles using an indexing head.

TASK: Align Milling Machine Attachments

Level II

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:

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

TASK: Mill Internal Slots with a slotting attachment

Level II

PERFORMANCE OBJECTIVE: Given a blueprint, work piece, 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:

- Explain the safety precautions/procedures for cutting internal slots and keyways.
- Explain the ability to grind and sharpen cutting tools.
- Determine the correct cutters for various applications.
- Calculate depth and size of keyways and slots.
- Describe set up procedures for the length of stroke.
- Calculate speed in strokes per minute.
- Describe procedures for machining internal slots and keyways.

TASK: Perform Cutting-Off Operation

Level II

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

ENABLING OBJECTIVES:

- Explain how to calculate depths, speeds and feeds for slitting saws.
- Explain how to set up work pieces with kickers to cut precision lengths.
- Cut work pieces to precision lengths.
- Slot various shapes of work pieces.

TASK: Set Up and Perform Slab Mill Operations

Level II

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

ENABLING OBJECTIVES:

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

TASK: Use an Edge Finder and Wiggler

Level II

PERFORMANCE OBJECTIVE: Given a work piece and an edge finder or wiggler locate the center of the work piece to within + .001 inch.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures.
- Explain the correct care and use of an edge finder or wiggler.
- Describe the procedures for touching off with an edge finder and a wiggler.
- Mark the center of a work piece after locating it with a wiggler or edge finder.

TASK: Use Digital Readouts

Level II

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

ENABLING OBJECTIVES:

- Explain the safety cutting precautions/procedures for drilling holes.
- Describe the procedures for using digital read out for accurate table positioning.
- Calculate the amount of table movement for each position.
- Describe the procedures for keeping backlash out of lead screws.
- Calculate the correct cutting speed and feed.
- Describe the procedures for drilling equally spaced holes.
- Identify the correct cutting fluids for drilling.
- Drill equally spaced holes in a work piece using digital read outs to locate centers.

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

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures.
- Explain the purpose of and applications for gang milling operations.
- Describe the procedures for mounting cutters and arbor in machine.
- Explain why a key is needed in the arbor.
- Calculate speed, feed, and depth of cut for gang milling operations.
- Describe the procedures for gang milling.

TASK: Set Up and Use a Sine Vise
Level II

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

ENABLING OBJECTIVES:

Explain the safety precautions/procedures.
Describe the care and use of parallels.
Describe the procedures for seating a part in a milling sine vise.
Set up and seat a work piece in a sine vise.

PRECISION MACHINING - LEVEL III

Prerequisite: Level II

A course designed to provide student with team work, critical thinking, problem solving, diagnostics, and repairing/producing to industry standards.

TASK LISTING

Interns/Apprentices Performance Standards Effective- Date: June 2016

- **PROGRAM AREA: Trade & Industrial Education**
- **PROGRAM TITLE: Precision Machining Technology**

DEMONSTRATE EMPLOYABILITY SKILLS - The student will be able to:

Level III

- Identify employment opportunities
- Apply employment-seeking skills
- Interpret employment capabilities
- Demonstrate appropriate work behavior
- Maintain a business-like image
- Maintain working relationships with others
- Communicate on the job
- Adapt to change
- Demonstrate knowledge of business operation

Perform Prerequisite Machining Skill - The student will be able to:

Level I II

- Demonstrate proficiency in maintaining immediate work area
- Perform mathematical calculations
- Demonstrate proficiency in blueprint reading and machine planning
- Perform measuring operations
- Perform maintenance on machines and tools

Demonstrate Proficiency in Performing Bench Work Skills - The student will be able to:

Level III

- Cut materials by using hand hacksaws
- Cut threads by using hand taps and dies
- Ream holes by using hand reamers
- Hand-sharpen cutting tools by using abrasive stones
- Remove damaged screws and other hardware
- Set up and use arbor press broaches
- Deburr work pieces
- Identify and use proper hand finishing tools

Demonstrate Proficiency in Setting Up and Operating Lathes - The student will be able to:

Level III

- Identify the parts of the lathe
- Comply with safe and efficient work practices
- Measure stock
- Set up an engine lathe
- Secure tools, tool-holders and fixtures or attachments
- Select and set feeds and speeds
- Set up lathes and face work pieces held in chucks
- Rough-cut and finish-cut with lathes
- Deburr parts using filing procedures
- Align lathe centers using accurate methods
- Drill holes with lathes
- Countersink holes with lathes
- Ream holes with lathes
- Tap threads with lathes
- Die-cut threads with lathes
- Counter bore holes with lathes
- Bore holes with lathes
- Knurl parts with lathes
- Cut external threads with lathes
- Re-chase threads with lathes
- Cut internal threads with lathes
- Set up and perform taper turning with taper attachments
- Set up and perform taper turning with compound
- Cut internal tapered surfaces
- Set up and operate tool post grinders
- Perform contour, angular or radial cuts with lathes
- Set up and use follow and steady-rests

- Set up face plates and dogs

Demonstrate Proficiency in Setting Up and Operating Milling Machines - The student will be able to:

Level III

- Identify the parts of the horizontal and vertical milling machine
- Lubricate milling machines.
- True up the head and align milling machines fixtures
- Select and set feeds and speeds for milling work
- Square up work pieces with a table vise
- Perform end milling
- Perform fly-cutting operations
- Drill holes with a milling machine
- Perform reaming operations
- Cut external keyways
- Bore holes with milling machines
- Perform form milling
- Perform indexing operations using a dividing head
- Set up and operate rotary tables
- Mill cylindrical work
- Mill an external radius
- Mill an angle
- Align milling machine attachments
- Mill internal slots with a slotter and attachment
- Perform cutting-off operations
- Set up and perform slab mill operations
- Use an edge finder and wiggler
- Use digital readouts
- Set up and use a sine vise

Demonstrate Proficiency in Setting UP and Operating Surface Grinding Machines - The student will be able to:

Level III

- Identify the parts of the machine
- Comply with safe and efficient work practices
- Clean and lubricate surface grinding machine
- Select the proper wheel
- Inspect, balance, dress, and true grinding wheels
- Attach and align work pieces for grinding operations
- Set up and grind parallel flat surfaces
- Set up and grind four sides square
- Set up and use angle plates
- Cut off or part work pieces with grinding machines
- Measure, inspect, and rework work pieces on grinding machines
- Set up, grind, and sharpen pre-shaped lathe tools
- Set up and use radius dressers

Demonstrate Proficiency in Applying Computerized Numerical Control Operations - The student will be able to:

Level III

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

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 1 - EMPLOYABILITY SKILLS

This is one of a series of modules which comprise TCCBTTS Proprietary School Certification Missouri Higher Education 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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TASK: Identify Employment Opportunities

Level III

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

ENABLING OBJECTIVES:

- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

TASK: Apply Employment-Seeking Skills

Level III

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:

- Locate a job opening.
- Complete a resume.
- Prepare for an interview.
- Participate in an interview.
- Complete tests required.
- Complete forms required.
- Complete an application letter.
- Complete a follow-up letter.
- Complete an acceptance letter.
- Evaluate a job offer.
- Evaluate a job rejection.

TASK: INTERPRET EMPLOYMENT CAPABILITIES

Level III

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:

- Match an interest to job area.
- Match aptitudes to job area.
- Verify abilities.
- Identify immediate work goal.
- Develop a career plan.

TASK: DEMONSTRATE APPROPRIATE WORK BEHAVIOR

Level III

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

ENABLING OBJECTIVES:

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

TASK: MAINTAIN A BUSINESS-LIKE IMAGE

Level III

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:

- Participate in the institution's orientation.
- Demonstrate knowledge of company or agency products and services.
- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

TASK: MAINTAIN WORKING RELATIONSHIPS WITH OTHERS

Level III

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

ENABLING OBJECTIVES:

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

TASK: COMMUNICATE ON THE JOB

Level III

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

ENABLING OBJECTIVES:

- Read and comprehend written communications.
- Use correct grammar.
- Speak clearly when addressing others.
- Use job-related terminology.
- Listen attentively.
- Write legibly.
- Use telephone etiquette.
- Follow written and oral directions.
- Ask questions.
- Locate information needed to complete the task.
- Prepare written communication.
- Demonstrate keyboarding skills.
- Demonstrate computer skill.

TASK: ADAPT TO CHANGE

Level III

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

- ENABLING OBJECTIVES:
- Recognize the need to change.
- Demonstrate a willingness to learn.
- Demonstrate flexibility.
- Participate in continuing education.
- Seek challenge in the work place.
- Adjust goals and plans when necessary.

MODULE 2 - PREREQUISITE MACHINING

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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 TCCBTTS interns/apprentices. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize there sources and personnel within the institution to improve or complement the instructional process.

The benefits to TCCBTTS interns/apprentices and institutions derived from these curriculum standards should be considerable. Articulation of TCCBTTS interns/apprentices 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. TCCBTTS Interns/Apprentices 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 2 - PREREQUISITE MACHINING SKILLS

TASK: Demonstrate Proficiency in Maintaining Immediate Work Area

Level III

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:

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

TASK: Perform Mathematical Calculation's

Level III

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, and machine shop environment.

ENABLING OBJECTIVES:

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

TASK: Demonstrate Proficiency in Blueprint Reading and Machine Planning

Level III

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:

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

TASK: Perform Measuring Operations

Level III

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

ENABLING OBJECTIVES:

- Read and measure with rules and calipers.
- Read and measure with micrometers.
- Read and measure with Vernier tools.
- Read and measure with dial indicators.
- Measure using as surface plate.
- Read and interpret surface finish (ANSI Y14)

TASK: Perform Maintenance on Machines and Tools

Level III

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:

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

CURRICULUM STANDARDS FOR PRECISION MACHINING

MODULE 3 - BENCH WORK

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MODULE 3 - PERFORM BENCH WORK SKILLS

TASK: Cut materials by using hand hacksaws

Level III

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

ENABLING OBJECTIVES:

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

TASK: Cut threads by using hand taps and dies

Level III

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

ENABLING OBJECTIVES:

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

TASK: Ream holes by using hand reamers

Level III

PERFORMANCE OBJECTIVE: Given a hand reamer, ream a series of previously drilled holes to a tolerance of +.001.

ENABLING OBJECTIVES:

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

TASK: Hand sharpen cutting tools by using abrasive stones

Level III

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:

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

TASK: Remove damaged screws and other hardware

Level III

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 work piece.

ENABLING OBJECTIVES:

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

TASK: Set up and use arbor press broaches

Level III

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

ENABLING OBJECTIVES:

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

TASK: Deburr work pieces

Level III

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

ENABLING OBJECTIVES:

- Demonstrate how to properly hold files and three corner scrapers.
- Demonstrate how to sharpen a three corner scraper.
- Deburr work pieces to required tolerances.

CURRICULUM STANDARDS FOR PRECISION MACHINING
MODULE 7 – Demonstrate Proficiency in Setting Up and Operating - LATHES

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MODULE 7 – Demonstrate Proficiency in Setting Up and Operating - LATHES

TASK: Identify the parts of the lathe.

Level III

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

ENABLING OBJECTIVES:

- Explain the major parts of the lathe.
- Explain the function of the bed.
- Explain the function of the carriage and the parts therein.
- Explain the function of the head stock and the parts therein.
- Explain the function of the tail stock and the parts therein.

TASK: Comply with general safe and efficient work practices.

Level IIII

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

ENABLING OBJECTIVES:

- Explain the need for safety glasses.
- Explain the hazards of chip handling.
- Explain the set up hazards.
- Explain the chuck removal and installation hazards.
- Explain the hazards of work piece burrs.
- Explain the proper housekeeping and tool hazards.
- Demonstrate knowledge of safety by completing a written safety test

TASK: Measure stock

Level III

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

ENABLING OBJECTIVES:

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

List accepted drafting abbreviations and/or symbols for the following terms:

- Outside diameter
- Inside diameter
- Threads per inch
- Inch
- Millimeter
- Counter-bore
- Depth
- Measure a cylindrical work piece.

TASK: Set up an engine lathe

Level III

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:

- Explain the relevant safety precautions/procedures for mounting chucks on lathes.
- Explain the operation of lathe.
- Describe the use of wood blocks as cradles between bed-ways and chuck.
- Discuss the applications for independent, universal, and collect chucks.
- Describe the procedures for mounting chucks on lathe.
- Describe the procedures for mounting face plates.

- Describe the procedures for mounting and using follower and steady rests.

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

Level III

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:

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

TASK: Select and set feeds and speeds

Level III

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

ENABLING OBJECTIVES:

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

TASK: Set up lathes and face work pieces held in chucks

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for facing.
- Describe the uses of carbide, high speed, and cutting tools as applied to facing operations.
- Define micro-inch.
- Calculate cutting speeds and feeds for facing operations.
- Describe the procedures for facing.
- Identify the correct cutting fluids for facing.
- Face a work piece to specifications.

TASK: Rough-cut and finish-cut with lathes

Level III

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:

- Explain safety for lathe operation.
- Explain lathe feeds and describe the guideline
- Select speeds and feeds and mount stock in work holding devices.
- Explain tool position and tool geometry (angles).
- Define trial cuts.
- Make required trial cuts.
- Using appropriate measuring tools, measure work piece.
- Perform required rough and finish cuts to specifications.

TASK: Perform lathe filing to deburr parts

Level III

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

ENABLING OBJECTIVES:

- Explain lathe safety.
- Select spindle speed and mount project in lathe.
- Define micro-inch finishes.
- List names of different deburr tools.
- Explain grit size of abrasive clothes.
- List and identify shape, cut and size of files as required by worksheet.
- List other tools needed.
- File, polish and deburr a work piece.

TASK: Align lathe centers using accurate methods.

Level III

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

ENABLING OBJECTIVES:

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

TASK: Drill holes with lathes.

Level III

PERFORMANCE OBJECTIVE: Given blueprint, work piece, drill, lathe attachments, and cutting fluid, drill hole in work piece to a tolerance of + .005 inch, - .000 for diameter.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for drilling operations.
- Calculate speeds for drilling operations.
- Describe the procedures for drilling on a lathe.
- Identify the correct cutting fluid for drilling operations.
- Drill a hole in a work piece.

TASK: Countersink holes with lathes

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for countersinking operations.
- Calculate speeds for countersinking operations.
- Describe the procedures for countersinking on a lathe.
- Identify the correct cutting fluid for countersinking.
- Countersink a hole in a work piece.

TASK: Ream holes with lathes

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for reaming operations.
- Calculate speeds for reaming operations.
- Describe the procedures for reaming.
- Identify the correct cutting fluid for reaming.
- Ream a hold in a work piece.

TASK: Tap threads with lathes

Level III

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

ENABLING OBJECTIVE:

- Explain the safety precautions/procedures for tapping operations.
- Determine tap drill size using the charts and formulas.
- Describe the procedures for tapping on a lathe.
- Identify the correct cutting fluid for tapping.
- Describe the proper use of a plug gauge.
- Tap threads in a work piece.

TASK: Die-cut threads with lathes

Level III

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

ENABLING OBJECTIVES:

- Explain safety requirements for cutting external threads.
- Calculate lathe RPM.
- Set up work piece in chuck.
- Remove tail stock center and explain how to follow the die with the tailstock spindle.
- Describe procedures for cutting external threads.
- Identify the proper cutting fluid.
- Die cut external threads on a work piece.

TASK: Counter-bore holes with lathes

Level III

PERFORMANCE OBJECTIVE: Given blueprint, work piece, lathe attachments, boring bar, cutting fluid, and precision measuring instruments, counter-bore hole in work piece to a tolerance of + .001 inch for diameter and depth.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for counter-boring operations.
- Calculate speeds for counter-boring operations.
- Describe the procedures for counter-boring.
- Identify the correct cutting fluid for counter-boring operations.
- Counter-bore a hole in a work piece.

TASK: Bore holes with lathes

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for boring holes with a lathe.
- Calculate speeds for boring operations on lathes.
- Describe the procedures for boring holes.
- Identify the correct cutting fluids for boring.
- Bore a hole in a work piece.

TASK: Knurl parts with lathes

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for knurling a work piece.
- Explain the proper use of knurling tools.
- Calculate speeds and feeds for knurling operations.
- Describe the procedures for knurling a work piece.
- Identify the correct cutting fluid for knurling.
- Knurl a work piece.

TASK: Cut external threads with lathes

Level III

PERFORMANCE OBJECTIVE: Given blueprint, work piece, tool holder, tool blank, center gauge, cutting fluids, and precision measuring instruments, cut external threads on work piece 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:

- Explain the safety precautions/procedures for cutting external threads.
- Explain the formulas used in the three wire system for measuring external threads.
- Calculate proper speeds for cutting external threads.
- Describe the procedures for cutting external threads.
- Select the correct cutting fluid for threading operations.
- Calculate thread depth.
- Calculate total in feed of compound.
- Determine depth per pass.
- Determine compound off-set angle (right or left hand threads).
- Cut external threads on a work piece.

TASK: Re-chase threads with lathes

Level III

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

ENABLING OBJECTIVES:

- Explain safety precautions for re-chasing threads.
- Describe procedure for setting up a lathe to re-chase threads.
- Identify tools needed to re-chase threads.
- Select correct cutting fluid for re-chasing threads.
- Re-chase threads on a work piece.

TASK: Cut internal threads with lathes

Level III

PERFORMANCE OBJECTIVE: Given blueprint, work piece, tool holder, tool blank, thread center gauge, cutting fluids and precision measuring instruments, cut internal threads on work pieces 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:

- Explain the safety precautions/procedures for chasing internal threads.
- Calculate total in feed of compound for unified threading.
- Calculate proper speeds and hole size for cutting internal threads.
- Describe the procedures for cutting internal threads.
- Select the correct cutting fluid for threading.
- Determine depth of cut per pass.
- Determine compound off-set angle.
- Cut internal threads on a work piece.

TASK: Set up and perform taper turning with taper attachments

Level III

PERFORMANCE OBJECTIVE: Given blueprint, work piece, turning tool, tool holder, dial indicator, micrometer carriage stop, cutting fluids, and precision measuring instruments, machine external taper on work piece holding a tolerance of .00l per 4 inches in length and a surface finish as specified by the blueprint.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for machining an external taper.
- Explain the use of taper attachments.
- Describe the procedures for cutting external tapers.
- Calculate speeds and feeds for external tapering operations.
- Explain how to check taper over a 4.000 inch length.
- Identify the correct cutting fluids for external tapering operations.
- Turn an external taper on a work piece.

TASK: Set up and perform taper turning with compound.

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures.
- Calculate cutting speed for cutting external angle with compound.
- Describe the procedures for cutting external angles.
- Identify the correct cutting fluid for cutting external angles.
- Cut an external taper with a compound on a work piece.

TASK: Cut internal tapered surfaces

Level III

PERFORMANCE OBJECTIVE: Given blueprint, work piece, boring bar, tool blank, boring bar holder, cutting fluid, and precision measuring instruments, cut internal tapered surface on work piece 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:

- Explain the safety precautions/procedures for cutting internal tapered surface.
- Calculate speeds and feeds for internal tapering operations.
- Describe the procedures for boring internal tapers with taper attachment.
- Identify the correct cutting fluids for boring internal tapers.
- Cut an internal taper on a work piece.

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

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for free hand forming a work piece.
- Describe the procedures for angular concave or contour cuts with lathes.
- Explain the proper use of radius gauges.
- Calculate speeds for free hand forming operations.
- Describe the procedures for free hand forming concave and convex radii.
- Identify the correct cutting fluids.
- Cut contour, concave and angular surfaces on a work piece.

TASK: Set up and use follower and steady-rests

Level III

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

ENABLING OBJECTIVES:

- Explain safety precautions for using follow and steady rests.
- Install face plate.
- Describe the procedure to install work using a lathe dog and faceplate.
- Install steady rest or follower rest and adjust to part.
- Turn work to size with proper follow and steady rest setup.

TASK: Set up face plates and lathe dogs

Level III

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

ENABLING OBJECTIVES:

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

CURRICULUM STANDARDS FOR PRECISION MACHINING
MODULE 8 - MILLING MACHINES

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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.

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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. TCCBTTS Interns/Apprentices 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 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING MILLING MACHINES

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

Level III

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

ENABLING OBJECTIVES:

- Identify types of milling machines.
- Identify major parts of milling machines.
- Describe the function of major parts.

TASK: Lubricate Milling Machines

Level III

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:

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

TASK: True up the Head and Align Milling Machine Fixtures

Level III

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:

- Explain the safety precautions/procedures in alignment of heads.
- Explain the operation of a swivel head on a mill.
- Explain the use of dial indicator for aligning swivel heads.
- Describe the procedures for aligning the head of a milling machine.
- Describe the procedures for aligning a vise on a milling table.
- Align a vise on a milling table.
- Align a head of a milling machine.

TASK: Select and Set Feeds and Speeds for Milling Work

Level III

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

ENABLING OBJECTIVES:

- List the correct cutting speed and feed for the following materials:
  - Cold rolled steel, with 1/2" end mill.
  - Aluminum, with 1/4" end mill.
  - Tool steel, with 3/8" end mill.
- Set correct feeds and speeds on a milling machine for selected material.

TASK: Square up Work pieces with a Table Vise

Level III

PERFORMANCE OBJECTIVES: Given a blueprint, work piece, 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 + .001 inch for linear dimensions.

ENABLING OBJECTIVES:

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

TASK: Perform End Milling

Level III

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

ENABLING OBJECTIVE:

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

TASK: Perform Fly-Cutting Operations

Level III

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

ENABLING OBJECTIVES:

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

TASK: Drill Holes with a Milling Machine

Level III

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

ENABLING OBJECTIVES:

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

TASK: Perform Reaming Operations

Level III

PERFORMANCE OBJECTIVES: Given blueprint, work piece, holding device, Center-drill, drill, reamer, cutting fluid, and precision measuring instruments, Center-drill, 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:

- Explain the safety precautions/procedures for center-drilling and reaming a hole.
- Explain the uses of center-drills, drills, and reamers.
- Calculate proper speeds and feeds for center-drilling, drilling, and reaming operations.
- Describe the procedures for center-drilling, drilling, and reaming on a milling machine.
- Identify the correct cutting fluids for center-drilling, drilling and reaming.
- Determine the proper drill size for reaming.
- Ream a hole in a work piece holding required tolerances.

TASK: Cut External Keyways

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for end milling key-seats.
- Calculating proper speeds, feeds, and depth of cut when milling key-seats.
- Describe the procedures for setting up and milling key-seats.
- Identify the correct cutting fluids for milling key-seats.
- Determine keyway depth.
- End mill a key-seat in a work piece holding required tolerances.

TASK: Bore Hole with Milling Machines

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for boring and counter-boring holes.
- Explain the procedures for accurately adjusting a boring head.
- Calculate speeds and feeds for boring operations.
- Describe the procedures for setting up and completing boring operations.
- Identify the correct cutting fluids for boring and counter-boring.
- Bore a hole in a work piece using a boring head on a milling machine to required tolerances.

TASK: Perform Form Milling

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for form milling.
- Define the terms concave and convex as they pertain to milling cutters.
- Calculate speeds, feeds, and depth of cut for milling cutter.
- Describe the procedures for form milling.
- Identify the correct cutting fluids.
- Form mill a work piece to required tolerances.

TASK: Perform Indexing Operations Using a Dividing Head

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for machining using the differential indexing method.
- Explain the calculations for the indexing head when performing differential indexing.
- Explain the proper technique for assembling gears in gear train.
- Define simple gearing and compound gearing.
- Explain the use of an idler gear.
- Describe the procedures for machining a work piece using differential indexing.
- Identify the correct cutting fluids.
- Explain the use of wide range indexing.
- Machine a work piece with deferential indexing using a dividing head.

TASK: Set Up and Operate Rotary Tables

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for milling radii using a rotary table.
- Describe set up and clamping procedures for a rotary table.
- List the applications for a rotary table.
- Explain the procedures for avoiding backlash of rotary table and milling machine screws.
- Calculate the correct speeds for machining outside radius.
- Describe the procedure for milling outside radius using a rotary table.
- Identify the correct cutting fluids.

- Describe the procedures for centering spindle with rotary table.
- Mill an outside radius using a rotary table on a machining machine.

TASK: Mill an External Radius

Level III

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

ENABLING OBJECTIVES:

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

TASK: Mill an Angle

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for milling holes using angular indexing.
- Explain the calculations required for the indexing head when performing angular indexing.
- Calculate speeds and feeds for angular indexing operations.
- Describe the procedures for milling holes using angular indexing.
- Identify the correct cutting fluids.
- Drill holes in a work piece to specified angles using an indexing head.

TASK: Align Milling Machine Attachments

Level III

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:

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

TASK: Mill Internal Slots with a slotting attachment

Level III

PERFORMANCE OBJECTIVE: Given a blueprint, work piece, 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:

- Explain the safety precautions/procedures for cutting internal slots and keyways.
- Explain the ability to grind and sharpen cutting tools.
- Determine the correct cutters for various applications.
- Calculate depth and size of keyways and slots.
- Describe set up procedures for the length of stroke.
- Calculate speed in strokes per minute.
- Describe procedures for machining internal slots and keyways.

TASK: Perform Cutting-Off Operation

Level III

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

ENABLING OBJECTIVES:

- Explain how to calculate depths, speeds and feeds for slitting saws.
- Explain how to set up work pieces with kickers to cut precision lengths.
- Cut work pieces to precision lengths.

- Slot various shapes of work pieces.

TASK: Set Up and Perform Slab Mill Operations

Level III

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

ENABLING OBJECTIVES:

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

TASK: Use an Edge Finder and Wiggler

Level III

PERFORMANCE OBJECTIVE: Given a work piece and an edge finder or wiggler locate the center of the work piece to within + .001 inch.

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures.
- Explain the correct care and use of an edge finder or wiggler.
- Describe the procedures for touching off with an edge finder and a wiggler.
- Mark the center of a work piece after locating it with a wiggler or edge finder.

TASK: Use Digital Readouts

Level III

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

ENABLING OBJECTIVES:

- Explain the safety cutting precautions/procedures for drilling holes.
- Describe the procedures for using digital read out for accurate table positioning.
- Calculate the amount of table movement for each position.
- Describe the procedures for keeping backlash out of lead screws.
- Calculate the correct cutting speed and feed.
- Describe the procedures for drilling equally spaced holes.
- Identify the correct cutting fluids for drilling.
- Drill equally spaced holes in a work piece using digital read outs to locate centers.

TASK: Perform Straddle Milling Operations on the Horizontal Mill

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures.
- Explain the purpose of and applications for gang milling operations.
- Describe the procedures for mounting cutters and arbor in machine.
- Explain why a key is needed in the arbor.
- Calculate speed, feed, and depth of cut for gang milling operations.
- Describe the procedures for gang milling.

TASK: Set Up and Use a Sine Vise

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures.
- Describe the care and use of parallels.
- Describe the procedures for seating a part in a milling sine vise.
- Set up and seat a work piece in a sine vise.

CURRICULUM STANDARDS FOR PRECISION MACHINING
MODULE 9 - SURFACE GRINDING MACHINING

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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 9 - SETTING UP AND OPERATING SURFACE GRINDERS

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

Level III

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

ENABLING OBJECTIVES:

- Identify types of surface grinders.
- Identify major parts.
- Describe the function of major parts.

TASK: Comply with Safe and Efficient Work Practices

Level III

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:

- Explain the safety precautions/procedures for mounting grinding wheels.
- Explain how to determine if a wheel is cracked before mounting.
- Explain the importance of cleanliness when mounting a wheel.
- Explain the importance of the blotters on the wheel.
- Describe the procedure for determining how tight the flanges should be.

TASK: Clean, inspect, and lubricate surface grinding machine

Level III

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:

- Explain the safety precautions/procedures for cleaning, inspecting, and lubricating.
- Explain the reasons for performing routine cleaning, inspection, and lubrication.
- List the applications for lubricants used.
- Locate the lubrication points on the grinder using the manual.
- Describe the inspection procedures.
- Identify the materials and describe the procedures used for cleaning surface grinders.
- Lubricate a surface grinding machine.

TASK: Select the Proper Wheel

Level III

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:

- Explain the safety precautions/procedures for mounting grinding wheels.
- State type of grit, structure, grade, bond, and grit size for grinding the following materials:
    - Machine steel
    - Hardened tool steel
    - Carbide, d) cast iron
- Explain how to determine if a wheel is cracked before mounting.
- Explain the importance of cleanliness when mounting a wheel.
- Explain the importance of the blotters on the wheel.
- Explain the reasons for the manufacturer printing the operating wheel speed on grinding wheels.
- Explain the relevant safety precautions/procedures in regard to the diameter of the flanges in relationship to the diameter of the wheel.
- Describe the procedures for mounting and balancing a grinding wheel.
- Mount and balance a grinding wheel.

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

Level III

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:

- Explain the safety precautions/procedures for truing and dressing a grinding wheel.
- Identify the different types of wheel dresser.
- Determine the types of dresser to be used on different grinding wheels.

- Explain the reasons for truing and dressing grinding wheels.
- Describe procedures for truing, dressing, and balancing a grinding wheel.
- Explain the safety precautions/procedures for using a diamond wheel dresser.
- True and dress a grinding wheel using a diamond wheel dresser.

TASK: Attach and Align Work pieces for Grinding Operations

Level III

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:

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

TASK: Set Up and Grind Parallel Flat Surfaces

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for surface grinding flat surfaces.
- Describe the dressing procedures for grinding flat surfaces.
- Explain the reason for using a coolant.
- Describe the procedures for grinding flat surfaces.
- Identify the correct coolant.
- Discuss safe wheel mounting procedures.
- Grind parallel flat surfaces to required tolerances.

TASK: Set Up and Grind Four Sides Square

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for grinding square.
- Define square in relation to surface grinding.

- Describe the procedures for grinding square.
- Grind four sides of a work piece square.

TASK: Set Up and Use Angle Plates

Level III

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

ENABLING OBJECTIVES:

- Explain the safety precautions/procedures for grinding angular surfaces.
- Define the term "wringing" in relation to the use of gage blocks.
- Describe the correct care and use of gauge blocks.
- Describe the use of gauge blocks for setting up angles.
- Describe the correct care and use of angle vises and sine plates.
- Describe the procedures for grinding angular surfaces, using dressed angular wheels, angle vise, and sine plate.
- Grind angular surfaces on three work pieces to required tolerances.

TASK: Measure, inspect and rework work pieces on grinding machines

Level III

A PERFORMANCE OBJECTIVE: Given a grinder, flat work piece, outside micrometer, Vernier caliper, and surface plate, precision measure the work piece.

ENABLING OBJECTIVES:

- Explain correct drafting standards for dimensioning blueprints.
- Demonstrate the proper care, use, and calibration of precision measuring instruments.
- List accepted drafting abbreviations and/or symbols for the following terms:
    - outside diameter
    - inside diameter
    - threads per inch
    - inch
    - millimeter
    - counter-bore
    - depth
- Measure and grind a work piece to blueprint specification.

CURRICULUM STANDARDS FOR PRECISION MACHINING
MODULE 10 - COMPUTERIZED NUMERICAL CONTROL

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MODULE 10 - COMPUTERIZED NUMERICAL CONTROL

TASK: Perform Preventive Maintenance on NC/CNC Machines

Level III

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:

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

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

Level III

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

ENABLING OBJECTIVES:

- Select from a list, facts concerning numerical control.
- Label work areas of CNC Machines.
- Label major parts of CNC Machines.
- Select from a list, facts concerning the Cartesian coordinate System.
- Label the axes on a CNC Machine.
- Label coordinate points.

TASK: Identify and Select Proper Machine Controls

Level III

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 CNC machine.

ENABLING OBJECTIVES:

- Complete a CNC safety test.
- Match terms associated with machine and control power-up to their correct definitions.
- Identify controls and indicators used to power up, check, and shut down the machine.
- Match controls and indicators used to power up, check, and shut down the machine to their correct functions.
- State functions of mode select switch positions used to power up, check, and
- shut down the machine.
- Describe the types of programming used in a CNC Machine.
- Match letter addresses to their correct meanings.
- Match selected G codes to their correct functions.
- Match selected M codes to their correct functions.
- Identify types of CRT displays.
- State meanings of status display codes.
- Match alarm codes to their correct descriptions.
- Complete statements about the operation of the joystick/axes controls.
- Describe the purpose of emergency stops and power switches.
- Troubleshoot alarm indicators during power up.
- Demonstrate the ability to:
    - Power up, check, and shut down CNC Machines
    - Perform axes accuracy checks.

TASK: Write a Program and Apply Basic Programming Skills to a Turning Operation

Level III and/or a Milling Machine

PERFORMANCE OBJECTIVE: The TCCBTTS interns/apprentices 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:

- Match terms associated with writing a program to their correct definitions.
- State purpose of the program.
- Match program letters to their basic functions.
- Match G codes to their modes of operation.
- Match M codes to their functions.
- Modify blueprint dimensions to fit CNC Program Planning.
- Calculate axes values using absolute method.
- Calculate axes values using incremental method.
- Calculate axes values using tool radius compensation.
- Calculate I, J and K values.
- Write a lathe program for turning, contouring and threading.
- Write a mill program for drilling, milling and continuous path contouring.
- From a list select the steps to determine threading passes.
- From a list select the factors to consider when selecting tooling required for turning, milling, and drilling procedures.
- From a list select the guidelines for planning procedures.
- Calculate speeds and feeds.
- Arrange in order, steps in writing a program utilizing appropriate canned cycles.
- From a list select the steps in writing a program to set dwell.
- Plan procedure.
- Complete a setup sheet.
- Write a program to set dwell.

TASK: Select Proper Work Holders for a Production Run

Level III

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:

- Match terms associated with production runs to their correct definitions.
- Calculate efficiency.
- Calculate productivity.
- State guidelines to follow in monitoring tool life.
- From a list select the guidelines to follow when monitoring dimensional accuracy during a production run.
- Demonstrate the ability to perform production run to required efficiency and productivity standards.
- Monitor dimensional accuracy and change offsets as required.
- Monitor tool life and change tools as required.

TASK: Select Proper Cutting Tools

Level III

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

ENABLING OBJECTIVES:

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

TASK: Machine Parts to Blueprint Tolerances

Level III

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:

- Match terms associated with machining evaluation to their correct definitions.
- From a list select the items to check during a visual inspection of first run.
- Match blueprint symbols to their correct meanings.
- Match inspection equipment to their correct descriptions.
- From a list select the items to check during a dimensional inspection of first run.
- Identify three indications that program editing may be necessary.
- List actions to take for setup flaws.
- Compare finished part to blueprint.
- Calculate revised offset values.
- Determine required program and setup changes.
- Demonstrate the ability to:
    - Run first part.
    - Evaluate first run.
    - Edit program and change setup as required.
    - Run and evaluate second part.

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

Level III

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 AUCAM competency.
3. Post process a simple CMC program.