ME218a Smart Product Design

ME 218a Fall 2016 Project
Automatic Reactive Technology for Mechatronic Art Creation and Human-Interaction,

ART MACHINES: a New Exhibition at Stanford

Project Presentations on November 30, 2016 starting at 10am
Public Session begins at 7:00pm

Background:

Concerned that many Silicon Valley people can't relate to art, Stanford has decided to promote a Technology in the Arts program. As part of this program, students in ME218a have been commissioned to create Automatic Reactive Technology (ART) for the viewing pleasure of the public. Art Reviewers Touring Institutions of Suitable Technology (ARTISTs) will survey the gallery and interact with the various displays. These ARTISTs may not be familiar with the mechatronic aspects of your ART, and so it must be able to be operated not only by your fellow ME218ers, but also by common folks (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 (and potential) ARTISTs of all ages.

The ART will be displayed in the gallery (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 these. You are 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, the Cabinet of Freedom and consumable art supplies[1] do not count against the limit; all other items count at their Market Value.

On the night of the presentations:

Your ART will be installed in the gallery (that is, distributed around the Atrium of Bldg. 550 (our classroom building)) where the ART MACHINES will be presented. The guests will wander around the room interacting with the ART and finding their inner ARTISTs. You should strive to make the ART exciting, active, durable and electro-mechanical. *Art is not what you see, but what you make others see (Edgar Degas).*

Specifications

ART Operation:

- ☐ The ARTs will power up into a welcoming mode, encouraging interaction with the ARTIST. Whenever the device is in this mode it should create a display to maximize its sporadic creativity.
- ☐ Your ARTs must produce either ART2Keep (a take-away piece) or ART2See (a performance).
- ☐ We all know that the attention span of the average ARTIST is very limited, so the average ARTIST should take approximately 45 seconds to interact with your ART. No one except Edgar Degas (ED) should be able to completely evaluate tour ART in less than 30 seconds.
- ☐ Due to the short attention span of art critics, each ART should include a creative display of the passage of the time since the ARTISTs have begun their work. **7-segment displays don't count**.
- ☐ Your ART must require creative input. The ART should reset after the ARTIST stops interacting with the ART within 2 minutes if producing ART2Keep or 30 seconds if producing ART2See.
- ☐ In pursuit of originality your ART should involve at least 3 distinct ARTIST interactions.
- ☐ Your ART should require large scale motion on the part of the ARTIST for at least one of its interactions.
- ☐ If the ART is finished with its ART2Keep, it should provide a clear audio and/or visual indication that will inspire a sense of accomplishment in ARTISTs everywhere. This indication may last no more than 30 seconds before the ART resets.

[1] No glitter!

- ☐ The ART should be usable without the guidance of a Master ARTIST. Any static instructions must be only in pictorial form (Think: Ikea assembly instructions).

Basic Specifications:

- ☐ A team of four class members will construct an ART.
- ☐ The ART must have parts that visibly move under the control of the Tiva LaunchPad.
- ☐ Each team must construct an ART. While it is permissible to use consumer devices as components, copyright concerns 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 ART 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. The analog input must be used to produce some behavior by the ART that makes use of the analog nature of the input. No simple thresholds.
- ☐ In addition to the analog input, at least one of the user interactions must involve non-contact sensing.
- ☐ Each ART 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 complete ART must be a self contained entity, capable of meeting all specifications while connected only to the provided project power supply.
- ☐ Since your ART needs to be transported along the campaign trail to the gallery, your ART must fit into a SPoRTS bag. In order to fit into the trunk of the Batmobile that DrEd (pronounced "dread") stole from ESPN0xFF, the ART **MUST** fit into a footprint no more than 18" wide by 18" deep by 36" high. During operation, the user interaction may occupy a volume of no more than an 24" wide x 18" deep x 80" high in front of the ART. Two ARTs must both be usable while sitting together on one of the 5' wide tables in our classroom. The entire ART must be easily and safely moved from the construction site to the grading session and then again to the gallery (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! And no glitter!**
- ☐ While it is normally not a good practice, the finished circuitry may be constructed on your proto-boards. 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 ARTs must be safe for both users and spectators. Any art supplies used by your ART must be Child Safe, non-toxic, and clean-up with water.
- ☐ Please consider how you will contain any art supplies.

- ☐ No Glitter!
- ☐ Be considerate of your neighbors in the lab when debugging any audio output; use headphones.
- ☐ There is 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 Glitter!!
- ☐ **No Painting in the SPDL!**
- ☐ No part of the ARTs may become ballistic outside the 18"x18"x36" size envelope outlined above.
- ☐ No pyrotechnics or fire of any kind! Ionizing Radiation and bombs are strictly prohibited by the Geneva Convention.
- ☐ No Glitter!!!
- ☐ **If the ARTs contain 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 on November 9th in room 162 & 126 of the Peterson building (our classroom building) we will conduct design reviews. Signups for the hour-long slots for 4 teams will happen via Canvas. Each group should prepare a few **simple** PowerPoint slides (scans of sketches are OK). **No code, no state diagrams, no circuits**. The slides should show your concepts, a preliminary event list, with responses and a list of *how you are going to meet the user interface requirements*. One member of the team must bring a laptop and any necessary adapters to produce a VGA or HDMI 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.** *Creativity is allowing yourself to make misteaks. Art is knowing which ones to keep. (Scott Adams)*

First Check-Point:

On or before 11/11/16, you must submit a schematic of at least the core functionality initially identified on 11/09 and a refined set of events with details on the responses. Modifications to the core functionality may take place up to this point. An Altium schematic in a word document describing your core functionality should be uploaded to Gradescope. Only one team member needs to submit your check-point documentation. *We don't make mistakes, just happy little accidents. (Bob Ross)*

Second Check-Point:

On or before 11/17/16 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 and user feedback

Submission of an Altium schematic of your circuit will also be required. *Computers creating art is an upsetting concept, mostly because of what it means about humans. (Jason Lee Miller)*

Third Check-Point:

On 11/28/16 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. *Art is the stored honey of the human soul, gathered on wings of misery and travail (Theodore Dreiser)*

Grading Session:

On 11/30/16 you will be required to demonstrate your fully integrated and finished machine. *Art is what you can get away with. (Andy Warhol)*

Report:

Draft due on 12/05/16 at 4:00pm. Final version with revisions is due by 5:00pm on 12/09/16. *An artist cannot fail; it is a success to be one. (Charles Horton)*

"Don't short power to ground" (Benjamin Franklin)

Evaluation

Performance Testing Procedures:

All ARTs will be tested by a demonstration, performed by a team member, that should show all of the possible user interactions.

Grading Session Presentation:

Each team should prepare a **30 Sec.** (no more) presentation to introduce their ART. This presentation should highlight the unique features of the design, **not the circuit or software 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 ART, 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 ART will be photographed. Starting at 5:00pm you will move your ART 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 ART. 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 5, 2016 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 actual web-site must be submitted as **a single Zip file** (7-zip is installed on all the workstations in the lab). In addition, if your web- site is hosted, you should include a text file with the URL to your site. 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 plus URL) by 5:00pm on 12/09/16. 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 un-zipped, 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 ART 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 12/06/16.

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. 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.seeedstudio.com`
  - `www.jameco.com`
  - `www.mouser.com`
  - `www.newark.com`
  - `www.ponoko.com`
  - `www.adafruit.com`
  - `www.hackaday.com`
  - `www.digikey.com`
  - `www.mcmaster.com`
  - `www.hobbyking.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, look to your favorite artists for inspiration.

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 and software, 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

Be sure to check out the ME218 Archive (me218archive.weebly.com) for guidance from past generations.