
Goals:

Having SPDL on your resume has landed you a job as part of the top secret Applied Sciences Lab at Wayne Enterprises. As part of the ASL you are charged with developing training scenarios to help Batman prepare to face his Bat-Foes or practice the use of his Bat-Gadgets. You have also been approached by shadowy figures that have made enticing offers to develop similar technology for them...

Batman's Applied Technology Training Scenarios (BATTSSs) 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. Your design should be suitable and appropriate for viewing and use by a throng of interested Gothamites of all ages.

The BATTSSs will be displayed and demonstrated 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 pair of 'C32 Boards. 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** of four 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 Bat-Market Value.

On the night of the presentations:

Everyone will be summoned by the Bat-Signal to the Atrium of Bldg. 550 (our classroom building) where the BATTSSs will be presented. They will be distributed around the Atrium and the space leading to the glass garage door. The guests will wander around the room visiting the various BATTSSs and experiencing the different teams' interpretation of Batman's Applied Technology Training Scenarios. You should strive to make the experience an exciting, active, electro-mechanical one. *Give the audience not the entertainment that they need but the entertainment that they deserve.*

Specifications**BATTSS Operation:**

- The BATTSS will power up into a lockdown mode to maintain Bat-security. The only way to exit this lockdown mode and enter training scenario operation will be the use of a BatID device. The core of the BatID will be an SPDL-supplied module that emits IR radiation in a flashing pattern. The Bat-ID that you build will trigger the module to produce the optical Bat-signal by grounding a pin in a manner of your own choosing. Your BATTSS will be required to detect the optical signal to unlock and start its operation. The BatID (which is a separate device from your BATTSS) must be functional at a minimum of 12" away from the detector. The SPDL-supplied module may be re-packaged and extend outside the size envelope for the rest of the BATTSS, defined below.
- Both Batman and the shadowy figures from Batman's Rogues Gallery demand that the BATTSSs should include interactions with two users. The head of Applied Sciences Lucius Fox has dictated that this requirement be met by assigning one 'C32 to each user's interactions.
- Training is no good without a partner so your BATTSS should not progress without continued input from the two users.
- Batman has limited training time available, so the average Caped Crusader should take approximately 30 seconds to interact with your BATTSS. No one except Bane should be able to complete the process in less than 20 seconds.
- In the event that the users are unable to complete the training process within 45 seconds, the BATTSS should stop interacting with them, return to lockdown mode and indicate that it is ready for new users.

- Your BATTTS's interaction with the users should involve at least 3 distinct user interactions for each Bat-user.
- The process of interacting with your BATTTS should progress through several stages of training, with the BATTTS responding differently in the different stages depending on either user performance or choices
- Your BATTTS should require large scale Bat-motion on the part of the user for at least one of its interactions.
- At least 2 of the interactions with the user must produce different outcomes based on the training stage of the BATTTS. We have a legal responsibility to inform you that attempts to force Batman to choose between people he cares about have historically ended in Bat-punch-related injuries for the scenario maker regardless of how the individuals in peril ultimately fare.
- Each BATTTS should include a creative display of the passage of time. No 7-segment displays.
- Each BATTTS should include an indication of when it is active (and therefore responsive to interactions) and when it is locked down.
- When the users complete the interaction, the BATTTS should provide an exciting audio and/or visual experience that will inspire hope, or strike fear into the hearts of criminals (or citizens) everywhere.
- Each 'C32 in the BATTTS should react not only to events that it detects directly, but also to events seen by the other 'C32 and to the passage of time. Each 'C32 should be capable of conveying at least 8 distinct messages to the other 'C32.
- Interactions with a user on one 'C32 must influence what is happening with the user on the other 'C32.
- The BATTTS must be usable without human instruction. Any static instructions must be only in pictorial form (Think: Ikea assembly instructions).

Basic Specifications:

- A team of four class members will construct each BATTTS.
- Each BATTTS must have parts that visibly move under the control of each of the C32s.
- Each team must construct a BATTTS. While it is permissible to use consumer devices as components, the covert, secret-identity-protecting nature of the Applied Sciences Lab requires 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 BATTTS must respond to at least three distinct inputs/interactions.
- At least one of the user interactions with each C32 must be interpreted as an analog input from the user.
- At least one of the user interactions with each C32 must involve non-contact sensing.
- Each BATTTS 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 BATTTS must be a self contained entity, capable of meeting all specifications while connected only to the project power supply that will be provided.

- In order to fit into the trunk of the Batmobile, the BATTs **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 BATTs. Two BATTs must both be usable while sitting together on one of the 5' wide tables in our classroom. The entire BATTs must be easily and safely moved from the construction site to the grading session and then again 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 or furniture. **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 are such a useful aid in debugging that **you should be prepared to show your up-to-date schematic to any coach or TA whenever you ask them for help on your project.**

Safety & Hygiene:

- The BATTs must be safe for both users and spectators.
- No guns, no killing.!
- Be considerate of your neighbors in the lab when debugging any audio output; use headphones.
- District Attorney Harvey Dent 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 BATTs may become ballistic outside the 18"x18"x80" size envelope outlined above. This is how the Joker got his scars.
- No pyrotechnics or fire of any kind!
- If the BATTs contains any liquids, they may not be conductive (with the exception of water) or corrosive, and **MUST** be packaged in a fail-safe manner. Introduction of fear toxin into the water supply will not be tolerated.

Check-Points

Design Review:

During the evening of November 7th between 6:30 & 10:30pm in **ART 2 (Cummings Art Bldg.)** we will conduct a design review. Each group should prepare a few **simple** Powerpoint slides (4:3 format, .ppt **not** .pptx format)(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.** The presentation files must be in the "presentations" folder on the server by 8pm. You will present these to 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.**

First Check-Point:

On or before 11/09/12, you must submit a schematic of at least the core functionality initially identified on 11/07 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. *Why so serious? Because you need to get going right away!*

Second Check-Point:

On or before 11/15/12 you will be required to demonstrate a minimal level of function:

- The hardware & software necessary to do each of the following independently on each ‘C32
 - sense inputs(Bat-ID and at least 3 user inputs)
 - make decisions (state machine with at least 3 states driven by keyboard input)
 - implement electro-mechanical actuation for end of training display and user feedback
 - communicate at least 8 independent messages back and forth between the two ‘C32s

Submission of a Protel schematic of your circuit will also be required. *Now is not the time for fear. That comes later.*

Third Check-Point:

On 11/26/12 you will be required to demonstrate integrated functionality of all sensing inputs, plus software and timing, full communication between the ‘C32s 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. *We'll find out what breaks first, your spirit or your widget.*

Grading Session:

On 11/28/12 you will be required to demonstrate your fully integrated and finished machine. *Now is the time for fear!*

Report:

Draft due on 12/05/11 at 4:00pm. Final version with revisions due by 5:00pm on 12/09/11.

Evaluation

Performance Testing Procedures:

All machines 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 the machine. 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 machines, 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 machine will be photographed. Starting at 5:00pm you will move your machines 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 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, 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 3, 2012 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 12/07/12. 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 BATTs 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 12/04/12.

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 one 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

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| <ul style="list-style-type: none"> <input type="checkbox"/> www.sparkfun.com <input type="checkbox"/> www.seeedstudio.com www.jameco.com www.mouser.com www.newark.com www.ponoko.com | <ul style="list-style-type: none"> www.adafruit.com www.hackaday.com www.digikey.com www.mcmaster.com www.hobbyking.com www.servocity.com |
| <ul style="list-style-type: none"> <input type="checkbox"/> 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 pantomime your favorite Bat-moments.

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.