FIRE PROTECTION ENGINEERING DESIGN CHALLENGE

Organized by the Department of Fire Protection Engineering, University of Maryland

Overview:
By participating in this challenge, students will learn basic fire protection engineering concepts. Their efforts begin with an overview of fire phenomena and fire protection subsystems. Materials are provided to students via videos and written documents and include background information of core fire protection strategies and demonstrations (that can be viewed via identified online resources or could be done in a controlled environment at the high school). Materials are also provided to enable instructors/mentors to engage students in discussions or breakout group challenges. Once the foundation is established, students work in teams to design a small-scale structure with creative detection and suppression systems designs. Here, students gain experience in creative design and construction while applying fire protection engineering fundamentals. The Challenge culminates in a burn day held at a location in central Maryland. Should the number of participants grow appreciably, a preliminary round of experiments may be conducted regionally, with only finalists participating in the final day. Performance metrics are provided (see below) to select award winners in the challenge.

Objectives: By participating in the project, the students will:

- Understand the principles of fire protection engineering
- Gain experience in creative design and construction
- Practice the scientific method to formulate and test hypotheses
- Gain confidence in their abilities to succeed in STEM

Description: The challenge presented in this project is to create a design for a typical 2-room apartment that accomplishes 2 principal objectives:

- Provide early detection of the fire
- Suppress the fire so it does not spread to the other room

Evaluation Criteria: The Judging Rubric includes the metrics used to assess the effectiveness of the proposed designs.

- Cost: total estimated cost, including the value of any donated materials.
- Livability: accounts for the realistic nature of the contents, including furniture composed of soft materials, carpet and wall linings.
- Response time of detector: needs to include some indication that detection has occurred
- Time for suppression: time for fire to be controlled
- Room Spread (is fire confined to room of origin).

Strategies: Background information provided about fire protection engineering includes a description of five Core Fire Protection Engineering strategies: Material Flammability, Compartmentation, Ventilation, Detection and Suppression.

Help/Support

Assistance is available from a Graduate Assistant of the Department of Fire Protection Engineering at the University of Maryland on a 24/7 basis. Email is the preferred means of communication, though web-based meetings are also available. Additionally, alumni or professional mentors are sought to lend assistance to student teams.

Schedule
The annual competition is announced in early Nov., with the final test day scheduled in April.

Challenge Overview

Goals

The goal of the challenge is to accomplish the following in a typical apartment:

- Provide early detection of the fire
- Suppress the fire so it does not spread to the front room
- Realistically represent a typical apartment

The Judging Rubric provided below identifies the categories that will be used to evaluate the performance of the design in each student group submittal. General considerations include:

Cost is a driving factor in engineering. Detection and suppression systems only become viable if they are effective and affordable. Hence. the total estimated cost is considered, including the value of any donated materials.

Livability is a category for judging the realistic nature of structure and furniture. Past students have built furniture of steel and concrete that was placed in rooms with no windows. This is not representative of an apartment that most people would live in.

Response Time is included as faster detection and activation of suppression systems is typically desired as small fires are generally easier to suppress than large fires. However, even though a system may activate quickly, if it is not capable of limiting spread or extinguishing the fire, the fire will continue to burn. All fires will be allowed to burn for a maximum of 7 minutes (experiments may be terminated sooner if judged to not be changing or if the entire model is involved in fire. Once the test is terminated, a staff member will manually extinguish the fire.

Room Spread shows whether the fire is contained within the room of origin.

Judging Rubric

All designs will be evaluated using the following rubric.

Judging Rubric	Category Points	Points
Total Estimated cost	[$]/10	
Livability	[1-5] (1=best)	
Detection Time	[seconds]*	
Notification Time	[seconds]*	
Suppression Activation Time	[seconds]*	
Suppression Effectiveness	[1-5] x 5 (1 = best)	
Spread to other objects	[# of objects involved in fire] x 5	
Creativity	[1-5] (1 = best)	

* If action was not achieved = 30.

Building Requirements

Requirement	Details
Money	Each team may spend up to $50 for materials for the project. All materials must be accounted for, even if donated or free samples. Teams will be provided with an Arduino kit which need not be included in their budget.
Structure	The structure will be 18"x12", with a ceiling height of 12". A glass wall will be provided for 1 long wall, all other walls, floor and ceiling must be comprised of solid, opaque materials. There will be two rooms: one 12"x12", the second 6"x12". The ceiling **MUST** be removable, though when put in place should fit reasonably well. The interior must be accessible for inspecting the furniture and for igniting the fire. Systems that reach more than a foot above the roof must be approved prior to construction. Systems must remain within the footprint of the building.
Openings	There must be **one** doorway (6.5" x 2.5") leading out of the front room of the compartment (to outside) and **one** doorway of the same size connecting the two rooms by means of the interior wall. There must be **one** window on two exteriors wall for the larger room (two windows.) Windows must be at least 3" wide and 2" high, not to exceed 9 in^2 in area. Openings may be closed as part of the design, but must be open initially.
Furniture	See Furniture Requirements below. Furniture should be movable, to be put into position by the University team on the day of the test.
Wall & Floor Finish	Carpet must be provided for the floors of both rooms. Curtains for the windows and at least one 3" x 3" "poster" must be included.

Furniture Requirements

Each team must build and furnish their room with the following furniture. The furniture must be representative of real furniture, i.e. materials selected for furniture must be similar to materials used in actual homes and incorporate materials such as foam plastic, cotton, wood, and cloth.

Qty.	Furniture	Size (LxWxH in inches)
Back room (16" x 12")		
2	Bed	6 x 3 x 2, composed only of a polyurethane foam slab (no frame)
2	Desk	4 x 2 x 3
Front room (8" x 12")		
2	Chair	2.5 x 2.5 x 2

Design Testing

Students are encouraged to test components of the design prior to the final burn days to confirm system(s) perform as proposed. This could include testing of individual components or full systems.

The use of Arduino microprocessors and sensors, or similar, are encouraged. These can be used to detect the fire, act as a notification system once the fire is detected or as part of the suppression design. The Arduino programming software is available free online or can be obtained by contacting the Graduate Assistant at the University.