Precision Machining Technology

Purpose

To evaluate each contestant's preparation for employment and to recognize students for excellence and professionalism in the field of precision machining technology

Clothing Requirement

Official SkillsUSA khaki work shirt (or SLC T-shirt) and pants, black or brown leather work shoes, and safety glasses with side shields or goggles should be worn. (Prescription glasses can be used only if they are equipped with side shields. If not, they must be covered with goggles.)

Eligibility

This contest is open to active SkillsUSA members enrolled in programs with precision machining technology as the occupational objective.

Equipment and Materials

1. Supplied by the technical committee:

    a. All necessary machines, workholding devices and work-piece materials

    b. All necessary hand tools and precision measuring instruments needed by contestants and/or judges

    c. All necessary personal computers and software

    d. All necessary reference material, charts, and work instructions to be used by contestants and/or judges

2. Supplied by the contestant:

    a. Calculators are not required, but are allowed.

    b. All competitors must create a one-page résumé and submit a hard copy to the technical committee chair at orientation. Failure to do so will result in a 10 percent penalty.

    c. Contestants are not to bring any tools or reference materials to the contest.

    d. Contestant should bring all Personal Protective Equipment.

Scope of the Contest

The contest will be based on and consistent with the National Institute for Metalworking Skills (NIMS), Duties and Standards for Machining Skills, Levels I and II. Information on how to obtain these skill standards may be obtained directly from NIMS by calling 703-352- 4971, or online at https://www.nims-skills.org/. Competencies to be tested are determined by the SkillsUSA Virginia Championships Technical Committee.

Knowledge Performance

The contest will include written assessments that require the understanding of precision machining technology-related knowledge (theory). The technical committee could include any of subject matter from the contest standards and competencies that includes the words “demonstrate knowledge” in the written theory test.

Skills Performance

The contest will include a hands-on skill competition. Each contestant in the SLC is expected to demonstrate competency in manual machining performance skills. This includes applying fundamental computational skills; interpreting engineering drawings, technical data and other graphics; applying physical science principles; setup and operation of manual metalworking machines; industrial safety and hygiene requirements; use of a PC and keyboarding skills; using offline CNC programming software; and having the ability to program, set up, and operate basic CNC machines.

Contest Guidelines

1. It should be understood that some of the standards and competencies beginning with the statement “demonstrate knowledge” are also a normal part of the hands-on portion, such as reading engineering drawings and making calculations.

2. Each year, the technical committee will conduct an interview with each contestant as part of the contest.

3. Actual CNC machine setup and operation is not a requirement in the Precision Machining Technology competition. This section is covered in a separate NIMS Level II CNC contest area and is not part of precision machining technology.

Standards and Competencies

PMT 1.0 — Demonstrate machining-related computational competencies using both metric and U.S. customary units in accordance with related requirements identified in NIMS Machining Skills Level 1, KSAO Area 2: Mathematics

1.1 Apply basic arithmetic skills to solve problems

1.2 Apply functional algebra, geometry, and trigonometry to solve problems

1.3 Use formulas, handbook tables, charts, and technical reports to solve problems or make decisions

1.4 Chart, interpret, and explain statistical process control and inspection data

1.5 Calculate the correct amount of grind stock to be left on a part when doing roughing operations

1.6 Calculate center offsets for taper turning and compound slide settings for angle turning

PMT 2.0 — Demonstrate professional development competencies in accordance with related requirements identified in NIMS Machining Skills Level 1, Duty Area 7: Career Management and Employment Relations and in KSAO Area 4: Social Skills and Personal Qualities

2.1 In an interview situation, explain a technical issue related to precision machining technology, such as sequence of operations, one-piece vs. production setups; related non-machining operations such as heat treating, deburring, and material handling.

2.2 Analyze a specific machining-related problem and then make an oral report.

2.3 Respond to general questions that typically would be part of an employment-type interview.

2.4 Demonstrate poise, confidence, and knowledge of the subject, oral communication skills, and the ability to react to new situations and to make sound decisions in an interview situation.

2.5 From photographs, identify and explain the proper use or application of precision machining technology-related machinery or tooling.

2.6 From a list of modern precision machining technology-related terms, explain the meaning of each term and discuss the current application of each term.

PMT 3.0 — Demonstrate communication competencies in accordance with related requirements identified in NIMS Machining Skills 1, KSAO Area 1: Written and Oral Communication and KSAO Area 5: Engineering Drawing and Sketches

3.1 Using a SDS, determine and explain the steps to be taken related to the cleanup and reporting of a chemical spill in a typical machine shop situation.

3.2 Read, interpret, conceptualize, and be able to report (orally and on a handwritten note or paper document) common manufacturing processes related to precision machining and relate them to features of a part or an engineering drawing of a part.

3.3 Interpret single or multiple-page engineering drawings or sketches (inch or metric) to determine features to be machined.

3.4 Translate geometric tolerance symbols and other part specifications contained within feature control symbols used in machining and measurement (ASME Y14.5-1982).

3.5 Demonstrate knowledge and understanding of projection theory and other engineering drawing principles.

3.6 Produce an appropriate freehand orthographic, oblique, isometric, or perspective sketch of a part to be machined.

3.7 Write or letter legibly.

3.8 Enter, retrieve, update, change, or analyze computer-stored data related to machining or inspection.

3.9 Orally explain machining procedures and/or practices.

PMT 4.0 — Use knowledge of physical science in precision machining situations in accordance with related requirements identified in NIMS Machining Skills Level 1, KSAO Area 7: Metal Working Theory

4.1 Demonstrate knowledge of principles of mechanics, machines, heat, light, sound, and other forms of energy in relation to cutting and workholding tooling used in both manual and CNC machining.

4.2 Describe the physical and/or metallurgical characteristics of cast irons, steels, nonferrous metals, composites, plastics, and other materials that could be machined.

4.3 Discuss the effects of heat-treating and coating processes on materials used for work pieces and/or cutting tools.

4.4 Explain the process by which carbide and/or ceramic cutting tool inserts are made.

4.5 Read and use machinability tables to determine the effect the work-piece material has on such things as cutting speed, feed rate, depth of cut, cutter selection, tool wear, and surface finish.

PMT 5.0 — Demonstrate safety and hygiene competencies in accordance with related requirements identified in NIMS Machining Skills Level 1, Duty Area 6: Industrial Safety and Environmental Protection and in KSAO Area 4: Social Skills and Personal Qualities

5.1 Understand and practice safe operation of the machines now being used.

5.2 Define and demonstrate an understanding of safety codes and rules used to safeguard self, other workers, and the equipment and tooling.

5.3 Apply good hygiene in the use of cutting fluids and/or other chemicals typically used for machining.

5.4 Read, understand and follow a safety data sheet (SDS).

5.5 Demonstrate safe work habits when performing any of the machining, bench work, material handling, or measurement competencies listed for this precision machining competition.

PMT 6.0 — Perform competencies related to manual turning (lathe) operation in accordance with related requirements identified in NIMS Machining Skills Level 1, Duty Area 2: Job Execution

6.1 Set up machine for single- or multiple-part production, which includes setting machine stops, proper speeds, feeds, and depth of cuts for the material to be machined and the type of cutting tools available.

6.2 From the cutting tools available (e.g., HSS, cast alloys, or carbide), select the best tool for the operation and mount it properly.

6.3 Perform basic turning operations: work between centers, three- or four-jaw chuck work, collet work, center drilling, straight turning, shoulder and end facing, chamfering, radius turning, grooving, cutting off, drilling, boring, reaming, taper and angle turning, roughing (leaving grind stock) and finishing, knurling, filing and polishing, and internal and external thread chasing.

6.4 Demonstrate the ability to hold inch/or metric dimensional, geometric, and surface finish tolerance requirements.

6.5 Identify and discuss the application of other types of lathes and the advantages of each.

PMT 7.0 — Perform competencies related to manual milling machine operation in accordance with related requirements identified in NIMS Machining Skills Level 1, Duty Area 2: Job Execution

7.1 Set up machine for single- or multiple-part production, which includes setting machine stops, calculating proper cubic feet-per-minute, chip load, depth of cut, speeds, and feeds for the material being machined, and the type of cutters available.

7.2 Select the proper work-holding device and set it up correctly to withstand the cutting forces present.

7.3 Make table setups, using straps and clamps, vise setups, V-block setups and indexing devices.

7.4 Select the proper cutting-tool holding device; mount it properly; determine correct direction of rotation; determine when a cutter is dull; be able to change inserts and chip breakers.

7.5 Perform basic milling operations that include plain, face, end, side, form, angle, grooving, keyway/keyseat, and cutoff.

7.6 Set up and use a dividing head and/or rotary table.

7.7 Tram in the machine head, milling vise, or other work-holding devices.

7.8 Demonstrate knowledge of cutter types, styles, and materials.

PMT 8.0 — Perform competencies related to manual drill press operation in accordance with related requirements identified in NIMS Machining Skills Level 1, Duty Area 2: Job Execution

8.1 Prepare machine and select proper RPM for the cutting tool being used.

8.2 Select and safely mount work-holding device.

8.3 Mount work piece in work-holding device.

8.4 Select the proper cutting tool for the job.

8.5 Perform drilling, counter-sinking, counter-boring, spot-facing, reaming, and tapping operations.

8.6 Demonstrate knowledge of drill press classifications and their applications.

8.7 Demonstrate knowledge of common drill press cutting-tool types and applications.

8.8 Demonstrate knowledge of common drill press work-holding devices and their applications.

PMT 9.0 — Perform competencies related to manual grinding machine operation in accordance with related requirements identified in NIMS Machining Skills Level 1, Duty Area 2: Job Execution

9.1 Demonstrate knowledge of surface, cylindrical, center-less, and internal grinding machines and their applications.

9.2 Set up and operate a manual, horizontal, reciprocating surface grinder.

9.3 Perform surface-grinding operations to produce flat, parallel, stepped, and angled surfaces.

9.4 Use a permanent magnet chuck (table) on a surface grinder.

9.5 Determine proper in-feed, work speed, and cross-feed speed.

9.6 Dress the wheel.

9.7 Demonstrate knowledge of grinding-wheel characteristics, construction, standards, and selection including wheel markings, wheel shapes, proper storage for wheels, and grinding wheel inspection methods.

9.8 Demonstrate knowledge of cutting fluids used in grinding operations.

9.9 Demonstrate knowledge of super-abrasive technology and applications.

9.10 Obtain and hold surface-finish tolerances.

9.11 Obtain and hold close-inch or metric dimensional tolerances.

PMT 10.0 — Perform competencies related to bench and hand tool use in accordance with related requirements identified in NIMS Machining Skills Level 1, Duty Area 2: Job Execution

10.1 Use layout hand tools (in conjunction with the measuring tool competencies listed in the next section), including coating materials, surface plates, V-blocks, scribers, dividers, trammels, keyset rules, hermaphrodite calipers, angle plates, surface gage, and prick and center punches.

10.2 Find the center of a square, cylindrical, or rectangular work piece; lay out bolt circles and hole locations; lay out features to be produced.

10.3 Properly use hammers, screwdrivers, files, chisels, wrenches, hand taps and tap wrenches, threading dies, hand reamers, hand hacksaws, blade applications, and a bench vise.

10.4 Deburr work pieces after machining or hand operations.

10.5 Hand letter or number stamp parts.

PMT 11.0 — Demonstrate the ability to use process control and measurement in accordance with related requirements identified in NIMS Machining Skills Level 1, Duty Area 3: Quality Control and Inspection

11.1 Using current industrial engineering drawings and work pieces, make precision measurements for specific features.

11.2 Select and use the proper measuring device (U.S. customary or metric) for the feature to be measured.

11.3 Explain the reason for using calibrated measuring tools.

11.4 Make the appropriate calculations to set up the measuring device or to mathematically determine location of part features.

11.5 Demonstrate knowledge of and be able to select, assemble, and disassemble gauge black sets using the least block method.

11.6 Demonstrate knowledge of and ability to measure surface finishes.

11.7 Be able to effectively use common precision-machining measuring tools (U.S. customary or metric) such as steel rulers, combination square sets, depth gages, spring calipers, outside/inside/depth micrometers, Vernier/dial/digital calipers, Vernier/digital height gauge, protractor, mechanical/electronic indicators, go/no-go gauges, comparators, surface plates, angle plates, parallel blocks, inspection centers, sine bars/plates, and profilometer/surface finish comparison devices.

11.8 Physically measure for parallelism, squareness, roundness, concentricity, axial run-out, flatness, hole location and size, angles, tapers, threads, and linear.

11.9 Identify which manufacturing processes are capable of producing specific surface finishes economically.

11.10 Demonstrate knowledge of the general classes of fits.

11.11 Demonstrate knowledge of statistical process control (SPC) terminology

PMT 12.0 — Demonstrate knowledge of power sawing processes

12.1 Demonstrate knowledge of power-, hack-, and band-sawing processes including machine types and applications, work-holding accessories, basic setup considerations, blade/band selection, and special safety precautions.

PMT 13.0 — Demonstrate knowledge of machinability

13.1 Identify and explain the components that boost machine performance and cut costs.

13.1.1 Use of optimum speeds and feeds when machining

13.1.2 Selection of the best cutting tool for the material being machined

13.1.3 Selection of proper cutting tool geometry related to horsepower of machine and the material being machined

13.1.4 Capability of the machine to the tolerance required

13.1.5 Selection of the most suitable measuring tool for the tolerance specified

13.1.6 Testing for and maintaining machine geometries to manufacturer specifications

13.1.7 Awareness of new or emerging precision-machining technologies

13.2 Discuss the variables that could cause machining problems such as tool/work overhang, tool grade/geometry, machine condition/power, cutting fluid, shape of work, chip breakers, or material hardness.

13.3 Discuss what chip shape and color can tell you about optimum cutting.

13.4 Discuss the relative machinability of steels.

PMT 14.0 — Perform competencies related to CNC milling programming in accordance with related requirements identified in NIMS Machining Skills Level 1, Duty Area 2: Job Execution

14.1 Identify machine capabilities to determine proper speeds, feeds, and depths of cuts for the cutting tools available and the material being machined.

14.2 Complete the operational sequence required for machining linear- and circular-interpolation profiles.

14.3 Use standard-preparatory and miscellaneous-function codes for straight line moves in the X, Y and Z axis.

14.4 Use G02 and G03 codes for arcs and circles.

14.5 Write a CNC program to machine a simple part using offline-programming software on a personal computer.

14.6 Verify the CNC program using graphic verification with offline programming on a personal computer.

14.7 Demonstrate knowledge of types of CNC machines including machining centers, axes designations, advantages of CNC,.CAD/CAM, work-holding systems, and cutting tools used with CNC machining.

PMT 15.0 — Perform competencies related to CNC turning (lathe) programming in accordance with related requirements identified in NIMS Machining Skills Level 1, Duty Area 2: Job Execution.

15.1 Identify machine capabilities to determine proper speeds, feeds, and depths of cuts for the cutting tools available and the material being machined.

15.2 Complete the operational sequence required for machining cylindrical parts.

15.3 Use standard-preparatory and miscellaneous-function codes for straight line moves in the X and Z axes.

15.4 Use G02 and G03 codes for arcs and contours, and macro code for the incremental feed command on a fixed cycle.

15.5 Write a CNC program to machine a simple part using offline-programming software on a personal computer.

15.6 Verify the CNC program using graphic verification with offline-programming software on a personal computer.

PMT 16.0 — Demonstrate knowledge of flexible manufacturing systems and new technologies.

16.1 Describe and explain trends and new manufacturing technologies that relate to precision machining such as CAD/CADD, CAE, CIM/CAM, CIM/GEN, PLCs, computer-communication networks, and information exchange, the Internet's influence, high-speed machining, LBM (lasers beam machining), water jets, EDM (electrical discharge machining), robots in production, rapid prototyping, net-shape/ near-shape technologies, just-in-time (JIT), and automated inspection/measurement.