

## OVERVIEW

In 2008, the National Academy of Engineering tasked an international group of leading technological thinkers to identify the [Grand Challenges for Engineering \(GCE\) in the 21<sup>st</sup> century](#). Fourteen (14) game-changing goals for improving life on the planet were identified and grouped into the themes of sustainability, health, security, and joy of living. Applying leadership and 21<sup>st</sup> century skills in conjunction with the engineering design process, teams develop a solution to one of the grand challenges based on the annual theme posted on the [TSA website](#) under Competition Themes/Problems.

## ELIGIBILITY

Three (3) teams of three (3) or more individuals per state may participate.

## TIME LIMITS

- A. Ten (10) minutes are allowed for the presentation.
- B. Five (5) minutes are allowed for the interview.

## ATTIRE

TSA competition attire is required for this event.

## PROCEDURE

### PRE-CONFERENCE

- A. Participants access the annual theme posted on the [TSA website](#) under Competition Themes/Problems.
- B. Participants concentrate their efforts conducting research on engineering practices and brainstorming a solution.
- C. Participants create and test a prototype/model of their solution.
- D. Participants prepare their documentation and display according to the regulations.

### PRELIMINARY ROUND

- A. No more than two (2) team members report to the event area at the time and place stated in the conference program to check in:
  - 1. the portfolio in PDF format on two [2] USB flash drives
  - 2. a free-standing display
  - 3. a prototype/model of the solution
- B. Entries are evaluated by the judges with neither students nor advisors present.
- C. A list of twelve (12) semifinalists (in random order) is posted.

### SEMIFINAL ROUND

- A. Participants report at the time and place stated in the conference program to sign up for a presentation/interview time.
- B. Participants report at the assigned time and place for the presentation/interview.
- C. Semifinalist teams present in front of their display and model/prototype, which may be used as a reference.
- D. Judges evaluate the entries.
- E. The top ten (10) finalists are announced at the awards ceremony.

## REGULATIONS AND REQUIREMENTS

Students will work to develop their leadership and 21<sup>st</sup> century skills in the process of preparing for and participating in this TSA competitive event. The development and application of those skills must be evident in their submission, demonstration, and/or communication pertaining to the entry.

### PRELIMINARY ROUND

- A. Students prepare an electronic portfolio that includes each step of the engineering design process when developing a solution to their selected grand engineering challenge based on the annual theme.

## B. Documentation Portfolio:

1. Documentation materials (comprising “a portfolio”) are required and must be submitted on two (2) USB flash drives in PDF format, with the following pages in this order:
  - a. Title page with the challenge listed, event title, the conference city and state, and the year; one (1) page
  - b. Table of contents; pages as needed
  - c. Identification and definition of problem; one (1) page
  - d. Information gathering that explains the importance of developing a solution to the grand engineering challenge and how a solution would impact the lives of people. A concise historical perspective of the challenge must also be included; one (1) page
  - e. The identification and explanation of three (3) possible solutions to the challenge must be included. For each possible solution presented, a concise narrative must be included that supports the plausibility of each solution based on a specific scientific, technical, and/or engineering concept; one (1) page per solution, three (3) pages total
  - f. Of the three (3) possible solutions, select the most plausible solution and create a prototype/ model. Provide an appropriate, specific, and descriptive, visual representation of the solution (ex. engineering drawings, schematic, flowchart, etc.); pages as needed.
  - g. A written summary of the of the iteration process in the design of the prototype and the results of each test; pages as needed. At a minimum, four (4) pages describing the below points are required:
    - i. If a solution is not working or cannot be evaluated/tested, a narrative for a means of testing the chosen solution.

- ii. Refinements of the prototype based on evaluation/testing conducted. If a solution cannot be evaluated/tested, write in narrative form a reflection of possible refinements that could be made to the chosen solution based on the testing means developed.
- iii. A reflection of the effectiveness of the selected solution and the testing means developed (i.e. did or would the tests developed actually prove that the solution is plausible?).
- iv. Describe any other issues found during the iteration process.
- h. Plan of Work log; pages as needed
- i. References and resources page in Modern Language Association (MLA) style; pages as needed

## C. The Display:

1. A free-standing display must be used and the dimensions of the display may not exceed 15" deep x 3' wide x 4' high.
2. A tangible prototype/model must be included with the display and must physically fit within the display board dimensions.
3. If the display and/or prototype/model requires power, they must be powered by dry-cell batteries or photo-voltaic cells.
  - a. The power supply must physically fit within the display board dimensions.
  - b. All power must be switched off once the team has completed set-up.
  - c. If teams want judges to activate any electronic device in their model/display, complete instructions must be provided to judges on how to power up the model/display.
4. No harmful or illegal substances are permitted. No viruses, live plants, or animals are permitted. No dangerous processes, experiments, and/or physical models may be displayed/demonstrated.

## EVALUATION

### PRELIMINARY ROUND

- A. The displays
- B. The prototype/model
- C. The documentation portfolio

### SEMIFINAL ROUND

- A. The presentation/interview

Refer to the official rating form for more information.

## STEM INTEGRATION

This event aligns with the STEM (Science, Technology, Engineering, and Mathematics) educational standards.

## LEADERSHIP AND 21<sup>ST</sup> CENTURY SKILLS DEVELOPMENT

This event provides opportunity for students to build and develop leadership and 21<sup>st</sup> century skills including but not limited to:

- Communication
- Collaboration/Social Skills
- Initiative
- Problem Solving/Risk Taking
- Critical Thinking
- Perseverance/Grit
- Creativity
- Relationship Building/Teamwork
- Dependability/Integrity
- Flexibility/Adaptability

## CAREERS RELATED TO THIS EVENT

This competition has connections to one (1) or more of the careers below:

- Engineer
- Environmental scientist
- Health and safety specialist
- Manufacturing consultant
- Mechanical engineer

# ENGINEERING DESIGN

## 2021 & 2022 OFFICIAL RATING FORM

### HIGH SCHOOL

Judges: Using minimal (1-4 points), adequate (5-8 points), or exemplary (9-10 points) performance levels as a guideline in the rating form, record the scores earned for the event criteria in the column spaces to the right. The X1 or X2 notation in the criteria column is a multiplier factor for determining the points earned. (Example: an "adequate" score of 7 for an X1 criterion = 7 points; an "adequate" score of 7 for an X2 criterion = 14 points.) A score of zero (0) is acceptable if the minimal performance for any criterion is not met.

#### Go/No Go Specifications

- Before judging the entry, ensure that the items below are present; indicate presence with a check mark in the box.
- If an item is missing, leave the box next to the item blank and place a check mark in the box labeled ENTRY NOT EVALUATED.
- If a check mark is placed in the ENTRY NOT EVALUATED box, the entry is not to be judged.

- ☐ Documentation portfolio is on two [2] USB flash drives)
- ☐ Display meets the size constraints and is free-standing
- ☐ Prototype/model is present and meets size constraints
- ☐ ENTRY NOT EVALUATED

DISPLAY AND MODEL (40 points)				Record scores in the column spaces below.
CRITERIA	Minimal performance	Adequate performance	Exemplary performance	
	1-4 points	5-8 points	9-10 points	
<b>Aesthetics</b> (X1)	The display design is unattractive in appearance and shows a lack of understanding of graphic design principles.	The display design is somewhat attractive and shows an adequate understanding of the use of graphic design principles.	The display is of professional quality with an exemplary use of graphic design principles.	
<b>Prototype/Model</b> (X1)	Models are confusing and do not represent and/or support the proposed problem solution.	Models provide adequate representation and support of the proposed problem solution.	Models provide excellent representation and support of the proposed problem solution.	
<b>Overall Impact</b> (X2)	The display information and models do not detail or enhance the essential components of the team's problem identification and solution.	The display information and models somewhat detail and enhance the essential components of the team's problem identification and solution.	The display information and models greatly detail and enhance the essential components of the team's problem identification and solution.	
<b>DISPLAY SUBTOTAL (40 points)</b>				

DOCUMENTATION PORTFOLIO (110 points)				Record scores in the column spaces below.
CRITERIA	Minimal performance	Adequate performance	Exemplary performance	
	1-4 points	5-8 points	9-10 points	
<b>Portfolio Components</b> (X1)	Portfolio is unorganized and/or is missing three (3) or more components.	Portfolio has most components and is generally organized.	Portfolio has all required components and is well organized.	
<b>Identification and Problem Definition</b> (X1)	The problem is not clearly defined or communicated and does not fall within the grand challenge selected.	The problem is somewhat defined and communicated.	The problem is clearly written, concise, and well defined; the problem falls within the grand challenge selected.	

DOCUMENTATION PORTFOLIO (110 points) – continued				
<b>Information Gathering</b> (X1)	There is little evidence of research; there is a lack of understanding of the issues cited.	There is some evidence of research; an adequate understanding of the issues is present.	Thorough research is clearly evident with a firm understanding of the issues established.	
<b>Possible Solutions</b> (X1)	A very brief explanation of the final solution is presented; there is a lack of creativity; descriptions are weak.	An adequate description of the solution is presented and supported by some amount of research and evidence; the solution is somewhat creative.	The solution is supported by the research gathered and scientific and engineering evidence; the solution is plausible and creative.	
<b>Selected Solution</b> (X2)	Solution conveys a sloppy design, and/or does not incorporate key elements in the engineering challenge; visual representations of the solutions are not appropriate or accurate and do not follow established conventions.	Solution incorporates most elements laid out in the engineering challenge; visual representations of the solutions are somewhat appropriate, accurate and loosely follow established conventions.	Solution exudes creativity and addresses all engineering challenge elements; visual representations of the solutions are appropriate, accurate and follow established conventions.	
<b>Evaluation and Testing</b> (X1)	Method of evaluation is impractical and/or does not adequately represent a means to test the solution for real-life application.	Method of evaluation loosely provides a means for the solution to be evaluated under real-life application.	Method of evaluation for solution is replicable, concise, and able to be performed in real-life conditions/ applications.	
<b>Refinements</b> (X1)	Little or no correlation to selected solution based on prior solutions; refinements are not concise and/or organized.	Refinements are somewhat understood and based on prior solutions and refinements are organized in a logical start to finish manner.	Refinements depicted clearly illustrate rational thought and progress in a logical sequence from start to finish.	
<b>Communication of Solution</b> (X1)	The solution is difficult to understand as communicated and is presented in an illogical manner.	The solution is communicated adequately, and thoughts are somewhat organized and/or concise.	The solution is communicated in an organized, clear, and concise manner.	
<b>Plan of Work Log</b> (X1)	The log is poorly organized and/or incomplete.	The log is adequately detailed, organized, and contains most of the required components.	The log is detailed and contains all the required components.	
<b>References and Resources</b> (X1)	There are few references listed, and/or references listed show little relevance to the project's goal.	There are a sufficient number of credible references listed.	Many credible references are listed, reflecting research in the areas covered.	
<b>DOCUMENTATION PORTFOLIO SUBTOTAL (110 points)</b>				
<p>Rules violations (a deduction of 20% of the total possible points for the above sections) must be initialed by the judge, coordinator, and manager of the event. Record the deduction in the space to the right.</p> <p>Indicate the rule violated: _____</p>				
<b>PRELIMINARY SUBTOTAL (150 points)</b>				

SEMIFINAL PRESENTATION/INTERVIEW (50 points)				Record scores in the column spaces below.
CRITERIA	Minimal performance	Adequate performance	Exemplary performance	
	1-4 points	5-8 points	9-10 points	
<b>Organization</b> (X1)	Team seems unprepared and unorganized for the presentation/ interview, with an illogical explanation of the project.	Team is prepared for the interview and is somewhat organized in its presentation to judges; team's presentation thesis is, for the most part, logical and/or clear.	Team's presentation/interview with judges is well organized; the interview is concise and logical, with a clear explanation of the development of the project.	
<b>Knowledge</b> (X1)	Team members seem to have little understanding of the concepts in their project; vague interview answers are provided.	Team members have a generalized understanding of the concepts discussed and answer questions adequately.	Evidence is clear that team members have a thorough understanding of the concepts discussed; they answer questions thoroughly.	
<b>Articulation</b> (X1)	Communication of the solution is unclear, unorganized, and/or illogical; leadership and/or 21 <sup>st</sup> century skills are not evident.	Communication of the solution is somewhat logical and clear; leadership and/or 21 <sup>st</sup> century skills are somewhat evident.	The interview provides a clear, concise, and easy-to-follow analysis of the solution; leadership and/or 21 <sup>st</sup> century skills are clearly evident.	
<b>Delivery</b> (X1)	The team is verbose and/or uncertain in its presentation/ interview; participants' posture, gestures, and lack of eye contact diminish the delivery.	The team is somewhat well-spoken and clear in its presentation/ interview; participants' posture, gestures, and eye contact result in an acceptable delivery.	The team is well-spoken and distinct in its presentation/interview; participants' posture, gestures, and eye contact result in a polished, natural, and effective delivery.	
<b>Team Participation</b> (X1)	Only one person in the group communicates with judges; there is little or no participation from other team members.	Team members all participate to some extent and generally seem to understand the concepts.	Team members seem to fully understand the concepts and share an equal role in the interview.	
<b>SEMIFINAL PRESENTATION/INTERVIEW SUBTOTAL (50 points)</b>				
Rules violations (a deduction of 20% of the total possible points for the above sections) must be initialed by the judge, coordinator, and manager of the event. Record the deduction in the space to the right.  Indicate the rule violated: _____				

<b>SEMIFINAL SUBTOTAL (50 points)</b>	
---------------------------------------	--

<b>To arrive at the TOTAL score, add any subtotals and subtract rules violation points, as necessary.</b>	<b>TOTAL (200 points)</b>	
---	---------------------------	--

Comments:          I certify these results to be true and accurate to the best of my knowledge. <b>JUDGE</b> Printed name: _____ Signature: _____
---

# ENGINEERING DESIGN EVENT COORDINATOR INSTRUCTIONS

## PERSONNEL

- A. Event coordinator
- B. Judges:
  1. Preliminary round, two (2) for each thirty (30) entries
  2. Semifinal round, two (2)

## MATERIALS

- A. Coordinator's packet, containing:
  1. Event guidelines, one (1) copy for the coordinator and for each judge
  2. TSA Event Coordinator Report
  3. Stick on labels for entries
  4. Envelopes for portfolio flash drives
  5. List of judge/assistants
  6. One (1) stopwatch per team of judge
  7. Results envelope
- B. Table and chairs for semifinalist presentation

## RESPONSIBILITIES

### AT THE CONFERENCE

- A. Attend the mandatory coordinator's meeting at the designated time and location.
- B. Report to the CRC room and check the contents of the coordinator's packet.
- C. Review the event guidelines and check to see that enough personnel have been scheduled.
- D. Inspect the area(s) in which the event is to be held for appropriate set-up, including room size, tables, chairs, etc. Notify the event manager of any potential problems.
- E. At least one (1) hour before the event is to begin, meet with judges and assistants to review time limits, procedures, regulations, evaluation, and all other details related to the event. If questions arise that cannot be answered, speak to the event manager before the event begins.

## EVENT CHECK-IN

- A. Check in the entries at the time stated in the conference program.
- B. Late entries are considered on a case-by-case basis and only when the delay is caused by events beyond participant control.
- C. In order to compete, participants must be on the entry list or must have CRC approval.
- D. Requirements for attire do NOT apply during check-in, only on the first day of the conference.
- E. Place an entry number on each USB storage drive, display, and prototype/model.
- F. Instruct participants to position displays for viewing.
- G. Secure the entries in the designated area.

## PRELIMINARY ROUND

- A. Judges independently assess all displays, prototypes/ models, and documentation portfolios to determine the twelve (12) semifinalists.
- B. Decisions about rules violations must be discussed and verified with the judges, event coordinator, and CRC manager to determine either:
  1. To deduct twenty percent (20%) of the total possible points in this round or
  2. To disqualify the entry
 The event coordinator, judges, and CRC manager must initial either of these actions on the rating form.

- C. Submit the semifinalist results and all related forms in the results envelope to the CRC room.
- D. Create semifinalist sign-up sheet for each team's final presentation.

## SEMIFINAL ROUND

- A. Semifinalist teams report at the time and place stated in the conference program to sign up for a presentation/interview time.
- B. Semifinalist teams report at the assigned time and place for the presentation/interview.
- C. Manage the completion of the on-site presentations and interviews.

- D. Discuss rule violations (e.g. 20% deduction, disqualification) and have all relevant parties initial the rating form.
- E. Judges determine the ten (10) finalists and discuss and break any ties.
- F. Submit the finalist results and all related forms in the results envelope to the CRC room.
- G. If necessary, manage security and the removal of materials from the event area.