

Request for Proposal #1

The Egg Smash Competition

Goal

A raw egg is placed 2 m from a 5 cm (width) by 15 cm (height) wooden barrier 2 m long. Teams must design and construct a *means* that will pick up the egg, transport the egg, and deposit the egg, **unbroken**, to a 5 cm by 5 cm area, located 2 m away on the opposite side of the barrier, in less than 2 minutes. A contest session will provide teams with the opportunity to compete against each other.

Design Descriptors

Steps: Establishment of objectives and criteria, synthesis, analysis, construction, test, and evaluation.

Features: Creativity, open-ended, wide variety of alternative solutions.

Constraints: Time, space, human factors, and obviously cost.

Efforts: Team of 3 people.

Limitations and Constraints

- a. No trained pets are allowed.
- b. You can interact with the means *only once* during the run.
- c. The target area can be marked for sensor tracking. However, There will be no control on the conditions of the contest environment.
- d. The initial location of the egg on the start line and that of the target on the end line are not known *a priori*. They will be assigned after the *means* is set up.
- e. No interaction with an external PC is permitted during the run.
- f. The operation volume is $3 \times 4 \text{ m}^2$ on the surface and 2 m in height. However, a tolerance of 10 cm is allowed around the start and end lines and up to 50 cm around the sidelines at the corners.
- g. The power source (electric, pneumatic, etc.) can remain outside the operation volume.
- h. If your means breaks the egg, you
 1. receive a 50 point penalty, and
 2. you must clean up the mess.
- i. For every second your team losses one (1) point.
- j. A run is disqualified if the means hits the wall, hits the ceiling, structurally collapses, or falls over.
- k. Remote control devices are not permitted.

Performance Evaluation

Each team will receive 50 points if the means can pick up the egg unbroken. Each team will receive additional points if the egg is unbroken and is transported as follows:

Across the barrier	100 pts.
To within $1 \times 1 \text{ m}^2$ zone of the target	100 pts.
To within $0.5 \times 0.5 \text{ m}^2$ zone of the target	150 pts.
To within $0.25 \times 0.25 \text{ m}^2$ zone of the target	200 pts.

To within $0.1 \times 0.1 \text{ m}^2$ zone of the target	250 pts.
To the bulls eye ($0.05 \times 0.05 \text{ m}^2$ zone of the target)	350 pts.
Penalty points are awarded as:	
egg is broken	-50 pts;
will not put the egg down	-50 pts;
per second	-1 pt.

Expected Outcomes:

Design and Construction Process: The team must follow a logical process in accomplishing their tasks of design and construction. The detailed process must be reflected in the final report submitted by the team.

Proposal: Each team must work together to generate proposal documentation on the design. The design proposal should reflect the steps to be taken in the design, and the construction process to be followed in making the product.

Final Report: This report should include the following items:

- a. Problem definition and objectives
- b. Limitations and requirements
- c. Preliminary ideas (sketches and brief description)
- d. Final detailed design (sketches and detail list of parts)
- e. Construction and integration
- f. Test and debugging
- g. Conclusions
- h. Codes, drawings, catalogs, references, etc. in the Appendix.

Final Product: The final product developed by the team should reflect the work presented in the proposal. Any significant changes in the design of the product must be justified in the final report. The quality of the final product may vary widely depending on the background of the team, the difficulty of the concept, and other constraints. Many of the deficiencies of these products can be resolved later in the students' academic career. For this reason, a smaller portion of the student grade is allotted to the product construction and performance.

Team Dynamics: The team must propose a solution and the plan in the proposal, and remain *loyal* to the proposal during the entire process. Hence a close interaction between members of team is required initially to be able to "*plan ahead*." Early team dynamics may be strained, but interaction increases as the construction and integration of the *means* proceed. Maximum team interaction occurs during the system integration, test and competition. The instructor will enhance the team dynamics by spending some time with the teams evaluating the process. In many cases students remember this team experience (including their teammates) when they are seniors, or even when they are returning alumni.

Grade evaluation will be heavily weighted to the generated design concepts, proposal, final report, and the way each team has followed the tasks. The final product and performance evaluation (competition) will have less influence on the overall grade.

Statement of Work

Each team is composed of three students. The conceptual design must be performed through a close interaction of all members of the team. However, for the implementation, tasks can be broken into the following assignments:

Computer Software and Hardware

One student shall program all the software for the system. The software may be written in whatever language the group elects to use; however, for a low power portable computer the only language available will likely be assembly. This student also has the responsibility of programming the system processor. It is advised that the processor be functional and programmable by the end of Reading Week, so that subsystem integration and testing may begin. Often integration requires additional minor adjustments to the computer hardware. In addition, after Reading Week, the person responsible for computer hardware shall assist the Interface and electro-mechanical subsystem with duplication or fabrication of components and subassemblies.

Instrumentation and Actuation

One student shall be responsible for incorporating whatever actuators and transducers are required in the system. The person responsible for the electro-mechanical system shall also calibrate the I/O signals.

Interfacing

One student shall construct all the digital and analog interfacing electronics to connect the transducers and actuators to the computer interface card. Where the primary calibration for a transducer is positional in nature (such as a stop switch), it will be the responsibility of the electro-mechanical modules to provide and mount them. In all other cases, the transducers and their calibration are the responsibility of the interface subsystem.

Discussion

The word "means" is used to provide the designers the maximum latitude in creating a solution. If the word "vehicle" or "robot" is used then the solutions are limited to a particular category. Using the term "means" in the problem description permits student creativity to investigate not only vehicles and/or robots, but structures, rotating cranes, fluid power, etc.

Solutions to this problem can be as varied as the number of teams working on this project. Some typical solutions include:

- Small battery-powered vehicles with scoops on the front to capture the egg, travel in an arc around the barrier to destination, or crawl over the barrier in a direct line to the destination.
- Rotating cranes with a structure that straddles the barrier; battery powered arm rotates from starting point to destination; scope at the end of boom, rotates egg around end of barrier, or lifts egg up and over barrier as it rotates.
- Ski lift structure with a scoop mechanism that picks up the egg, transports it via a belt driven system over the barrier and delivers it to the destination.
- Dynamically powered, rolling vehicles which move around or across the barrier to deliver the egg to its destination. Power is generally furnished through a falling weight.
- And anything else that does the job!

Students can encounter problems with construction of the product. With limited experience in shop practices, final products may not always work as anticipated. This can be frustrating to the students. As with any life experience, the product building will improve as the students gain maturity, not only in shop practice, but also in improved engineering science background. The contest session provides proof of the paper design. It also demonstrates to students that in real life the result does not always follow the prediction of theory. This is a good time to remind the students that "*equations, tables and curves are only a mortal's representation of reality.*"