Prototype I and Customer Feedback

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Introduction:

The first prototype is created to act as a proof of concept for the different systems in the project. In order to properly convey the system processes, pseudocode was written for the Scheduling/Reservation subsystem, Machine Monitoring subsystem, and Inventory subsystem. Sketches were used to depict the dashboard UI and a physical model was created inorder to depict the sensors, protoboard and Node MCU for the inventory and machine monitoring subsystem. This prototype was tested against hypothetical inputs to confirm the feasibility of the project of pseudocode. The tests also helped in spotting future problems and making corrections. Using the prototype the team was also able to gather customer feedback and make final notes on how to improve this prototype further.

Proof of Concept:

Physical Model:

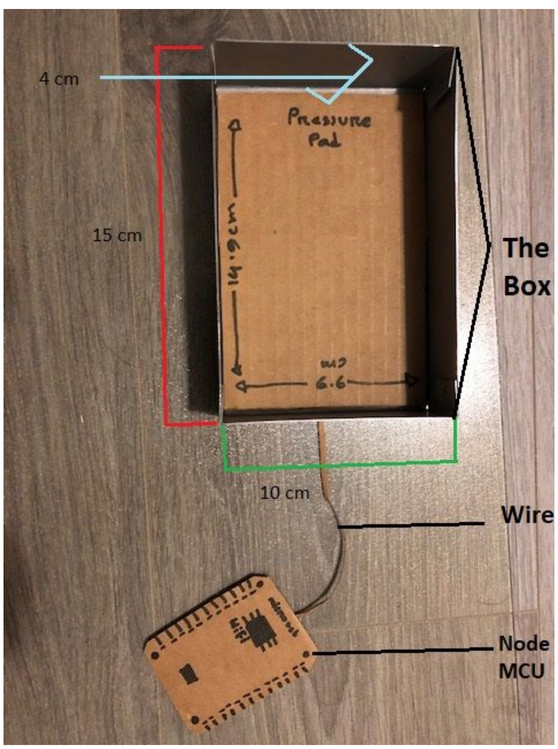

Figure 1: Bird's Eye View of System

Subsystem Pseudocode:

Scheduling/Reservation:

Reservation pseudo code

Variables:

2D Boolean array: bool *day* [6][7] = {……, ……, ……};

2D String array: String *name* [6][7] = {……, ……, ……};

2D String array: String *uCode* [6][7] = {……, ……, ……};

String *enterName, enterCode, currentTime*;

Boolean *confirm* = false;

Pseudo Code:

Initially, all values of the *day* array are set to "true", & the strings in both array *name* and *uCode* are set to "empty". On dashboard, a table is set up as a visual to make it easier for the user to see which times are available for machine use.

The table will be linked to all three arrays. If a section of the *day* array is set to "true", the table will light up green on the time slot linked with the array, and red if the array is set to "false".

Part One: Creating a reservation

User selects a green time slot (*day* is "true", *name* & *uCode* are "empty")

The user is taken to a new page where they are asked to fill in arrays *name* & *uCode*:

The user enters their name in a box and fill the *enterName* string. Users then scan their UOttawa card on an RFID scanner and fill the *enterCode* string. Both their name and code are presented on screen. The user is then promoted to confirm their time slot. Once completed, *enterName* and *enterCode* are put in arrays *name* and *uCode* respectively that match with the original timeslot selected.

```
*user clicks timeslot in row 4 column 3*
    if (day [3][2] == true) //Making sure its an available time
    {
*new page opens*
User is told to enter name
```

enterName becomes the users input

user is tol to scan UOttawa card on scanner

enterCode becomes the users input

if *enterCode* and *enterName* don't both contain "empty" then:

user is told to confirm time slot

user clicks confirm button

Confirm becomes equal to true

If confirm equals true

The slot for *name* and *uCode* that match *day* are filled with *enterName* and *enterCode* respectively. *enterName* and *enterCode* are then set to contain "empty" and *confirm* is set to false.

Part Two: removing a reservation

The user clicks "remove a reservation" and is asked their name they entered on the reservation and to scan their UOttawa card. If both codes match what is stored in the array, then the reservation is cancelled.

User clicks remove reservation and is prompted to select the one they wish to remove

The program checks if the day is currently reserved

If it is the user is asked to enter the name and scan their UOttawa card

The name and card that was scanned is compared to the name and card code in the system.

If they match the reservation is removed and the time slot becomes available again.

Part Three: Erasing completed reservations

Once a time slot for the current week has been completed, it must be emptied so that a new reservation can be made next week. This will be completely automated and will not require any action from the user.

```
For (j < 6)
{
Int i = 0, j =0;
Int time = *gets time from clock puts it to the current hour*
If (time == i+1)
{
day[i][j] = true;
name[i][j] = "empty";
uCode[i][j] = "empty";
i++;
}

If (i == 6) //end of day
{
j++;
i = 0;
}
If (j == 5) //end of week
{
j = 0;
}
}
```

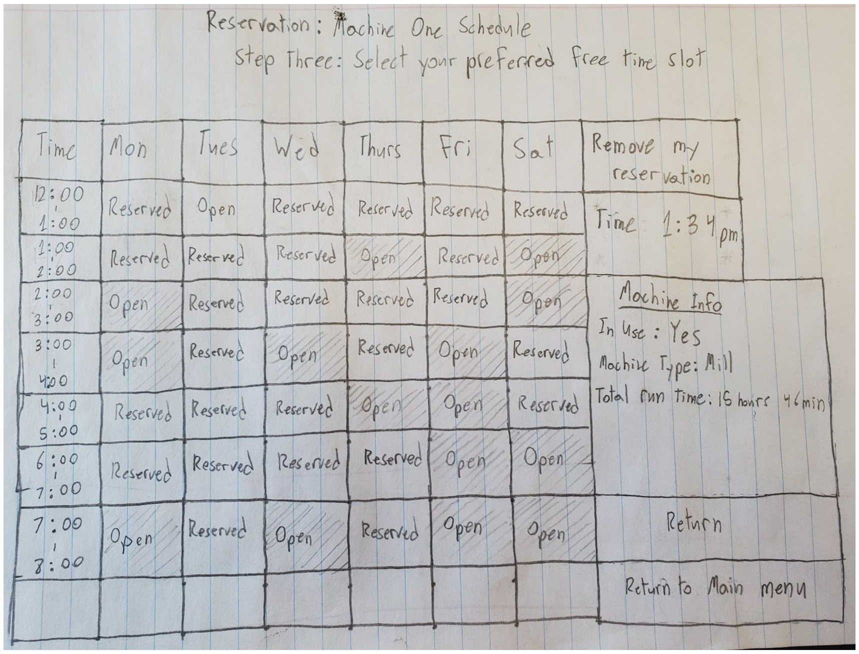

Figure 2: Schedule system

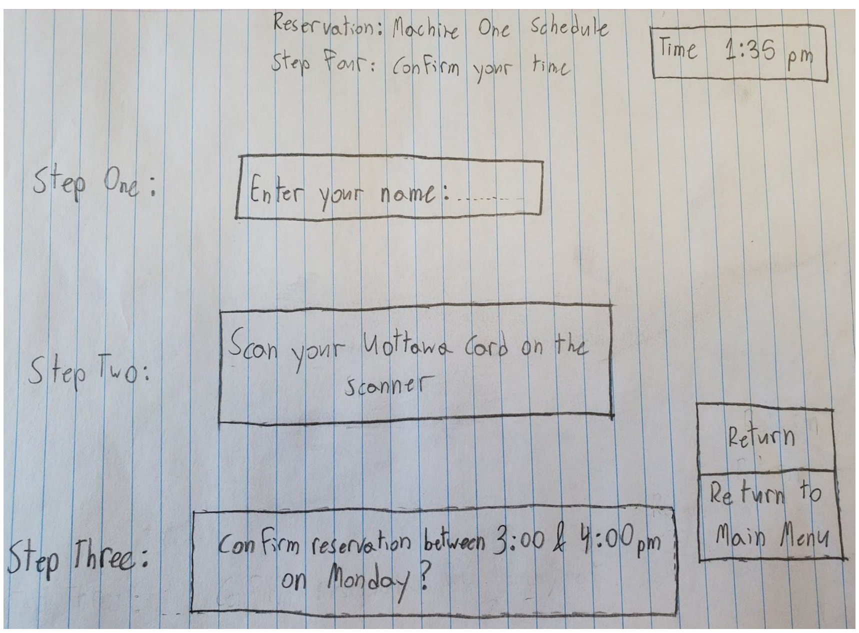

Figure 3: Confirming time slot in schedule

Inventory:

Pseudo Code: Inventory Subsystem

Set variables:

User, w = 0, t = 0, name, numItems, check, array inventory [n][2], n = 0, array list [n][2], exit

Ask user if they would like to add a new item or view list

The user must set up an item before it is ready to be tracked in the system.

```
If new item:
    Start while loop:
        Add 1 to n
        Prompt user for item "name" and weight "w" of individual item
        Set list [n][1] = "name"
        Set inventory [n][1] = "name"
        Set list [n][2] = "w"

        Prompt user to place items on the pad
    Ask user if all items are on pad
    If yes:
        Set total weight as "t"
        Divide "t" by "w" set it equal to "numItems"
        Set inventory [n][2] = "numItems"
        Output array to the screen
        Ask user if they would like to add another item
        If yes:
            Set check = true
        If not:
            Set check = false
End while loop if check == false
```

To view the number of items and how the lists will work.

If view list:

While loop start:

Output:

For loop from 1 to n

Output:

Inventory [n][1]

Inventory [n][2] = current t divided by list [n][2]

End For loop when condition is met

Ask if user wants to exit list

If yes:

Set exit to True

If not:

Set exit to false

End loop when exit == True

Machine Monitoring:

Pseudocode: Machine Monitoring

IN PROCESSOR

```
Set Variables:
 t = 0, flag, user, usage [n][2], st, et, duration, time, flag2, n = 0, day = 0, flag 3
Start loop
        Add one to n
        Add one to t
        If user taps on pad
                Set t equal to st start time
                Start while loop
                        If user taps on pad again
                                Set t equal to et end time
                                Set usage [n][2] = et - st
                        If not:
                        Add one to t
                        Set flag 2 = false
                Exit loop when flag 2 equals true
        If not:
        Set flag to true
Keep looping while flag is equal true
```

IN DASHBOARD

Take in info from scheduling subsystem

```
Set usage [n][1] = username
Output:
For Loop 0 to n
        Usage[n][1]
        Usage[n][2]
End for loop when condition is met.
```

Outputting Maintenance cycle info

Start Do While loop

flag 3 = true

    Check if “machine maintained” is selected

    if yes:

        set seconds = 0

add 1 to seconds

end loop if flag 3 is equal to false

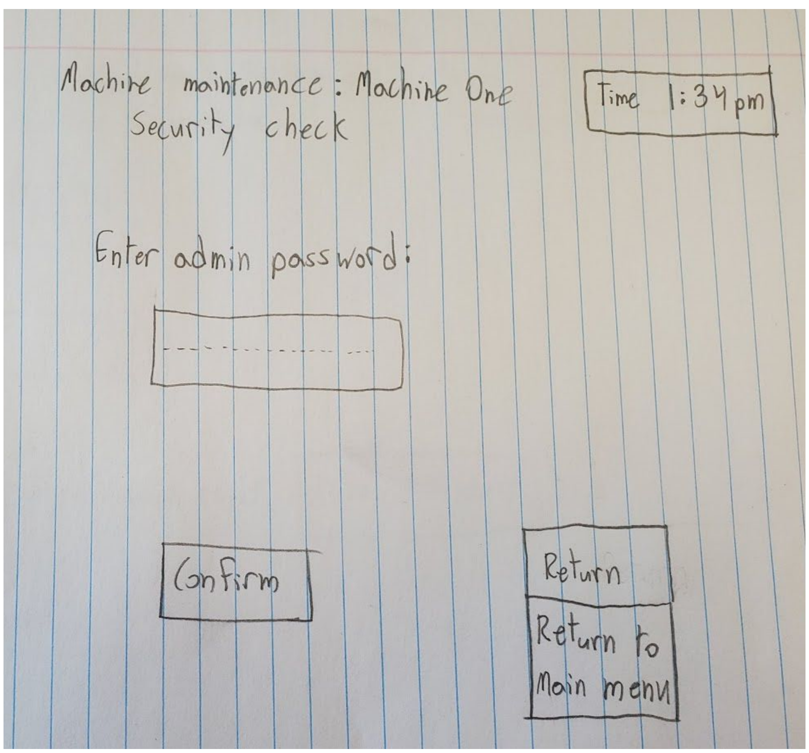

Figure 4: page prior to accessing machine monitoring

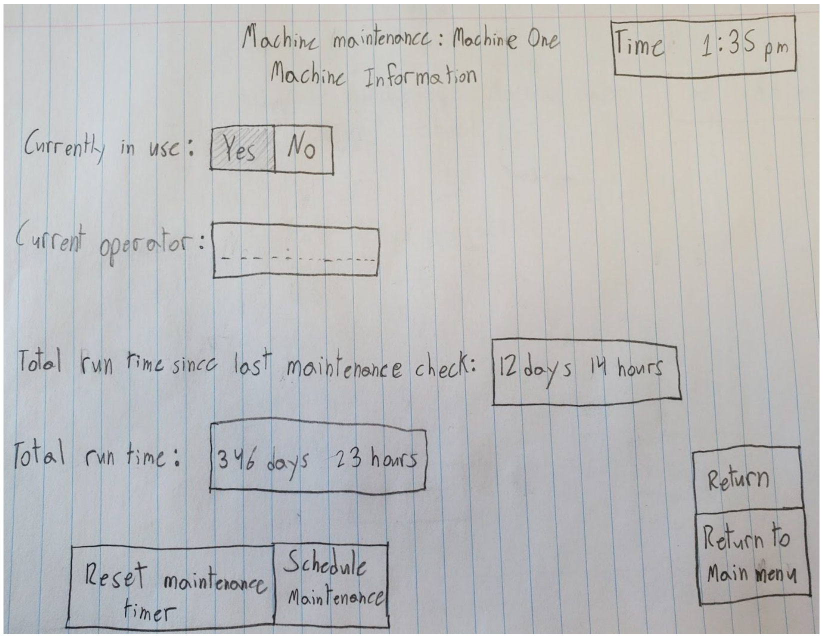

Figure 5: information displayed in machine monitoring

Dashboard:

Pseudocode: Display of Machine Information and Schedule

```
Variables:
n=0;

(string variables)
info;
sch;


schedule [ ]; (This is an array variable which has the schedules for all the machines)


information [ ]; (Array variable with information about machine)

*Selection of machine*

If (n==1); /*It could be any machine. Machine number 1 is selected in this example. User Enters this number */

Info=information [1]; //Now Info has the information about machine 1


Sch=schedule [1]; //Sch has the schedule for Machine 1

printf(" %s of Machine 1 is %s ",Sch,Info);

}
```

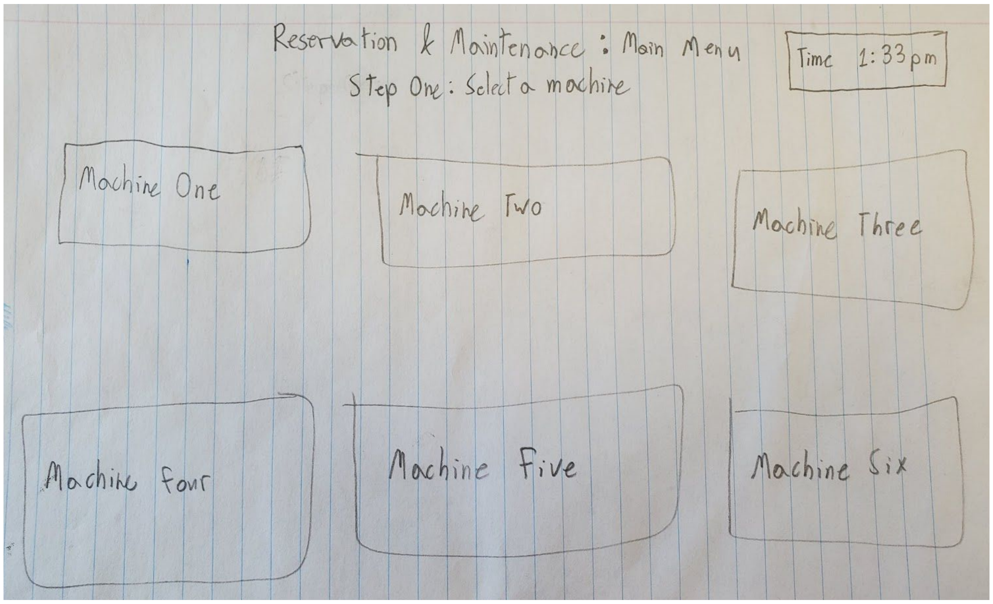

Figure 6: the main menu for our Dashboard

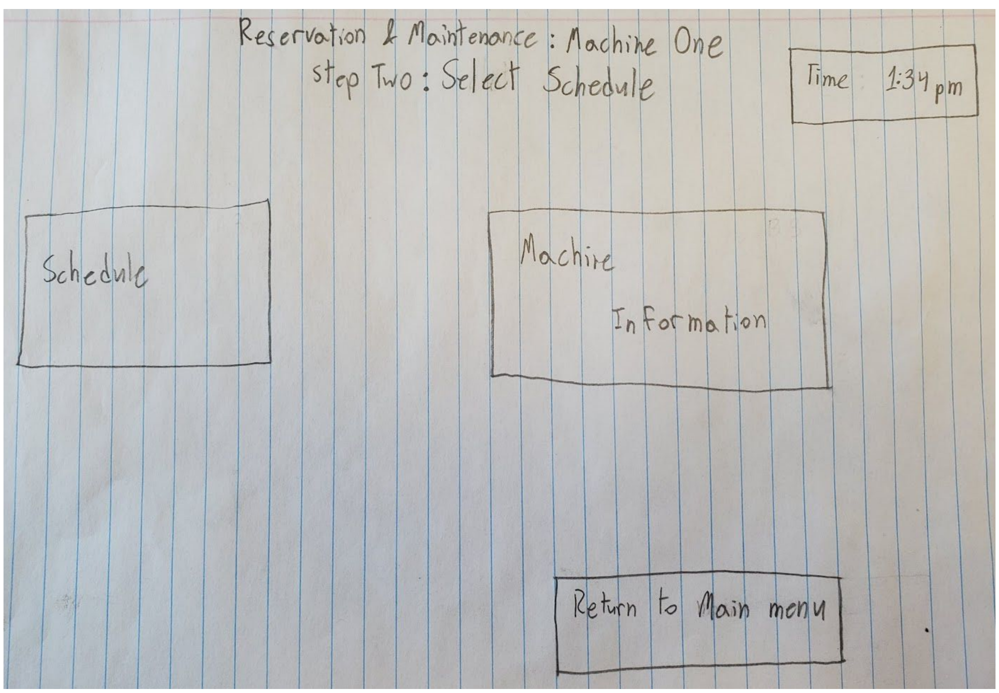

Figure 7: page displayed after selecting a machine

Prototype Description:

In order to create an in depth proof of concept, the team decided to also create a written model for the subsystem processes and present it as pseudocode or a flowchart in addition to a physical model. The physical model represents what the users will be interacting with while the pseudocode and flowcharts represents the inner processes of the system.

The physical model represents one of the sensor inputs in the system. The system will have two different physical subsystems; one for the machine monitoring subsystem and another for the inventory subsystem. Both systems will essentially look the same in appearance as depicted in figure 1. They will consist of a box to hold the proto-board and Node MCU and a cable connecting the system to the pressure pads. The inventory management system will have 2 pressure pads connected to it since it will need to cover a larger area.

The dashboard display as represented by Figure 6 and 7 will consist of buttons, each button will give the user access to the different options. The display will be very minimalistic inorder to drive the user's attention towards the important features. There will be a tutorial/help button available for the user's convenience, should they get stuck or confused. The dashboard subsystem system will act as a terminal that will organize all the inputs and outputs to the machine monitoring and inventory subsystem. The dashboard will also directly display the scheduling system, thus organizing the various users.

The machine monitoring system as described by the pseudocode above, will input how many times a machine had been used in a day and for how long. The system will collect this information through pressure sensors and organize it using arrays in dashboard. This will allow the staff to more efficiently maintain the quality and performance of the equipment available in the workshops. This system will work in collaboration with the scheduling system. This way should there be any damage to a piece of equipment, the management will be able to track who is responsible and behave accordingly. The information will be presented to the user as shown in Figure 5. This display will also be very minimalistic and only present the vital information. This page will also include and guide for troubleshooting should there be any difficulties encountered during its lifetime.

The inventory management system has two main parts. The first part consists of the pressure pad and Node MCU. The pressure pad will take in the total weight of whatever the item(s) are and the user will input the weight of an individual item into dashboard. Using this information the number of items will be calculated, and refreshed intermittently. The second part is the information display, the information will be organized and displayed on dashboard for the user/admin to view. When an item becomes low (the definition of “low” will be determined by the user when setting up an item) a notification will be displayed on the UI for CEED to see.

The scheduling system has three main components: Creating the reservation, removing the reservation, and removing a completed reservation from the system. For creating a reservation; the user selects which machine and what time they would like to reserve. The user enters their name and scans their Uottawa card to confirm their reservation. The system saves their name and Uottawa code for if they wish to remove their reservation. To remove a reservation the user selects their timeslot. To prevent people from removing others reservations, users will need to enter the name they entered for the reservation and rescan the Uottawa card. The system compares the entered values with what was stored in the system. If the values match, the reservation is removed. The system will have a calendar, and will use it to check the time. When the system finds a completed time slot the reservation is deleted and all information is cleared. The UI is designed to be intuitive to use for students and CEED members. There will also be basic information about the selected machine in the schedule table. Figure 2 and 3 represent what the user should see when scheduling a reservation.

Analysis:

The physical model has the following Dimensions:

Length= 15 cm

Width= 10 cm

Height= 4 cm

Thickness= 0.1 cm

Density= 2.7 g/cc

Volume= 24.7 cubic centimeters

and will weigh:

66.69 grams

It was found that using the boxes made in the MTC lab provided a relatively small and portable housing unit for the proto-board and Node MCU. When the concept was first presented to CEED, they mentioned that an incentive for users to use the systems would be required, the team decided the best way to do this would be to advertise and promote the fact that using the system meant that the needed machines would be available for use to the users for the time they had already decided upon. This would be convenient and efficient for everyone using the shop. CEED also mentioned that they would like a better way to not only track their inventory, but to remind them when items are running low. In order to do this, the teams new design has a notification system that will alert the staff about any shortages. The system has been designed to be as customizable as possible to ensure that the staff can get the most out of it. The system will also be secure, ensuring that not anyone can access the information entered into the system.

Test Plan:

This prototype and test will check the system's feasibility and will highlight any issues early on in the prototyping process. The prototype will help in communicating the basic concepts of the system to the client. Through communicating the concept Team 7 will be able to learn about what the system lacks.

Test Objectives Description:

The main purpose of the tests is to see if the brainstormed ideas are feasible. In the tests the team will trace the pseudocodes and flowcharts with the various hypothetical inputs. For the scheduling and reservation subsystems, the tests will track the various inputs the user selects throughout the code. The objective for this subsystem will be to see if the user will be able to successfully create and cancel a reservation and if the admin will be able to track the info compillied. For the machine monitoring subsystem, the test will trace the input from the pressure pad through the system, the system's ability to integrate with the reservation system. The objective of this test will be to see if the system successfully tracks the number of times a machine is used in a day and the usage duration. An additional adjective of the test will be to see if the system can also organize and display the information collected from the sensors to the admin. For the inventory system, the test will consist of tracing the input from the pressure pad and the calculations that would occur once the data is collected. The test would also track the organization or presentation of the information to the admin. The test objective for this subsystem is to see the systems ability to calculate the number of items accurately from the information inputted and display the information to the user/admin. For the final dashboard subsystem the test will trace the UI pseudocode as hypothetical inputs are run through the system and ensuring that the user experience is smooth and organized. The test objective for this subsystem will be to ensure that all information is presented effectively and that all information is present is an efficient manner. The team hopes to catch any issues early on and reduce the possibility of issues later on into the prototyping process.

The prototype will convey how the system will monitor machine usage, track inventory and create/remove machine reservations. Through the pseudocode the team will be able to describe the systems processes by describing what the system will do. The physical model will represent what will actually be present in the workshop and the various sketches will give the user/customer a taste of what the system will be able to do.The team hopes to learn what processes would benefit Brunsfield and what processes would be counterproductive.

This prototype will probably have very few numerical results. The team expects the results to describe what the system will do and if it's possible. The tests will be more hypothetical and will require the team to run through each line of the pseudocode and see if the system as a whole makes sense. The various inputs will be traced through the pseudocode to ensure that the actual outputs match the expected ones. The Physical model will be tested to see if the design is usable in the workshop, we expect to see the different sizes and weights possible for the system, and test which sizes would be the best to use. Based on the results of the tests. We will decide on what subsystem performed their designed tasks well and what subsystems didn't work. The systems that failed their test or some part of it will be edited to make sure they work. The test will also determine if certain processes that are either unnecessary and must be removed or needed and must be added.

Test Criteria:

The test criteria for success for the first prototype will be if the pseudocode makes logical sense and if the physical model is small enough to not become a nuisance at Brunsfield. The physical model will be deemed feasible if the team has access to the required materials and if the model is small enough to fit comfortably in their final location. For the pseudocode, it will be deemed a success if the code is written properly and achieves its intended purpose. It will be considered a failure if it fails to perform its task. If the expected outputs match the actual outputs then the test will be deemed a success. If some of them match the test will be an almost success and if none match then the test will be a complete failure.

Prototype and Test Type:

This prototype will be both comprehensive and focused. This prototype has visits every subsystem, however it focuses on each individual subsystem and its functionality and not how they will interact. The team selected this prototype to have three different forms: a physical model, pseudocode, sketches. These three forms were selected so that a skeleton of all subsystems were represented and defined. This prototype will not only act as the basis and guide for any future prototypes, but communicate the design and purpose of the project to the user or customer. The physical model represents what will be physically in the room; the pseudocode describes the different processes of each subsystem; finally, the sketches represent the UI, the users will be interacting with. This prototype allows the team to spot and correct any logical flaws in the design.

A variety of different values will be measured for each subsystem. More specifically, for inventory management; the initial weight and the current weight of the objects on the pressure pad will be measured. This will aid our system to know when the amount of what's under the pressure pad is running low. For machine monitoring; how long each machine has been running will measured. The system will know when the machine has been turned on, and when it was turned off, and measure how much time had elapsed. For the schedule; no metrics are measured. Instead the system has to remember who signed in for their specific time slot and if they can properly cancel their reservation. The dashboard subsystem does not measure any values but represents the UI. The Team will be observing the ability of the machine monitoring, inventory, and scheduling subsystem to properly perform their intended functions. The team will observe if the systems actual outputs match their intended ones. They will record if the task was performed successfully or otherwise and record the results. The information is simply being written down at this stage and not put into a table.

This prototype will be created using basic materials found in a household. The strings will represent the wire and the boxes will represent where the Node MCUs will be kept. The sensors will be represented using labelled paper and the display will be drawn out as well. The UI will be represented using sketches and all pseudocode will be typed out onto a document. The prototype will cost the team zero dollars. The Team require further development of their software code. They have completed the pseudocode, but the final product requires the code in C. For the physical model, they need to connect their sensors to the Node MCU and connect the MCU to dashboard. They also need to configure their RFID sensor with the system.

Test Dates:

The tests should only take 15 to 20 minutes each. Before the tests are conducted, we must ensure that the pseudocode and physical model represent the final systems processes to a reasonable accuracy. The test will confirm the systems functionality and concept. The results are required by October 29th, 2019 at the latest so that the team may begin working on creating a functional system. The specific dates can be found in the figure below.

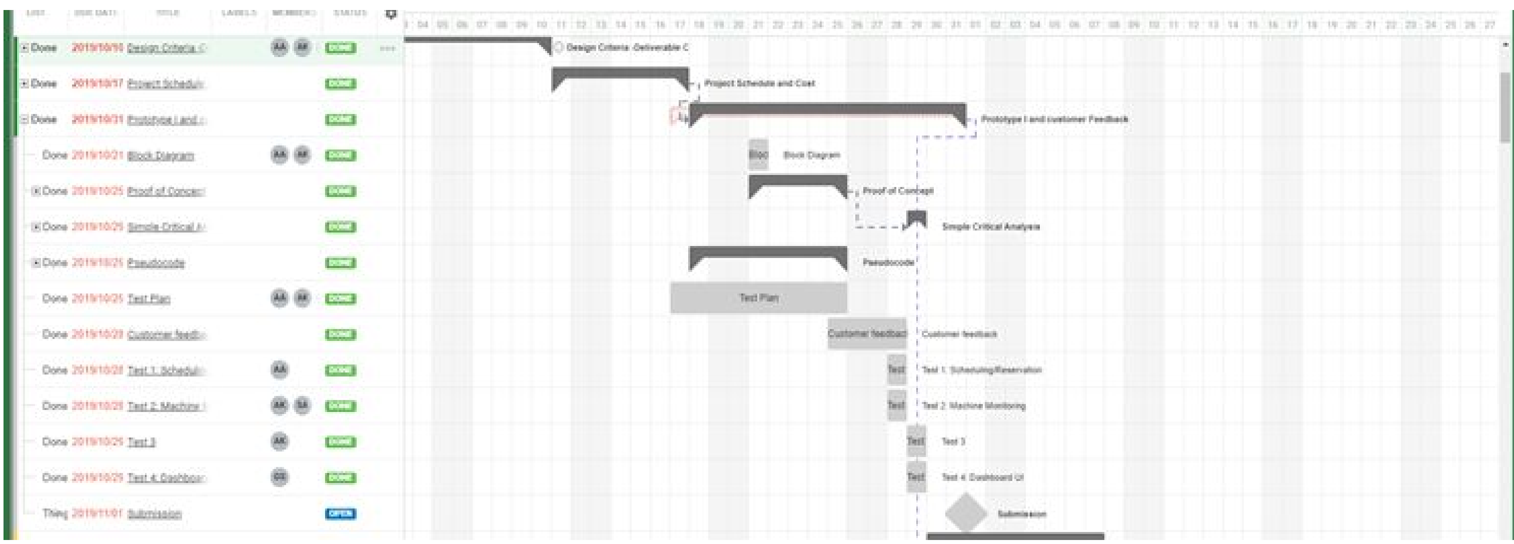

Figure 8: Test plan

Prototyping Results:

Test 1: Scheduling/Reservation Subsystem

Inputs: User Name, UOttawa Number, Time

Expected Outputs: storing user name and UOttawa code. Time is constantly checked to eliminate completed reservations.

Actual Outputs: the actual outputs were as predicted, the software properly stored the users inputted name and UOttawa code, it was also able to properly remove reservations at the time they were completed.

Notes: The expected outputs and the actual outputs were a match, therefore this test is a success.

Test 2: Machine Monitoring Subsystem

Inputs: Pressure Pad, User Information

Expected Outputs: Usage Duration, Usage Time, Usage Ownership, Time Since maintenance

Actual Outputs: Usage Duration, Usage Time, Usage Ownership, Time since Maintenance

Notes: The units for the time need to be changed from seconds to a more sensible unit, otherwise the expected and actual outputs matched, therefore this test was mostly successful.

Test 3: Inventory Subsystem

Inputs: Pressure Pad, User information

Expected Outputs: Number of Items, Total Weight, List of Items and Weights

Actual Outputs:, Number of Items, List of Items and Weights, Total Weight

Notes: The total weight of the items may be an unnecessary output. Otherwise, the expected and actual outputs matched, therefore the test was a success.

Test 4: Dashboard UI subsystem

Expected on display: Inventory, machine monitoring and scheduling/reservation

Actually on display: Machine monitoring and scheduling/reservation

Notes: The UI sketches and pseudocode accounted for most subsystems, however, the system did not display the inventory information. Therefore the test is an almost success.

Client Feedback:

Client Name: Cedric - Post-graduate student

Notes: Cedric had many recommendations to improve our design. For the reservation system; he said there should be a penalty if users cancelled their reservation close to their actual scheduled time. To increase the users commitment to their selected time. He also said it might be tedious to sign out multiple different machines at once, and that the time slots should be in half hour increments instead of an hour.

Client Name: Patrick Elten - CEED employee

Notes: Patrick recommended that there should be a system that checks if a user is certified to use the machine they wish to sign out. He also suggested that each machine should have a RFID scanner that will only activate the machine if they are currently reserved to use it.

Client Name: Matt - CEED employee

Notes: Matt recommended a visual map of Brunsfield be added to help orient the user to which machine is which. He also made some recommendations to our inventory tracking system. He said that the idea would work well for larger items that had large masses, but that the system may struggle to sense a change in weight if the object is very light. He also informed us that the operating hours on the website were inaccurate. Brunsfield is open on weekdays from 12 - 6pm and 10 - 6pm on Saturdays.

All people interviewed were impressed with the user experience of navigating through the reservation/machine monitoring software, and thought that the inventory management system was a great solution. They also believe that the addition of our project into Brunsfield will improve the space.

Improvements:

Upon receiving this information, the team decided that instead of identifying users by name and student ID, the system would only use the student ID. The team will also try to indicate the correct operating hours onto the display for convenience, when users are asked to make a reservation. The UI will also try to display the various machine information in such a manner that identifying them for newcomers will be easier. The UI will also contain a page or tab for the inventory to be displayed in. The team will try to implement a system where only certified personnel can use the machines.

Conclusion:

The first prototype is an analysis of the feasibility of the most critical systems for the entire project. Tests were performed on how these systems would operate. The team took the results from the tests as well as client feedback and used them to decide on how to improve the designs for the next prototype. The systems that were analyzed were the inventory management, Machine monitoring, scheduling and dashboard UI. Physical models were made for the machine monitoring and inventory management subsystems and sketches were used to represent the UI. The inventory, scheduling/reservation and machine monitoring subsystem were represented using pseudocode. These models helped let the user give us the feedback the team needed to make improvements to the system. The additions and improvements that will be made based on the feedback received from the first prototype will help to make the project a definite improvement to the Brunsfield space.

Works Cited

Omondi, S. (2017, October 13). What Is the Density of Aluminum? Retrieved October 29, 2019, from https://www.worldatlas.com/articles/what-is-the-density-of-aluminum.html.