ENGINEERING TECHNOLOGY/DESIGN

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 engineering notebook.

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

ELIGIBILITY (TEAM OF 3)

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.

CLOTHING REQUIREMENT

Class A: SkillsUSA Official Attire

For men: Official SkillsUSA blazer or jacket, black dress slacks, white dress shirt, plain black tie with no pattern (or SkillsUSA black tie), black socks, black shoes
For women: Official SkillsUSA blazer or jacket; black dress skirt (knee-length) or black slacks; plain business-like white, collarless blouse (or white blouse with small, plain collar that may not extend onto the lapels of the blazer); black sheer or skin-tone hose; black shoes

These regulations refer to clothing items that are pictured and described at: www.skillsusastore.org. If you have questions about clothing or other logo items, call 800-401-1560 or 703-956-3723.

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

OBSERVER RULE

No observers will be permitted to enter the contest 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 should avoid teams who are actively being judged and will be asked to leave if they are disruptive during the judging process.

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 standard 8' conference table
2. Supplied by the contestant 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 contest area by the contestant team on the move in and set up day. No help will be provided by SkillsUSA.
   b. Design board
   c. Engineering notebook
   d. Industrial review of engineering design
   e. Laptop, computer, projector and small screen, if necessary; documentation and presentation software such as Microsoft Office or Open Office
   f. All competitors must create a one-page résumé and submit a hard copy to the technical committee chair at orientation. Failure to submit a résumé for any one team member 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 at http://updates.skillsusa.org.

Scope of the Contest

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 contest year and may not compete in more than one contest at the national level. High school and college/postsecondary educational institutions are eligible to participate.

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 (see definition in the Eligibility section).

Each team will have one design board explaining the new innovation it collaboratively developed. This should represent the engineering process, detailing brainstorming efforts, schedule, prototypes, modeling, relevant industry regulations, restrictions and laws, safety considerations, manufacturability, and more – 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 should 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 lasts no longer than 10 minutes. Following the oral presentation, there may be a question and answer session by the judging panel — not to exceed 5 minutes — to clarify any questions that arise during the presentation.

Each team is required to have an industrial review of its proposed engineering design completed by a technical person in that area of study. This review should be conducted by engineers, technicians or other technical professions within the design's respective industry. The reviewer is to give written feedback to the team, which will be submitted to the judges at the NLSC.

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 according to its own merits and compliance with the listed criteria. Participants should read the guidelines carefully and make sure 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 (e.g., a newly designed air-intake system for a high-mileage vehicle). The design prototype must accurately reflect the engineering design accomplishment referred to in the presentation. These criteria include CAD, virtual modeling, materials selection ergonomics, manufacturing analysis, construction and asthetics. Design prototypes will be judged independently of the oral explanation and presentation.

2. Engineering Notebook
   Teams are required to keep an engineering notebook documenting the engineering process they used to design and prototype their innovation. Every page should be numbered. Every entry should be dated and should follow a general engineering notebook format. The entire engineering process should be documented with such things as sketches, notes, calculations, evidence of research, photographs, etc. The notebook will be submitted to the judges after they have reviewed the team's design prototype.

   Engineering notebooks in an electronic format will be accepted for review and are expected to meet in full the criteria described above. Teams should bring a copy of the electronic engineering

notebook on a USB drive, to be delivered to the judges.

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

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. *A written review of the presentation from the technical person must be submitted to the judges at the NLSC.* This important process allows teams to interact with technical professionals and engineers, practice presenting their innovation, and get feedback on their design.

5. Design Board
   The design board will chronicle the history of the innovation from idea to reality. The storyboard will be judged on the explanation of the team's engineering process, quality, imagination, impacts, appearance and overall effectiveness of the project. A Gantt chart is required to document the progress of the engineering design throughout the project history.

6. On-Site Problem-Solving Activity
   Teams will be given an on-site problem-solving activity during the competition. All 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 (e.g., storyboard, design prototype) 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 and overall professionalism.

Items judges will be evaluating at NLSC:

- **Design Prototype —** CADD and virtual modeling, material selection, ergonomics, manufacturing analysis, construction and aesthetics, Q&A Prototype—Process

- **Design Board —** A comprehensive engineering design process summary. Brainstorming, Gantt Chart (schedule), cost of materials, consideration of industry regulations, laws and limitations, product testing, applicable redesign, overall appearance.

- **Engineering Notebook —** Format, depth of documentation, professionalism, storyboard-Gantt Chart, engineering process, appearance

- **Industrial Review —** Written technical review, market data and information, overall effect/synergy between content, accuracy, and professionalism

- **On-site Problem Solving**

- **Oral Explanation and Presentation—** Clear communication, design feasibility and analysis, team participation, presentation of the design, Q&A general knowledge

Standards and Competencies

ENG 1.0 — Integrate knowledge of basic engineering principles into technical writing and presentations following the guidelines the contest 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 contest
    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 contest 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 contest.

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 matrixes
- Graph linear equations
- Solve problems using proportions, formulas and functions
- Find 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: http://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.