

## Robotics and Automation Blueprint

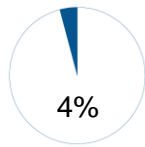
This Blueprint contains the subject matter content for the Career Essentials - Assessment.

**Note:** To fully prepare for the [Robotics and Animation](#) SkillsUSA Championships contest, refer to the current year's SkillsUSA Championships Technical Standard, now included with your SkillsUSA Professional Membership. If you need help in accessing this benefit, contact the SkillsUSA Customer Care Team at 844-875-4557 or [customercare@skillsusa.org](mailto:customercare@skillsusa.org)

### Standards and Competencies

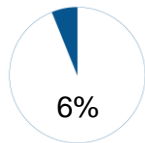
Competencies are weighted throughout the assessment. The percent shown is the weight of the competency. There are 50 questions per assessment.

#### Demonstrate knowledge of general safety rules and practices.



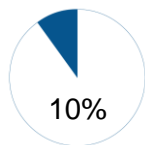
- Keep your work area clean and safe.
- Describe response procedures for different emergency situations.
  - Demonstrate basic first aid.
- Utilize appropriate safety apparel for the task being performed.
  - Wear appropriate safety goggles, hard hats, work boots, etc., for a given situation.
- Identify and demonstrate safe use of hand tools.

#### Demonstrate knowledge of safety rules and practices when working with electrical equipment.



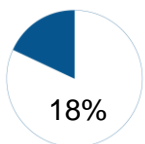
- Exercise caution when working near energized lines.
  - Demonstrate proper use of lockout/tagout.
- Understand and demonstrate proper usage of circuit protection devices, such as fuses, circuit breakers, and ground fault circuit interrupters.
  - Understand the importance of grounding.

#### Demonstrate knowledge of safety rules and practices specific to a robotic workcell as defined in the Automation Safety Requirements of the ANSI/RIA R15.06 1999 Standards.



- Demonstrate proper use of emergency stop buttons.
- Follow safety rules during installation and layout of a robotic workcell.
- Prevent accidents in the robotic workcell.
  - Prevent impact or collision accidents, such as unpredicted movements, component malfunctions, or unpredicted program changes related to the robot's arm or peripheral equipment.
  - Prevent crushing and trapping accidents.
  - Prevent mechanical part accidents, such as the breakdown of the robot's drive components, tooling or end-effector, peripheral equipment, or its power source.
- Demonstrate proper teach pendant safety.
  - Demonstrate understanding of working in Teach mode.
  - Demonstrate proper usage of the Deadman switch.

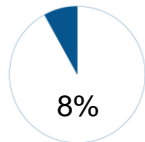
#### Demonstrate an understanding of basic robotic systems.



- Identify the components of a robotic system, including the manipulator, end effector, teach pendant and controller.
- Identify the joints of a robotic arm.
- Define different methods to power a robot joint, such as hydraulic, AC or DC power.
- Define work envelope.
- Define the term "degree of freedom" and explain how it affects types of joints.
- Demonstrate the use of gears in robots.
  - Demonstrate the use of harmonic drives in robots.
- Demonstrate the use of incremental and absolute encoders.
- Demonstrate the use of closed loop control in robotic systems.

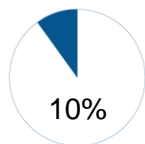
- Explain how Proportional Integral Derivative (PID) control is used in robotic systems.
- Demonstrate an understanding of when, why and how a robot should be homed.
- Explain how robot positions are defined.
  - Define the term Tool Center Point (TCP) and its importance to robotic positioning.
  - Define and differentiate between joint coordinate systems and Cartesian coordinate systems.
- Define a pick and place operation.

**Demonstrate an understanding of the function of and need for robot accessories.**



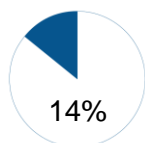
- Identify accessories that can extend the robot work envelope, such as a slidebase.
- Identify different types of end of arm effectors and their usage.
- Identify robot accessory devices that are used to transport materials, such as conveyors, rotary tables, XY tables, etc.

**Demonstrate an understanding of the use of a teach pendant.**



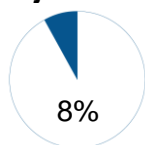
- Identify and differentiate between the available modes of operation, such as Teach and Auto.
- Identify factors that must be considered before moving a robot manually.
- Operate the open/close gripper function.
- Determine and select the movement type appropriate to an operation.
- Determine and select the appropriate speed for moving a robot.
- Determine and select the appropriate joint or axis upon which to move the robot.
- Record a position.
- Move the robot to a predefined position.

**Connect a robot such that it can communicate with its environment.**



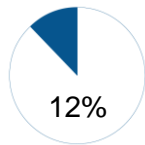
- Connect a robot controller to a PC, and verify its connection.
- Define serial communication and its use in a robot workcell.
- Understand and use digital inputs and outputs.
  - Identify and define the function of a digital input.
  - Identify and define the function of a digital output.
  - Calculate the load an output can support.
  - Define the terms sink and source.
  - Connect an external device to an output, such as a warning light, solenoid, relay or pneumatic actuator, and control it.
  - Connect an external device to an input, such as a contact or inductive proximity sensor, and monitor it.
  - Connect an external device to an output through an external relay, and control it.
- Explain the function of a mechanical relay.

**Design the layout of a workcell, ensuring that the cell operation is optimized with regards to its objectives.**



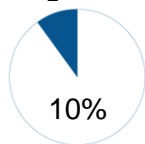
- Place devices in a workcell based on required functionality.
- Consider critical factors when designing the workcell, such as wiring, air, power, facilities and safety.
- Adhere to a design specification when physically setting up a workcell.
- Test the physical layout of the workcell as defined in the design specification, using the robot and peripheral devices.

**Work with positions in a robotic workcell.**



- Define different position types, such as joint, Cartesian and tool.
- Define and differentiate between different types of movement from one position to another - joint, linear and circular.
- Demonstrate an understanding of how, when and why to adjust speed when moving a robot.
- Teach a robot with a 2-finger gripper to grasp a part, taking into consideration the part's geometry.
- Demonstrate an understanding of absolute robot positions and when they should be used when planning the position scheme in a workcell.
- Demonstrate an understanding of relative robot positions and when they should be used when planning the position scheme in a workcell.
- Demonstrate an understanding of the use of intermediate and approach positions.
- Set a position scheme for the cell that achieves all objectives, and explain your considerations.
  - Document workcell positions.
  - Precisely record on and above positions for a part in a fixture.
  - Record and/or teach the positions defined in the position scheme.
  - Move the robot to each of the positions defined according to the sequence in the workcell layout, to ensure that all positions are precise and adequately meet the cell objectives.

**Program a robotic workcell.**



- Develop a flowchart that outlines a robotic program based on cell requirements.
- Develop a robotic program based on cell requirements.
- Use correct syntax of a given robotic programming language.
  - Define the relationship between the positions defined and their implementation in a program.
  - Use variables and constants in a robotic program.
  - Use comments/remarks in a robotic program.
  - Use counters and accumulators in a robotic program.
  - Use arithmetic operations and functions in a robotic program.
  - Use conditional statements and branches in a robotic program.
  - Program interfacing with input and output devices.
- Create a robotic program that communicates with an external device.
- Execute a dry-run of a robotic program.
- Debug a simple robotic program.
- Modify an existing robotic program.
- Run a robotic program.

**Demonstrate professional development skills in a simulated customer service or employment situation. Examples may include:**

- Job interview
- Customer service scenario
- Communications
- Decision making, problem solving and/or critical thinking



## **Committee Identified Academic Skills**

The SkillsUSA national technical committee has identified that the following academic skills are embedded in the robotics and automation technology training program and assessment:

### **Math Skills**

- Use fractions to solve practical problems
- Use proportions and ratios to solve practical problems
- Simplify numerical expressions
- Use scientific notation
- Solve practical problems involving percentages
- Solve single variable algebraic expressions
- Solve multiple variable algebraic expressions
- Measure angles
- Apply transformations (rotate or turn, reflect or flip, translate or slide and dilate or scale) to geometric figures
- Construct three-dimensional models
- Make comparisons, predictions and inferences using graphs and charts
- Organize and describe data using matrixes
- Solve problems using proportions, formulas and functions
- Use measures of interior and exterior angles of polygons to solve problems
- Find arc length and the area of a sector

### **Science Skills**

- Plan and conduct a scientific investigation
- Use knowledge of potential and kinetic energy
- Use knowledge of mechanical, chemical and electrical energy
- Use knowledge of heat, light and sound energy
- Use knowledge of temperature scales, heat and heat transfer
- Use knowledge of sound and technological applications of sound waves
- Use knowledge of the nature and technological applications of light
- Use knowledge of speed, velocity and acceleration
- Use knowledge of Newton's laws of motion
- Use knowledge of work, force, mechanical advantage, efficiency and power
- Use knowledge of simple machines, compound machines, powered vehicles, rockets and restraining devices
- Use knowledge of principles of electricity and magnetism
- Use knowledge of static electricity, current electricity and circuits
- Use knowledge of magnetic fields and electromagnets
- Use knowledge of motors and generators

### **Language Arts Skills**

- Provide information in conversations and in group discussions
- Provide information in oral presentations
- Demonstrate use of verbal communication skills, such as word choice, pitch, feeling, tone and voice
- Demonstrate use of nonverbal communication skills, such as eye contact, posture and gestures using interviewing techniques to gain information
- Analyze mass media messages
- Demonstrate comprehension of a variety of informational texts
- Use text structures to aid comprehension
- Identify words and phrases that signal an author's organizational pattern to aid comprehension
- Understand source, viewpoint and purpose of texts
- Organize and synthesize information for use in written and oral presentations
- Demonstrate knowledge of appropriate reference materials
- Use print, electronic databases and online resources to access information in books and articles



- Demonstrate narrative writing
- Demonstrate informational writing
- Edit writing for correct grammar, capitalization, punctuation, spelling, sentence structure and paragraphing

### **Connections to National Standards**

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

#### **Math Standards**

- Numbers and operations
- Algebra
- Measurement
- Problem solving
- Reasoning and proof
- Communication
- Connections
- Representation

**Source:** NCTM Principles and Standards for School Mathematics. To view high school standards, visit: <http://www.nctm.org/standards/content.aspx?id=16909>.

#### **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: [www.mcrel.org/standards-benchmarks/](http://www.mcrel.org/standards-benchmarks/).

#### **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.readwritethink.org/standards/index.html](http://www.readwritethink.org/standards/index.html).