GNG1103

Technical Report

Deliverable E – Project Plan and Cost Estimate

Submitted by

Project Group 19

Senthura Yogarajan, 300077498

Dayu Liu, 300063931

Tom Lin, 300076426

Kian Mozafarian, 300138481

Alexander Steeves, 300085657

Date: October 17, 2019

University of Ottawa

Abstract

This project is being executed because we want to solve problems regarding the automation of STEM. We have empathized with our clients by becoming users in their space and listening to their needs. We then defined a problem statement in which we highlighted the main problems. We have ideated to assist in brainstorming possible designs and solutions. We found that our ideas are like solutions that already exist. This means that we can learn from these solutions and use these solutions to further develop our idea.

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1 Introduction

The current system for 3D printing lacks automacy. A lot of time is wasted by users because they must enter Makerspace to check on their print frequently. The process of selecting a printer, signing out a SD card, preparing the STL file, uploading the g-code on to the SD card, and starting the print can take upwards of ten minutes. Not only that, some computers are not compatible with the larger SD cards, meaning that the user will need an adapter to save the g-code onto the SD card. Group 19 seeks to improve the speed of this process by uploading g-code from a single computer in the Makerspace which will eliminate the tedious process users have to currently go through. The basic user requirements will ensure that the solution created will make users work efficiently and productive while using Makerspace. Our designs are associated with anyone using Makerspace or the Brunsfield Centre. The system created will be easier to use and will eliminate the complexity and tedious steps to reduce the time taken for users to set up a print in Makerspace. Within this report we will discuss potential materials for designing the prototype of our product and create a plan to create our prototype.

1.1 Problem Statement

We want to design a system and user interface that improves the current problems with automating the use of 3D printers while eliminating the troubles with SD cards to enhance the user and staff experience with 3D printing, organizing, time management, and ease of use.

2 Client's Needs

Table 1: List of Client Needs

#	Needs	Design criteria
1	Allowing for usage of tools (e.g. 3D printers) to be used in a more organized and faster manner	• Less time wasted when using Makerspace tools (mins) • Decreased time in vacancy of tools (mins)
2	A way to let students know what machines are being used before entering the Maker Space and Brunsfield Center.	• Decreased time in vacancy of tools mins)
3	Tracking system for signed out tools such as SD cards allowing for items to be returned and not lost.	• Decrease in amount of SD cards lost (# of SD cards lost)
4	A way to keep track of materials/tools in stock especially in the Brunsfield Center.	• Decrease in amount of questions pertaining to stock of materials/tools (# of questions) • Decrease in the number of tools misplaced or lost (# of tools lost/misplaced)
5	A better way to help users navigate STEM	• Decrease in lost users (surveying users)
6	A tool or system indicate users to pack up/clean up before the rooms are closed	• Decrease in the time it takes to close (mins)
7	A functional security system for makerspace. Makerspace currently doesn't have cameras set up for security.	• Decrease in theft and damage (# of things lost or damaged)

Table 2: List of Functional Requirements

#	Design Specifications	Relation (=, <, or >)	Value	Units	Verification Method
1	Increase the number of people using the 3D printers	>	5	People/ Day	Analysis
2	Time taken to set up the 3D printers	<	2	Minutes	Test
3	Decrease in the number of SD cards lost	<	10	SD Cards/Month	Analysis
4	Quick setup time	<	2	min	Test

Table 3: List of Non-functional Requirements

#	Design Specifications	Relation (=, <, or >)	Value	Units	Verification Method
1	Aesthetics	=	Yes	NA	Test
2	Product life	>	3	Years	Test
3	Ease of usage	=	Yes	NA	Test
4	Safety	=	Yes	NA	Test

Table 4: Constraints

#	Design Specifications	Relation (=, <, or >)	Value	Units	Verification Method
1	Cost	<	100	Dollars ($)	Budget
2	Size	=<	5 x 3(3/32) x 1(1/8)	Inches	Measure
3	Time to Build	<	2	Months	Trello (Gantt Chart)
4	Time to learn Ross Video	<	2	Months	Ability to incorporate Ross Video successfully into project

A key requirement said by the client for our project was a user-friendly interface. The client also specified that they would like to see a decrease in the amount of SD cards lost. Not only that, one of the clients needs included reducing the amount of time taken to clean up. The client also stated that they would like to have a system that would indicate the vacancy of 3D printers and estimated time left for a print.

After talking to our client, we have obtained valuable information about the 3D printers. This information will assist us in creating our prototype. We have learned that CEED staff manually check if the printers are vacant. The printers lack features that help them to prevent malfunctions and mishaps in the print. Since printers use hot nozzles, they are not allowed to run after hours with no supervision.

Empathizing with our client, we have found that they would like a way to decrease the loss of SD cards. Not to mention, they have already attempted a way in solving this problem, by trying to wirelessly send g-code to the printer. However, after several unsuccessful attempts they have settled on using the traditional way of 3D printing with the use of SD cards. We plan on improving up on what they have previously attempted with additional features to enhance the 3D printing process in Makerspace while solving many problems along the way.

3 Conceptual Designs

Here is a list of 3 of the 15 conceptual designs that we have come up with in deliverable D:

Concept 1:

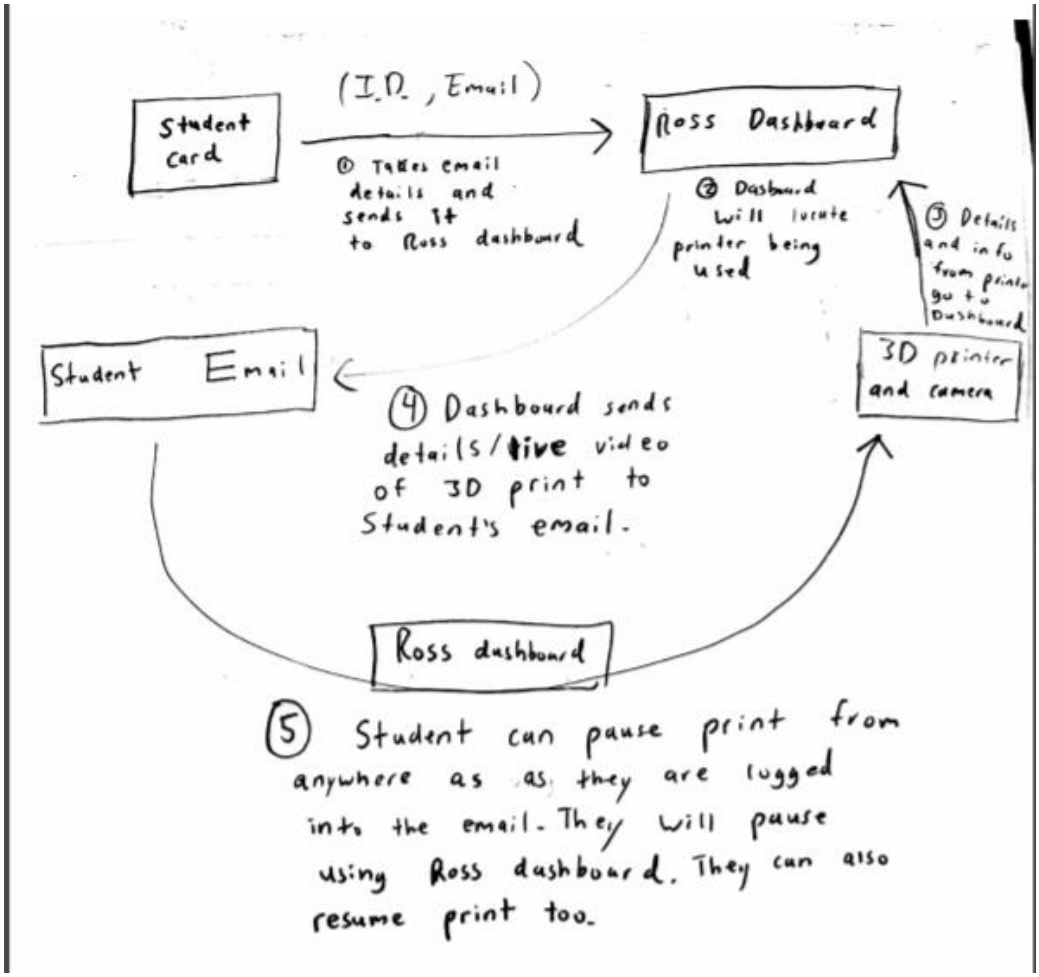


Figure 1: Flow Chart of Email Automation

The flow chart in Figure 1, is a visual representation of how this concept is to work in junction with Ross Video. This concept takes the user's email after they scan their student card and will send updates on their 3D print. A camera will also be incorporated in the 3D printer to

allow the user to monitor the print progress live from anywhere with internet access. Ross video will be used to collect the printing data to send the user print updates via email. This data includes print time remaining and current progress of the print from video camera. Ross video will also be able to allow the user to cancel the print if anything seems to go wrong without being in Makerspace. This will be done with OctoPrint. This will save the user time as they don't need to constantly enter Makerspace to check their 3D print for errors and the user can arrive to pick up the print right when it finishes.

Concept 4:

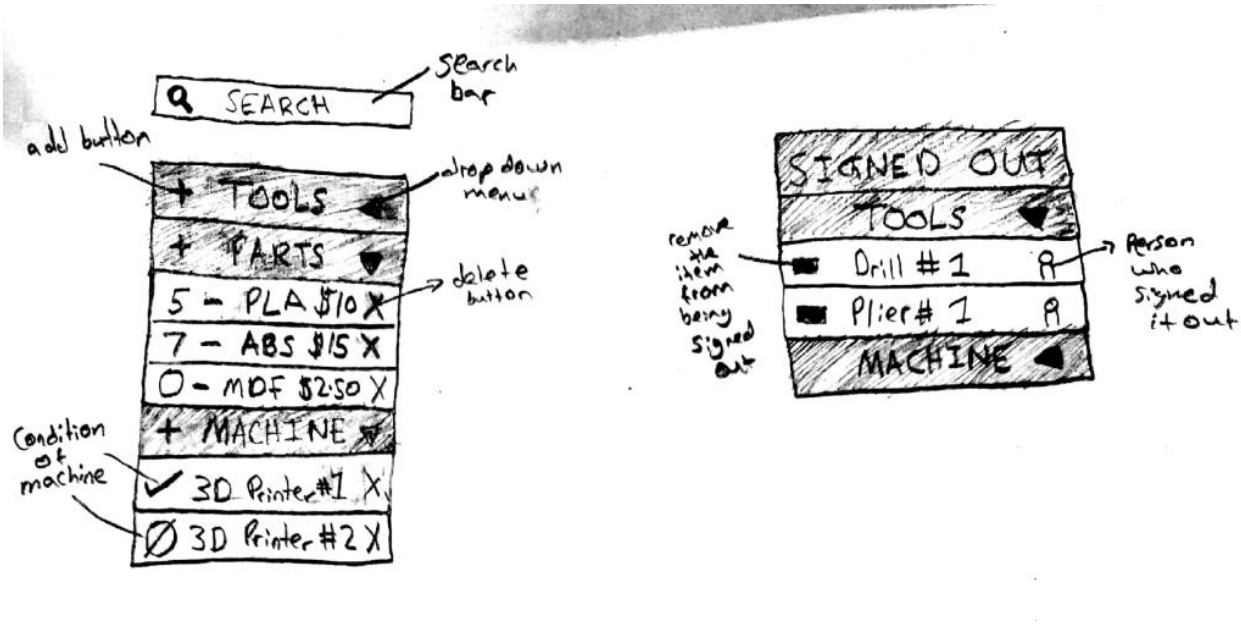


Figure 2: User Interface for Sign In/Out System for Tools, Parts, and Machinery

Ross Video can be used to create a user interface which can keep track of inventory of all parts/tools/machinery etc. There will have to be initial inputs for what parts/tools/machinery exist in these spaces and at what quantity. These will then be categorized into what space they belong

to. The user interface will be a sign in/out system in which users can be registered when utilizing a tool/machinery in Makespace or the Brunsfield Centre when tapping their card to connect to Maker Repo. This will allow CEED staff members to hold people accountable for what they have signed out. As seen in Figure 2, the user interface will make organizing the tools, parts, and machines much more easy, efficient, and reliable. Not only that, it will be visible to the user as to what machinery is available to use and what is not. To add, there will be a way to view the history of what tools/machinery have been used to assist CEED staff members with the maintenance of the tools/machinery.

Concept 5:

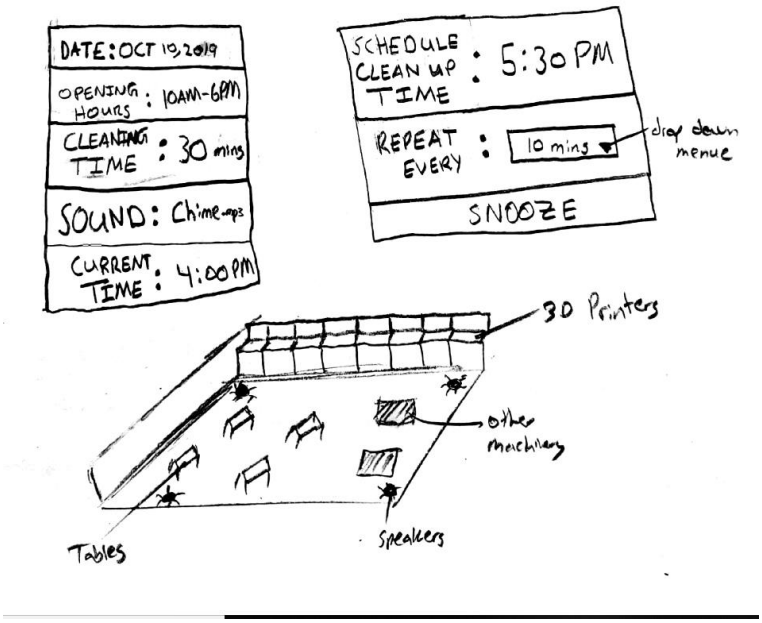


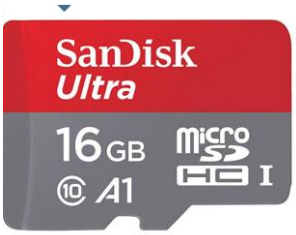
Figure 3: User Interface and Diagram Describing Clean Up Sound System

Another way to incorporate Ross Video is to create a user interface which alerts the users of Makerspace or the Brunsfield Centre when it is time to pack up. Figure 3 demonstrates how the

user interface will be connected to wireless speakers which are placed around Makerspace or the Brunsfield Centre. Whatever amount of time is required to clean up will entered into the system. A sound/song will be initiated x number of mins before Makerspace or the Brunsfield Centre closes to indicate to users that it is time to clean. Every few mins that a user specifies, the sound/song will play again to remind the users that there is x number of mins left before Makerspace or the Brunsfied closes. The user interface will also connect to the lights in Makerspace or the Brunsfield Centre to turn them on and off for the specified working hours.

We decided to go with concept one because it meets all the functional requirements of increasing the amount of people using the 3D printers, time taken to set up the 3D printers, decrease the number of SD cards lost, and a quick setup time. For non-functional requirements, concept one also meets all the requirements of aesthetics, product life, ease of usage, and safety. Concept one is also more fascinating compared to the others. Finally, concept one passes 3 out of the 4 constraints in Table 4. This makes concept one the highest rated compared to the other conceptual designs.

4 Project Plan, Execution, Tracking & Bill of Materials

Part Name	Picture of Template	Description/ Specification	Quantity	Supplier	Cost (CAD)
Raspberry Pi		N/A	1	https://www.amazon.ca/RS-Components-Raspberry-Model-Motherboard/dp/B07BFH96M3/ref=sr_1_4?crid=J5VNE19VQ5WU&keywords=raspberry+pi+3b%2B&qid=1571017689&sprefix=raspberry+%2Caps%2C182&sr=8-4	$55.97
Micro SD		16 GB	1	https://www.amazon.ca/Sandisk-Ultra-Micro-UHS-I-Adapter/dp/B073K14CVB/ref=sr_1_3?keywords=SanDisk+16GB&qid=1571260591&sr=8-3	$10
Printer Cable		6ft/1.8m	2	https://www.amazon.ca/gp/product/B00NH11KIK/ref=ox_sc_mini_detail?ie=UTF8&psc=1&smid=A3DWYIK6Y9EEQB	$9
3D Printed Case + Stand		ABS/PLA	1	https://www.thingiverse.com/thing:3719217	$0

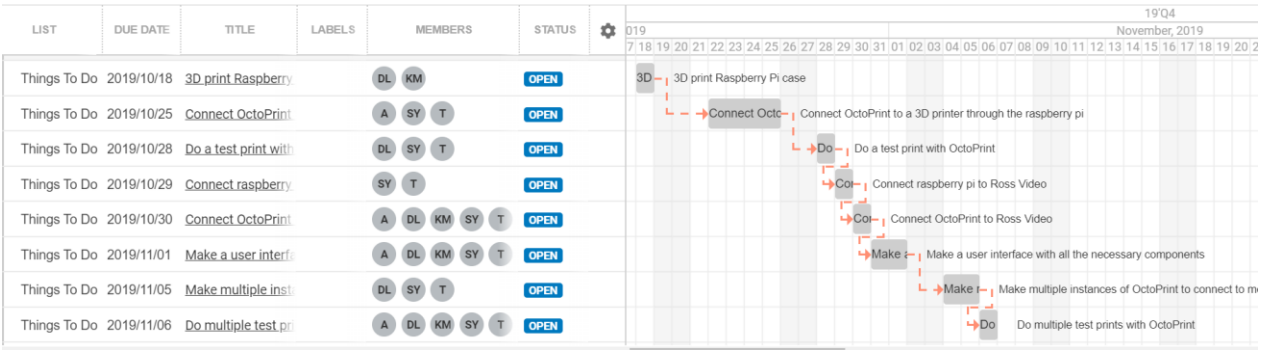


Figure 4: Gantt Chart Describing Due Dates and Task Delegation

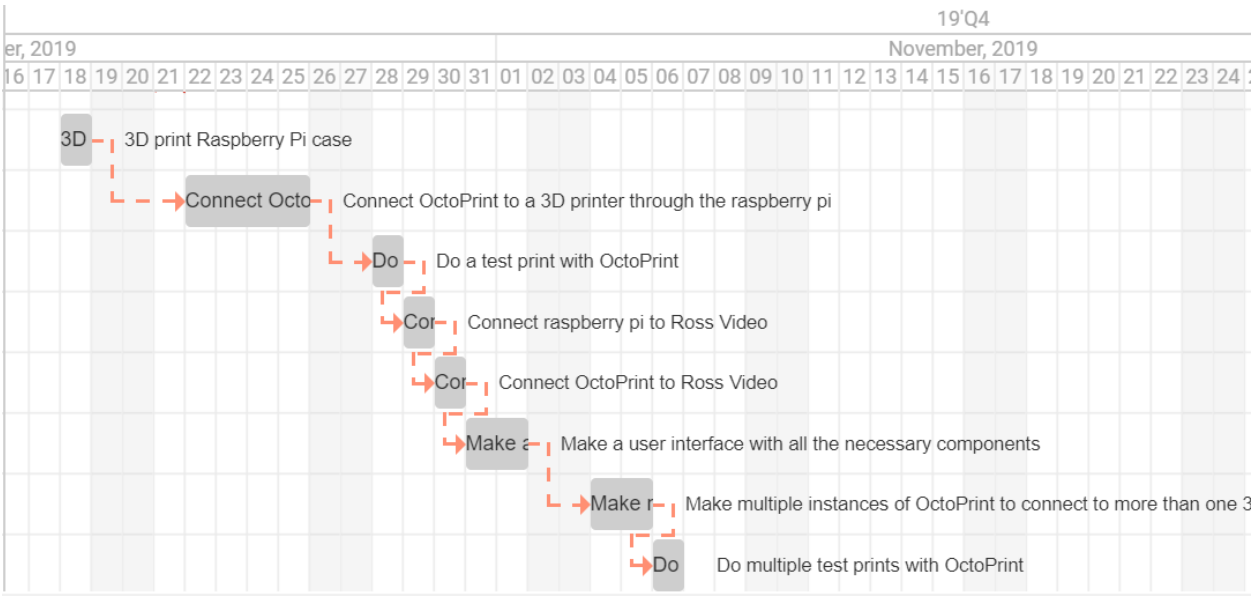


Figure 5: Gantt Chart Highlighting the Dependencies and Task Dates

5 Benchmarking

Existing solutions:

Zach from howchoo, (Zazh, 2019),was able to connect OctoPrint to a raspberry pi and then to a 3D printer. Zach had even gone further to connect a camera as well. His project is very similar to what we are trying to accomplish. Zach had also wanted to control and view his 3D print from his web browser and print things remotely. We can learn from Zach's project to learn about what works and what doesn't when completing our project.

6 Analysis

Prototype 1 risks and solutions:

This prototype is about connecting the raspberry pi to OctoPrint and then to a printer. This prototype should successfully print a part without the use of a SD card.

We are only purchasing 1 raspberry pi due to our budget. This is risky as the cost for 1 raspberry pi is slightly more than half our budget.

A solution to this is doing research before making a large purchase. We have researched into solutions that already exist which incorporate a raspberry pi to send g-code wirelessly to a 3D printer.

Prototype 2 risks and solutions:

This prototype is about getting the variables from OctoPrint to be able to design the user interface through Ross Video.

Ross Video may not have the features required to successfully connect all the components together. For example, we may not be able to acquire web-based variables from OctoPrint to design the user interface in Dashboard.

The solution to this risk is to go through the user manual and look at all the features that already exist within Dashboard. Also, by going through the user manual, it will allow us to see what is possible and what is not possible through Dashboard. If our current idea does not work, we will have time to change the way we are implementing Ross Video.

Prototype 3 risks and solutions:

The third prototype is about making multiple instances of OctoPrint and connecting them to multiple 3D printers. This will allow us to connect to multiple printers through one computer and will reduce the use of SD cards.

Possible problem that may arise is that the raspberry pi might crash, or Ross Video might crash.

A solution to this is to reduce the load on the raspberry pi by disconnecting printers until no crashes occur and the software is running smoothly.

7 Prototyping and Testing Strategies

First, we are going to talk to our clients about our prototype to obtain their views. If the interaction is positive, we will move on to creating the prototype. After this is completed, we will proceed into the testing stage. The testing for our prototype will consist of how efficient our prototype is when completing the desired task. This will be tested with the amount of successful prints started wirelessly. We would know we are successful if we have a success rate of 100% to ensure that our prototype is as efficient as using a traditional SD card. Not only that, we would ensure that our prototype is much faster at starting 3D prints much faster than an SD card to ensure we are automating STEM.

8 Conclusions and Recommendations for Future Work

After brainstorming and benchmarking, we have learned that there are many different ideas which can be used to accomplish the same task. If we did not do research or generate ideas, we would not have been able to make an informed decision on what the ideal solution may be. We should always brainstorm many ideas before deciding on one. We have also learned that some ideas may not work because they may be too complex. In the future, we should be more realistic in creating concepts based on our abilities, knowledge, and time constraints. As a group we have learned to not leave work till the last minute. This will help us in completing our project on time and to properly delegate tasks.

9 Bibliography

Zazh. (2019, October 3). *OctoPrint: Control Your 3D Printer Remotely with Raspberry Pi and OctoPi*. Retrieved from howchoo: https://howchoo.com/g/y2rhnzm3odz/control-your-3d-printer-with-octoprint-and-raspberry-pi