

# CNC 5-AXIS MILLING PROGRAMMER (DEMO)



## PURPOSE

The purpose of this contest is to evaluate each contestant can independently plan and program jobs and provide instructions for 5-Axis Computer Numerical Control milling machine operators to execute. In addition, to recognize outstanding students for excellence and professionalism.

First, download and review the General Regulations at: <http://updates.skillsusa.org>.

## ELIGIBILITY

Open to active SkillsUSA members enrolled in programs with precision machining, automated manufacturing or CNC as the occupational objective.

## CLOTHING REQUIREMENT

### Class C: Contest Specific — Manufacturing/Construction Khaki Attire

- Official SkillsUSA khaki short-sleeve work shirt and pants.
- Black, brown or tan leather work shoes.

**Note:** Safety glasses must have side shields or goggles (prescription glasses may be used only if they are equipped with side shields. If not, they must be covered with goggles).

These regulations refer to clothing items that are pictured and described at: [www.skillsusastore.org](http://www.skillsusastore.org). If you have questions about clothing or other logo items, call 1-888-501-2183.

**Note:** Contestants must wear their official contest clothing to the contest orientation meeting.

## EQUIPMENT AND MATERIALS

1. Supplied by the technical committee:
  - a. Computer with pre-installed CAD/CAM software
  - b. Scientific calculator
  - c. Machinery's Handbook
  - d. Pencils and paper
2. Supplied by the contestant:
  - a. Contestants who choose to use CAD/CAM software outside of what is supplied by the technical committee must bring their own computer and CAD/CAM software.
  - b. All contestants 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-point penalty.

**Note:** Your contest may also require a hard copy of your résumé as part of the actual contest. Check the Contest Guidelines and/or the updates page on the SkillsUSA website: <http://updates.skillsusa.org>.

## SCOPE OF THE CONTEST

### Knowledge Performance

The contest will include a written test to evaluate a contestant's knowledge of Computer Numerical Control milling programming in such areas as: safety, materials, measuring and test equipment, applied mathematics, engineering drawings, geometric dimensioning and tolerancing, machine technologies, controls, navigation and maintenance, mechanical design, cutting tool and holder technologies, computer operations and software technologies.

### SKILL PERFORMANCE

This contest will assess the ability to write CNC milling programs, interpret prints (including GDT), and measure/gauge parts. Participants also will demonstrate theoretical knowledge of CNC machine configuration, setup and operations.

### Contest Guidelines

1. Each contestant will be provided with the following technical documents to program a part using CAM software:

- a. Programming instructions
  - b. Dimensional drawing and/or digital product definition data set
  - c. Solid models
  - d. Resource list (available CNC machine, part material, cutting tools, holders, and withholding devices)
2. Programming
- a. Document process plans
  - b. Create and/or modify solid models
  - c. Align and position models in CAM programming environment
  - d. Create 3+2 and synchronized 5-axis toolpaths
  - e. Simulate program in virtual machine environment
  - f. Post process NC program file(s)
  - g. Create technical documentation
3. Contestant submits:
- a. Process plan
  - b. NC program file(s)
  - c. Tool list(s)
  - d. Setup sheet(s)
4. Technical committee:
- a. Evaluates documents for required elements
  - b. Runs and scores the part using a simulation software
  - c. May run program on machine if simulation runs without safety violations, errors or crashes
5. Contestant measure sample parts
6. Contestant demonstrates ability to navigate CNC machine control to perform functions
7. An overview of a CNC machine will be available for orientation before the competition with technicians on hand to help contestants familiarize themselves with the interface.

- 1.2.3 With one or more features requiring synchronized 5-axis milling
- 1.3 Select:
- 1.3.1 Machine tools
  - 1.3.2 Workholding devices and accessories
  - 1.3.3 Cutting tools and holders
- 1.4 Determine:
- 1.4.1 Extension out of holders (EOH) and length of cut (LOC)
  - 1.4.2 Speeds and feeds

#### **AMP 2.0 — Modeling: Create and/or modify solid models**

##### ***Practical***

- 2.1 Create solid models
- 2.2 Modify existing solid models

##### ***Critical Thinking***

- 2.3 Verify models

#### **AMP 3.0 — Assembly Modeling: Create solid model assemblies**

##### ***Practical***

- 3.1 Align and position models

##### ***Critical Thinking***

- 3.2 Verify assemblies

#### **AMP 4.0 — Toolpath Creation: Create toolpaths to mill parts**

##### ***Practical***

- 4.1 Create 3+2 and synchronized 5-axis toolpaths
- 4.2 Simulate in the CAM software:
  - 4.2.1 Parts and workholding devices
  - 4.2.2 Secondary operations with cut parts from prior operations
- 4.3 Post processing

##### ***Critical Thinking***

- 4.4 Avoid collisions and gouging
- 4.5 Position tool axis
- 4.6 Compare cut part against model

#### **AMP 5.0 — Program Verification: Verify programs in a virtual environment**

##### ***Practical***

- 5.1 Simulate program in virtual machine environments

##### ***Critical Thinking***

- 5.2 Analyze cut parts for gouges

## **Standards and Competencies**

### **AMP 1.0 — Process Planning: Formulate strategies to mill parts**

#### ***Practical***

- 1.1 Document process plans

#### ***Critical Thinking***

- 1.2 Process planning part(s):
  - 1.2.1 Require one or multiple operations
  - 1.2.2 With several features requiring 3+2 axis milling

- 5.3 Compare cut part against model
- 5.4 Determine potential machine collisions

**AMP 6.0 — Documentation: Create technical documents required to communicate instructions required for machine operators to execute programs**

**Practical**

- 6.1 Create technical documents

**Critical Thinking**

- 6.2 Evaluate documents to ensure content and format clearly communicate instructions

*Source:* NIMS CNC 5-axis Programmer Standards. For more information, visit: <https://www.nims-skills.org/machining-smart>.

**Committee Identified Academic Skills**

The technical committee has identified that the following academic skills are embedded in this contest.

**Math Skills**

- Use fractions to solve practical problems
- Simplify numerical expressions
- Apply Pythagorean Theorem
- Solve problems using proportions, formulas, and functions
- Solve problems using trigonometry
- Solve problems using Cartesian coordinate system

**Science Skills**

None Identified

**Language Arts Skills**

None Identified

**Connections to National Standards**

State-level academic curriculum specialists identified the following connections to national academic standards.

**Math Standards**

- Numbers and operations.
- Algebra.
- Geometry.
- Measurement.

- Problem solving.
- Reasoning and proof.
- Communication.
- Connections.
- Representation.

*Source:* NCTM Principles and Standards for School Mathematics. For more information, visit: <http://www.nctm.org>.

**Science Standards**

- Understands the sources and properties of energy
- Understands forces and motion
- Understands the nature of scientific inquiry

*Source:* McREL compendium of national science standards. To view and search the compendium, visit: [www2.mcrel.org/compendium/browse.asp](http://www2.mcrel.org/compendium/browse.asp).

**Language Arts Standards**

- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge
- Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion and the exchange of information)

*Source:* IRA/NCTE Standards for the English Language Arts. To view the standards, visit: [www.ncte.org/standards](http://www.ncte.org/standards).