The University of Kansas

High School Design Competition Rules

October 24th, 2018

Aerospace Engineering Competition

You work for an aerospace company that is competing for a bid to design an airplane for a tour company. Your team may consist of a maximum of 4 members. This company carries tourists to visit the natural wonders of the world. Many of these wonders are in harsh terrains with questionable weather patterns. There are generally only very short and narrow runways at these locations and typically they are not well maintained. There will be two parts to this competition: a presentation component, and a flight component. For the presentation, you must argue why your plane is the best one for the job within a 5-minute time limit, with the use of visual aids. For the flight component of the competition, you must build a rubber band powered aircraft that can clear an 18-inch-tall obstacle with a runway length of 12ft. Since the runways will be narrow, the planes with the shortest wingspan will have the best chance at winning the bid. To make the aircraft more robust for the tough runway conditions, there will be different runway conditions you will encounter:

Sand condition: a light layer of sand will cover the runway with a depth of approximately ⅛ inch

Pebble condition: one layer of small pebbles no more than ⅛ inch in diameter will be placed on the runway

Log condition: standard #2 pencils will be placed perpendicular to the runway at approximately 6-inch intervals

Note: Each of these hazards will not be attached in any way to the runway

You will get three (3) opportunities to take off. The runway condition can be changed between attempts. The highest score from the three attempts will be taken.

Once you are in the air, you will need to make sure your plane stays in one piece. A wing tip loading structural analysis test will be performed to ensure the plane can fly in the harshest weather conditions. A line will be attached to each wingtip, and an upwards force from a simple spring scale will be tested until wing failure. “Failure” is defined as the inability to fly. A load will be applied until an audible cracking sound is heard. At that point, the load will be recorded and then released. The team will have the option to attempt flight. If the plane can take off completely, the loading will continue until the next audible cracking sound; however, if the plane cannot take flight, the wings will be considered to have “failed.” The max force recorded will be the max wingtip loading capacity. You can use a plane from a kit; however, it is recommended that this plane be modified so that the score can be maximized. One backup plane is allowed and can be switched between flight attempts; however, the plane that obtains the highest flight score will be the one that will undergo the wing tip loading test.

<u>Scoring:</u>

Presentation score: The presentation will be scored by a panel of judges on a scale from 0-10 on how well the team can persuade the judges to select that plane for the bid

Flight score = (Leave ground) * (Clear obstacle) * (Max wingtip loading capacity) *(Runway Condition) / (wingspan * weight)

Leave ground: 1 point if plane entirely left the ground or 0 if it did not

Clear obstacle: 5 points if plane cleared the obstacle or 1 if it did not

Max wingtip loading capacity: Max recorded force from wingtip structural analysis test (in lbs.) (“Failure” is considered “non-flyable” or when “first audible sounds occur”)

Runway Condition: 1 point for sand runway, 2 points for pebble runway, 3 points for runway with log

Wingspan: Longest horizontal aircraft span (in inches)

Weight: Weight of aircraft (in oz.)

Total score = (Presentation score) * (Flight score)

Bioengineering Competition

(The competition formerly known as Mechanical)

The Seven Wonders of the world have been iconic spectacles of human kinds engineering brilliance for years. Now, they are our tools to test a generation of young engineering students in their journey to develop new wonders in an advancing world. Using the Seven Wonders, you and your group will create a Seven Wonders themed team name and compete to outscore the competition in the limited time you are given. Your team may consist of a maximum of 4 members. Each Wonder will serve as a goal (sitting side by side in a row of seven) and will earn you a specific amount of points, exponentially increasing from 5 to 20 points from the center to the outside goals (also decreasing in size). You will create a mechanical "leg," which has the strength and ability to continuously kick 205-gram mini soccer balls 10-15 feet. The leg must be able to rotate on axis, as you will not be able to move it from the starting point (center of the goals). The time allotted to you will be 1 minute and 30 seconds, so make sure the leg can be reloaded easily.

Game Setup:

- ➔ Device will be placed 10 feet from center goal
- ➔ The center goal will be 18 inches in width and height. Each goal extending from the center will decrease proportionally by 2 inches from the previous neighboring goal (center- 18 in, one from center- 16 in, two from center- 14 in, and three from center- 12 in)
- ➔ Each goal will be separated by 6 inches

*Size, specs, and point distribution of goal setup are subject to change, but this does not affect the design process whatsoever

Building Specs:

- ➔ No limit to size of device
- ➔ Must have some form of kicking ability without help from participants, but participants can re-adjust device for each kick (examples: spring-loaded, swing, etc.)
- ➔ Display team name on the device
- ➔ Any material can be used to create the device, but a document describing how and where each material is utilized must be presented (also include a bill of materials)
    - ◆ Adding on to this, although you are allowed to use any material and mechanism to create your device, you must be creative. Use your engineering intellect and skill to create the device with even the most basic of materials. Avoid just buying your way through the construction. (Large portion of points comes from creativity)
- ➔ No weight limit for the device
- ➔ Device must be stabilized on its own
- ➔ Insure that the leg can rotate at least 60 degrees from the center in both directions (in order to aim at different goals)

Presentation:

- ➔ Points will be given for a presentation of the designed device. Students will be expected to provide a quality visual aid for their design (posters and PowerPoints are acceptable formats, a projector will be provided), including images and a description of their design process. This design process will also be a major component of points awarded in this category, which includes evidence of research, brainstorming, creativity, prototypes, and an explanation for their thought and design process throughout the various stages of the project.

Chemical Engineering Competition

Thousands of tourists come each year to visit the Seven Wonders of the World. It is your job to create the fastest and most luxurious chemical chariot to allow them to get from the airport to the wonder. Your team may consist of a maximum of 4 members. Some of the sites are far from the airport, so extra distance will be worth extra points. When tourists get off the plane, they want to reach their destination as fast as possible, so the fastest chariots will be awarded extra points. The final category that will be graded is the design and appearance of the chariot. Creative designs will be awarded extra points.

Objective/pre-submission:

The chariot must be operated by a non-combustible reaction that travels at least 10 feet. Extra points will be awarded if the chariot travels longer than 10 feet and points will be deducted if it travels less. One week prior to the competition day there must be a document submitted that includes how the chariot works and why the reaction was chosen. **Students may use any chemical reaction to power their vehicle so long as it does not put any students at risk of physical or chemical harm.** This portion of the competition will be worth 30 points.

Competition Day:

There will be points based on how fast the chariot travels the 10 feet. This will be out of 20 points. We will start with a basis of a 10-15 seconds being rewarded a full 20 points. This may be altered based on the rest of the competitors on the day of the competition.

Judging:

A panel of students, volunteers, and industry professionals will be judging the chariots based on aesthetics as well. This portion is worth 10 points but extra points may be collected if the chariot far surpasses its competition. This will be scored based off of the design and creativity of the chariot. Points will be deducted if it is found that the vehicle was made using a pre-made kit, and may be grounds for disqualification.

Final Score:

Distance	<5 feet 10 points	5-9 feet 20 points	10 feet 30 points	>10 feet Extra points
Speed	>20 seconds 10 points	15-20 seconds 15 points	10-15 seconds 20 points	<10 seconds Extra points
Aesthetic	Based off competition			

Civil Engineering Competition

Lawrence needs a new bridge, and it's up to your engineering firm to design it! Your team may consist of a maximum of 4 members. The city leaders who hired you for the project want you to look at other bridges around the world for inspiration and report to them about one of them. You do not have to make your design like the global bridge you report on, but you do have to discuss one in your presentation. Your presentation should also include a team introduction, your AutoCAD drawings, and a brief explanation of the process of designing the bridge. Additionally, make sure everyone on the team has a part in the presentation.

Three Parts:

1. **Presentation:** short presentation in front of the judges regarding their bridge. This presentation should include their AutoCAD/manual drawings, the planning process, and why their bridge design will be able to carry the 1 lb. load. Additionally, present for about a minute about the design strengths of one of four "world wonder" bridges: Christopher S. Bond Bridge (KCMO), Golden Gate Bridge (San Francisco, CA), Sydney Harbor Bridge (Australia), Armando Emilio Guebuza Bridge (Mozambique), or London Bridge (UK).

	Beginner 2 points	**Developing 4 points**	**Acceptable 6 points**	**Effective 8 points**	**Excellent 10 points**
World Wonder Presentation	No mention of the world wonder bridge	Bridge is not named OR there is no mention of its design strengths	Bridge is named, no specific design strengths are mentioned	Bridge is named, design strengths are well explained	Bridge is named, design strengths are thoroughly explained
Presentation Skills	No eye contact, no team introduction, too quiet to hear, negative body language	Minimal eye contact, barely/no team intro, barely audible presentation	Some eye contact, good intro, good voice projection	Good eye contact, intro, and projection; even distribution of speaking parts	Captivating presentation; great eye contact, voice volume; all members present equally
	Beginner 1 point	**Developing 2 points**	**Acceptable 3 points**	**Effective 4 points**	**Excellent 5 points**
Knowledge and Enthusiasm	No explanation of design process, knowledge about bridge, or enthusiasm	Vague description of design process, little knowledge about bridge, not much enthusiasm	Some explanation of design process, some knowledge about bridge, some enthusiasm	Good explanation and knowledge about their bridge; mostly enthusiastic	Explains the design process, knowledgeable and enthusiastic about bridge

-*Worth 25/100 points*

2. **Top, Side, and 3D Drawing:** side, top, and 3D model of bridge. Use the AutoCAD application or a *neat, detailed* hand sketch in pen for your drawings. Side and top models are 5 points each, the 3D model is 15 points.

	Beginner 1 point	**Developing 2 points**	**Acceptable 3 points**	**Effective 4 points**	**Excellent 5 points**
Top View	No drawing submitted	Drawing is very messy, not professional, and inaccurate to actual bridge	Drawing is messy but represents actual bridge design	Drawing is accurate and mostly professional, but still a little messy	Drawing is accurate, professional, neat, and detailed
Side View	No drawing submitted	Drawing is very messy, not professional, and inaccurate to actual bridge	Drawing is messy but represents actual bridge design	Drawing is accurate and mostly professional, but still a little messy	Drawing is accurate, professional, neat, and detailed
	Beginner 3 points	**Developing 6 points**	**Acceptable 9 points**	**Effective 12 points**	**Excellent 15 points**
3D Model	No drawing submitted	Drawing is very messy, not professional, and inaccurate to actual bridge; difficult to differentiate between pieces	Drawing is messy but represents actual bridge design; possible to differentiate between pieces	Drawing is accurate and mostly professional, but still a little messy; can differentiate between pieces	Drawing is accurate, professional, neat, and detailed; different pieces easily identifiable

-*Worth 25/100 points*

3. **Load & Cost-to-Load Ratio:** If the bridge withstands the initial 1 lb. load, more is added slowly until it breaks. If the bridge does not withstand the initial load, they are disqualified. Each K'Nex piece "costs" a certain amount, and there is only a certain number of each type of piece allowed. Based on this, the cost will be calculated. A cost-to-load ratio will be calculated and compared to the other bridges, and the groups with the lowest ratios will get the most points.

How to get total cost of bridge:

➔ (Total number of rods) x ($5) = Rod cost

- ➔ (Total number of connections) x ($3) = Connection cost
- ➔ (Rod cost) + (Connection cost) = **Total cost**

Cost/Weight Percentile Range	Points Awarded
0-10%	5
10-20%	10
20-30%	15
30-40%	20
40-50%	25
50-60%	30
60-70%	35
70-80%	40
80-90%	45
90-100%	50

-*Worth 50/100 points*

Rules:

1. Bridge Height and Span Length Requirements
   - ➔ Minimum height for boat clearance: 1.5 feet
   - ➔ Maximum height: 3 feet
   - ➔ Minimum central span length between the two supports: 3 feet
   - ➔ Maximum central span length between the two supports: 4 feet
   - ➔ Minimum overall deck span (from end to end): 5 feet
   - ➔ Ensure that the bridge deck is one consistent height so cars can drive across the road and has two supports
   - ➔ The ends of the bridge will be supported on the day of the competition by supports outside the design structure
   - ➔ NO adhesives will be allowed in the structure, only approved K'Nex pieces
2. Approved K'Nex Pieces
   - ➔ Standard gray rod (7 and ½ inches)
   - ➔ Standard red rod (5 and ⅛ inches)
   - ➔ Standard yellow rod (3 and 7/16 inches)

- ➔ Standard blue rod (2 and ¼ inches)
- ➔ Standard dark gray connection
- ➔ Standard red connection
- ➔ Standard blue connection
- ➔ Standard white connection

3. Bridge must be able to withstand initial load (1 lb.) attached in the middle of the bridge
4. Team presentation cannot exceed 4 minutes including World Wonders portion. The team will be cut off at exactly 4 minutes even if the presentation is not finished.
5. The competitors must submit all materials (plan sheet with drawings and cost analysis) except the pitch at least 2 days before the competition.

Mechanical Engineering Competition

(The competition formerly known as Mindstorms)

Description:

Robotics has been at the forefront of young engineer's minds since the field's inception. Robotics lies at the intersection of mechanical engineering and computer science. Mechanical engineers must describe a machine's motion and design how it will interact with its environment so that computer scientists can then program it to accomplish these tasks. Every day, new robots are being created to solve new problems and overcome obstacles that we previously thought were insurmountable. In the University of Kansas' 2018 Mechanical Engineering competition, students will design and program a Mindstorms robot to move through a themed obstacle course as efficiently and effectively as possible. Your team may consist of a maximum of 4 members. There will be progressively more challenging obstacles in the course and upon completion of each of them the team will receive points for their problem-solving skills. At the end of the course, there will be a challenge that will also reward points based on accuracy and precision of the robot. This final challenge will not be an all or nothing system like the obstacles. This challenge is meant to determine which robot is the most efficient and best optimized to solve the challenge. Teams will receive dimensions and specifications of the entire course. Teams will be given multiple attempts and their best attempt will be counted towards their final score and ranking. Teams are expected to build their robots before the competition and have a working code before their first run. This will allow teams time to tweak and improve their code or body of their bot as they encounter problems during the day.

Rules:

1. Teams will be placed in a random queue upon arrival.
2. Teams will be called to attempt the course using this queue.
3. Teams may choose to not attempt the course when called, but they will be moved to the bottom of the queue.
4. During the attempt, the robot must show progress or forward motion through the track or the attempt will end and the points for the attempt counted.
5. Every time an obstacle is completed on an attempt of the course the team will receive a set amount of points according to the difficulty of the obstacle.
6. If an NXT can no progress pass an obstacle then the team may choose to skip that obstacle but they will automatically lose 25 points.
7. The points for the obstacles are as follows:
    a. Obstacle 1: 100
        i. Robot must navigate through a revolving door. The door will just be on an axel, and it will not be in motion without the robot moving it.
    b. Obstacle 2: 100
        i. Robot must navigate through a maze of only right angle turns.
    c. Obstacle 3: 100

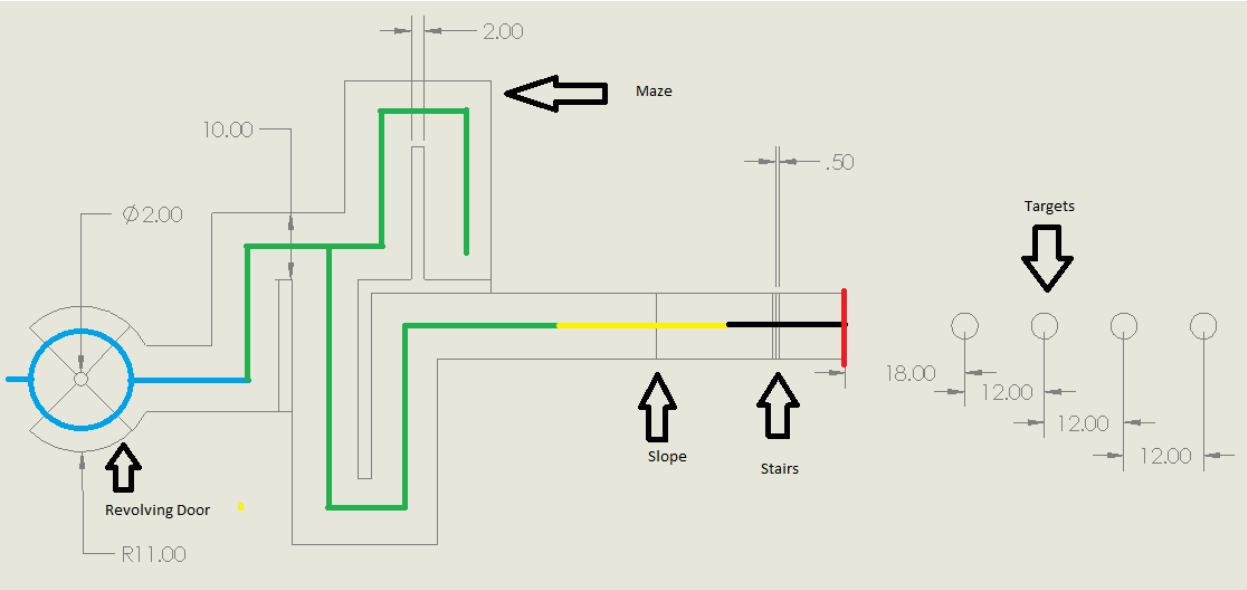
        i. The Robot must climb a slope at a 30 degree incline. At the top of the slope will be a sharp angle and then a downward slope at the same angle as the upward slope.
    d. Obstacle 4: 150
        i. The robot must ascend a short staircase of 3 steps. The steps will be half inch by half inch squares.
8. At the end of the course, every target hit by the robot will provide 25, 50, 75, 100 points depending on the distance of the target. Points will be capped at 250 points for the accuracy challenge. Teams will be allowed to aim the robot. But it must remain 1.5 feet away from the nearest target. The robot must fire the projectile on its own.
9. If a team receives all the possible points in an attempt then the attempt will end.
10. Only the best attempt's score will be counted towards a team's final score. (There is no chance to lose points on a second or third attempt.)
11. Teams will be given an equal amount of attempts.
12. In the event of a tie, the robot that weighs less will win the tie. The lighter robot accomplished the same tasks with less and is therefore more efficient.
13. Every challenge will have a unique color of tape that runs through the center of the course in that area. For the accuracy challenge, there will just be a red line that runs perpendicular to the track.

Robot Parameters

To keep this challenge as competitive and open to as many schools as possible. All teams must only uses parts from a LEGO Mindstorms kit. If we notice extra parts that clearly do not belong with the kit, then that team will lose 50 points off any attempt they make unless they remove the parts and replace them with allowed parts. *IF a team is unable to comply with these regulations, have your educator contact us and we will work with you to make sure the competition remains fair and competitive and still allow you to compete.

Course Specifications

*Course is drawn to scale. All measurements are in inches. The color used in the drawing will be the color of tape used in that area of the track. The walls are 3.5 inches high at least.



Computer Science Competition

Each student team will be given several problems of varying difficulty and point values. Your team may consist of a maximum of 4 members. You will be allotted three hours to compete for as many points as possible. Teams will be able to select which problems they tackle and in what order they choose to do so in order to accumulate the most points possible. In the case of ties, collective time (as marked in seconds, running from the beginning of the competition) will be used as a tiebreaker. Therefore, teams should strategically pick which questions to work on first according to their comfort level.

All programming will be done via the use of a web browser, ensuring a level playing field. Teams will not be allowed to access any outside information during the competition, this includes internet resources and printed materials. The primary focus of the problems will test the principles of programming logic and algorithmic thinking.

Students could expect to see topics such as but not limited to:

- for-loops
- while-loops
- if/else statements
- input/output.

Some advanced problems might dive deeper into topics such as data structures, and sorting algorithms.

Here are some resources that could help you prepare for the competition. Keep in mind that the best way to learn is going out and finding examples to work on.

- CodeAcademy
- Euler Project
- Stackoverflow
- Treehouse (paid)
- Udacity (paid)

Because we have an automated judging system, we recommend that you use one of these three supported programming languages:

- Java
- Python
- C++.

If you have any questions, feel free to reach out. We look forward to seeing you on campus this fall!