

Goal:

The goal of this project is to provide a framework in which you can apply your knowledge of microcontrollers to provide an enjoyable experience for users and observers.

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 and signal & 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 any consumable supplies do not count against the limit; all other items count at their Market Value.

Background:

The date is February 18, 21800 CE. You've been waiting for this day for years, the day the Intragalactic Olympic Committee (IOC) starts accepting proposals for worlds to host the Games of the 4095th Olympiad. It's been a rough couple hundred years in the galaxy, with the rate of supernovae increasing and the saber rattling of various planetary confederations getting louder.

The IOC seems to have taken this into account and wants to make the 4095th special; you want to showcase your homeworld and put it emphatically on the galactic map.

And so, February 18. You've grabbed three of your friends, and you all watch the IOC's descriptions of proposals they want to see. Each proposal should be in the form of an Automated Representation of Kulture (ARK), which can be shipped to the galactic capital for evaluation. The process is strictly democratic;¹ since it's impractical to get the entire galaxy to vote at once, a small, randomly selected group of ALIEN League Intragalactic Event Negotiators (ALIENs) will be brought to the galactic capital, where they will evaluate your ARKs. This year, the random selection was extended to include kids, in an effort to broaden the inclusivity of the Olympics.

Your devices must be at the capital in ten years and two and a half weeks. Since you live way on the outer arm of the galaxy, you only have two and a half weeks to get your ARK built and tested. As always, you want to showcase the best your planet has to offer.

The Task:

Your ARK will be installed in the gallery (that is, distributed around the Atrium of Bldg. 550 (our classroom building)) to be presented to the ALIENs. The ALIENs will wander around the room interacting with the ARK and attempting to visualize the grandest of intragalactic Olympics on your world. You should strive to make the ARK exciting, active, durable and electro-mechanical.

The most important thing in the Olympic Games is not winning but taking part.

Pierre de Coubertin

Specifications

ARK Operation:

- The ARKs will power up into a welcoming mode, encouraging interaction with the ALIEN. Whenever the device is in this mode it should create a display to awe the ALIENs with the majesty of your world.

¹Apparently there had been all sorts of selection shenanigans when the Olympics were first held 20 000 years ago; you think whoever had the most stuff got to do it, which doesn't make sense, but it's easy to get stuff wrong with ancient history.

- Due to the sheer number of worlds in the galaxy, the ALIENS will have minimal time to interact with each ARK, so the average ALIEN should take approximately 45 seconds to interact with your ARK. No one except Emperor DrED (ED) should be able to completely evaluate your ARK in less than 30 seconds.
- Because some ALIENS may perceive time differently, each ARK should include a creative display of the passage of the time since the ALIENS have begun their evaluation. **7-segment displays don't count.**
- To make the ALIENS part of the experience, your ARK must interact with the ALIENS. The ARK should reset within 30 seconds after the ALIEN stops interacting with the ARK.
- To accommodate ALIENS with different anatomical compositions, your ARK should involve at least 3 distinct ALIEN interactions.
- Your ARK should require large scale motion on the part of the ALIEN for at least one of its interactions.
- When the ARK completes its Olympic pitch, it should provide a clear audio and/or visual indication that will inspire the ALIENS to cast their vote for your world. This indication may last no more than 30 seconds before the ARK resets.
- The ARK should be usable without the guidance of a Master ALIEN. To respect the diverse languages of the galaxy, any static instructions must be only in pictorial form (Think: IKEA² assembly instructions).

Basic Specifications:

- A team of four class members will construct an ARK.
- The ARK must have parts that visibly move under the control of the Tiva LaunchPad.
- While it is permissible to use consumer devices as components in an ARK, intragalactic regulations require that such devices must be substantially modified before being incorporated 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 ARK 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 ARK 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 ARK 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 ARK must be a self contained entity, capable of meeting all specifications while connected only to the provided project power supply.
- In order to fit into a USPS³ Flat-Rate Box, the ARK **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 24" wide x 18" deep x 80" high in front of the ARK. Two ARKs must both be usable while sitting together on one of the 5' wide tables in our classroom. The entire ARK must be easily and safely moved from the construction site to the grading session and then shipped to the galactic capital (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!

²Intragalactic Knowledge Enforcement Agency

³Universal Starship Postal Service

- While it is normally not a good practice, the finished circuitry may be constructed on your solderless breadboards. 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 bread-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 ARKs must be safe for both users and spectators.
- 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 ARK in the SPDL.
- No painting in the SPDL (or anything attached to the SPDL).
- No part of the ARKs 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 Intragalactic Convention.
- If the ARKs contain any liquids, they may not be conductive (with the exception of water) or corrosive, and **MUST** be packaged in a fail-safe manner.

Checkpoints

Design Review:

During the day on **November 8** 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 a Google Sheet. 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.

If you fail to prepare, you're prepared to fail.

Mark Spitz

First Checkpoint:

On or before **11/10/17**, you must submit a schematic of at least the core functionality initially identified on 11/8/17 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 checkpoint documentation.

That's one small step for (a) man, one giant leap for Mankind.

Neil Armstrong

Second Checkpoint:

On or before **11/16/17** 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 electromechanical actuation and user feedback
- Submission of an Altium schematic of your circuit will also be required.

Space is not finite, but your state machines should be.

J Edward Flahie

Third Checkpoint:

On **11/27/17** 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.

The hard days are the best, because that's where champions are made.

Gabby Douglas

Grading Session:

On **11/29/17** from **1:00 pm to 5:00 pm** you will be required to demonstrate your fully integrated and finished machine.

In the end, I am just a guy wearing Spandex that turns left really fast.

Olivier Jean

Public Presentation:

This will take place on **11/29/17** at **7:00 pm** in the Atrium of Building 550. At this event, members of the public will be encouraged to act as operators of the ARKs.

Arrrggghnnn. Grrrh. Gahr.

Chewbacca

Report:

Draft due on **12/4/17** by 4:00 pm. The final version (with revisions incorporated) is due by 5:00 pm on **12/8/17**.

Language is a virus from outer space.

William S Burroughs

Evaluation

Performance Testing Procedures:

All ARKs 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 second (no more) presentation to introduce their ARK. 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 ARK, one at a time, and delivering your presentation in room 202 Thornton between 1:00 pm & 5:00 pm on the day of the presentations. During this time each team and their ARK will be photographed. Starting at 5:00 pm you will move your ARK into the Atrium 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 and coding for the ARK. 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 craftsmanship and finished appearance.

- **Performance (40%)** Half of this (20%) will be based on the results of the checkpoints, 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 4, 2017** at 4:00 pm. 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 website must be submitted as a **single Zip file** (7-zip is installed on all the workstations in the lab). In addition, if your website is hosted, you must **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 5:00 pm on 12/8/17. 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 YouTube or another 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 ARK 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 4:00 pm on 12/5/17.

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.

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 real or fictional worlds/universes 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 project 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, project failures are often due to poor mechanical design or implementation. Pay attention to craftsmanship. It will pay dividends in many ways.

Resources

Websites:

[SparkFun \(www.sparkfun.com\)](http://www.sparkfun.com)

[Mouser \(www.mouser.com\)](http://www.mouser.com)

[Adafruit \(www.adafruit.com\)](http://www.adafruit.com)

[McMaster-Carr \(www.mcmaster.com\)](http://www.mcmaster.com)

[Seeed Studio \(www.seeedstudio.com\)](http://www.seeedstudio.com)

[Newark \(www.newark.com\)](http://www.newark.com)

[Hackaday \(www.hackaday.com\)](http://www.hackaday.com)

[HobbyKing \(www.hobbyking.com\)](http://www.hobbyking.com)

[Jameco \(www.jameco.com\)](http://www.jameco.com)

[Ponoko \(www.ponoko.com\)](http://www.ponoko.com)

[DigiKey \(www.digikey.com\)](http://www.digikey.com)

[ServoCity \(www.servocity.com\)](http://www.servocity.com)

Local Stores:

J&M Hobby House in San Carlos

[Jameco](#) in Belmont

[TAP Plastics](#) in Mountain View

Gems of Wisdom:

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