GNG1103

Technical Report - Deliverable E

Submitted by

Project Group 18

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Abstract

This projects mission is to develop a design that aids the CEED program at the University of Ottawa using the Ross Dashboard.

This project has a few aspects that need to be completed, an idea, a design, a prototype and possible final product in the future. Upon meeting the client the first time we had an ample amount of ideas that could possibly achieved in the time frame given. During the process we decided to go with the idea that we could prototype for the availability of 3D printers in the Makerspace / Makerlab in the STEM building. This idea would be ideal as it would be expanded in the future to other labs across the campus or could be expanded in the makerspace to other machines that are there.

The aim of this is to help the CEED staff monitor the usage of the machines and also know the availability of the machines and this can also be relayed to students and the general public. This would allow users to plan usage of printers knowing their availability.

We then compiled all of our ideas into a comprehensive schedule which outlines when we'll have each stage of the prototyping process completed. We then analyzed the different risks associated with a project like this, along with the projected cost of the materials.

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1 Introduction

1.1 Managing time and increasing work efficiency

The University of Ottawa CEED workspace has need of an automated system that is easy to use, fits the CEED aesthetic, durable, and inexpensive which makes use of Ross Video's "DashBoard" tool to increase the space's organization and productivity. Time is the single thing everyone wished they had more of. So, instead of wishing for the attainable, this project focuses on managing the time at hand in order to make the most of what's available. When the system is made to be the most efficient it can be, more and more projects and visions could come out of the CEED makerspace. As a result, the entrepreneurial spirit is stronger and that'll encourage more people to make use of the space. In addition, a more efficient space makes all the users' work a lot easier and would speed-up their creative processes allowing them to make more prototypes helping them inch closer towards their final goal.

1.2 CEED and CEED users

Since 2006, there has been a 14x increase in the number of makerspaces worldwide[1] going from around 50 to 1400 makerspaces all around the globe (Lou, 2016). Each makerspace is home to hundreds of entrepreneurs and thousands of their visions that they're trying to make come to life. Some of these users are dedicating all their time to reach for their dreams and makerspace can make it possible. With this large of number of spaces, and even larger number of users, it might be possible that some life changing product would end up being created at the makerspace. CEED not only provides makerspace, but it also provides other services such as the

Manufacturing Training Center which provides access to heavy machinery and the John McEntyre Team Space which provides competitive teams with resources they need to excel in competitions. Helping CEED with increasing the efficiency of their workspace, would in turn be helping all of these users reach their goals.

1.3 Our Product

As discussed in the previous report, we are going to be trying to increase the working efficiency of the CEED space through the development of a product powered by “Dashboard”. After a few weeks of deliberations, along with meetings with our client, we have decided on a project to pursue.

Our product will be the following: an Arduino powered machine that can tell users in real time whether a 3d printer is currently in use by sending real-time feedback onto a webpage in response to a machine being used. The product will consist of 2 sections. The first housing will contain the Arduino board and the breadboard. This part would be the central control of the entire system we are attempting to develop. The Arduino board will be responsible for sending the information onto the webpage. As for the second section, it will contain a housing which contains an accelerometer. This housing would be placed right in front of the SD card slot of the 3D printer. When it’s moved out of the way, the accelerometer will pick up on the movement, and in turn send a signal to the Arduino indicating that the printer is currently going to be in use. Then the Arduino would then relay that message onto the webpage that we will build specifically for this purpose.

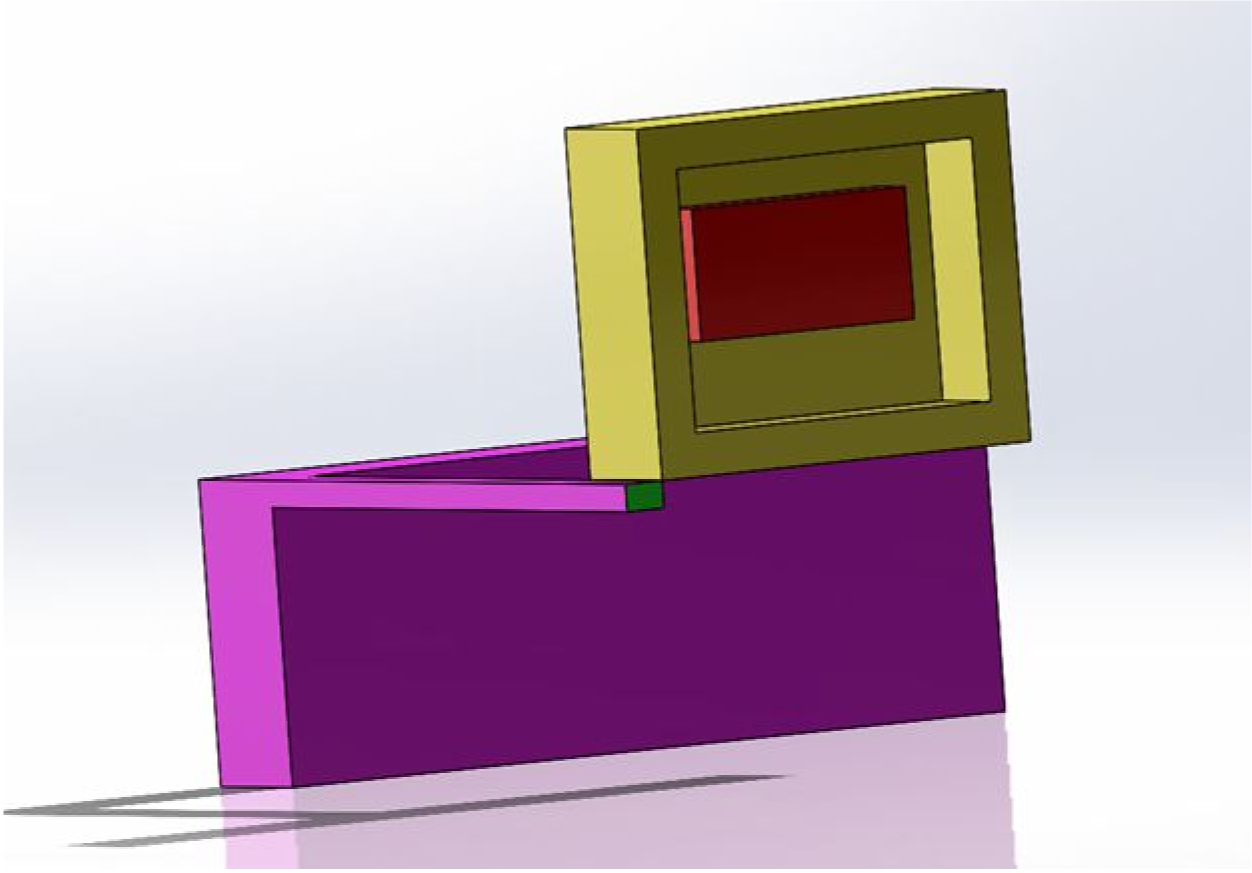


Figure 1. Rough computer model of the front of the product The yellow box represents the housing that'll contain the accelerometer (pictured in red). The green section represents a hinge that'll allow the housing to move back and forth.

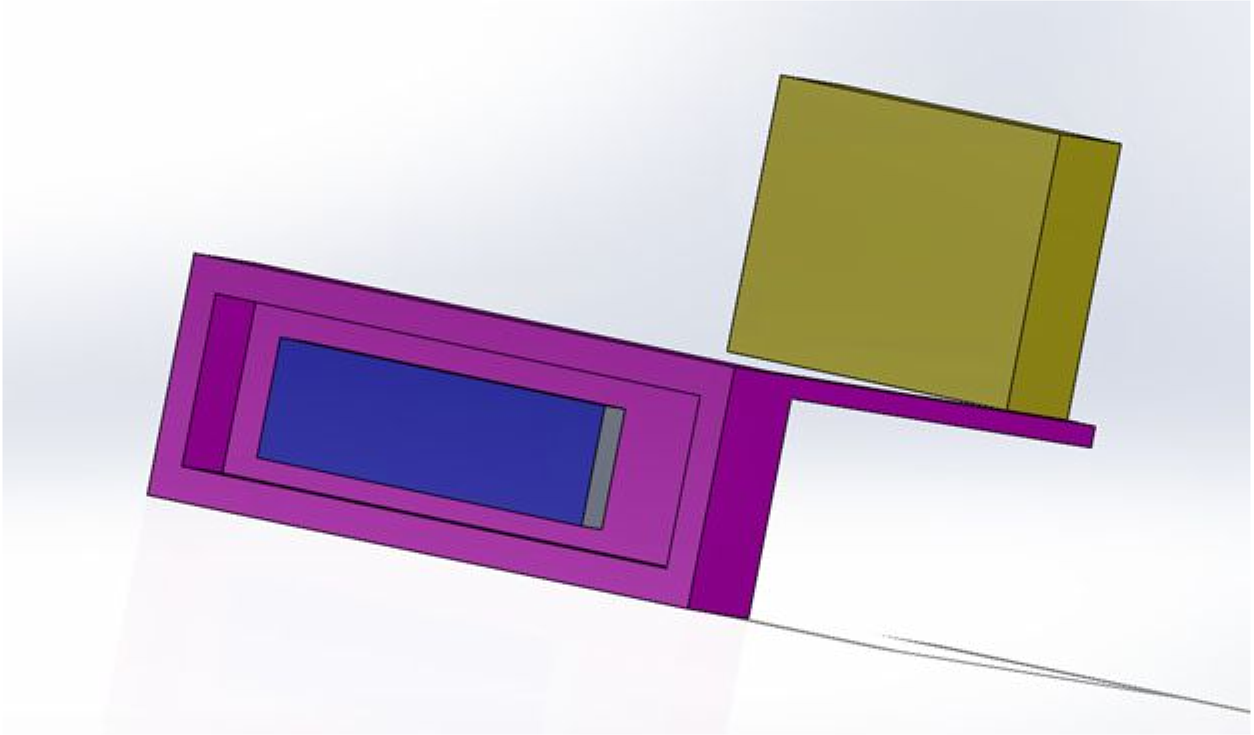


Figure 2. Rough computer model of the back of the product. The purple box represents the housing that contains the Arduino board, represented in blue, stacked onto the breadboard, represented in grey.

1.4 The Plan

The next step for us is to compile all of our previous ideas into a comprehensive schedule that we'll follow throughout the 3 prototyping stages. The first stage is a very simple conceptual design, the second focuses more on the most critical subsystem, and the 3rd will be our functional prototype to be showcased at design day. We've also analyzed some potential challenges we may run into and came up with plans on how to mitigate each one. Finally we compiled all of our previous work into a list of materials that we'll need to bring the idea to life.

2 Need Identification and Product Specification Process

CEED's needs as our client could be organized into two categories. The first category regards efficiency at their workspaces so that users can make the most of their time in the space and take full advantage of the resources that CEED provides. Second, managerial organization of the workplace to help staff stay on top of their duties thus providing a better work environment for the CEED users.

In this section, we'll be discussing CEED's need for increased workspace efficiency. A common occurrence in Makerspace, is that users seem to lose track of time when they're diving in their project ideas. As a result, some equipment, such as the laser cutter, seem to get crowded especially during the busier seasons. Another issue that arises due to that is the users losing track of the time they have left to access the space itself. At Makerspace, time is of the essence. The more organized the space itself becomes, the more time will be saved thus increasing the efficiency of the space.

Managerial organization is a common concern in a public workplace , specifically for the makerspace due to the large variety of equipment and tools they use. The staff have expressed a need for a management system to keep track of tools in use and the one using it. From time to time, users tend to move tools and do not return them to their appropriate storage space, which creates a mess both for the staff and the users. Another problem the staff face is the lack of a proper inventory system in place. This causes some disorganization and makes working and answering users' inquiries a lot more difficult than it needs to be.

The following table organizes the clients' wants in order to help visualize a fuller picture of the situation at hand:

Client Need	Need Interpretation	Type of Need
Remind users how many hours left in the day	Help users manage the time they have in the workspace	Organizational
Machine vacancy monitoring	Help user know what machines are free before going to the workspace	Organizational
Interactive workspace map	Help users to have a better understanding of each area of the workspace	Organizational
Inventory management system	Staff would like to have a better grasp of what materials are available/missing to ease the ordering system	Managerial
Estimated timer for 3D printers	Help users manage the time they have in the workspace	Organizational
Reminder to encourage workers to move	Encourage users to be involved in more healthy practices instead of sitting all day	Managerial
Indoor environment monitor (temp, humidity, etc)	Machinery and equipment are sensitive to certain changes in the room and staff would like to keep track of these changes	Managerial
Security system	Help staff keep the workspace secure during the day and when not in use	Managerial
Inventory locator	Helping new users know where tools and equipment are so	Organizational

	they don’t have to ask a staff	

Table 1 - List of Interpreted Needs

The next table ranks the importance of the qualities the client would like in their product:

	Customer Statement	Interpretation	Importance
1	Easy/Useful	Product must be easy to use, and genuinely improve the productivity of one of the CEED spaces	5
2	Attractive	Product’s cosmetic design must fit well within the CEED space	4
3	Stable	Product easy to use and not have many bugs or constantly crash	2
4	Maintainable	Product must be intuitive and easy to repair in the event of an error	3
5	Inexpensive	Product must cost $100 or less	5

Table 2 - Importance of Interpreted Needs

These needs have arised in other workplaces besides just CEED. So other solutions have been developed to fulfill these needs. Interactive maps are used in shopping malls in order to show customers where each store is (1). A product like this can help CEED users tell which machines are available to use before going on site. Indoor humidity gages can be bought that read the amount of humidity in a given room (2). A product like this would be helpful in MTC because it can get very humid in the workspace due to all the heavy machinery. There is software that is designed to show where in a workplace certain tools and equipment are stored and when a supply of certain products are getting low. In the CEED spaces new users have trouble finding tools, equipment, and materials needed to work on their projects. A system like this would help new users find the things that they need in order to complete their work. Finally, a product that could tell users which machine is under use would be very beneficial to the space as it would significantly cut wait times and situations where it could get too crowded. A similar product that this could be modelled after is the parking space guiding systems (3).

3 Conceptual Designs

Subsystem 1: Operator Interface

This subsystem will show the CEED staff and users which machines are in use and which are free. Here's a list of potential ideas:

- List of which machines are being used
- Top-down map of the MakerSpace which visualizes which machines are in use
- Timer left for an apparatus to be free
- Total number of free and available machines
- Check remotely (phone, computer..) time left for a given job
- Camera to keep track of the work
- CEED colours (orange, grey, wood)
- Holographic display
- Online model of the print
- AI
- Display when the makerspace is over capacity
- TV on wall of makerspace with map of machines
- Backlights for each machine that's in use
- Speaker that sounds when a print is done
- Sends notifications to user device once print is complete

Subsystem 2: Sensor

This subsystem will be used to determine if a given machine is in use or not. Here are some potential ideas:

- IR sensor
- Ultrasonic sensor
- Physical button
- Switch that covers SD slot
- Camera sensor
- Weight sensor
- Motion sensor
- retinal scan
- fingerprint
- face scan
- sensor integrated within 3D printer
- Printer automatically relays the info
- System is notified upon the injection of the SD card
- User types code into computer plugged into printer
- Ross video board

Subsystem 3: Ross DashBoard

This subsystem will show how the Ross DashBoard software will be used to help monitor the availability of the machines. Here are some potential ideas:

- Relays which machines are in use to online web page
- Allows the user to input approximate times remaining for each machine.
- Tells the amount of time that the Makerspace is open for.
- Allows the user to monitor which SD cards are currently in use
- Relays it to a website
- Mobile + desktop compatible
- Organizes based on type of machinery
- Uses CEED aesthetic (orange, grey, wood)
- Updates in real time
- Highly modifiable (if new machines are added)
- Can post public updates from the CEED staff
- Simple and user friendly
- Easily maintainable (easily replace faulty parts)
- Linked to MakerRepo
- Ability to create accounts

Final Solution 1:

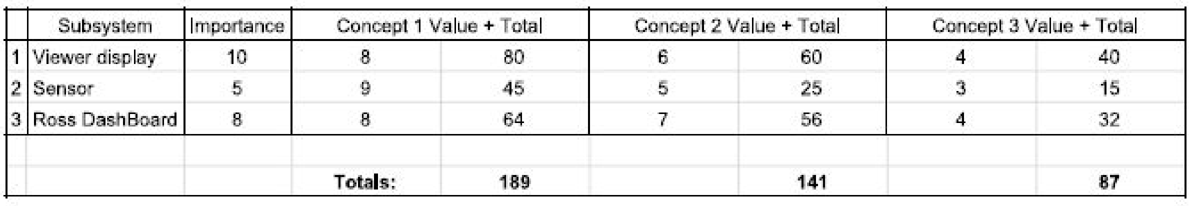
Solution 1 will help both the CEED staff and the CEED users to keep track of which machines (3D printers and laser cutters) are currently in use. Upon arriving at a machine, the user will uncover the SD slot to use the printer. This cover will also act as a switch, relaying the information that the machine is in use to an Arduino device. Using the Ross Video DashBoard software, the CEED staff will be able to see which machine is being used, and input the approximate time remaining for the print, and the SD card that is currently being used with that machine. All of this information will be outputted to a display which can be viewed by everyone in the CEED space.

Final Solution 2:

Solution 2 will display a list of all the machines being used in the makerspace both to the users and the CEED staff. A button connected to an arduino as seen in laboratory 3 will be placed besides each machine in the makerspace. So that when a user or staff starts using a machine, they click on the specific button. After that the information will be relayed to a Ross Video DashBoard that in turn will display a list of all the machines in use. This will let the users and the staff work more efficiently.

Final Solution 3:

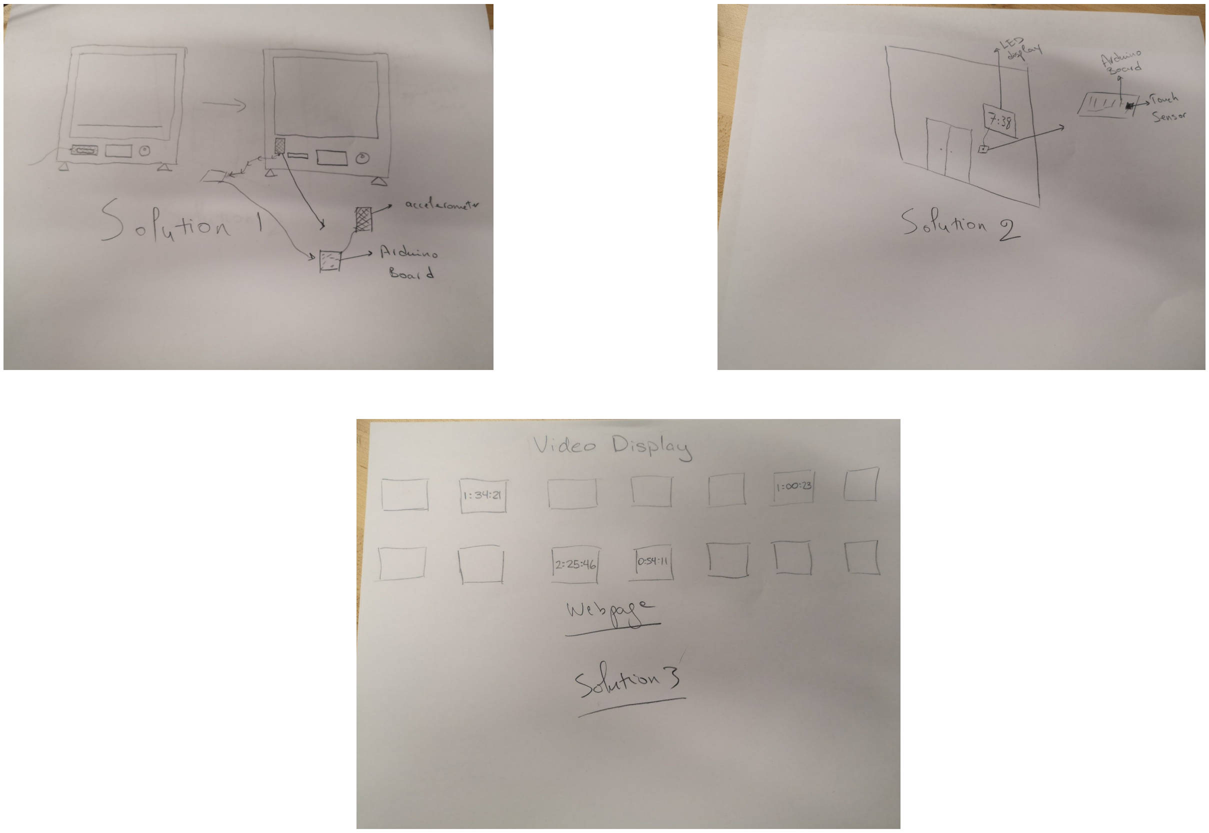
Solution 3 will employ the use of a motion sensor to detect if the given machine is in use. The motion sensor will observe the machine itself to see if the motors are active. Every machine is fitted with a coloured backlight behind it. If the machine is active, the light will illuminate for the entire Makerspace to see. The motion sensor will relay info through an Arduino and DashBoard to the lights.



	Subsystem	Importance	Concept 1 Value + Total		Concept 2 Value + Total		Concept 3 Value + Total	
1	Viewer display	10	8	80	6	60	4	40
2	Sensor	5	9	45	5	25	3	15
3	Ross DashBoard	8	8	64	7	56	4	32
			Totals:	**189**		**141**		**87**

Table 3 - Decision Making Chart

Therefore, from our analysis of the 3 different solutions, and the importance of each subsystem, we've determined that Final Solution 1 will yield the most desirable results.



Figures 1, 2, 3 - Sketches of the 3 Solutions

4 Project Plan and Cost Estimate

The design of our system will be refined and finalized over the course of 3 different prototypes.

Prototype 1:

The first prototype will be a very simple iteration of the final design. It will mostly be a prototype to test out the dimensions and the sizes we'll need that'll comfortably fit all the wiring along with making sure we're able to block the SD card slot properly.

Prototype 2:

The second prototype will be much more involved than the first one. This prototype would be a working prototype that'll allow us to test the code we've written along with Finally, the 3rd prototype will be fully comprehensive and operate as intended. This is where we'll be working on making the system run as smoothly as possible.

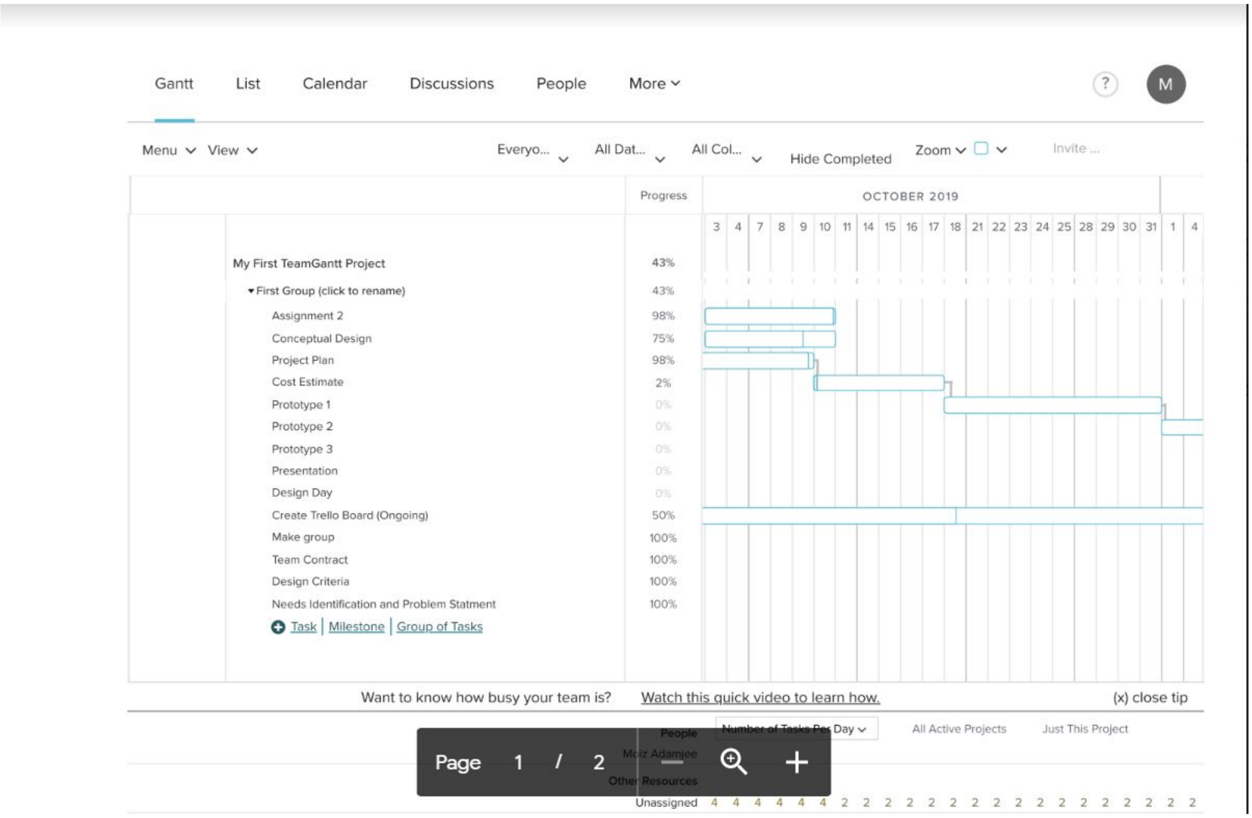
Prototype 3:

The third prototype will be the last prototype we make. It'll be a culmination of everything we've learned using the previous prototypes. This prototype will be fully functioning and aesthetically pleasing, being the prototype which we'll submit to the CEED clients.

Below is a table depicting which jobs need to be accomplished, who is responsible for each, and when they need to be accomplished.

Task	Deadline	Person responsible
Purchase all required materials for all 3 prototypes	Until Oct 23rd	Cole
Come up with a conceptual design for the DashBoard interface	Until Oct 31st	Jonah
Come up with a conceptual design for the output display	Until Oct 31st	Fadi
Design switch mechanism	Until Oct 31st	Kim
Come up with a conceptual wiring diagram for the arduino board	Until Oct 31st	Moiz
Design a simple Arduino code which registers the input of the switch	Until Nov 7th	Cole, Jonah
Design the housing mechanism for the arduino and breadboard	Until Nov 7th	Jonah
Examine how to integrate arduino with DashBoard in a simple program	Until Nov 20th	Moiz, Kim, Fadi
Add the timer function into DashBoard	Until Nov 20th	Kim
Finalize the design for the DashBoard interface and output	Until Nov 20th	Fadi, Cole
Integrate a 2nd switch into the design	Until Nov 20th	Moiz
Refine any aesthetics of the physical unit and/or the DashBoard interface	Until Nov 20th	Everybody

Table 4 - Project Plan Schedule



	Progress
My First TeamGantt Project	43%
▾First Group (click to rename)	43%
Assignment 2	98%
Conceptual Design	75%
Project Plan	98%
Cost Estimate	2%
Prototype 1	0%
Prototype 2	0%
Prototype 3	0%
Presentation	0%
Design Day	0%
Create Trello Board (Ongoing)	50%
Make group	100%
Team Contract	100%
Design Criteria	100%
Needs Identification and Problem Statment	100%

Figures 4 - Gantt chart

With a project like this, there are many different risks which can greatly impact our final product if they aren't accounted for. In the table below, some of these risks are outlined, along with plans to mitigate them should they arise.

Project risks	Plans to mitigate
Difficulty understanding how to implement certain functions in DashBoard	There are many different resources to help us gain experience using DashBoard. Watching videos, and seeking help from TAs and/or peers will help us gain comfort. Also practicing with the software will make it much easier
Difficulty designing the wiring diagram for the Arduino board	Similar to the risk above, there are a great number of resources available to us which will help us gain comfort with a new technology

Lack of spare parts while assembling the system	Use the money spared from prototyping to purchase new ones. Or even use scraps.

Table 5 - Potential Project Risks

After analyzing each step of our design process, we've compiled a list of items to be purchased along with their approximate cost. Most materials will be purchased from the MakerStore with the exception of the rotary encoders and the resistors which we'll need to purchase online.

Item	Cost ($)
Arduino Uno Board	$17
Breadboard	$10
Accelerometer	$25
Wiring (30 wires)	$3
Acrylic	$13
Resistors	$3
Total Cost:	$71

Table 6 - Project Cost Estimate

The total projected cost for this design is $71. This will leave plenty of extra space for any additional costs such as shipping or any unforeseen materials that we may need.

5 Conclusions and Recommendations for Future Work

With a plan of action and a cost estimate in hand, along with the potential materials that’ll be used throughout the course of the project, our next steps are going to be focusing on getting the prototypes made along with taking care of the coding aspect of the product, which undoubtedly will be the biggest challenge we’ll face.

6 Bibliography

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