Building Escape Rooms to Increase Student Engagement in First-Year Engineering Classes

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Duncan Davis is an Assistant Teaching Professor in First Year Engineering. His research focuses on using gamification to convey course content in first year classes. Mostly recently, he has implemented a series of escape room projects to teach engineering to first year students through the process of designing, prototyping, and refining these play experiences.

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This complete evidence-based practice paper will discuss building escape rooms using programming, computer aided design (CAD), engineering design, and prototyping to teach first year engineering students the fundamentals of engineering. An escape room is a cooperative play experience where a team of players solves a series of puzzles in a set amount of time to win. In the work described here, students design and build escape rooms containing puzzles made using Arduino hardware, laser cut and CNC milled parts, and 3D printed models.

Students become more invested in their education when they find the course content interesting and engaging. First year engineering students were enrolled in an introduction to engineering course that has used themes including robots, sustainability, and games to encourage student participation with course materials and foster student engagement through open-ended projects. Here, we describe and analyze the use of a new theme: escape rooms and puzzles.

Throughout two semesters, students are required to create three projects.

1) Individual students design a puzzle using the engineering design process to iterate on their ideas until they make an innovative and interesting project.
2) Groups of 3-4 students make a tabletop escape room contained within a small box to encourage the creation of an escape room experience with smaller components. The students make 3-4 puzzles using Arduino hardware, laser cut or CNC milled parts, and inspiration from course content. They also choose a theme and story to link the puzzles together with a narrative.
3) Each class works collaboratively together to make one big, traditional escape room. In this project, students are divided into small groups and larger committees. The small groups make two puzzles, a fabricated object (cabinet, skee ball machine, mirror maze, etc.), and a 3D printed object linked to their puzzle. The committees help link all the groups together by deciding the flow of the puzzles, the narrative of the room, the look and design of the room, and the marketing of the room to the local community.

In spring 2018, we had over 200 unique people come onsite to play through four escape rooms built by first year engineering students. Surveys were distributed to the students at the beginning, middle, and end of each semester as well as the community participants who played through the finished escape rooms. Final analysis of these surveys are presented in the paper.

Introduction

An escape room is a group activity where a team of players is locked in a room and must solve a series of mental and physical challenges to discover how to escape from the room. Often escape rooms will employ a series of themed puzzles within a larger narrative to make the story come alive as the players discover plot twists and unexpected clues to the puzzles throughout the narrative. As of 2017, over 2,800 escape rooms exist worldwide[1]. Escape rooms have become a phenomenon with varying themes such as zombies, mad scientists, bank heists, detectives, haunted houses, and ancient tombs[2]–[4]. Primarily designed for fun, educators have started using them to convey and test content in their classes. Escape rooms have captured the attention of various disciplines across universities in departments that include education[2], nursing[3], chemistry[4], pharmacy[5], [6] , and surgical medicine[7].

An escape room designed purely for fun lends itself to teaching the participants leadership, communication, and other soft skills[2]. Researchers created a pilot program for 13 participants to test how well students learned the intended soft skills and found that the students engaged well with their experience[2]. They extrapolated their preliminary findings to make a framework for how other institutions could implement the escape room activity into their curriculum. They sought to prove that escape rooms have intrinsic educational value and made a framework to implement these projects on a small scale.

Escape rooms have also been used to deliver course content[3]–[7]. These rooms were built for different class sizes from 10 - 150 students depending on the needs of the institution. In surgical medicine, the researchers used a Vascular Surgery-themed escape room to increase student motivation, satisfaction, and engagement in CanMEDS roles for a class of 13 students[7]. Researchers taught introductory level pharmacy via escape room to 141 students[5] and 83 students[6] in two different universities. The flexibility in teaching both small and large classes make escape rooms effective for many different classrooms.

Here, the escape rooms are implemented in Cornerstone, an introduction to engineering course for first year university students that implements project-based learning. Previous studies on Cornerstone have shown its effectiveness as an introduction to engineering course [8]–[11]. The Cornerstone course teaches students the basics of AutoCAD, Solidworks, C++ programming, Matlab, Arduino, engineering ethics, and engineering design. Throughout the course, we use lecture, classroom activities, homework assignments, exams, and quizzes to teach and reinforce these concepts. We connect these disparate topics through a theme. Unlike other Cornerstone classes, our theme is escape rooms.

Methods and Results

Throughout the class we facilitate three bigger projects to reinforce the learning objectives. First, we assigned a Puzzle Project to ensure that students could demonstrate the fundamentals of making puzzles in an engineering context to carry fundamentals to the next project. Second, we assigned the Tabletop Escape Room project to teach the students to work with milestones and

plan their long term project effectively in addition to learning course objectives with some expansion on previous skills and concepts. This project allowed students to express a level of creativity with their puzzles, while demanding a specific skill set dictated by the learning objectives. Lastly, we assigned the Traditional Escape Room project which kept the open-ended nature of the previous projects while having the entire class build one escape room. This project requires all the skills accumulated throughout the course and a comprehensive understanding of the learning objectives.

Puzzle Project

To learn the basics of puzzle design, the students are required to make a puzzle using only simple office supplies as described in the Appendix. The puzzle must fit in a 1 ft^3 space and take 5-10 minutes to complete. These puzzles must be original so simply copying an existing puzzle will not be acceptable. They are graded based on the rubric in Table 1.

Table 1 - The rubric for the Puzzle Project. This table provides an outline of the expectations for the Puzzle Project. For a full grading scale with an exact point breakdown see the Puzzle Project documentation in the Appendix.

A	Innovative, unique puzzle. Leads the user to a solution through its design (without being trivial to solve). Elevator pitch conveyed the idea behind the puzzle and excited the audience.	Reviews show an understanding of another person's work and offers constructive, positive criticism to improve the puzzle.
B	Clever puzzle. Fulfills the requirements above without going above and beyond. Elevator pitch conveyed the idea behind the puzzle.	Reviews offer constructive criticism and would help improve the puzzle on the next iteration.
C	Used an existing, popular puzzle and made few/no unique innovations.	Reviews offer negative/destructive criticism.
D	Handed in a puzzle. Puzzle had trouble functioning or was unsolvable.	Reviews were not handed in or were unintelligible.
F	Failed to hand in an assignment, or handed in a project that did not meet the requirements above.	Reviews were not handed in or were incomplete.

This exercise introduces the students to puzzles from a creation perspective. They are expected to create a new puzzle or combination of existing puzzles to generate a new product with limited material selection and time. Within game design, "restrictions breed creativity"[12]. By heavily restricting the material selection, we force student to be more creative. This project also follows the engineering design cycle.

The engineering design cycle is a series of steps used by engineers to define problems, generation solutions, evaluate their solutions, and iterate upon their ideas until a problem is solved. Here, students follow the ideation and fabrication steps in a practical way to gain a sense of the whole design process.

When the projects are due, the students play their classmates' puzzles in class and submit a review of three of the puzzles they attempted. This process allows them to experience a variety of different puzzles, evaluate their peers, and understand how different kinds of puzzles lead to different user play experiences.

Lastly, this project prepares students to make puzzles for the next two projects. Once they learned how to create a puzzle from conception to implementation, it is easier to make future puzzles and to think through what types of puzzles are suitable for creating particular play experiences. In addition, playing their classmate's puzzles gives the students exposure to a wide variety of different puzzles. Through playing many different puzzles, students were exposed to different techniques, goals, and styles of puzzles. Synthesizing these ideas, the students were better scaffolded for making more complex and unique puzzles. The puzzles created with this project act as a starting point in the ideation step for future projects.

Tabletop Escape Room

Within the board game industry, developers such as Kosmos, Asmodee, and Spin Master created an escape room experience contained in a small box. These games allow a team of players to solve a series of problems from the comfort of their home while providing an experience similar to traditional escape rooms. We converted this product to a project for first year engineering students by syncing the requirements for the puzzles with the learning objectives of the course. The course topics include C++ programming, Arduino hardware, AutoCAD, and engineering design. By syncing the puzzle requirements with course objectives, we ensure that this project aligns the fun elements of making an escape room with the course content. The full project description is in the Appendix but it is summarized here:

This project assigns teams of 3-4 students to work together to build a tabletop escape room. They must build a project that contains the following:

- One Puzzle using Arduino/Sparkfun hardware
- One Puzzle using laser cut or CNC milled parts
- One Puzzle using one of the following concepts:
    - Orthographic projection
    - Branching computer logic in an analog puzzle

- The cycle of engineering design
- A puzzle inspired by coursework from Cornerstone

o One decoder (acrylic or wood) – similar to what is in the published tabletop escape games
o Instructions are typed and presented in a clear and concise format

Escape rooms created by the small groups differed vastly, as students have contrasting creative design ideas. **Figure 1** shows two different Tabletop Escape Room projects. Each project has the same requirements, milestones, and rubrics, but vastly different final products.

Figure 1 - Two examples of Tabletop Escape Room projects created by students. The groups used acrylic, wood, and laminated paper to create polished projects. (Left) The players are trapped on an island and must traverse a cave and steal a pirate ship to escape. (Right) The players are on a luxury cruise when their boat starts to sink. They must escape from the vessel before drowning.

Milestones mimic the engineering design process and create periodic deadlines to keep students on track to successfully complete the project. They set completion goals for the ideation, prototyping, product testing and iteration, and final creation steps. These goals loosely guide students through the engineering process to be successful: they have to generate ideas, design and prototype their puzzles, and iterate upon their projects for the students to be successful.

Thematic decisions and puzzle complexity were at the discretion of each group. The main limits to creative control are based on the requirements of each individual part in the puzzles and the overall 30 minute time limit. For example, since the students need a laser cut or CNC milled puzzle, they will make a physical object the players can manipulate as opposed to an escape room composed entirely of cerebral puzzles like riddles or word games. Since the entire experience lasts a maximum of 30 minutes, no individual puzzle can be too long. The difficulty of each project differed between groups, depending on the complexity of each of their individual puzzles. Ideas for puzzles were generated through ideation sessions, playing published tabletop escape room games, and playing the Puzzle Projects. The published tabletop escape room games

were played by students outside of class, and a group report was written about key features that they enjoyed and how they could change it to could incorporate into their projects.

Each piece of the Tabletop Escape Room project directly requires utilization of a skill learned in class. Creating an Arduino puzzle requires knowledge of basic C++ architecture, and circuit board design involving buttons and lights. Laser cut parts, CNC milled parts, and the decoder require knowledge of CAD software, for which most students used AutoCAD.

At the end of the semester, we hosted an Escape Room Expo where students, faculty, and staff were able to play the escape rooms the students created. The event was conducted for 6 hours with available puzzles rotating every 2 hours. Anecdotally, participants enjoyed playing through the escape rooms, but no formal feedback was collected from the participants. We gathered feedback from the students as discussed below.

Traditional Escape Room

Students were assigned a project to construct a full-sized escape room within a university classroom. The full project description is in the Appendix. The escape room was run for a 9-hour period on a Saturday, where participants were given the opportunity to register online in advance for an attempt to solve one of four different rooms.

Throughout the semester, milestones toward completion are assigned to maintain student progress. These milestones consist of students presenting or playtesting what they fabricated in accordance to the milestone guidelines in the Appendix. Necessary skills for each milestone are taught in class, and students can enhance their skills to create higher quality products outside of class. Prototyping products was required. Some groups went through 3-4 iterations before deciding upon a final design. The class teaches Solidworks and AutoCAD, so students are able to use their drawings in conjunction with laser cutting, 3D printing, and CNC milling to make their prototypes and final product.

Students worked in ‘small groups’ of 3-4 people to complete a fabricated object, 3D printed object, and two puzzles. The entire class had one theme, so we divided that theme into various topics and distributed them to the groups. Puzzles were designed by the groups, and critiqued by the whole class and the professor, with peer review sessions incorporated into 3 of the 5 milestones. Of the two puzzles created by the small groups, one is used in the final Escape Room and the other is used in the waiting room. The waiting room is the staging area outside the escape room where participants wait for their turn to play the escape room. During the first year of implementation, we did not have waiting room puzzles. Instead, the puzzle that was not selected by the flow committee was discarded and not used further. Most students construct their modules in the First Year Engineering Learning and Innovation Center (FYELIC), where tools and equipment are available to students free of charge. The following is a more detailed description of the project requirements:

- Fabricated object – Make a themed object from scratch. Usually this will be part of your puzzle, but they can also be hiding places and objects of interest in the room. For examples: Puzzle boxes, a small chest of drawers, the apparatus used to play your puzzle, or theme appropriate furniture (still needs to be portable). **This object should be small enough for one person to carry it without assistance.**
- 3D printed object – Using Solidworks to make the object, each team will 3D print a small piece(s) used in their puzzle and/or fabricated object. Examples: Three different colors of numbered keys, a dodecahedron that holds a message, a figurine that must be taken out of the room with you, or the treasure hidden in your puzzle.
- Puzzles – each group will make two puzzles. They will contribute one puzzle to the escape room and one to the waiting room (the staging area outside the escape rooms where teams wait to play the room they signed up for). **Please make one hard puzzle and one easy puzzle.** The Flow committee will decide which puzzle from each group will be used for the room. The waiting room will have the rest of the puzzles for people to play while they wait their turn to play the escape room. Waiting room puzzles are discussed more below.

Themes for the small groups come from a classwide ideation discussion on theme-appropriate puzzles and objects. Each student votes to decide upon an escape room theme for their class. That overall escape room theme is subdivided into topics that are split up among the groups. This prevents the groups from independently creating the same puzzles and objects. This method allows student choice while allowing groups to work on the topics most interesting to them. Some examples that required Arduino hardware in a "Circus" themed traditional escape room were: a "carnival games" topic that led to a skee-ball machine scored by an Arduino program, a "fun house" topic that led to a laser maze with an Arduino photoresistor, and a "fortune teller" topic which lead to a Zoltar-inspired fortune teller machine controlled through Arduino (Zoltar is a famous brand of mechanical fortune tellers). An example of one traditional escape room is shown in **Figure 2**.

The introduction to the project and the milestone assessments are done during class time, while construction of the projects are done outside of class. Students construct their projects in their own creative vision. Materials, electronics, and methodology are all decided by the students, with the instructor available for advice or troubleshooting on particular parts. Generally, students gravitate toward cost-efficient materials like plywood and acrylic. Many groups use Arduino hardware and sensors to add an electrical component to their project. Woodworking was done using either a CNC mill, a laser cutter, or hand tools such as a chop saw or a table saw. The FYELIC and the library provide access to CNC mills, laser cutters, and 3D printers.

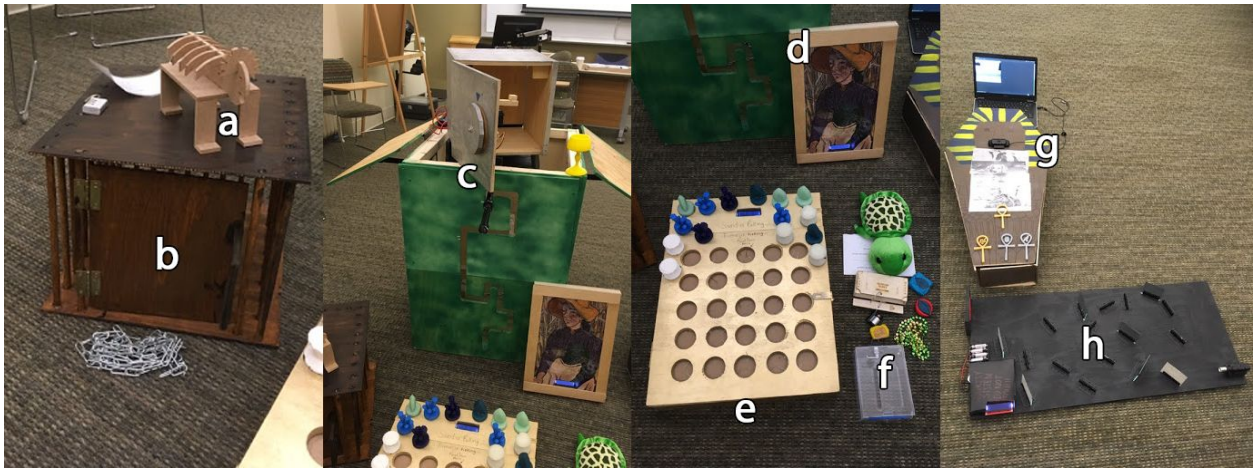

Figure 2 - Components from one traditional escape room with a museum heist theme. Students built the following puzzles and objects: (a) a dinosaur that made a math equation when built, (b) a cage that must be searched for a hidden key, (c) a mechanically locked safe bound by chains and hidden in a green puzzle box, (d) a framed picture with touch sensors that are pressed to receive a code, (e) gems placed in an hourglass pattern to complete an electrical circuit, (f) clay artifacts in a display case used to link color words to numbers, (g) a photo recognition puzzle using a camera imbedded in a sarcophagus, and (h) a mirror maze that connects a laser to a photoresistor.

During the milestones, students play the puzzles made by their peers and give feedback to help improve the project. They also submit these opinions to the professor in a report as discussed in the Appendix.

Each group gives one of their members to one of the four committees: Narrative, Flow, Infrastructure and Marketing. The Narrative committee writes a theme appropriate story about the room to immerse players in the experience. They name the room and tell the players why they are trapped. The Flow committee link together the puzzles made by the small groups and create a master document to help volunteers run the rooms at the end of the semester. The Infrastructure committee creates a bigger fabricated object that would be too complex for one small group. They also design the layout of the escape room. The Marketing committee advertises the room to the student body through student-designed flyers, and run signups for launch day. They also make a digital signup sheet and a poster for the waiting room puzzles. These committees meet on certain class days to set goals for themselves, and communicated with the professor to ensure that deadlines for milestones were met.

The class was largely independent for the small groups, but when it came to construct the room during the milestones and final event, the committees coordinated how to combine the small groups into one final product. Communication between committees was a challenge in the first year of implementation, as there was no efficient method of communicating without some form of mismatched contacts, misinformation, or loss of information. Currently we use Slack, a

communication software, to alleviate these issues. Using Slack, every member of the committee is guaranteed to be in the discussion on the appropriate channel once added to Slack in the beginning of the semester. No one is left out of a meeting that they could not make or a text thread they were forgotten on.

The traditional escape room is the culmination of the individual pieces of every group and committee in the class. If any group fails, the entire project suffers. Therefore, students have an extra level of responsibility to the class as opposed to just their team or themselves. We plan to look at the effect of accountability to the whole class in a future paper.

At the end of the semester, we simultaneously ran four escape rooms for 9 consecutive hours in an event where students, faculty, staff, and community members were able to play the escape rooms in teams of 6-8 participants. We gathered feedback from both the participants and the students as discussed below.

Discussion

We assessed the projects through survey feedback, course evaluations, anecdotal observations, and comments from participants. Overall, students enjoyed working on the escape room projects and the participants loved playing through them. At the end of each semester, the university conducts course evaluations. A general, free response question about the course saw 19% (N = 99) of the students mention the escape room projects. Of those comments, 68% were positive. The following are examples of these responses:

> "The strength of this course is giving students projects to work on and then letting them run with it and make their own creative solution"
>
> "I was very proud of the outcome of our project this semester."
>
> "It may be the only time in your engineering career where your homework is to make an Escape Room, so get into it! It will be more enjoyable if you actually try."
>
> "He makes the class fun and interesting, and his puzzle theme is engaging! "
>
> "The long term team project really puts all the onus onto you and your team. It is a good taste of what projects will be like in the future of college and I liked the responsibility to set my own deadlines and get things done on time."

At the end of each semester, we give the students a chance to provide feedback to improve the final escape room project for the following year. Over the course of the project, 54% (N = 82) of students volunteered constructive feedback. The two major requests from students were to 1) increase the number of responsibilities in the projects and 2) to enable the committees to better plan or organize their pieces of the project. In response to these requests, in second year of implementing this theme, we added a 'waiting room' puzzle to the responsibilities of the small groups and adopted Slack as the group communication tool. To fill the waiting room, students

will make two puzzles for the early milestones. The Flow committee decides which puzzles will be used in the escape room and which will go to the waiting room. We started using Slack to coordinate the committees during the traditional escape room project. Using Slack, students were able to fix problems in real time, coordinate meeting outside of class, and ask the instructor for feedback throughout the design process.

Through creating the escape rooms, students enjoyed learning the fundamental engineering topics. They enjoyed having the freedom to go in a number of different directions and work together to make a product they were proud of. The students embraced giving constructive feedback to make future iterations of the project better, showing that they care about the future of the project more than simply the grade they received for their work. They want the next year to be better than the year before it.

In spring 2018, we had over 200 unique people come onsite to play through four traditional escape rooms that were student built. After finishing the escape room, 88 participants filled out the feedback forms written by the Marketing committee. On a 1-10 scale (10 highest), the escape room event earned a 8.2 ± 1.7 on enjoyment and a 7.3 ± 2.2 on aesthetics. Given the positive reception to the escape rooms, we plan to expand the project in future years.

Conclusions

Throughout a two semester introduction to engineering course, students complete three milestone-assessed projects based on escape rooms. Through producing the projects, students learn C++ programming, Arduino architecture, CAD programs, and fabrication methods. The Puzzle Project lays the scaffolding for students to become comfortable creating puzzles. The Tabletop Escape Room project teaches the students to make an escape room on a small scale with complete creative control. The Traditional Escape Room emulated a larger company where each group works together to make a final product of which they can be proud.

In the future, we plan to refine the escape room projects to maximize learning course objectives and creating unique student projects. Several universities have expressed an interest in our work, so we will explore this project in multiple contexts and for different courses. We plan to document the feedback of students, participants, and instructors, to examine long term trends in student engagement, participant, enjoyment, and course outcomes. Finally, we plan to explore how students approach open-ended design projects and evaluate their design skills, efficiency, and comfort with open-ended design problems before and after the course.

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Appendix

The following are the handouts the students receive for the Puzzle Project, the Tabletop Escape Room project, and the Traditional Escape Room project.

Puzzle Project:

By class time on the due date, please do all the following:

Design an original puzzle using only paper, cardboard, ink, scissors, tape, pens, glue, marker, staples, and pencils (color okay). The puzzle must fit in a 1 ft^3 space. All puzzles must be portable and cannot be stored in the FYELIC. Brainstorm and come up with puzzle ideas. You may work with other people in the class on the puzzles, but each of you must submit your own unique puzzle (you cannot submit the same puzzle as your teammate). Aim for the puzzles to be solved in 5-10 minutes.

Write clear instructions for how to operate your puzzle. Please include:

- The goal of the puzzle
- Rules of play (what you can and cannot do to complete the objective)
- Any restrictions (for example in Sudoku, no two numbers in the same row, column, or 3x3 grid can be identical)
- If your puzzle is similar to an existing puzzle, it must contain at least one unique twist.

On the due dated, be prepared to give a brief overview of your puzzle to the class (30 seconds – 1 minutes). I will have a timer and will stop you if you go over.

On the due date, we will play each other's puzzles and write a review of at least 3 puzzles (2 pages max – there will be a separate form for that assignment). These reviews will be submitted to Blackboard. The rubric for this project is on the following page.

Rubrics for Puzzle Project

Puzzle Designer's Name:

A	Innovative, unique puzzle. Leads the user to a solution through its design (without being trivial to solve). Elevator pitch conveyed the idea behind the puzzle and excited the audience.	Reviews show an understanding of another person's work and offers constructive, positive criticism to improve the puzzle.
B	Clever puzzle. Fulfills the requirements above without going above and beyond. Elevator pitch conveyed the idea behind the puzzle.	Reviews offer constructive criticism and would help improve the puzzle on the next iteration.
C	Used an existing, popular puzzle and made few/no unique innovations.	Reviews offer negative/destructive criticism.
D	Handed in a puzzle. Puzzle had trouble functioning or was unsolvable.	Reviews were not handed in or were unintelligible.
F	Failed to hand in an assignment, or handed in a project that did not meet the requirements above.	Reviews were not handed in or were incomplete.

Puzzle						
Aesthetics/Theme	0	2	4	6	8	10
Used Proper Components	0	2	4	6	8	10
Fun + Hard (Subjective)	0	2	4	6	8	10
Innovation/Creativity	0	2	4	6	8	10
Instructions	0	2	4	6	8	10
Elevator Pitch						
Did they speak well (Stumbles? Ums?)?	0	1	2	3	4	5
Did they sell their puzzle?	0	1	2	3	4	5
Excitement/Follow through?	0	1	2	3	4	5
Timing (Falls within 30 sec and 1 min)?	0	1	2	3	4	5
Peer Reviews						
Positivity	0	2	4	6	8	10
Constructive criticisms (not just platitudes)	0	2	4	6	8	10
Big picture (Next iteration/escape room fit)	0	2	4	6	8	10

Tabletop Escape Room:

There will be Milestones throughout the semester with different due dates.

Design an escape room composed of 3-4 puzzles, a decoder, and instructions. All puzzle must be portable and cannot be stored in the FYELIC. Work with your groups to come up with puzzle ideas. Aim to make the entire Escape Room take 15-30 minutes to complete.

The Escape Room must be composed of:

- One Puzzle using Arduino/Sparkfun hardware
- One Puzzle using laser cut or CNC milled parts
- One Puzzle using one of the following concepts:
    - Orthographic projection (we will discuss this during a future AutoCAD class)
    - Branching computer logic in an analog puzzle (if-else)
    - The cycle of engineering design
    - A puzzle inspired by coursework from Cornerstone
- One decoder (plastic or wood) –similar to what is in the published tabletop escape games
- Instructions are typed and presented in a clear and concise format
- Full Report detailing design, research, reflection, and solving flowchart
- If the Group chooses to spend money, please do not spend more than $75 (per group) on the project. I expect most groups will spend much less than this amount. Previously, the group average was ~$15.

Milestones:

- MS1) Escape Room Proposal - Theme and Puzzle Ideas
    - 5 min Presentation of your idea + theme
    - 1 page write up of your idea + theme
- MS2) Paper Prototype – Playtestable and Self-review
    - All puzzles made from paper with a rough draft of the rules to guide the players
    - Playtesting on the due date with classmates
    - Reflection on your own escape room and plans moving forward (2 pages max)
- MS3) Fully Playable Prototypes
    - All puzzles must be done (other than minor tweaking)
    - Rules should be done
    - Survey for groups
    - Playtesting on due date with classmates

- Review another group's escape room. What final tweaks should they make between now and their final. Be positive and constructive (2 pages max)

o MS4) Final Product Due
- All puzzles finished and presented coherently
- Rules finalized, concise, and clear
- Full report include research (including solution flowchart)

Milestone 1:

Your presentation must talk about the following:
- Your Escape Room's Theme
- Your 3-4 puzzles ideas (you may change them later or present approximate ideas)
- Each person must talk during the presentation
- How you will implement the decoder

Your report should include the same information as the presentation but in written form. There is a 1 page limit, so these should not be long reports. If you use any pictures in your report, please add them as an Appendix (Appendixes do not count toward page limits). One report per team.

Milestone 2:

You must bring your escape room to class. The non-Arduino puzzles should be a playable prototype. Since we are playtesting, you do not need a final version of the puzzle so that you can change it. If making a paper version is too difficult, you may bring a version that is closer to a final version.

For the Arduino puzzle, please bring a working version if you have finished it. If you do not finish it, you may bring an incomplete version or simpler version with a detailed flowchart or description of what the final version would do. Both versions will be worth full credit.

You will play some classmate's escape rooms and then provide them with feedback on how to improve it. Be positive and constructive! Then, each group will write a report on the feedback given to them and their pathway forward (what are your plans on how to finish the project). This report will have a 2 page max and should include a quick introduction to your escape room, a summary of the feedback given to you, and how you plan to proceed (what changes will you make, how will you address the concerns given in the feedback, etc.). One report per team.

Milestone 3:

You must bring your escape room to class. We will play through another group's escape room and review it. The first one you play you must review, but you may end up playing more than 1. All of your puzzles should be done (if you need to make a minor tweak or two, it will be allowed but they should be done). The rules should be finished and typed. Our Escape Rooms

can be more guided than the Exit Escape Games. If you want to give less guidance, give the basic rules at the beginning and say they will discover more as they play.

This Milestone will also have a group survey where you will talk about how your group is working together and how much effort each group member is making (is anyone not pulling their weight or overly controlling of the project?). If you have problems earlier than this, please come talk to me in my office (office hours, setup a meeting via email, or come whenever the door is open). I consider these surveys in your final grades for the projects.

In the review, talk about how their Escape Room worked. Did the puzzles all work? Were they too hard or too easy? Did the flow make sense? What tweaks could this group make to improve the final product? Be constructive! Be Positive! One report per team.

Milestone 4:

You must bring your final escape room to class. After class, we will bring them over to my office to store until the Escape Room Gala (we will talk about this more in class). Each group will have a chance to show off their final escape room and then we will play the final version of any group(s) you have not played thus far. In the final version, you will need a box to store your escape room. The final report is described in a separate document. Please see that document on Blackboard for more information on the final report. The final reports are individual, so each group member will submit their own report.

For MS4, you should have Hint Cards for your puzzles. They should help the user finish it with the 2nd or 3rd club making the puzzle 'too easy'. Please also make a solution card for the escape games. You must also make a container to protect your Arduino wiring. These can be simple and are mostly to avoid wires getting pulled out onsite during the Expo. Finally, you need a container that can hold your entire escape room. This is to avoid losing parts when transporting the games from my office to the Expo and back. I recommend making it out of wood of plastic. If you make it out of cardboard, please make it look nice!

Please remember to look at the rubrics before you finish each Milestone!

Traditional Escape Room:

There will be Milestones throughout the semester with different due dates.

Small Groups - As a class, we will work together to make one escape room. The class will be broken up into teams of 3-4 students to design pieces of the room. Each team will be responsible for making:

- Fabricated object – Make a themed object from scratch. Usually this will be part of your puzzle, but they can also be hiding places and objects of interest in the room. Examples: Puzzle boxes, a small chest of drawers, the apparatus used to play your puzzle, or theme appropriate furniture (still needs to be portable). **This object should be small enough for one person to carry it without assistance.**
- 3D printed object – Using Solidworks to make the object, each team will 3D print a small piece(s) used in their puzzle and/or fabricated object. Examples: Three different colors of keys, a dodecahedron that holds a message, a figurine that must be taken out of the room with you, or the treasure hidden in your puzzle. I am happy to discuss the viability of any idea!
- Puzzles – each group will make two puzzles. They will contribute one puzzle to the escape room and one to the waiting room (the staging area outside the Escape Rooms where teams wait to play the Room they signed up for). **Please make one hard puzzle and one easy puzzle.** The Flow committee will decide which puzzle from each group will be used for the room. The waiting room will have the rest of the puzzles for people to play while they wait their turn to play the Escape Room. Waiting room puzzles are discussed more below.
- All objects and puzzles must be portable and **cannot be stored** in the FYELIC (First Year Engineering and Innovation Center). Work with your groups to brainstorm and come up with great puzzle ideas.
- Each group may spend a maximum amount of $60 per group of their own money on this project. I expect most groups will spend much less.

Committees – In addition to being in a group, each student will be in a committee to help connect the pieces together. Within your small group, decide who will represent your team in each of the following (groups that have 3 students will lack representation in one group):

- **Narrative** – This committee will write the story behind the escape room and decide where to hide tidbits in the room. They will guide the creation of the escape room to make sense and feel immersive. They will make laminated story sheets for the room and decide on the title for the escape room.
- **Flow** – This committee will thread the puzzles together to make a cohesive escape room. They will divide each small group's puzzles between the escape room and the waiting room. They will also make a "Master Flow" document that contains every puzzle in order with hints

and solutions to aid the students monitoring the players playing through the room when we run the rooms at the end of the semester.

o **Infrastructure** – This committee will design the layout and background materials for the escape room. They decide the placement of the puzzles and control when each area of the room open. They will need to work with the Flow committee to make sure the right pieces are available at the right time. In addition, as a committee, they will build a piece of furniture for the room based on the theme of the room.

o **Marketing** – This committee will make a flyer that we will hangout around campus to advise the escape room. They will manage the online signup form and will make a feedback form for their escape room. They will also manage student volunteer signups for helping out while we are running the rooms for the general public. They will make a poster advertising the waiting room puzzles for this class. They will need to work with other classes to keep our marketing strategy aligned across all classes.

Milestones:

o MS1) In class you will present to the class about your planned project for up to 5 minutes. Must include:

- Summary of your puzzle ideas (at least 2 completely different puzzles).
- A description of both your 3D printed and fabricated object.
- Bullet points of your plan to make both objects and both puzzles. Include an estimate of how long each step will take.
- Submit the presentation on Blackboard on the date listed.

o MS2) In class you will play your classmates puzzles and critique their objects. You must bring:

- Precision drawings of both the fabricated object (any program) and the 3D printed part (Solidworks). Please include dimensions for both. I recommend using orthographic projection to describe your fabricated object fully. Please keep the theme in mind: A teleportation pad does not belong in a Gothic Castle library.
- A playable paper prototype of both the hard and easy puzzles.
- **Due date on Blackboard** – Post on the class Slack channel and submit on Blackboard a 1 page write up of how your puzzles (each one separately) could **work with your fabricated object and 2 other groups' fabricated objects.** (1 per group). In addition, you must comment on 2 other people's posts on slack before Milestone 3.

o MS3) In class you will present your creations and then play/provide feedback on your classmate's projects. Bring the following to class:

- Final versions of the puzzle chosen for the escape room (based on Flow committee decision) and the 3D printed object. **The puzzle used in the waiting room does not need to be brought on this day. It needs to be finished by Milestone 4.**

- Rough construction of fabricated object. It needs to be functional but does not need to be perfect.
- Group led presentation of your work so far (~2 min/group). Please include a status update and a future plan for each object and puzzle. This do not need to be a power point, but you could present slides if you would like.
- **Due date on Blackboard** - Reflection on your committee's progress and how your small group's project (puzzles and objects) fits into your committee. If there is not a lot of overlap between your group and your committee, talk how your small group's project fits into the escape room instead (2 pages max, 1 per individual).

o MS4) In class, half of the class will play through the escape room (in groups of 6-8 people at a time). Everyone else will playtest the waiting room puzzles.

- Your group's contribution to the escape room should be done other than minor tweaking (1 puzzle, 3D printed object, and fabricated object). You will get a chance to modify your waiting room puzzle.
- We will setup the entire escape room and have small teams of 6-8 people play through it while everyone else tests the waiting room games. Once a group finishes, we will reset the room and send another group through.
- **Due date on Blackboard** - Reflection on waiting room puzzles you played. What were you favorites? Are there any last minute changes that would improve one of these puzzles? Be positive and constructive (2 pages max, 1 per group)

o MS5) In class, we will setup the escape room. Anyone who did not play through the escape room will get a chance to try it. Everyone else will play the final versions of the waiting room puzzles. Everything should be done by this point.

- All groups and committees are finished
- **Due date on Blackboard** - Full report about the escape room, your critique of it, your contributions to your group and to your committee (1 per individual).

We will be running the rooms on the Saturday after MS5 from 12 pm – 9 pm. During this time, I will need volunteers to help me setup and run the rooms. Each shift will be about 1.5 hours long. We will discuss this more in class.

Final notes:

I recommend designing your puzzle first and then figuring out an object that would make your puzzle more interesting. For example, an object could be used directly in a puzzle, it could have the puzzle hidden inside or around it, it could provide hints to help solve the puzzle through its shape or design, or something completely different.

When making the 3D printed object, plan to make something smaller than 3" by 3". FYELIC determines whether they can print the object based on how long it take to print, so smaller

objects will be easier to print. **Please do not make boxes, marbles, or other very simple objects – show me that you understand how to make something more complex than that!** Take advantage of our 3D printers!
Fabricated objects are intended to be something your team builds out of materials like wood, plastic, metal, etc. Use this opportunity to show me your fabrication skills with hand tools and power tools (available in the FYELIC).

Waiting room puzzles need to be played without a person resetting them. To accomplish this, each should include the following in the rules:

- The contents of the puzzle and starting positions of the puzzle pieces
- How to play the puzzle
- How to reset the puzzle once you are done