



PRECISION MACHINING (WASHINGTON STATE ONLY CONTEST)

Rev 4 - 11/27/2023



PURPOSE

The precision machining competition evaluates each competitor's skills to independently plan/complete manual machining projects, and demonstrate associated skills/knowledge in print reading, measurement, quality evaluation, machining knowledge, and professional behavior.

CLOTHING REQUIREMENT

Class C: Competition Specific — Manufacturing/Construction Khaki Attire

- Official SkillsUSA khaki short-sleeve work shirt or light blue/light brown short-sleeve collared shirt
- Khaki pants or blue jeans (no tears, no fades)
- Black, brown, or tan work shoes

These regulations refer to clothing items pictured and described at www.skillsusastore.org. If you have questions about clothing or other logo items, call 1-888-501-2183.

Notes:

- Competitors must always wear their competition clothing including at the competition, orientation, and awards ceremony.
- Competitors must wear safety glasses or goggles with Z87.1 rating. Safety glasses must include side shields. (Prescription glasses are acceptable if Z81.1 rated and have side shields. Competitors can wear approved safety glasses or goggles over unrated prescription glasses.)
- Long hair must be tied back. No jewelry or loose clothing allowed. This includes rings, bracelets, neck chains, key chains, etc.

ELIGIBILITY

Open to active SkillsUSA members enrolled in programs with manual machining, precision machining, or CNC as an occupational objective. Competitors in Precision Machining must have manual machining experience on a mill and a metal lathe. The competition is open to high-school and college/postsecondary competitors.

EQUIPMENT AND MATERIALS

Equipment/Materials Provided:

- **Lathe/Tools/Materials Provided:**
 - Engine lathe with a DRO, three jaw chuck, CXA tool post, gearbox set for 10 TPI
 - Cutoff Tool (HSS or carbide)
 - Carbide external thread cutting tool
 - CAX quick change adapters for $\frac{1}{2}$ to $\frac{5}{8}$ in toolholders
 - Dial indicator with adjustable magnetic base (for manual thread depth)
 - $\frac{3}{4}$ x 10 UNC Nut (Class 2)
 - Cooling/cutting fluid/spray
 - Mild Steel Machining Blank Cut to Length
- **Lathe Tools to Bring (label with school name - one set per competitor)**
 - 6-inch Calipers
 - Vernier Micrometers
 - 6" Machinists Scale
 - Center Drill Set
 - $\frac{1}{8}$ drill bits (HSS, CO, or CHSS)
 - $\frac{1}{4}$ drill bits (HSS, CO, or CHSS)
 - Carbide Insert for turning OD/facing with RH Tool Holder ($\frac{1}{2}$ to $\frac{5}{8}$ inch square tool holder)
 - Threading Tool/Centering Gage
 - US Customary and Metric Allen Wrench set
- **Mill /Tools/Materials Provided:**
 - Mill: Bridgeport style knee mill with DRO, power feed, ball lead screws, R8 collet
 - R8 Collets ($\frac{1}{2}$, $\frac{3}{8}$, $\frac{1}{4}$ " diameter)
 - Parallels
 - Dead Blow Hammer
 - Cooling/cutting fluid/spray
 - Aluminum Machining Blank Cut to Size
- **Mill Tools to Bring (label with school name – need one set per competitor)**
 - Edge finder
 - $\frac{1}{2}$ in end mill (carbide)
 - $\frac{3}{8}$ in end mill (carbide)
 - $\frac{1}{4}$ in end mill (carbide)
 - $\frac{1}{8}$ drill bits (HSS, CO, or CHSS)
 - $\frac{1}{4}$ drill bits (HSS, CO, or CHSS)
 - 90-degree chamfer tool ($\frac{1}{2}$ diameter minimum)

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- Measurement Tools Provided:
 - Surface plate
 - Height Gauge with Test Indicator
 - 1-2-3 blocks (2x)
 - Pin gauge set (to 0.2500)
 - Surface Finish Scale/Comparator
- Measurement Tools to Bring (label with school name – need one set per competitor)
 - Digital or Dial Calipers
 - Vernier Micrometers
 - Telescoping Bore Transfer Gauge Set
 - Pitch Gauges
 - Machinist Handbook or other reference materials

Resume Requirement

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

PROHIBITED DEVICES

Cellphones, electronic watches and/or other electronic devices not approved by a competition's technical committee are NOT allowed in the competition area. Technical committee members may also approve exceptions onsite during the SkillsUSA Championships if deemed appropriate.

Penalties for Prohibited Devices

If a competitor's electronic device makes noise or if the competitor uses it at any time during the competition, the judges will disqualify the competitor.

SCOPE OF THE COMPETITION

KNOWLEDGE PERFORMANCE

The competition will include a written test to evaluate a competitor's knowledge of Precision Manual Machining in such areas as: shop safety, manual shop machine operation/maintenance, materials, measurement tools/equipment, manufacturing mathematics, engineering drawings, quality evaluation, tolerancing, machining technologies, and cutting tool/holder technologies.

SKILL PERFORMANCE

The skill portion of the competition will be a rotation through a series of three stations where each contestant will use a provided engineering drawing to make a part on a manual mill, make a part on a lathe, and evaluate the quality of part. The contestant will also examine and identify different metal samples at the part quality evaluation station.

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COMPETITION GUIDELINES

1. Competitors will use a blind draw to divide into rotation groups.
2. Lathe Competitors will use an engineering drawing and a steel rod blank to produce a part. Competitors will have 90 minutes to demonstrate the following skills:
 - a. Lathe safety
 - b. Engineering drawing reading/interpretation
 - c. Planning/execution of lathe order of operation/sequence
 - d. Lathe tool set up (tool height, tool angle,)
 - e. Compound slide/tool post initial position
 - f. Work holding (length to diameter ratio with/without tailstock and live center)
 - g. In process measurement (DRO/Scales/Micrometer Wheels/Calipers/Micrometers/Thread Pitch Gauges)
 - h. Turn OD/steps/taper
 - i. Drilling
 - j. Threading/relief
 - k. Chamfer
 - l. Deburr and mark part with their competitor number
 - m. Competitors must turn in their part after 90 minutes at this station.
3. Mill Competitors will use an engineering drawing and a squared aluminum blank to produce a part. Competitors will have 90 minutes to demonstrate the following skills:
 - a. Mill safety
 - b. Engineering drawing reading/interpretation
 - c. Planning/execution of milling order of operation/sequence
 - d. Mill tool set up (tool height, tool angle)
 - e. Work holding (clamp area, parallel surfaces)
 - f. In process measurement (DRO/Scales/Micrometer Wheels/Calipers/Micrometers)
 - g. Face/mill slots, mill pockets
 - h. Drill/Counterbore/Counter Sink
 - i. Chamfer edge
 - j. Deburr and mark part with their competitor number
 - k. Competitors must turn in their part after 90 minutes at this station.
4. The Quality Evaluation, Knowledge Test, and Material ID Tasks are combined into a 90-minute rotation
 - a. Part Quality Evaluation (20 minutes): Competitors will use a part and an engineering drawing to demonstrate the following skills:
 1. Engineering drawing reading/interpretation
 2. Tolerance interpretations and limits calculation
 3. GD&T interpretation and calculations
 4. Measuring using calipers and Vernier Micrometers
 5. Surface finish interpretation
 6. Feature identification
 7. Comparison of feature types, feature sizes/locations (dimensions) to specifications
 8. Competitors will submit a quality evaluation sheet after 20 minutes at this station.

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- b. Machining Basics Quiz (40 minutes): Competitors will take a written machining test comprised of forty multiple choice and short answer questions which may include the following areas:
 - 1. Calculation of machining cutting speeds on the drill press, mill, or lathe.
 - 2. Engineering drawing vocabulary: lines, views, tables, and blocks.
 - 3. Determining fit by calculating Allowance and Maximum Clearance using MMC/LMC.
 - 4. Shop safety including interpreting an SDS.
 - 5. Demonstrate knowledge of Unified National and SI (Metric) thread standards.
 - 6. Demonstrate knowledge of US Customary and SI (Metric) drill bit size standards.
 - 7. Demonstrate knowledge of mill, lathe, and drill bit materials including basic coatings/plating.
 - 8. Demonstrate knowledge of basic mill and lathe maintenance and set up.
 - 9. Competitors will submit the written test after 40 minutes at this station.
 - c. Material Identification (15 minutes): Competitors will use samples of various machinable materials to demonstrate the ability to identify the following:
 - 1. aluminum, mild steel, stainless steel, titanium, magnesium, brass, copper, bronze, acrylic, nylon, and polyethylene
 - 2. Competitors will submit a material identification sheet after 15 minutes at this station.
5. Judging and Scoring:
- a. A competitor's overall score will include mill, lathe, measurement, and materials identification skills task scores along with the knowledge based written test score.
 - b. Each of the three rotations are weighted equally.
 - c. The tie breaker will be the SkillsUSA Professional Test Score. If needed, the second tie breaker will be milled part face surface finish.
 - d. Mill and lathe projects will be scored one point for each feature within specification except for manually turned threads. Threads will earn four points, one for OD, one for pitch, and two points if the supplied nut screws on all the way.
 - e. The Materials test identification will score one point per correct answer.
 - f. The Written Test will be scored at one point for each correct answer.
 - g. The Measurement Test will be scored as one point for each correct answer. Depending on the technology, a range around the nominal answer will count as correct. Machinist's Scale: +/- 1/16 and 1 mm, Calipers: +/- .005 inches, Digital Height Gage with Test Indicator Probe: +/- .001 inches, Vernier Micrometers: +/- .0005 inches.
 - h. Scoring will be completed by a team of industry experts and the competitor's advisors following the competition.

STANDARDS AND COMPETENCIES

1.0 APPLY INDUSTRY SAFETY STANDARDS FOR MANUAL MACHINING

- 1.1 Properly use Personal Protective Equipment (PPE) appropriate for machining environment
- 1.2 Interpret basic Safety Data Sheet (SDS) information
- 1.3 Follow shop safety rules (appropriate clothing/jewelry/hairstyle, PPE, and accepted behavior)

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2.0 APPLY PRINT READING KNOWLEDGE AND SKILLS

- 2.1 Interpret and use technical drawings to plan, machine, and perform quality evaluation including application of basic tolerancing and GD&T methods
- 2.2 Identify shapes, geometric terms, and constructions, multiview drawings, section views, auxiliary views, hole/screw thread callouts, and screw thread representations
- 2.3 Identify fundamentals of part features including size, location, surface finish using dimensions/callouts/notes/drawing tables/drawing blocks

4.0 APPLY PRECISION AND SEMI-PRECISION MEASUREMENT

- 4.1 Use and handling of precision measurement tools (e.g., gage blocks, calipers, micrometers, dial/test indicators, and height gages)
- 4.2 Use semi-precision measurement tools (e.g., machinist's rule, combination sets, protractors, and scales)
- 4.3 Perform manufacturing/machining math (e.g., fractional operations, fractional/decimal conversion, ratios and proportions, English/metric conversions, basic geometry, angles, Cartesian coordinates, and basic trigonometry)
- 4.4 Recognize and apply ISO and ANSI/ASME drawing standards to interpret technical drawings

5.0 DISTINGUISH AMONG TYPES OF MATERIALS

- 5.1 Identify different basic ferrous and nonferrous materials (mild steel, SST, aluminum, titanium, brass, copper)
- 5.2 Demonstrate basic knowledge of materials classifications (Steel - SAE/AISI, Aluminum – TCPS/ANSI)
- 5.3 Demonstrate basic knowledge of steel heat treatment processes and metal properties

6.0 DESIGN AND APPLY A JOB PROCESS INCLUDING BENCHWORK, LAYOUT, AND MACHINING

- 6.1 Perform basic layout process and procedures including mathematical calculations using semi-precision, precision layout tools and manual machining controls (i.e., material selection, tool selection, machining sequence, use of drill and tap charts, use of micrometer wheels, DRO, etc.)
- 6.2 Demonstrate proper tool use and related safety precautions (i.e., hand drill, drill press, hammers, files, deburring tools, etc.)
- 6.3 Demonstrate safe operation of saws, cutoff machines, and drill press (PPE, securing workpieces, operation, and cleanup/housekeeping rules)
- 6.4 Explain the uses of offhand grinding and related safety precautions
- 6.5 Identify major components of a drill press and their functions
- 6.6 Demonstrate drilling, reaming, threading, and tapping operations
- 6.7 Demonstrate proper and appropriate deburring processes
- 6.8 Apply proper tool holding, work holding, and machine setup

7.0 APPLY ROUTINE MACHINE MAINTENANCE PER REQUIREMENTS

- 7.1 Know basic routine maintenance and setup tasks for manual mill (lubrication, inspection points, cutting fluids, alignment processes, squaring a vise, and trammig the head)
- 7.2 Know basic routine maintenance and setup tasks for manual lathe (lubrication, inspection points, cutting fluids, alignment processes, dialing in chuck, selecting/changing thread pitch gears)