ME218a Smart Product Design

ME 218a Fall 2014 Project
ARMed & Ready:
Distributed Operation Of Mechanical Systems to Destroy All? Yes!
Around the World with 20 DoomsDay Machines
Project Presentations on November 19, 2014 starting at 10am

Background:

Having SPDL on your resume has gotten you and the rest of the ME218a class kidnapped by the Evil Villain DrEd (pronounced dread). DrEd's latest plot for world domination involves destroying the beloved landmarks of the world with DoomsDay devices. He is forcing each team to build a mini-Dooms-Day device suitable to destroy one of the world's landmarks. The device must be camouflaged to blend into the landscape and avoid detection

You however, having moral fortitude, intend to design a back-door into your devices to be able to disARM the devices and thwart DrEd's Nefarious Plan. DrEd wishes to take the world by surprise so all of your devices will be networked to show their status on DrEd's Giant Red Button of Destruction.

Your device needs to be attractive enough to inspire everyday people to become Heroes by disARMing the Distributed Destruction Mechanism (DDM). Because there is a hero deep inside each of us, your device must be able to be disARMed not only by your fellow ME218 hostages, but also by common civilians (including children, 218 alumni, and random people off the street) who may know little of the technology involved. Your design should be suitable and appropriate for viewing and use by a multitude of interested potential Heroes of all ages.

The DDMs will be deployed across the world (that is, on tables in the Bldg. 550 Atrium ☺). Keep this in mind when designing your machine.

Purpose:

The underlying purpose of this project is to give you some experience building an electro-mechanical widget. We expect that this will involve working with sensors, driving actuators, designing event driven software and implementing that software in C on a Tiva LaunchPad. These are the elements that we expect to see in every solution.

Your lab kit contains sensors, signal and power transistors, although you are not limited to using only the parts in your kits. You are, however, limited to an expenditure of **$160.00/ team** for all materials and parts used in the construction of your project. Materials from the lab kit or the Cabinet Of Freedom do not count against the limit; all other items count at their Market Value.

On the night of the presentations:

Heroes will be made across the world (that is, in the Atrium of Bldg. 550 (our classroom building)) where the DoomsDayMachines will be presented. They will be distributed around the world (that is, in the Atrium of Bldg. 550). The guests will wander around the room visiting the various landmarks and finding their inner hero while disARMing the different teams' DDMs. You should strive to make the disARMing experience an exciting, active, electro-mechanical one. *Give the world not the HEROES that they need, but the HEROES that they deserve.*

Specifications

DDM Operation:

- ☐ The DDMs will power up into an ARMed mode. Whenever the device is in this mode it should create a display to maximize Fear and Panic.
- ☐ We all know that the attention span of the average Hero is very limited, so the average Hero should take approximately 45 seconds to interact with your DDM in order to disarm it. No one except Sean Connery's James Bond should be able to complete the process in less than 30 seconds.
- ☐ Each DDM should include a creative display of the passage of time since the Heroes have started to disARM the device. **7-segment displays don't count**.
- ☐ In order to avoid distracting the Heroes while they are disARMing the DDM, the display inspiring Fear and Panic should stop.
- ☐ In true Evil Villain fashion, the DDM should re-ARM if not completely disARMed within 60 seconds.
- ☐ To insure that DrEd does not discover your back-door, disARMing a DDM should include interactions with two users. It should be impossible for DrEd to disARM the device by himself.

- ☐ To prevent discovery of your back-door while developing your device, the disARMing of the DDM should require coordinated interaction between the Heroes and disARMing should not progress without the active involvement of both Heroes.
- ☐ DisARMing your DDM should involve at least 3 distinct user interactions. The Heroes are in it for the Glory so each Hero must participate in at least two of these interactions.
- ☐ One Hero's actions should affect the interactions with the other Hero.
- ☐ Your DDM should require large scale motion on the part of the Heroes for at least one of its interactions.
- ☐ When the Heroes succeed in disARMing the DDM, the DDM should provide an exciting audio and/or visual experience that will inspire Hope & Joy in the hearts of tourists everywhere.
- ☐ If DrEd ever discovers that a DDM has been disARMed, he will re-ARM it and seek out the team to take out his anger. To avoid this situation, your DDM should automatically re-ARM 30 seconds after it has been disARMed.
- ☐ The DDM should be usable without human instruction. Any static instructions must be only in pictorial form (Think: Ikea assembly instructions).
- ☐ The DDM must set external line to 5V to reflect ARMed state of the DDM.

Basic Specifications:

- ☐ A team of four class members will construct each DDM.
- ☐ Each DDM must have parts that visibly move under the control of the Tiva LaunchPad.
- ☐ Each team must construct a DDM. While it is permissible to use consumer devices as components, DrEd's intellectual property requirements require that such devices must be substantially modified before incorporation into your project. We don't want you to just buy significant portions of your project. If there is any question as to whether or not the purchased component has been modified significantly enough, please see the teaching staff.
- ☐ Each DDM must respond to at least three distinct inputs/interactions.
- ☐ At least one of the user interactions must be interpreted as an analog input to the Tiva from the user.
- ☐ In addition to the analog input, at least one of the user interactions must involve non-contact sensing.
- ☐ Each DDM must provide the user with feedback about his/her actions. The feedback must include at least one of: haptic/audio/tactile feedback. Multiple modes of feedback, including modes not listed here, are encouraged. The DDM should include feedback on the progress towards disARMing.
- ☐ The complete DDM must be a self contained entity, capable of meeting all specifications while connected only to the project power supply that will be provided.
- ☐ DrEd doesn't like paying bag fees so your DDM must fit into a SPoRTS bag. In order to fit into the trunk of the Batmobile that DrEd stole from ESPN0xFF, the DDM **MUST** fit into a footprint no more than 18" wide by 18" deep by 36" high. During operation, the user interaction may occupy no more than an 24" wide x 18" deep x 80" high volume in front of the DDM. Two DDM must both be usable while sitting together on one of the 5' wide tables in our classroom. The entire DDM must be easily and safely moved from the construction site to the grading session and then again across the world (to the Atrium) for the presentations. Make sure that you plan for this.

- ☐ The emphasis in the project is on *robust* electronics, software and mechanical systems built with *real craftsmanship*. Paint alone does not add to either functionality or craftsmanship. This is not to say that you may not decorate the machine, simply that it should not become a focus. Any painting that is done near the SPDL must be done using appropriate masking so that **no** paint residue is left on the building, furniture, sidewalk, driveways, grass or trees. **No Painting in the SPDL!**
- ☐ While it is normally not a good practice, the finished circuitry may be constructed on your proto-board. This has been done to allow you the maximum time to spend on your project, without having to learn electronic prototyping techniques as well. Be sure to secure the proto-board and connections so that they will not be disturbed by the moving process.
- ☐ Accurate schematics and state diagrams are such a useful aid in debugging that **you should be prepared to show your up-to-date schematic or state diagram to any coach or TA whenever you ask them for help on your project**.

Safety & Hygiene:

- ☐ The DDMs must be safe for both users and spectators.
- ☐ Be considerate of your neighbors in the lab when debugging any audio output; use headphones.
- ☐ DrEd is Evil, but he does not want to destroy the environment so he insists on a strict ban on toxic materials. This prohibition includes Volatile Organic Compounds (VOCs) (i.e. hydrocarbon based spray paints or other noxious fumes). **This prohibition also includes while you are working on the exhibit in the SPDL.**
- ☐ **No Painting in the SPDL!**
- ☐ No part of the DDMs may become ballistic outside the 18"x18"x36" size envelope outlined above.
- ☐ **No pyrotechnics or fire of any kind! Actual bombs are strictly prohibited.**
- ☐ If the DDMs contains any liquids, they may not be conductive (with the exception of water) or corrosive, and **MUST** be packaged in a fail-safe manner.

Check-Points

Design Review:

During the day of November 5th between 8:30am & 5:00pm in various rooms in the Peterson building (our classroom building) we will conduct a design review. Each group should prepare a few **simple** PowerPoint slides (scans of sketches are OK) showing your ideas, a preliminary event list, with responses and a list of how you are going to meet the user interface requirements. **No code, no state diagrams, no circuits**. One member of the team must bring a laptop and any necessary adapters to produce a VGA video signal to be used in connecting to the screen for your presentation. You will present these to other members of the class, members of the teaching staff and coaches so that all may hear about your ideas and provide feedback and advice. **At this time you will be required to identify the core functionality of your proposed design and how it meets the interaction requirements.** *I want my Laser Sharks!*

First Check-Point:

On or before 11/07/14, you must submit a schematic of at least the core functionality initially identified on 11/06 and a refined set of events with details on the responses. Modifications to the core functionality may take place up to this point. A Protel schematic plus a word document describing your core functionality should be left in your "Reports" folder. We'll sweep your "Reports" folder at 5pm. Only one team member needs to submit your check-point documentation. *Every world domination scheme starts with an over-the-top plan!*

Second Check-Point:

On or before 11/13/14 you will be required to demonstrate a minimal level of function:
The hardware & software necessary to do each of the following
sense inputs(at least 3 user inputs)

make decisions (state machine with at least 3 states driven by keyboard input)
implement electro-mechanical actuation for the display to inspire Hope/Joy/Fear and user feedback

Submission of a Protel schematic of your circuit will also be required. *The same thing that we do every night, try to take over the world.*

Third Check-Point:

On 11/17/14 you will be required to demonstrate integrated functionality of all sensing inputs, plus software and timing, plus activating all actuators that will be required. In other words, everything should be complete with the exception of improvements in user experience, and fit, finish, and appearance. *Don't test until you are satisfied. Test until you run out of minions.*

Grading Session:

On 11/19/14 you will be required to demonstrate your fully integrated and finished machine. *No, Mr. Bond, I expect you to die.*

Report:

Draft due on 12/01/14 at 4:00pm. Final version with revisions is due by 5:00pm on 12/05/14. *Shaken, not Stirred*

Evaluation

Performance Testing Procedures:

All DDMs will be tested by a demonstration performed by a pair of team members that should show all of the possible user interactions.

Grading Session Presentation:

Each team should prepare a **30 Sec.** (no more) presentation to introduce the DDM. This presentation should highlight the unique features of the design, **not the circuit details**. As an example, think back to the xylophone descriptions that were played on the first day of class. You will be setting up your DDM, one at a time, and delivering your presentation in room 202 Thornton between 10am & 5:00pm on the day of the presentations. During this time each team and their DDM will be photographed. Starting at 5:00pm you will move your DDM into the Atrium for the public presentation, which will begin at 7:00pm.

Grading Criteria:

- ☐ **Concept (20%)** This will be based on the technical merit of the design for the DDM. Included in this grade will be evaluation of the appropriateness of the solution, as well as innovative hardware, software and use of physical principles in the solution.
- ☐ **Implementation (20%)** This will be based on the prototype displayed at the evaluation session. Included in this grade will be evaluation of the physical appearance of the prototype and quality of construction. We will concentrate heavily on the craftsmanship exhibited by the final product.
- ☐ **Performance (40%)** Half of this (20%) will be based on the results of the Check-points, the other half will be based on the results of the performance testing during the evaluation session. Full performance credit will be given only if the machine works on the first attempt during the grading session. Performance will be judged first on the ability to demonstrate the core functionality and second on any embellishments to the core functionality. **To earn the Performance points, you must demonstrate at least the core functionality.**
- ☐ **Report (10%)** Preliminary project reports are due December 1, 2014 at 4:00pm. The report should be in the form of a stand-alone web site and must include schematics, pseudo-code, header & code listings, dimensioned sketches/drawings showing relative scale, a complete Bill-of-Materials (BOM) for the project as well as a 1 page description of function and a "Gems of Wisdom for future generations of 218ers" page. The web-site must be submitted as **a single Zip file** (7-zip is installed on all the workstations in the lab). It is critical that your report be in the Reports folder on time so that the peer reviewing team will have an adequate opportunity to review it before class the following day. Final versions of the reports, incorporating the review comments are due (also in the form of a single zip file) by 5:00pm on 12/05/14. The front page of your project description must be in a file called `index.html` at the root folder of the web site. Test your zip-file by unzipping it into an empty folder. Once unzipped, you should be able to view the entire site starting from the `index.html` file. **Do not embed video files** directly into your site. If you want to include video, link to a You-Tube or other video sharing site.

- [ ] **Report Review (10%)** These points will be awarded based on the thoroughness of your review of your partner team's report. Read the explanations, do they make sense? Review the circuits, do they look like they should work? Could this DDM realistically be built for $160? If, during grading, we find things that don't make sense or circuits that won't work we will consult your review. If the review caught them, then the team will lose points on their report. If the reviewers missed it, then they will lose points for their review. The report review should submitted be in the form of a word document that you place into one of your team members folders by 4pm on 12/02/14.

Suggestions

We understand that the project definition is probably a bit more open than you might be used to. To help you get your creative juices flowing we offer some reflections that you might want to consider.

- [ ] Don't just think buttons. Think about novel ways to sense an action and give feedback. Remember, you have more than just fingers available to actuate and you are mechanical engineers (at least most of you). Think fun linkages!
- [ ] **The Tao of 218:** Simplicity Leads to Reliability. We are extremely skeptical of the need for more than 2 of your proto-boards to hold the finished circuitry. Remember, you only have 456 hours available to complete the project (and tend to the other things in your life) before it is due.

Resources

- [ ]

www.sparkfun.com	www.adafruit.com
www.seeedstudio.com	www.hackaday.com
www.jameco.com	www.digikey.com
www.mouser.com	www.mcmaster.com
www.newark.com	www.hobbyking.com
www.ponoko.com	www.servocity.com

- [ ] J&M Hobby House in San Carlos
  Jameco in Belmont
  TAP Plastics in Mountain View

Exercise your creativity:

We encourage, and hope to foster, a wide range of solutions to the problem. This will make for the most enjoyable presentation for your audience. There is no 'Best' way to solve this problem, so don't spend time looking for it. While brainstorming, think about how you might parody your favorite Evil Villain. Choose the landmark where your DDM will be deployed. We will maintain a list of landmarks so that not everyone is doing the Eiffel Tower.

Remember that we interact with electronic devices every day. People tend to have more fun with projects that don't try to emulate the look and feel of actual products. ME218 is an opportunity to design things that are fun and whimsical. Take advantage of that.

Make your machine robust:

Your machine must be rugged enough to survive your testing as well as 'testing' by the audience. Don't be timid about playing with your project before the presentation. Play with it as if you didn't know its weaknesses. Let your friends play with it. Find out if it can survive people playing with it *before* the presentation.

While the emphasis in the lecture has concentrated on the electronics, don't forget the mechanical aspect. Historically, machine failures are often due to poor mechanical design or implementation. Pay attention to craftsmanship. It will pay dividends in many ways.

Gems of Wisdom from Past Generations

Will be available on the SPDL Web site. Be sure to check them out for guidance from past generations.