



# MARYLAND ENGINEERING CHALLENGES

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## 2015 SAFE RACER CHALLENGE

Supported By: Whitney, Bailey, Cox & Magnani  
Wallace Montgomery and Associates Employee Team

- ⇒ **Elementary School Level — Grades 2 to 3**  
⇒ **Engineer Contact — Dick Magnani — [rmagnani@wbcm.com](mailto:rmagnani@wbcm.com)**



### Important Dates

#### Coaches' Information Session

⇒ **Thursday, November 20, 2014 4:00 p.m. to 7:00 p.m.**

This “drop-in” event is designed for adults interested in coaching a team to stop by and chat with engineers. Find out if a particular Challenge is a good fit for your students. The Information Session is not required and there is no cost. Registration strongly encouraged. Contact Melinda at [mcane@thebmi.org](mailto:mcane@thebmi.org)

#### Coaches' Hands-On Workshop

⇒ **Saturday, January 31, 2015 10:00 a.m. to 2:00 p.m.**

Learn the practical aspects of this Challenge. Work with engineers to explore design and construction aspects of the project. Especially helpful for first-time Coaches and/or those with little previous engineering knowledge. Registration required. Contact Melinda at [mcane@thebmi.org](mailto:mcane@thebmi.org)

#### Registration Deadline

⇒ **Friday, March 6, 2015 Must be received prior to 4:00 p.m.**

In order to register, each team must have their adult Coach complete the online registration form at [www.thebmi.org](http://www.thebmi.org) AND submit the team's Written Report and \$5 Coach's Fee to the Baltimore Museum of Industry prior to the Registration Deadline.

#### Safe Racer Challenge

⇒ **Saturday, March 21, 2015 Doors open at 9:00 a.m.**

Full details about the Challenge date will be emailed to Coaches after the registration deadline.

## THE CHALLENGE

Design and develop a fast, open-top racecar—with suitable safety equipment—to enable the racing driver, Eggbert[a]—an uncooked egg, to survive a crash test and then go on to compete for the coveted Safe Racer Cup in the distance trials.

Students design and build model racecars, each containing a fragile raw-egg “driver,” which plunge down a 30-degree ramp and crash into a barrier. The cars will be designed for safety, however, so most of the eggs survive un-cracked. To demonstrate that the car has also been designed for egg-citement, at the next stage of the contest the barrier is removed and the car is free to speed down the track. Some cars travel more than 75 feet!

## ENGINEERING TEAM REQUIREMENT

Each team may consist of 1 to 6 students. There is no limit to the number of teams a school may have.

## DESIGN & CONSTRUCTION STANDARDS

### Racecar

- The car must be constructed by students from readily available recycled materials, except for the wheels and axles. Points may be deducted at the discretion of the judges based on the lack of recycled materials.
- The car must have an open top.
- The team logo must be displayed clearly on the car for identification.
- The car must be no more than 5 inches wide, including the wheels, and no more than 9 inches long. Oversize cars will have points deducted and the team will be given the opportunity to correct the condition where feasible so they can continue with the competition.
- The total weight of car, safety equipment, and Eggbert[a], a LARGE uncooked egg, must be less than 12 ounces. Overweight cars will have points deducted and the team will be given the opportunity to correct the condition where feasible so they can continue with the competition.
- The car design must include driver safety equipment. Eggbert[a] must have a “face” (a circle one inch in diameter), which **must not be covered**, and [s]he must be able to “see” the road. Either bring 1”-diameter labels with faces drawn on them or chose from assorted pre-printed labels at the egg selection table.
- The egg must be oriented in the car with the small end of the egg pointed up.
- It is important to easily remove Eggbert[a] from the car and safety equipment to examine him for damage. The team members must remove Eggbert[a] from the car, not the Judges. Eggbert[a] must not be wedged in tightly. The “comfort and convenience” of the equipment will be considered when judging the design. **If Eggbert[a] cannot be easily removed from the car, the team will be given the opportunity to correct the condition where feasible; otherwise points will be deducted at the discretion of the judges.**
- Eggbert[a] must wear a safety helmet, which must be easily removable.
- Other than a face for Eggbert[a], nothing else can be fastened to the egg with tape, glue, Silly Putty or any other adhesive.
- Obvious excessive help from adults will be penalized at the judges’ discretion.

## Test Ramp

- Test ramps will be available at the competition for all teams to practice.
- All cars will be tested on the same crash test ramp and distance trial ramp.
- Test ramp size = 6 feet long set at an angle of 30 degrees. The ramp is made with a 1x6 board ( $\frac{3}{4}$ " thick by  $5\frac{1}{2}$ " wide) with 1x3 board ( $\frac{3}{4}$ " thick x  $1\frac{1}{2}$ " wide) side rails, providing a chute  $5\frac{1}{2}$  inches wide (maximum width of car is 5 inches).
- The test ramp should have a curved surface made from stiff cardboard (such as the backing of a pad of paper) at the base to allow a smooth transition from the angled ramp to the floor surface.
- A crash barrier made of  $\frac{1}{2}$ " x 8" x 8" plywood [minimum] should be fastened to the end of the test ramp for the crash test element of the performance demonstration.

*Note: A LIMITED number of Safe Racer test ramps are available to purchase from the BMI (or to borrow with a refundable cash deposit). Cost is \$35; contact Melinda at [mcane@thebmi.org](mailto:mcane@thebmi.org) after December 1, 2014.*

## Required Construction Elements

- All cars must use the same wheel and axel components.
- ◇ *Each Coach for the Safe Racer Challenge may request one free Safe Racer kit per team registered. Each kit consists of 4 wheels, two 4"-long axles, and two straws to serve as axel bushings. It is not mandatory to use the straws provided in the kit as axel bushings, you may use any other recycled material for axel bushings (No ball bearings). To request your kit(s), contact Melinda at [mcane@thebmi.org](mailto:mcane@thebmi.org) after December 1, 2014. Kits will also be available at the Coaches' Information Session on November 20. Additional kits can be purchased from the BMI at \$2.00 per kit.*
- ◇ Wheels and axels are also available from:
  - Wheels: [www.kelvin.com](http://www.kelvin.com) item # 990171,  $1\frac{3}{8}$ " diameter,  $\frac{3}{16}$ " tread width,  $\frac{1}{8}$ " axle size. Axles: any hobby store,  $\frac{1}{8}$ " diameter metal rod x 4" long. (For the specified wheels, the maximum length of the axles is  $4\frac{3}{4}$ " to stay within the 5 inches overall width limitation.)
- There will be no external propulsion or braking of the car during the crash test and distance trials. Only the potential energy of the car due to gravity will propel the car freely down the test ramps; and only the friction of inadvertent rubbing of the wheels against the side rails will be allowed to retard the car.
- Only a dry lubricant can be used on the axles. Oil or grease will not only be messy, but will attract dust causing the oil or grease to gum up and be less slippery than no lubricant at all.
- No modification of the cars is allowed after the car has left the design and construction judging station except for emergency repairs after the crash test. After such repairs, the repaired car must be examined by the crash test judges before proceeding to the distance trials.

## PERFORMANCE DEMONSTRATION GUIDELINES

The winner of the Safe Racer Cup is the car that travels furthest, but the overall Challenge grading also takes into account a written report, an interview with the judges, and the design and construction of the vehicle. The team that is the overall winner must demonstrate a wide range of skills.

Teams must bring a 20" x 30" poster displaying the school name and team name in 3" high letters and a logo to identify your team during the demonstrations.

Performance demonstrations are conducted as follows:

### **Part 1 – Written Report**

The written reports will be reviewed by a group of Judges several days before the day of the Safe Racer Engineering Challenge. The Judges will be evaluating the reports for the following aspects:

- o Completeness
- o Neatness
- o Presentation, including use of drawings and photos
- o Originality of design ideas
- o Safety features
- o Report Cover and Logo
- o Other aspects that the Judges may deem worthy of recognition

Each team will be awarded a certificate of achievement for some outstanding aspect of its written report. One team will be awarded a certificate for the Best Written Report.

### **Part 2 – Registration**

Upon arrival at the BMI on the day of the Challenge, each team must register at the Check-In Station.

- o The Check-In Judge will record each team member present and verify the spelling of names.
  - o Each team will be given a team packet containing:
    - The Written Report
    - The order of team testing so each team can tell just when it is their turn
    - A Team Number Sign to be displayed along with the Team Poster at each judging station
    - Other material that may be important information during the course of the day
- If any team member arrives late, after the course of judging has started, the late member's team may have to go to the end of the testing order unless the team decides to start the judging without the late member. The late member may join the team at any point during the judging except for the Oral Report judging.

### **Part 3 – Egg Selection**

Each team will be called in turn to visit the Egg Selection Station. Each team will select their uncooked MEDIUM egg from one or two cartons of eggs. Bright lights and magnifying glasses will be available for the team to carefully examine the eggs to be sure there are no cracks that would weaken the chosen egg.

#### **Part 4 – Construction Judging**

Each car will be carefully examined for conformance to the construction rules. Teams whose car does not conform to the rules will be given an opportunity to modify their car at the Repair Pit.

#### **Part 5 – Crash Test**

Just prior to the Crash Test, a photo portrait will be taken of each race car and Eggbert [a] at the Portrait Station. Also, each team will pose for a group photo with their car and their poster in the background.

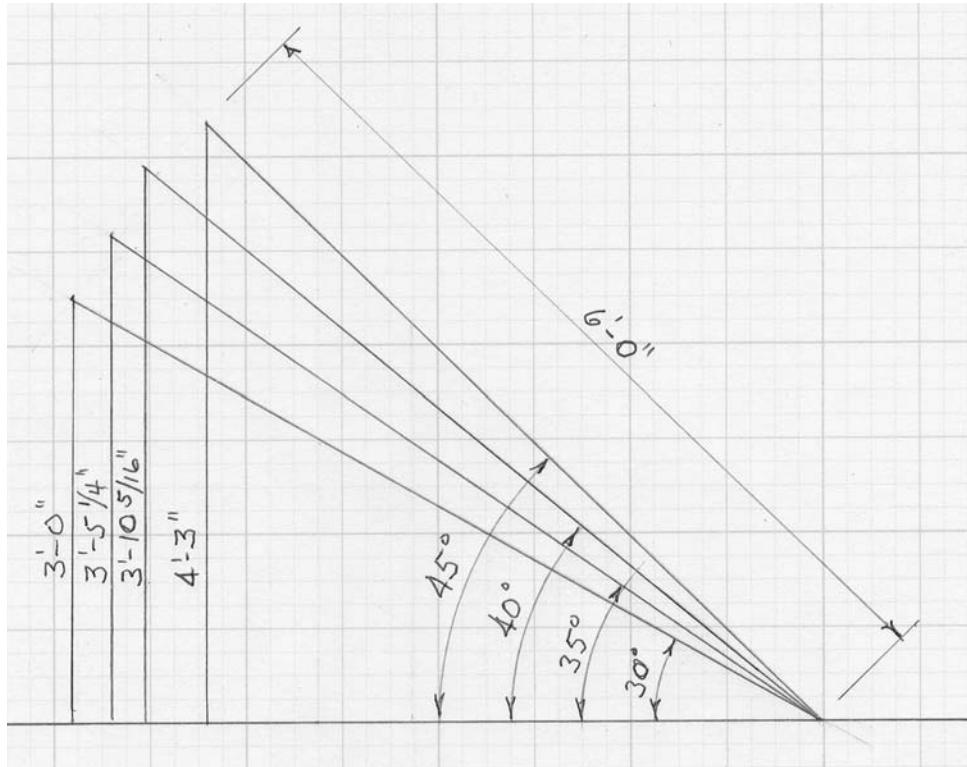
The car and Eggbert[a] will be rolled down the BMI's test ramp to crash into the barrier at the end. Eggbert[a] will then be carefully examined by the judges. A maximum of 20 points will be awarded based on the performance of the car and the condition of Eggbert [a]. All cars will go forward to the Distance Trials. Injured drivers (damaged eggs) will be replaced with an alternate driver (a fresh egg chosen by the team).

*OPTIONAL Rear-End Impact Test* – An opportunity to gain 5 bonus points.

To simulate a rear-end crash and test the car's ability to protect Eggbert[a], the car will be released one-quarter of the way down the ramp. If Eggbert [a] is injured, there will be a five point penalty, so be careful in deciding whether to go after the bonus points. The rear-end crash test will be conducted after the front-end crash test. If Eggbert[a] is injured during the front-end crash test, the team will be able to choose an alternate driver (fresh egg) for the rear-end crash test. Again, this is an optional chance to gain 5 points; but be very careful in deciding to go after the points because you could possibly lose 5 points if Eggbert[a] is injured! You will be asked after the Crash Test if you wish to try the *OPTIONAL Rear-End Impact Test*.

*OPTIONAL Super Crash Test* – An opportunity to gain even more bonus points.

. At any time up to 15 minutes after the last team has completed the regular Crash Test, a team can try for bonus points on the Super Crash Test ramp. The ramp for the regular Crash Test is inclined at 30 degrees. For the Super Crash Test, the incline of the ramp will be increased to 35 degrees. If Eggbert[a] survives the 35 degrees ramp crash, 5 bonus points will be awarded. If Eggbert[a] is injured, a 5 point penalty will be assessed. If Eggbert[a] is uninjured, the team may decide to try for more bonus points with the ramp increased to 40 degrees incline. If Eggbert[a] survives the 40 degree ramp crash, 5 bonus points will be awarded. If Eggbert[a] is injured, a 10 point penalty will be assessed. If Eggbert[a] is uninjured on the 40 degrees ramp crash, the team may decide to try for even more bonus points with the ramp increased to 45 degrees incline. If Eggbert[a] survives the 45 degree ramp crash, 5 bonus points will be awarded. If Eggbert[a] is injured, a 15 point penalty will be assessed. (A team can possibly earn 15 bonus points but not lose more than 5 points.) For the 35 degrees ramp, the car will hit the barrier with 1.15 times the force as for the 30 degrees ramp, 1.30 times for the 40 degrees ramp and 1.41 times for the 45 degrees ramp.



*Geometry of the Super Crash Test Ramp*

### **Part 6 – Distance Trials**

Eggbert[a] will be replaced in the car exactly as he was in the Crash Test. The barrier will be removed from the test ramp and cars will run down the ramp and along curbed track and across the floor. Each car will be run 3 times and the best (longest) run used for scoring. The car that travels the furthest will win the Safe Racer Cup and 10 points. The second furthest will be awarded 8 points, the third furthest 7 points, and so on.

### **Part 7 – Oral Report**

Each team will present an Oral Report to several Judges. The Oral Report has two parts:

The Judges will ask several questions of each team from a list of prepared questions. (No, you cannot have a copy of the questions.)

The Judges may ask the team to explain certain aspects of the design of its car, its design process, problems encountered, help from grownups, the safety features of the car, and other questions that may come to their minds.

The Orals will be from 5 to 8 minutes depending on the number of teams competing and the number of available Orals Judges. The Judges will base the scoring on:

Preparation

Knowledge

Poise of team members

After the Oral Report is complete, the car, poster, and written report must be left with the judges for further comparative judging of all posters and cars.

## EVALUATION STANDARDS

This elementary school-level competition involves four main components: the design and construction of the project, a written report, an oral report, and the performance demonstration.

WRITTEN REPORT *	Competition value: 15 points
<i>Late penalty</i>	<i>(-)5 points</i>
ORAL REPORT	Competition value: 15 points
POSTER	Competition value: 5 points
CAR CONSTRUCTION & DESIGN	Competition value: 10 points
SAFETY EQUIPMENT	Competition value: 15 points
SIZE & WEIGHT	Competition value: 10 points
<i>One point will be deducted for each ounce or portion thereof over the 12 oz. weight limit. There will be no bonus points for underweight cars. Oversize cars will be given the opportunity to correct the condition where feasible; otherwise, points will be deducted at judges' discretion.</i>	
PERFORMANCE DEMONSTRATION	
Crash Test	
Front-end crash	Competition value: 20 points
Optional rear-end crash	
<i>Successful</i>	<i>(+)5 points</i>
<i>Failure</i>	<i>(-)5 points</i>
Optional Super Crash Test	<u>35 degrees</u> <u>40 degrees</u> <u>45 degrees</u>
<i>Successful</i>	<i>(+) 5 points</i> <i>(+) 5 points</i> <i>(+) 5 points</i>
<i>Failure</i>	<i>(-) 5 points</i> <i>(-) 10 points</i> <i>(-) 15 points</i>
Distance Trials	Competition value: 10 points

An outline of what is required for each component, and general guidance on preparing for the competition, is in the "Elementary School Guide to Entry" which should be read in connection with this document.

\* The following pages are a suggested format for the Written Report. It is not mandatory that these pages be used as a form, to be filled in and keeping the same number of pages. You should keep the order of the presentation but the team is encouraged to personalize the report with photos and, sketches and art work. The report does not have to be elaborate but should be more than just filling in the blanks on the form. The report cover should have the team name, the school and the team logo. All written reports must have the Coaches' name and email address clearly indicated.

**GOOD LUCK TO YOUR TEAM!**

## **STUDENT DESIGN REPORT**

Team Name

Team Members

Team's School Name (if applicable) and County

Adult Coach

Coach's Email

### **DESIGN REPORT DIRECTIONS**

Make a copy of this booklet for each TEAM. Team members should complete each part by clearly printing the requested information. Additional pages may be inserted as needed. The information in this booklet must be the work of student team members, as certified on the final page. The following outline is a suggested format for the Written Report. It is not mandatory that the attached pages be used as a form, to be filled in and keeping the same number of pages. You should keep the order of the presentation; but, the team is encouraged to personalize the report with photos and, sketches and art work. The report does not have to be elaborate but should be more than just filling in the blanks on the form. The report cover should have the team name, the school and the team logo. All written reports must have the Coaches' name and email address clearly indicated. The report should be preferably typed by the students or neatly printed by the students. The reports will not be judged for spelling or grammar, but for the design and construction process and for content and presentation.

Written reports must be submitted, either by mail or in person, to:  
BMI, 1415 Key Highway, Baltimore MD 21230, prior to 4:00 p.m. on Friday, March 6, 2015



On a separate page, sketch your final Safe Racer design.

Drawing Date \_\_\_\_\_

What are the measurements of your Safe Racer design?

Length \_\_\_\_\_ Width \_\_\_\_\_ Weight \_\_\_\_\_

Explain how your Safe Racer design was selected.

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How was the design tested? Use a sketch or drawing to describe testing.

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Explain the improvements or changes made to your design after testing.

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What was the best measurement for distance during testing?

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Did the egg survive during testing?

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List the dates of important milestones in your project and describe those milestones:

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What math skills were needed in this challenge?

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What science skills were needed in this challenge?

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