ME218a Smart Product Design

ME 218a Fall 2007 Project: The Mechatronic Penny Arcade

Project Presentations on November 28, 2007 starting at Noon
Public Session begins at 7:00 pm

Goals:

To design and build an electro-mechanical widget that will provide an engaging and entertaining experience for players of your mechatronic penny arcade game. The projects will be viewed and enjoyed not only by your fellow ME218 students, but also by a throng of interested people (including children, 218 alumni and random people off the street) who may know little of the technology involved. You should keep this in mind when designing a project suitable for viewing by all ages. The machines will be displayed and demonstrated on the tables in Terman 556, so design accordingly for this as well.

Purpose:

The underlying purpose of this project is to give you some experience creating an electro-mechanical system. We expect that this will involve working with sensors, driving actuators, designing event driven software and implementing that software in C on the C32 Board. These are the elements that we expect to see in every solution.

Your lab kit contains sensors, signal and power transistors. Although you might be able to construct the electro-mechanical parts of this project using only the parts in your kits, you are not limited to this. You are, however, limited to an expenditure of $150.00/team of three 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 "fair market value".

Setting the Scene:

On the night of the presentations, the games will be arranged around the room in Terman 556 (our classroom). Each guest will be provided by SPDL with a supply of pennies, which will be needed to initiate play at each of the games. The guests will wander around the arcade, visiting and interacting with the projects. People will have only a little time at each game, so you should strive to make the experience an exciting and active electro-mechanical experience.

Fig. 1: A penny

Value: US$0.01 **Mass: 2.5 g** **Diameter: 19.05 mm (0.750 in.)** **Thickness: 1.55 mm (0.061 in.)**

Specifications

Basic:

- ☐ Each Mechatronic Penny Arcade Game (MPAG) must pay homage in spirit to games that you would find in a traditional penny arcade. Concepts may be old or new, traditional or contemporary, conservative or cutting-edge – but the experience of interacting with them must be reminiscent of a penny arcade experience. All MPAGs will involve interaction between the player and the MPAG.

  In the context of this project, the term "game" is intended to be a very general one. Conventional penny arcade games came in a great variety, from traditional challenges like pinball or miniature bowling, to feats of strength, endurance, or eye-hand coordination, to fortune telling. You need not create a "game" in the strict sense of the word – the overall goal is to devise an interactive experience that players find enjoyable, entertaining, rewarding and/or amazing.

  For those not familiar with penny arcades, they were a pre-modern-electronics-era version of video arcade games, with a generous dose of edgy carnival atmosphere. The objective of penny arcades was to attract and entertain players – and to pry as many pennies loose from those customers as possible. Ideally, this is achieved by providing the best entertainment value: the games that are the most fun to play or interesting rake in the most pennies.

- ☐ Each MPAG must dispense Stuff Won in an Arcade Game (SWAG), a reward to players who perform well within the context of the MPAG's theme. The SWAG will be something that players take home with them, and should be highly desirable but not expensive. You should expect to supply a large number of these rewards, both for testing and for the presentations, so choose something that you can easily obtain and bear to part with. The cost of the SWAG dispensed by your MPAG will not be included in the $150.00/team limit.

- ☐ Each complete MPAG must be a self contained entity, capable of meeting all specifications while connected only to the project power supply that will be provided.

- ☐ A team of three class members will construct each MPAG.
- ☐ The team must construct the MPAG. While it is permissible to incorporate consumer devices, such devices must be substantially modified before inclusion into your project. It is not acceptable to simply buy significant portions of your project.
- ☐ Interactions with each MPAG will begin with the insertion of a standard US penny (see Fig. 1) into the MPAG.
- ☐ There must be a minimum of 3 interactions (actions by the visitor) required to fully experience each MPAG.
- ☐ At least one of the interactions should require an analog response from the user.
- ☐ At least one of the interactions must involve non-contact sensing.
- ☐ The time needed to explore all of the interactions in an MPAG (from the insertion of the penny to the completion of interactions) should be in the range of 20-60 seconds.
- ☐ The time for interactions should be limited and a clear indication given when that time has expired.
- ☐ MPAGs must react to user input in at least two separate ways.
- ☐ At least one of the reactions must be electro-mechanical.
- ☐ At least one of the reactions must take on a variable number of levels (at least three). The choice of which level will result should be based on an analog input controlled by the user. The mapping between actions and reactions is up to each team.
- ☐ Reactions from the MPAG should stimulate at least two senses.
- ☐ Clear indication should be given when a visitor has explored all of the possible actions for a given MPAG.
- ☐ The entire operation of the MPAG MUST take place in a footprint no more than 3 feet wide by 2 feet deep. The tables in 556 will be available to hold the MPAG if required. The entire MPAG must be easily and safely movable from the construction site to the grading session and then again up to 556 for the presentations. Make sure that you plan for this.
- ☐ Your MPAG must be usable without human instruction. Think about how you could convey how to interact with the game without a list of instructions.
- ☐ 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 be a focus at the expense of function. Any painting that is done outside the SPDL must be done using appropriate masking so that no paint residue is left on the building or furniture.
- ☐ While it is normally not good practice, the finished circuitry may be constructed on proto-boards. This will 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 all the necessary connections so that they will not be disturbed when the systems are moved.
- ☐ Accurate schematics are such a useful aid in debugging that you should be prepared to show your up-to-date schematic to any coach or TA when you ask them for help on your project.

Initiating Play:

- ☐ Each visitor will insert a penny into the MPAG to begin play. This does not constitute one of the interactions described in the basic MPAG specifications.
- ☐ The MPAG must acknowledge insertion of a penny and begin the timing operations from the time of insertion. This also does not constitute one of the reactions described in the basic MPAG specifications.
- ☐ The MPAG should clearly indicate where and (if necessary) how to insert a penny in order for it to be correctly recognized. Incorrectly inserted pennies should not be acknowledged.

Safety & Hygiene:

- ☐ The MPAGs must be safe for both users and spectators.
- ☐ No live or previously alive animals may be used in an MPAG.
- ☐ No toxic materials. This prohibition includes Volatile Organic Compounds (VOCs) (i.e. hydrocarbon-based spray paints or other noxious fumes). This also includes while you are working on the exhibit in the SPDL.
- ☐ No part of the MPAG may become ballistic outside the size envelope outlined above.
- ☐ No pyrotechnics or fire of any kind.
- ☐ If the MPAG 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 evening of 11/7/07 between 5:00 & 7:30 pm we will conduct a design review. Each group should prepare a few sheets of paper showing your idea(s) and a preliminary software design. You will pin these up to the walls in 556 and members of the teaching staff and coaches will come around to 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.

First Check-Point:

On 11/9/07 you must demonstrate the ability to sense the insertion of a penny and control at least one of the actuators your MPAG will incorporate. You must also submit a schematic of at least the core functionality initially identified on 11/7. 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 copied to your reports folder. We'll sweep your reports folder at 5 pm. Only one team member needs to submit your check-point.

Second Check-Point:

On 11/13/07 you will be required to demonstrate a minimal level of function:
The hardware & software necessary to sense inputs, make decisions based on the inputs and display the activity of actuators on LEDs. A Protel schematic of your circuit will also be required.

Third Check-Point:

On 11/16/07 you will be required to demonstrate integrated functionality of all sensing inputs, plus software and timing, plus activating all actuators that will be required.

Grading Session:

On 11/28/07 you will be required to demonstrate your fully integrated and finished machine. You should have several pennies ready to use to demonstrate your compliance with the requirements.

Report:

Draft due on 12/03/07 at 4:00 pm. Final version with revisions due by 5:00 pm on 12/07/07.

Evaluation

Performance Testing Procedures:

All machines will be tested by a demonstration performed by a team member that should show all of the possible interactions as well as the MPAG response to a time-out.

Grading Session Presentation:

Each team should prepare a 30 second (no more) presentation to introduce the machine. This presentation should highlight the unique features of the design, not the circuit details. You will be setting up your machines, one at a time, and delivering your presentation in room 203 Thornton between 12:00 & 6:00 pm on the day of the presentations. During this time each team and their machine will be photographed. Starting at 5:00 pm you will move your machines into room 556 for the public presentation, which will begin at 7:00 pm.

Grading Criteria:

- ☐ Concept (20%) This will be based on the technical merit of the design for the machine. 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 (see above), 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 12/3/07 at 4:00 pm. The report should include schematics, pseudo-code, header & code listings, dimensioned sketches/drawings showing relative scale, a complete Bill-of-Materials (BOM) for the project and a 1 page description of function. 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 by 5:00 pm on 12/07/07.
- ☐ 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 MPAG realistically be built for $150?

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 and knobs. 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 one of your proto-boards to hold the finished circuitry. Remember, you only have 403 hours available to complete the project (and tend to the other things in your life) before it is due.

Exercise your creativity:

We encourage, and hope to foster, a wide range of solutions to the challenge posed. This will make for the most enjoyable presentation for your audience. There is no single “Best” way to solve this problem, so don't spend time looking for it. While brainstorming, think about the elements you find most engaging and enjoyable in an interactive experience like a game. For inspiration and to get a better sense of what a penny arcade is, you may wish to visit the Musee Mechanique in San Francisco, or learn about it on the Web (www.museemechanique.org) and Wikipedia (http://en.wikipedia.org/wiki/Musee_Mechanique).

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 of other electronic devices. 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.