



## **NCC Engineering Expo**

**May 1, 2019**

### **1. Quick Glimpse of the Challenge**

The object of the NCC Engineering Expo is to promote engineering as an exciting field for young people, to provide a service to society, to encourage teamwork, and to assist in education outside of the classroom.

Teams must design catapults to launch raw eggs a specified distance. The catapults will be designed and built by the teams. Each team must provide all materials and use their creativity and imagination in their designs.

The playing field will be a rectangular shape. The teams will set up their catapult in a designated launch area and will launch the eggs at a bull's eye target on the opposite end of the playing field. The catapult range must be adjustable because each team will be shooting from different distances to the target. The exact distance to the target will not be known until the day of the event. A range of distances will be specified in this document. Each team will get three practice shots and five scored shots. This field competition will count for 50 of the total 100 possible points.

In addition to the catapult, a poster must be created. The poster should include calculations of predicted distances, documentation of the design process, and a list of materials used, among other things. The poster will count for 50 of the total 100 points available in the competition. This poster should be of professional quality, visually attractive and demonstrate the groups' understanding of the principles involved.

Upon the completion of this challenge, the winning team will also receive an award for display at its school. The catapult competition will be held on **May 1st at NCC**.

## 2. Rules of the Competition

### 2.1 Teams

Teams will consist of a minimum of two students (recommend no more than eight) and one advisor. A student is someone who has not yet graduated from high school. An advisor may be a teacher, principal, parent, or guardian (anyone who is an adult and willing to take on the challenge and responsibility).

### 2.2 Field and Target Description

The competition field will be a level, rectangular field. The target is an 8' x 8' platform inclined at a 45° angle. The bull's eye will be in the center of the platform and be 4' in diameter (see Figure 1). The launching areas are described in section 2.4.

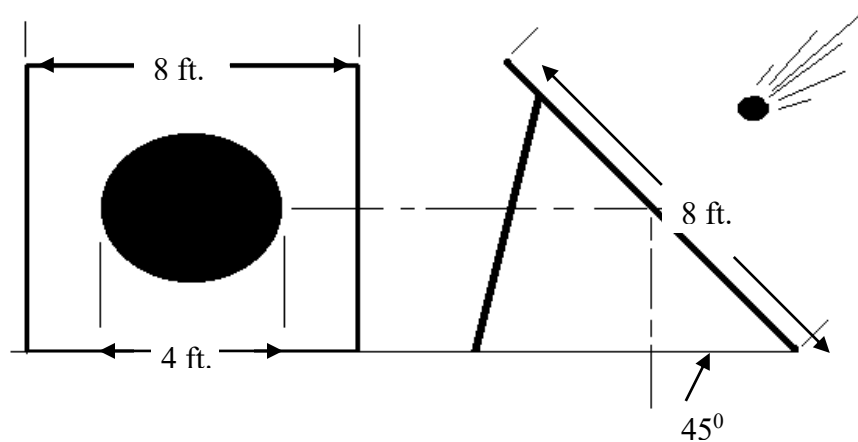


Figure 1. Target

The distance to the center of each launching area will be measured from the center of the bull's eye. There will be three launching areas for the teams to choose from: 60', 90', and 120 feet from the target (see Figure 2).

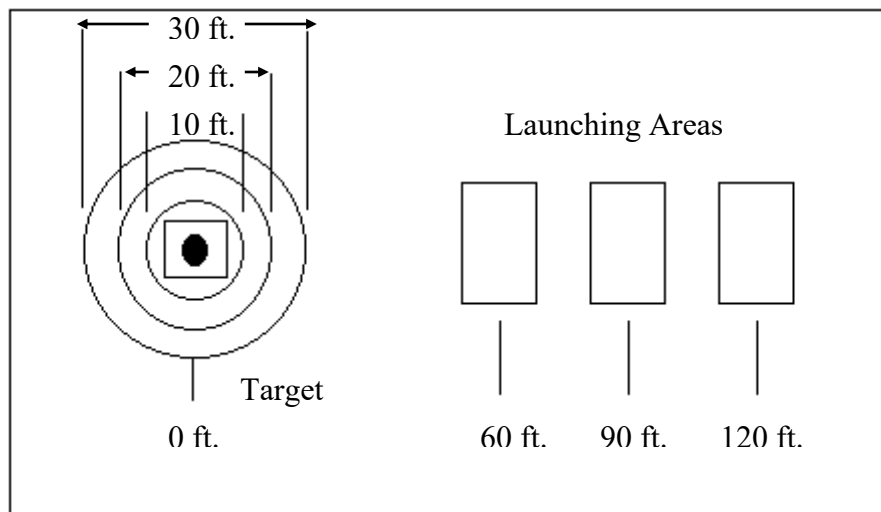


Figure 2. Competition Field

## 2.3 Launching Site

The launching sites will be rectangular areas that measure ten feet long by twenty feet wide. Each team will announce the launching area they wish to attempt at the time of the competition. A team member will then draw a random distance, zero to ten feet, out of a box and that distance will be measured from the front of the launching rectangle. All eggs will then be launched from this distance. The catapult's datum will be the most forward ground brace (see Section 3.8). As an example, a team may choose the 60-foot launching area. The random distance they draw from the hat will then place them anywhere from 55-65 feet from the target's bull's eye.

## 2.4 Eggs

Northwest Iowa Community College will supply all eggs used in the competition. They will be Grade A large eggs.

## 2.5 Practice Shots

Each team will be allowed a total of eight shots, three practice shots and five scored shots from the drawn distance. Teams must announce before each shot whether it will be a practice or scored shot. These practice shots must be carried out within the 30-minute time constraint. (See Section 2.7)

## 2.6 Scoring Shots

Each team will have five scored shots. Points will be awarded for eggs that hit the 4' diameter bull's eye as well as shots that strike the 8' x 8' target platform outside the bull's eye or land within one of the three circles surrounding the target. The landing point of the egg will determine the score (i.e. rolling the egg onto the target does not count). The points awarded will also depend on which launching area the group has chosen (see Table 1).

**Table 1. Scoring Scheme**

	<b>60'</b>	<b>90'</b>	<b>120'</b>
<b>Bull's-eye</b>	6	8	10
<b>Inside 10' Circle (Including Platform)</b>	4	6	8
<b>Inside 20' Circle</b>	2	3	4
<b>Inside 30' Circle</b>	1	2	3
<b>Miss</b>	0	0	0

To obtain the maximum score of 50 points, a group must choose the 120' launching area and strike the bull's eye with every attempt. Each group must therefore consider their catapult's ability and make an engineering decision on which launching area to attempt. CAUTION: Historically, choosing a longer range has adversely affected accuracy.

## 2.7 Time Constraint

From the time of the drawing, each team will only be allowed twenty minutes to place their catapult, launch all eight shots, and remove the catapult from the field. Catapults may be assembled before the twenty minute countdown begins.

## 2.8 DISTANCE COMPETITION

The distance competition will take place after the teams have competed in the accuracy contest. Each team be give 5 throws, using Grade A large eggs, trying to hurl the farthest distance. Awards will be given to the teams with the longest throw.

# 3. Construction Constraints

## 3.1 Initial Size

The size of the catapult must be no greater than 4'x 6'x 3' when disassembled; in other words, it should fit inside a box of these dimensions. This will be tested by judges on competition day! On competition day, a team may bring its catapult disassembled for size testing and then put it together to form a final unit larger than the stated dimensions. While there is no weight constraint, teams should keep in mind that the catapult will need to be transported some distance over grass. The catapult should not be so massive that it requires a truck to move it even short distances. Teams should be able to move their catapult a minimum of 1/4 mile manually.

## 3.2 Energy

The only allowed means of providing energy to the catapult will be that of a falling mass. No springs may be used in the construction of the launching mechanism. Northwest Iowa Community College would like to see creative designs resembling trebuchets rather than slingshots and no cannon style devices.

### 3.3 Materials

Materials that may be used are any items that may be found at a typical lumberyard or hardware store.

### 3.4 Remote Triggering Device & safety

Each catapult MUST be equipped with a remote triggering device and firing safety. (See Section 4.2)

### 3.5 Cost Constraint

The total cost for the construction of the catapult must be no greater than \$200.00 (see Section 5.6).

### 3.6 Broken Parts

During the competition there might be times when parts will break. These parts may be replaced as long as the replacement materials were included in the initial measurement box. Tools do not have to be placed in the box. All repairs must be done within the thirty-minute time constraint.

### 3.7 Adjustability

Teams will be allowed to make minor modifications and adjustments to their catapults with materials that were included in the initial measurement box. An important aspect of the catapult design is its ability to be adjusted in response to variable launch factors such as wind and distance to target.

### 3.8 Ground Anchors

Each catapult must be fitted with four ground anchors. These should be steel stakes at least 18 in. long (make sure that you remember a means for extracting these stakes after the competition). The stakes should be placed at the corners of a rectangle no less than 4'x 6' with the 6' dimension in the launch direction. The forward-most stake will serve as the datum for the catapult. Anchors will be provided by NCC.

### 3.9 Machined Parts

Ingenuity is desirable but excessive use of custom-machined parts, e.g. low friction bearing assemblies, may be penalized. The catapult should be constructed in a typical school or home workshop. Metal parts are acceptable, but metalworking tools should be limited to hand tools. Electric drills may be used. No welding or brazing will be permitted. If there are questions regarding this requirement please feel free to contact us (see Section 8.2).

## 4. Safety

### 4.1 Supervision

Supervision is required when constructing, testing, and transporting the catapult. Northwest Iowa Community College will not be responsible for injuries incurred during the construction, transportation, or operation of the catapults. BE SAFE!!

### 4.2 Remote Triggering Device & Firing safety

Each catapult must have a remote triggering device. The catapults must be triggered from a minimum distance of ten feet to the side of the launch line. All group members must be outside this minimum distance at the time of firing, and no one should be in the firing line (in front or behind) of the catapult. This minimum distance is required to ensure that no one is hit by the moving parts of the catapult. An example of a satisfactory remote triggering device would be a rope pull ten feet long that activates a launching device.

Catapults should also include a firing safety. The catapult should be unable to fire until the safety is released. The safety may be released within the ten-foot trigger limit.

### 4.3 Safety equipment

All group members that actively participate in the launching of the catapult will wear a hard hat and safety glasses. Northwest Iowa Community College will have hardhats and safety glasses available on the day of the competition, but groups may also bring their own safety gear. **Be sure to utilize appropriate safety gear when building and testing your designs!!**

#### 4.4 Release and Waiver of Liability

**All members participating in the catapult event must sign and complete a Northwest Iowa Community College Release and Waiver of Liability form and a Northwest Iowa Community College Medical Information/Release form. Also, any participant under the age of 18 must have the signature of a parent or guardian on the Release and Waiver of Liability form and also the Medical Information/Release form. ANYONE WITHOUT THESE FORMS SIGNED AND COMPLETED ON THE DAY OF COMPETITION WILL NOT BE ALLOWED TO COMPETE IN THE CATAPULT COMPETITION.**

### **5. Poster / Presentation**

#### 5.1 General Requirements

Each poster should be made on a 32 x 40 inch tag board. The poster should also be weather proofed either by lamination or covered with a clear garbage sack or plastic sack.

#### 5.2 Visual Attraction

The poster will be judged on overall visual attraction and professionalism of the poster. Each poster should contain a picture of the team's catapult. Additional pictures are welcome and encouraged. The poster should also include visual diagrams, including labeled diagrams of catapult designs, with dimensions. These drawings may be hand drawn, but computer generated drawings are encouraged.

#### 5.3 Design Process

The poster should include a section on the documentation of the design process. This process could include brainstorming and any research that the team carried out. Assume that the intended audience is not knowledgeable in catapult theory.

#### 5.4 Calculations

The poster should also include a section of basic calculations. These calculations should show estimates of how far the egg will shoot with various catapult settings. Clearly show how and why the design of the catapult was selected. Calculations should be organized and easy to follow.

## 5.5 Adjustability

The poster should also include a section on adjustability of the catapult. Specify how the catapult is adjustable and how adjusting it will affect predicted launch distances. Include any results from tests performed.

## 5.6 Prices & Resources

All materials used to create the catapult must be documented. All materials that are purchased must be recorded with the purchased price. Any donated materials, items found in students' garages, and so on must be recorded separately and given an estimated retail value, which will count toward the total cost of the project. The total cost should be no greater than \$200.00!

All resources must also be documented. Any books, movies, websites, or people consulted should be referenced appropriately. A table of resources is encouraged.

## 5.7 Submittal

Posters must be finished and ready to display on the day of the Catapult Competition. Questions about the poster may be submitted by e-mail to [swaldstein@nwwcc.edu](mailto:swaldstein@nwwcc.edu)

## 5.8 Scoring of the Poster

The poster will be scored out of a possible 50 points. The judges of the posters will be Northwest Iowa Community College faculty. The breakdown of scoring is as follows:

• Overall Visual Attraction and Professionalism	15
• Design Process	10
• Diagrams	10
• Calculations	5
• Price List	5
• <u>Description of Adjustability</u>	<u>5</u>
Total poster point value	50



## 6. Check in and Inspection process

### 6.1 Check in

The competition will occur on **May 1, 2019**. All teams should plan on arriving between **8 am and 9 am** to check in with the NCC judges. If you need to arrive earlier, contact us and special arrangements will be made for dropping catapults off before 8 am (see Section 8.2). Posters will be displayed when the teams arrive in the morning, and must be finished by noon. Northwest Iowa Community College Release and Waiver of Liability and Medical Information/Release forms will be collected at this time (section 4.4). **ANYONE WITHOUT THESE FORMS SIGNED AND COMPLETED WILL NOT BE ALLOWED TO COMPETE.**

### 6.2 Inspection Process

Northwest Iowa Community College will have had time to check the team's poster and will be looking for drastic modifications, expensive catapults, the operation of the remote triggering device, and firing safety before the start of competition. Teams may be asked to demonstrate that their catapult fits in the required volume (3.1).

### 6.3 Penalties and Bonuses

Points will be deducted from any team for the following rule violations:

Exceeds volume constraint (3.1)	-5
Exceeds cost constraint (5.5)	\$0-\$50, -5; \$51-\$100, -10; etc.
Safety violations (4)	-10/violation
Removing protective gear	
Lack of remote trigger	
Lack of ground anchors, etc.	
Time violation	-5

All other infractions will be determined by judges.

Up to five bonus points may be awarded to any team that incorporates a creative theme into their catapult. These may include, but are not limited to: painting schemes.

## **7. Selection of the Winners**

### **7.1 Recognition**

First, second and Third plaques place will be awarded in the following contests:

- Accuracy Contest
- Distance Contest
- Poster / Presentation Contest
- On-site Problem Solving Contest

Traveling Trophy

The team earning the most points in the four contests will be awarded the NCC Engineering Expo traveling trophy.

All results will be announced following the completion of the competition.

### **7.2 Awards**

First through third place will receive special recognition. All team will receive a participation award.

## **8. Administrative Notes**

### **8.1 Entry Form & Fee**

To enter the competition, the Online Entry Form on the Northwest Iowa Community College website must be completed: <https://nwicc.edu/engineering-expo/>