2022-23 EDITION

SkillsUSA CHAMPIONSHIPS

ENGINEERING TECHNOLOGY/DESIGN

SkillsUSA Championships Technical Standards

PURPOSE

To recognize an outstanding engineering design project that has been developed by a three-member team of engineering or technology students. The student team will present its innovative idea along with a design board, a design prototype and an engineering notebook.

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

ELIGIBILITY (TEAM OF THREE)

Open to active SkillsUSA members enrolled in a career and technical education engineering program or a curriculum that integrates engineering/pre-engineering concepts and techniques as an integral component of the instructional strategies. Each state may send one high school and one college/postsecondary team.

CLOTHING REQUIREMENTS

Competitors may choose between either Class A or Class E clothing as described below.

Class A: SkillsUSA Official Attire

- Official SkillsUSA red blazer or official SkillsUSA red jacket
- Button-up, collared, white dress shirt (accompanied by a plain, solid black tie or SkillsUSA black tie), white shirt (collarless or small-collared) or white turtleneck, with any collar not to extend into the lapel area of the blazer, sweater, windbreaker or jacket
- Black dress slacks or black dress skirt (knee-length at minimum)
- Black dress shoes

Note: The official SkillsUSA windbreaker, sweater and black Carhartt jacket are no longer available for purchase in the SkillsUSA Store. However, these clothing items are grandfathered in as previous official SkillsUSA clothing and can be worn in SkillsUSA competitions as directed in this document.

Note: Wearing socks or hose is no longer required. If worn, socks must be black dress socks and hose must be either black or skin-tone and seamless/nonpattern.

Class E: Competition Specific — Business Casual

- Official SkillsUSA white polo shirt
- Black dress slacks or black dress skirt (knee-length minimum)
- Black closed-toe dress shoes

Note: Wearing socks or hose is no longer required. If worn, socks must be black dress socks and hose must be either black or skin-tone and seamless/nonpattern.

Note: Competitors must wear their official competition clothing to the competition orientation meeting.

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

EQUIPMENT AND MATERIALS

1. Supplied by the technical committee:
   a. A space for the design prototype and design board that is no bigger than 10'x10'
   b. One standard 120-volt electrical outlet
   c. One table
2. Supplied by the competitors team:
   a. Design prototype: The design prototype cannot be hazardous in any way. If the prototype is not conducive to being presented in an indoor facility, please notify the SkillsUSA headquarters in advance so other arrangements can be made. Design prototypes must be transported and set up in the competition area during the orientation meeting. No help will be provided by SkillsUSA.
   b. Design board
   c. Engineering notebook
   d. Industrial review of engineering design
   e. One laptop computer or tablet
   f. One 6' multiple-outlet surge protector
   g. All competitors must create a one-page resume. See “Resume Requirement” below for guidelines.

RESUME REQUIREMENT

Competitors must create a one-page resume to submit online. SkillsUSA national competitors should submit their resume by June 1. The link for resume submission will be published on http://updates.skillsusa.org on May 1. Failure to submit a resume will result in a 10-point penalty.

Your resume must be saved as a PDF file type using file name format of "Last Name_First Name." For example, "Amanda Smith" would save her resume as **Smith_Amanda**. If you need assistance with saving your file as a PDF, visit the Adobe website for more information.

***Note*:** Check the Competition Guidelines and/or the updates page on the SkillsUSA website at http://updates.skillsusa.org.

PROHIBITED DEVICES

Cell phones or other electronic devices not approved by a competition's national technical committee are ***NOT*** allowed in the competition area. Please follow the guidelines in each technical standard for approved exceptions. 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 is seen using it at any time during the competition, an official report will be documented for review by the SkillsUSA Championships director. If confirmed that the competitor used the device in a manner which compromised the integrity of the competition, the competitor's scores may be canceled.

OBSERVER RULE

No observers are permitted to enter the competition area during the first day of competition. Judging will continue on the second day of competition; however, teams are invited to repeat their presentation to the public when they are not being judged. Observers must avoid teams that are actively being judged and observers will be asked to leave if they are disruptive during the judging process.

SCOPE OF THE COMPETITION

The team consists of three students, all enrolled in the same educational institution during the current school year. Students may be members of only one team per competition year and may not compete in more than one competition at the national level.

The project must be designed and constructed by students who are enrolled (or were enrolled immediately preceding the National Leadership and Skills Conference) in an engineering program or career and technical education program. Projects shall not continue or be "reused" from year to year.

Each team will have one design storyboard explaining the new innovation that was collaboratively developed. This must represent the engineering process, detailing brainstorming efforts, schedule, prototypes, modeling, relevant industry regulations, restrictions and laws, safety considerations and manufacturability as is relevant to design. The design board may not be any larger than a 36"x56" tri-fold display. Digital media, such as digital picture frames, can be attached to the design board. The board must be a comprehensive representation of the team's design process.

The design prototype must be an accurate reflection of what is being claimed in the oral explanation and presentation.

Importance is placed on the oral presentation, which is a maximum of 10 minutes. Following the presentation there may be a question-and-answer session by the judging panel — not to exceed five minutes — to clarify any questions that arise during the presentation.

Each team is required to have an industrial review of its proposed engineering design. This review must be conducted by engineers, technicians or other technical professions within the design's respective industry.

Mentorship from the team's career and technical instructor, academic teachers, and representatives from the business and industry world, including engineers and industrial designers, is highly encouraged.

The panel of judges will consist of engineers, engineering educators and members from business and industry.

JUDGING CRITERIA

Each engineering presentation will be judged in according to its own merits and compliance with the listed criteria. Participants should read the guidelines carefully to ensure the project presentation covers all the criteria.

1. **Design Prototype**
   The design prototype is a working model that demonstrates the results of the team's research and how the team has put its research into action. The design prototype must accurately reflect the engineering design accomplishment referred to in the presentation. These criteria include virtual modeling, schematics, assembly drawings. materials selection, ergonomics, manufacturing analysis, construction and aesthetics. Students should be able to answer questions about their prototype and its development process. Design prototypes will be judged independently of the oral explanation and presentation.

2. **Engineering Notebook**
   Teams are required to keep an engineering notebook in either handwritten or digital format. This notebook shall chronologically document the engineering process used to design and prototype their innovation. The Engineering notebook shall have the following characteristics:
   a. Entries for handwritten notebooks must be written in permanent ink — not pencil.
   b. Corrections to entries must be initialed and any pictures or sketches must be properly mounted and initialed to "marry" the item into the notebook.
   c. The notebook must have a table of contents.
   d. Every page must be numbered.
   e. The notebook must include a balance of entries made by each team member.
   f. Every entry must be dated and signed.

g. The entire engineering process should be documented - including but not limited to sketches, notes, calculations, evidence of research, photographs, test results, code descriptions, etc. as they apply to the design.
h. A digital notebook using a portfolio or E-book software application is acceptable. All paper notebook guidelines apply. A backup copy of all information in PDF format shall be submitted on a non-returnable flash drive with the team number affixed.

The notebook will be submitted to the judging team after that team's design prototype review. The notebook must be from the current school year in which the project is being presented.

3. **Oral Explanation and Presentation**
Students must demonstrate appropriate mastery of the engineering project. Each student should take an equal role during the allotted presentation time. The presentation given by the entire group must reflect excellent presentation skills, as well as clear communication and explanation of the technical process related to the engineering design project. This presentation must include analysis on the design feasibility.

4. **Industrial Review**
The project must demonstrate evidence of the integration and involvement of business and industry related to the engineering field. Each team must present its design project to a technical person in that area of study. The reviewer is to provide written feedback to the team, which will be submitted to the judges at the NLSC. The industrial review must include feedback on the engineering design including feasibility, industry regulations, laws and/or standards, design safety, prototype quality and suggested improvements as they apply to the design.

5. **Design Process Storyboard**
The storyboard will chronicle the comprehensive history of the innovation, from idea to reality. The storyboard will be judged on the explanation of the team's engineering process, to include brainstorming, scheduling (Gantt chart), cost of materials, consideration of industry regulations, laws, and limitations, safety, quality, product testing, redesign, overall appearance. The storyboard size shall not exceed a 36"x56" tri-fold board.

6. **Onsite Problem-Solving Activity**
Teams will be given an onsite problem-solving activity during the competition to allow for judging of team synergy. Each team should bring one laptop computer or tablet for this activity. All other required materials will be provided by the technical committee.

7. **Overall Effect**
The synergy of the overall presentation of the team's engineering design project and supplied materials must be projected in a businesslike and professional manner. The design prototype and presentation materials must be well organized. The judges will look for the students' display of knowledge, clear communication and overall professionalism.

STANDARDS AND COMPETENCIES

ENG 1.0 — Integrate knowledge of basic engineering principles into technical writing and presentations following the guidelines the competition technical committee has established

1.1. Apply engineering knowledge in the areas of force, work, rate, resistance, energy, power, force transformers, momentum, waves and vibrations, energy converters, transducers, radiation, optical systems

ENG 2.0 — Transform existing systems into conceptual models

2.1. Transform conceptual models into determinable models
2.2. Use determinable models to obtain system specifications
2.3. Select optimum specifications and create physical models
2.4. Apply the results from physical models to create real target systems
2.5. Critically review real target systems and personal performance
2.6. Design effective and usable IT-based solutions and integrate them into the user environment
2.7. Assist in the creation of an effective project plan
2.8. Identify and evaluate current and emerging technologies and assess their applicability to address the users' needs

ENG 3.0 — Showcase knowledge of project planning

3.1. Apply brainstorming techniques
3.2. Implement benchmarking
3.3. Discuss continuous improvement
3.4. Explain cause and effect relationships
3.5. Apply knowledge of customer satisfaction
3.6. Demonstrate how to collect data
3.7. Apply decision-making skills
3.8. Define and describe a process
3.9. Empower team members
3.10. Recognize methods of idea generation
3.11. Prioritize tasks
3.12. Reach consensus amongst the team
3.13. Display teamwork during the competition
    3.13.1. Have equal team participation
    3.13.2. Show positive group dynamics
    3.13.3. Define team roles

ENG 4.0 — Developing/identifying opportunities

4.1. Identify and define the opportunity
    4.1.1. Identify the customer
    4.1.2. Identify the customer's needs
    4.1.3. State the problem or areas of improvement within the identified opportunity clearly and concisely
    4.1.4. Quantify the opportunity with data
4.2. Show data gathered from research
    4.2.1. Identify opportunity for improvement

4.3. Make decisions based on facts, not opinions
4.4. Show how the team determined the cause(s) of the problem and gained an understanding of the variation that occurs in the process
    4.4.1. Diagram and perform a thorough assessment of the possible causes
4.5. Develop various solutions
    4.5.1. Show alternative approaches or changes that would improve the situation
    4.5.2. Show the analysis used to select the most beneficial solution to implement
    4.5.3. Define milestones
4.6. Recommend a plan to implement the solution(s)
4.7. Use analytical decision making by making full use of flow charts, bar graphs, cause and effect diagrams, Pareto diagrams, etc.
4.8. Describe a method to standardize or institutionalize the process

ENG 5.0 — Write a problem statement

5.1. Define the problem
5.2. Define the customer
5.3. Explain the customer expectations
5.4. Describe the product or service
5.5. Discuss how the product or service fulfills the customer's expectations
5.6. List the needed data
5.7. Reflect on how the process can be improved
5.8. Describe how the improved process will meet or exceed the customer's expectations

ENG 6.0 — Design and deliver a presentation that discusses the problems and processes of the local institution

6.1. Make the presentation clear and concise
6.2. Use graphics effectively to clarify presentation topics
6.3. Use time wisely while presenting

ENG 7.0 — Design and develop a presentation that is the result of findings from the on-site problem and process

7.1. Make the presentation clear and concise
7.2. Use graphics effectively to clarify presentation topics
7.3. Use time wisely while presenting

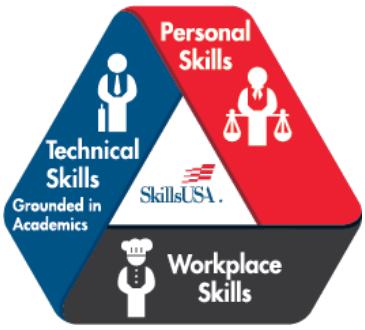
ENG 8.0 — Deliver the presentation in a professional manner, meeting the standards outlined by the technical committee

8.1. Explain the topic through the use of displays or practical operations
8.2. Demonstrate an effective and pleasing delivery style
8.3. Use verbal illustrations and examples effectively
8.4. Make a formal and effective introduction to the presentation that clearly identifies the scope of the presentation
8.5. Pronounce words in a clear and understandable manner
8.6. Use a variety of verbal techniques including modulation of voice, changing volume, varied inflection, modifying tempo and verbal enthusiasm
8.7. Demonstrate poise and self-control while presenting
8.8. Demonstrate good platform development and personal confidence

8.9. Communicate the primary points of the speech in a compact and complete manner
8.10. Tie organizational elements together with an effective ending
8.11. Complete the speech within the time limits set by competition requirements
8.12. Develop storyboards for the presentation outlining the process

ENG 9.0 — SkillsUSA Framework

The SkillsUSA Framework is used to pinpoint the Essential Elements found in Personal Skills, Workplace Skills, and Technical Skills Grounded in Academics. Students will be expected to display or explain how they used some of these Essential Elements. Please reference the graphic in the previous column, as you may be scored on specific elements applied to your project. For more, visit: www.skillsusa.org/about/skillsusa-framework/.



COMMITTEE IDENTIFIED ACADEMIC SKILLS

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

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
- Find surface area and perimeter of two-dimensional objects
- Find volume and surface area of three-dimensional objects
- Apply transformations (rotate or turn, reflect or flip, translate or slide, and dilate or scale) to geometric figures
- Construct three-dimensional models
- Apply Pythagorean Theorem
- Make predictions using knowledge of probability
- Make comparisons, predictions and inferences using graphs and charts
- Organize and describe data using matrices
- Graph linear equations
- Solve problems using proportions, formulas and functions
- Find the slope of a line
- Use laws of exponents to perform operations
- Solve quadratic equations
- Solve practical problems involving complementary, supplementary and congruent angles
- Solve problems involving symmetry and transformation
- 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 the particle theory of matter
- Describe and recognize elements, compounds, mixtures, acids, bases and salts
- Describe and recognize solids, liquids and gases
- Describe characteristics of types of matter based on physical and chemical properties
- Use knowledge of physical properties (shape, density, solubility, odor, melting point, boiling point, color)
- Describe and use the Periodic Table — symbols, atomic number, atomic mass, chemical families (groups), and periods
- Use knowledge of classification of elements as metals, metalloids and nonmetals
- 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: word choice, pitch, feeling, tone and voice
- Demonstrate use of nonverbal communication skills: eye contact, posture and gestures using interviewing techniques to gain information
- Organize and synthesize information for use in written and oral presentations
- Demonstrate knowledge of appropriate reference materials
- Demonstrate narrative writing
- Demonstrate informational writing

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
- Data analysis and probability
- Problem-solving
- Reasoning and proof
- Communication
- Connections
- Representation

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

Science Standards

- Understands the structure and properties of matter
- Understands the sources and properties of energy
- Understands forces and motion
- Understands the nature of scientific knowledge
- Understands the nature of scientific inquiry
- Understands the scientific enterprise

***Source:** McREL Compendium of National Science Standards. To view and search the compendium, visit: http://www2.mcrel.org/compendium/browse.asp.*

Language Arts Standards

- Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction, nonfiction, classic and contemporary works.
- Students apply a wide range of strategies to comprehend, interpret, evaluate and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, and graphics).
- 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 employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language and genre to create, critique, and discuss print and nonprint texts.
- Students conduct research on issues and interests by generating ideas and questions and by posing problems. They gather, evaluate and synthesize data from a variety of sources (e.g.,

print and nonprint texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

- 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.*