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 virtual environment for the high school). Materials are also provided to enable instructors/mentors to engage students in virtual discussions or breakout group challenges. Once the foundation is established, students work in teams to design creative detection and suppression systems for a small-scale structure. Here, students gain experience in creative design and cooperation while applying fire protection engineering fundamentals. Student teams will be tasked with creating engineering project proposals to defend their designs, with only finalists participating in the final day. The Challenge culminates in a burn day held at a location in central Maryland. Performance metrics are provided (see below) to select award winners in the challenge.

For the 2020-2021 Design Challenge, teams **will not** be building their own apartment structures. These will be completed by current FPE students in the on-campus laboratories. The UMD students will build identical apartment structures for the wall, floor, ceiling, and door and window openings for each team. They will implement the notification and suppression systems as instructed in the team proposals (discussed in the Project Selection section of this report).

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

Email is the preferred means of communication with UMD, though web-based meetings are also available. Our department can be reached through: **enfp@umd.edu.** Additionally, alumni or professional mentors are available to lend assistance to student teams.

Schedule
The annual competition opening event is held in November, 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 buildings will be evaluated using the following rubric.

Judging Rubric	Category Points	Points
Total Estimated cost	[$]/10	
Livability	[1-5] (1=best)	

Detection/Notification Time	[seconds]	
Suppression Activation Time	[seconds]	
Suppression Effectiveness	[1-5] x 3 (1 = best)	
Room spread	[# of rooms with fire] x 15	
Creativity	[1-5] (1 = best)	

Project Selection

Each individual team is expected to complete a Project Proposal detailing the overarching design goals, suppression system design, notification system design, detailed engineering drawings of both systems, and a prospective analysis of the expected efficity of both systems. For the detailed drawings, utilization of a computer-based design software is preferred but **neat** hand-drawn designs are also acceptable.

After each team completes a Project Proposal, each school will vote on 2 designs to submit to UMD staff to be built. These designs should have relatively different suppression and notification systems designs, e.g. a single school should not submit two designs that both incorporate water-based suppression systems and Flame Detector notification systems.

Building Requirements

Requirement	Details
Materials	All materials must be accounted for in a Schedule of Materials submitted with the design proposals. Please reference the attached materials inventory (To be Included Later) for a summary of acceptable materials to utilize.
Structure	The structure will be 18"x12", with a ceiling height of 12". The apartment structure will be provided, completely built, to each selected team. Walls, floor and ceiling will be comprised of provided materials. There will be two rooms: one 12"x12", the second 6"x12". The ceiling **WILL** be removable. The interior needs to 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 is one doorway (6.5"x2.5") 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 is one window on 2 of the 3 exterior walls for the larger room (two windows.) Windows are at least 3" wide and 2" high, and do not exceed 9 in^2 in area. Openings may be closed as part of your design, but must be open initially.
Furniture	See Furniture Specifications below.
Wall and Floor Finishing	The floors of both rooms are to be carpeted. Curtains for both windows or two 3" x 3" "posters" will be included to provide for realistic wall fire loading.

Furniture Specifications

The furniture of the apartment will be provided within each building structure. The furniture will be representative of real furniture, i.e. materials selected for furniture will 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 16)		
2	Beds	6 x 4 x 2 (bed will be lifted 1 in. above the floor)
2	Desks	5 x 3 x 4
2	Dressers	2.5 x 1.5 x 4
Front room (8 x 16)		
2	Chairs	2.5 x 2.5 x 2

Notification System Options

Due to the inability for teams to build their own structures, we will be offering the following 5 notification systems for teams to choose from:
- Arduino linear heat detector*
- Arduino flame detector*
- Arduino smoke detector*
- Mouse trap
- Popcorn kernels

NOTE: The Arduino systems (marked with an asterisk) will be preprogrammed, but teams need to decide where in the structure they would like the sensors to be located. Once activated, the sensors will trigger an LED light to flash, serving as the notification for the apartment. The other 2 systems will achieve notification requirements without programming, and teams are encouraged to be as creative as possible in the implementation of these systems. Designs should comply with the previously discussed building requirements, and only utilize materials listed in the included Schedule of Materials (To be Included Later) unless permission is obtained from UMD support staff.

Suppression System Options

Due to the inability for teams to build their own structures, we will be offering the following 5 suppression systems for teams to choose from:
- Water
- Baking soda
- Sand
- Fire suppression blanket
- Fans*

NOTE: The Arduino systems (marked with an asterisk) will be preprogrammed, but teams need to decide where in the structure they would like the sensors to be located. Though teams are limited to the above options in terms of general suppression methods, they are encouraged to be as creative

as possible in designing the specific aspects of their system. Designs should comply with the previously discussed building requirements, and only utilize materials listed in the included Schedule of Materials (To be Included Later) unless permission is obtained from UMD support staff.

Arduino Software Usage

The use of Arduino microprocessors and sensors, or similar, are encouraged. These can be used to act as a notification system once the fire is detected or as part of the suppression design. The Arduino programming software is available, for practice and learning purposes, free online or can be obtained by emailing enfp@umd.edu.

Restrictions

No design may include any explosive item. Also, any batteries used in the design must be placed at any location outside the structure, other than on the roof.