Deliverable E - Project Plan and Cost Estimate

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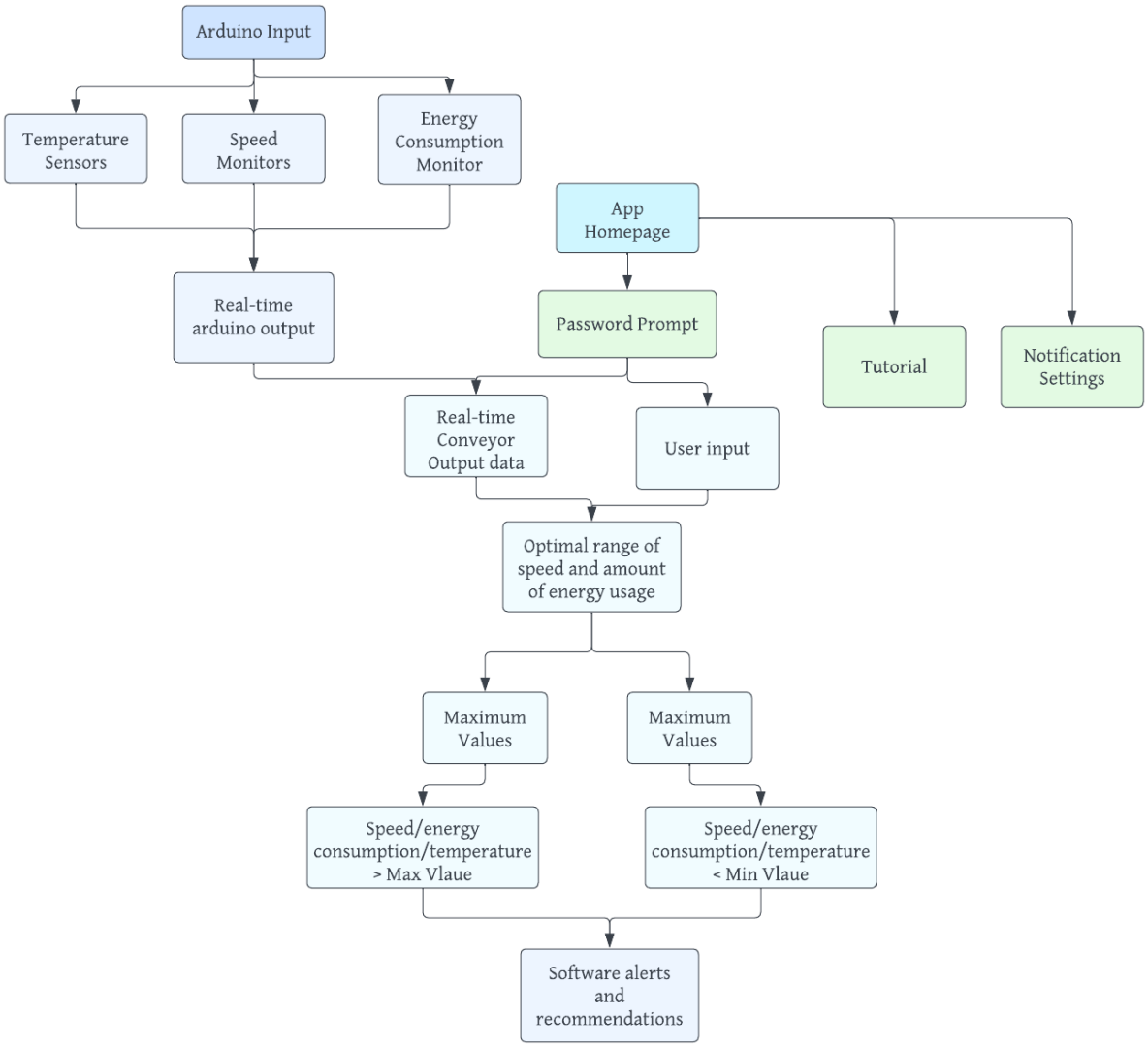
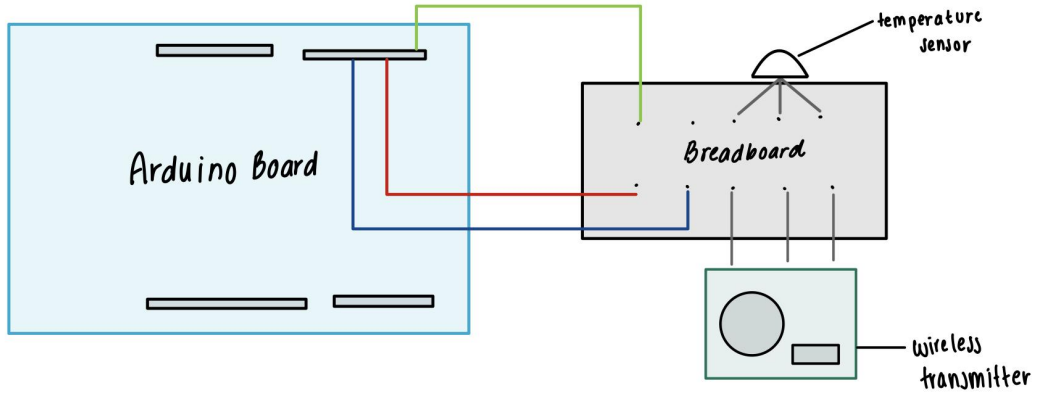
Detailed Design Drawing

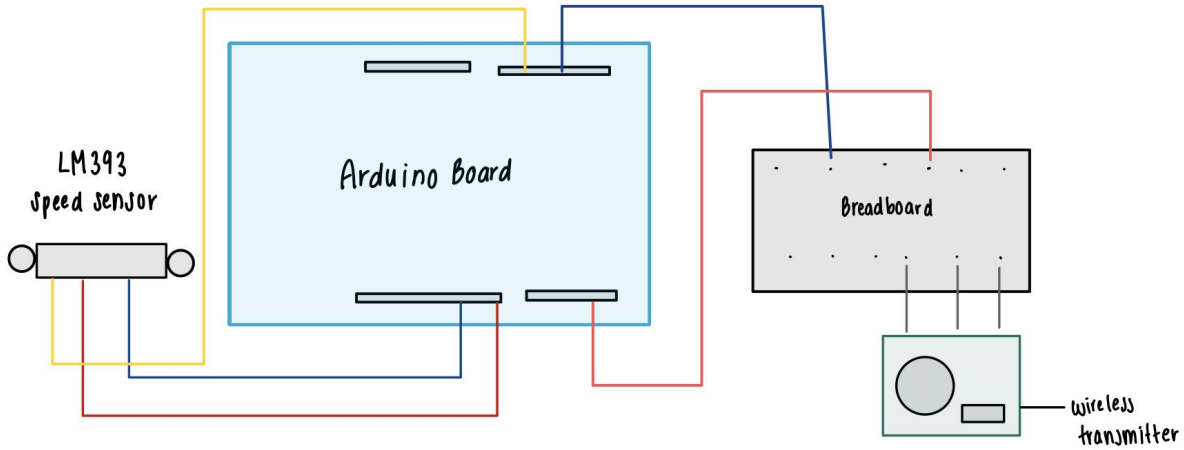


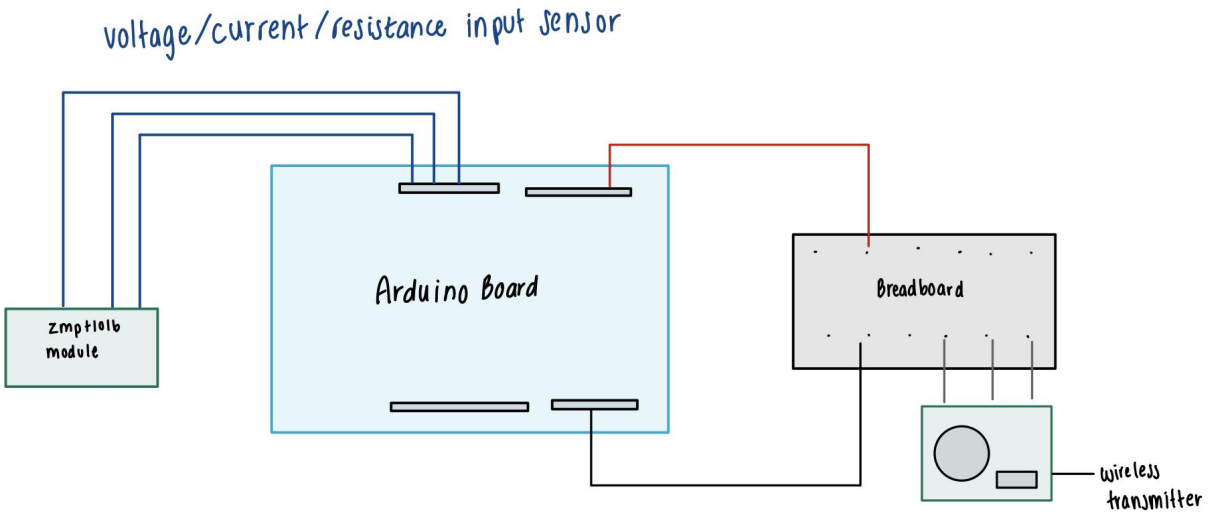
Arduino Input Drawing

Temperature Sensor Arduino Input

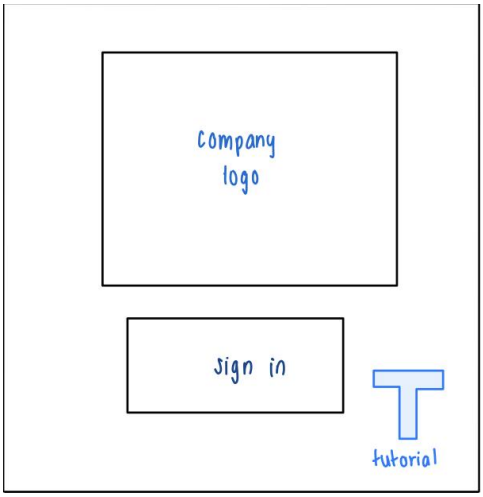
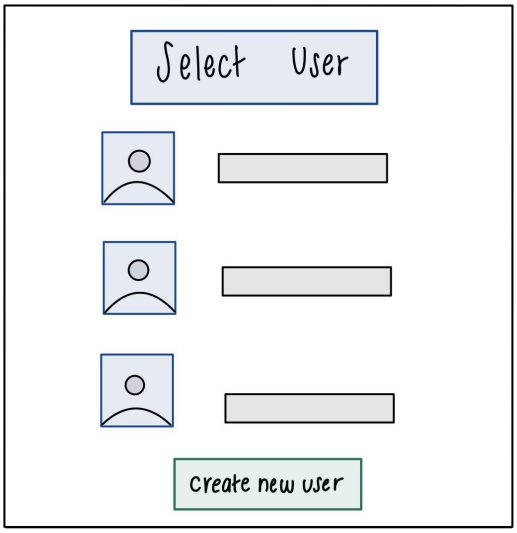
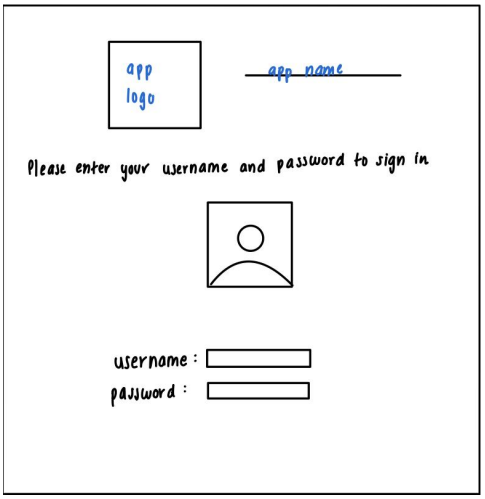


Speed Arduino Input Sensor

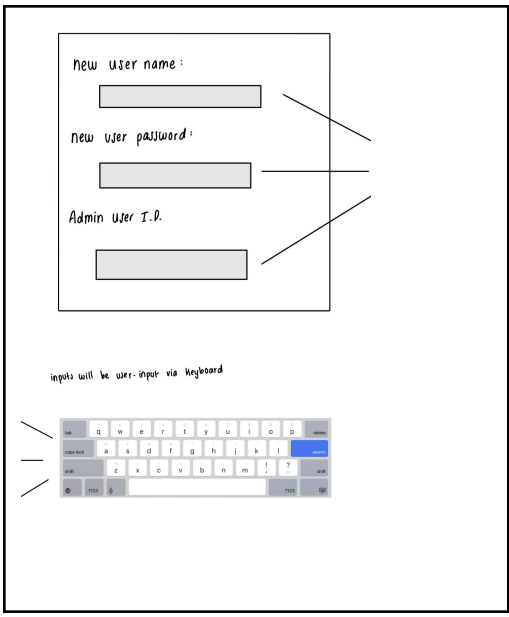


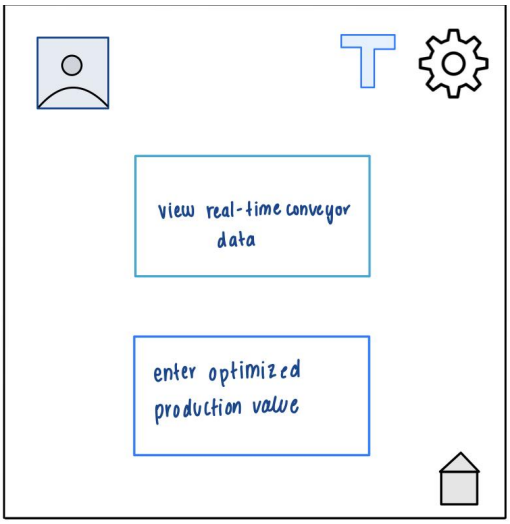


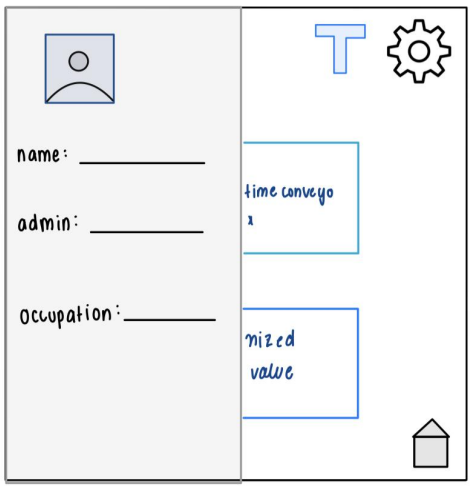
Software Design Drawing

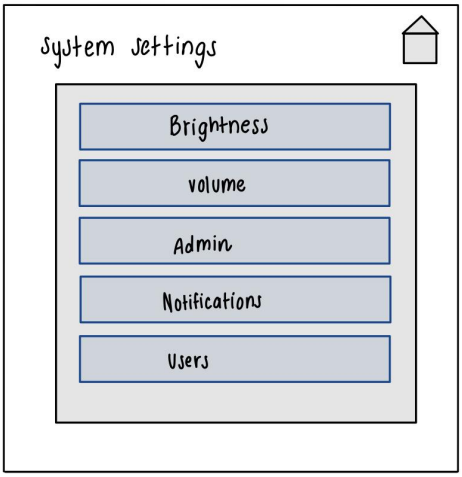
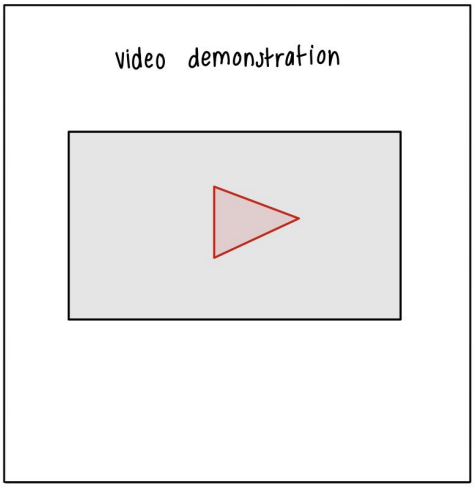
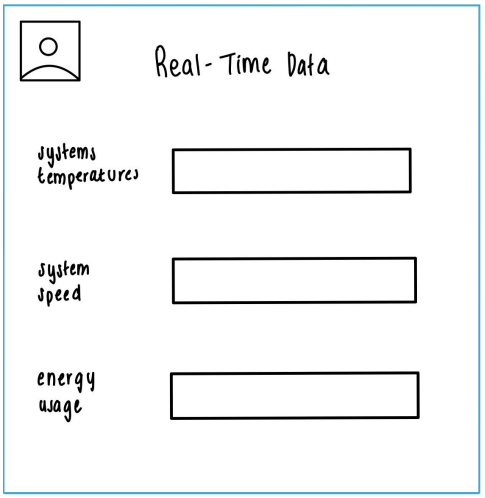
Homepage	Select user sign-in	User sign-in page
		

Create new user	User homepage	User profile

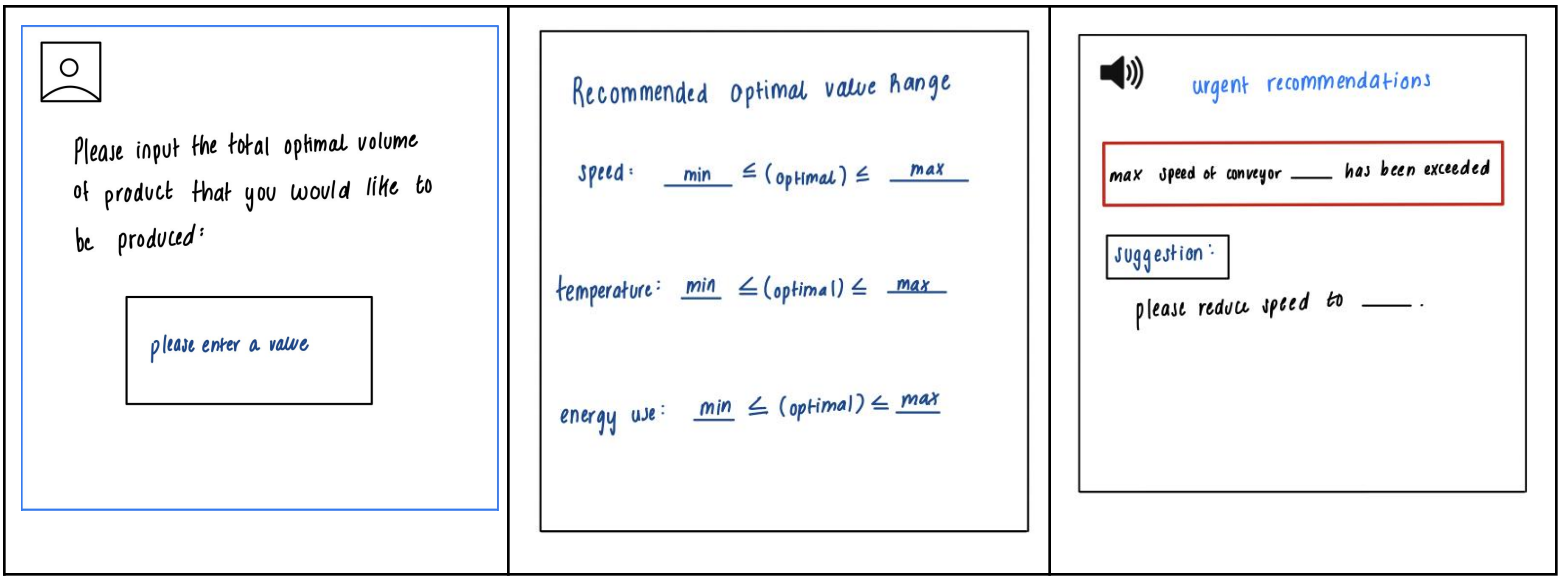






System settings	Tutorial Page	Real-time data
		

User-prompted input	Optimal Values	Urgent Recommendations



Prototype Materials/Bill of Materials

Prototype I Materials

The first prototype will be a basic proof of concept and should be made using materials and components that cost very little (e.g. things found around the house, scraps, etc.). A simple analysis of critical components or systems should also be included, based on your current knowledge of engineering science or other material. If the project is completely software-based, make sure that you include the cost of any special tools or software services that you will need for a functional prototype. Ideally, free software tools should be used only.

Material/Instrument/Apparatus	Cost
Thunkable	$0
Arduino IDE	$0
Arduino Uno https://www.sparkfun.com/products/11021	$27.95
Breadboard https://www.sparkfun.com/products/12002?_ga=2.85509022.64287471.1676664406-2079623805.1676664406	$5.50
Arduino/breadboard wires: https://www.amazon.ca/Elegoo-120pcs-Multicolored-Breadboard-arduino/dp/B01EV70C78/ref=asc_df_B01EV70C78/?tag=googleshopc0c-20&linkCode=df0&hvadid=292982668700&hvpos=&hvnetw=g&hvrand=4324305368329408397&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvl	$15.99

ocint=&hvlocphy=9000667&hvtargid=pla-362913641420&psc=1	
Wireless transmitter https://www.amazon.ca/HiLetgo-Transmitter-Receiver-Arduino-Raspberry/dp/B00LNADJS6/ref=asc_df_B00LNADJS6/?tag=googleshopc0c-20&linkCode=df0&hvadid=579148679207&hvpos=&hvnetw=g&hvrand=17228405542517373536&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000667&hvtargid=pla-319099859202&psc=1	$12.49
Total cost	$61.93

Equipment

- Arduino IDE

Prototype II Materials

The second prototype should be of a (or maybe the most) critical subsystem, to ensure that your design will work. An analytical, numerical or experimental model should also be included.

Material/Instrument/Apparatus	Cost
Thunkable	$0

Prototype III Materials

Finally, the third prototype should be a fully functional version of your solution (i.e. a comprehensive prototype). Many successful groups do more than three prototypes, based on their specific project risks, but at least three are required.

Material/Instrument/Apparatus	Cost
Thunkable	$0
Arduino IDE	$0
Arduino Uno x 3 https://www.sparkfun.com/products/11021	$27.95x3=$83.85
Breadboard x 3 https://www.sparkfun.com/products/12002?_ga=2.85509022.64287471.1676664406-2079623805.1676664406	$5.50x3=$16.50
Arduino/breadboard wires x 3	$15.99x3=$47.97

https://www.amazon.ca/Elegoo-120pcs-Multicolored-Breadboard-arduino/dp/B01EV70C78/ref=asc_df_B01EV70C78/?tag=googleshopc0c-20&linkCode=df0&hvadid=292982668700&hvpos=&hvnetw=g&hvrand=4324305368329408397&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000667&hvtargid=pla-362913641420&psc=1	
Wireless transmitter x 3 https://www.amazon.ca/HiLetgo-Transmitter-Receiver-Arduino-Raspberry/dp/B00LNADJS6/ref=asc_df_B00LNADJS6/?tag=googleshopc0c-20&linkCode=df0&hvadid=579148679207&hvpos=&hvnetw=g&hvrand=17228405542517373536&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000667&hvtargid=pla-319099859202&psc=1	$12.49x3=$37.47
Temperature Sensor https://www.digikey.ca/en/products/detail/analog-devices-inc.-maxim-integrated/DS18B20%2BT%26R/3478852?utm_adgroup=Sensors%2C%20Transducers&utm_source=google&utm_medium=cpc&utm_campaign=Shopping_Supplier_Maxim%20Integrated_8022_Co-op&utm_term=&productid=3478852&gclid=Cj0KCQiArsefBhCbARIsAP98hXRF49EMjOuuRjUkYujDEbe1j5QnA0AbY5NISB2iIx5BwPolzovg9AYaAuv5EALw_wcB	$12.18
Speed sensor https://www.amazon.ca/Aexit-Electric-Optocoupler-Measuring-Counter/dp/B07L69KCCK/ref=sr_1_8?gclid=Cj0KCQiArsefBhCbARIsAP98hXRtgxQc9c92Y1nrhkJbGmCbZnkusbQgU9c3ElT_pkG7KzBO2p8gDjYaAkJMEALw_wcB&hvadid=588772525893&hvdev=c&hvlocphy=9104932&hvnetw=g&hvqmt=e&hvrand=15420301692440699818&hvtargid=kwd-300064438547&hydadcr=24946_13554006&keywords=lm393+speed+sensor&qid=1676827999&sr=8-8	$10.02
ZMPT101B module https://www.amazon.ca/ZMPT101B-Voltage-Transformer-Module-Single-Phase/dp/B097JYWGT2/ref=sr_1_1_sspa?gclid=Cj0KCQiArsefBhCbARIsAP98hXTN2LG7LM2Gx9SP52Oae894AQnt9j3Qc6aTkUkStjeWxuW6Ds8UPJUaAlO_EALw_wcB&hvadid=324887748614&hvdev=c&hvlocphy=9104932&hvnetw=g&hvqmt=e&hvrand=250567	$10.13

2641327931673&hvtargid=kwd-369628778298&hydadcr=20847_10090734&keywords=zmpt101b&qid=1676828111&sr=8-1-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEzUTBTQzRORDFWMTBKJmVuY3J5cHRlZElkPUEwNzA3MjA5MTJDUVFWTFBDUUtYSiZlbmNyeXB0ZWRBZElkPUEwMjY0NzU5MktSQ0hDMEhFWEM2NiZ3aWRnZXROYW1lPXNwX2F0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU=	
Total Cost	$218.12

Project Risks

Project Risk	Contingency Plan & Task Update
The energy/electricity sensor implementation is too cost ineffective and is unable to be implemented. In the second meeting with the client, he mentioned that it is quite costly to gain yearly information regarding	In order to resolve this issue, the electricity sensor will either need to be removed from the final design, and this process will not be monitored at all, or a new way of monitoring the energy will need to be implemented. In order for this to take place, a more firm understanding of how electricity is circulated around the floor must be established. To mitigate this, questions will be asked to the owners via the Microsoft Teams channel. In the instance that this system would no longer be monitored, then more attention would have to be given to the other systems in order to compensate. This can be done through adding more features to the real-time data, or increasing aesthetic and other functional components of the software.
The data collected from the machines is inaccurate and delivers incorrect recommendations.	In the instance that the recommendations and real-time data are not performing up to standard, then debugging will have to take place in order to solve the issue. A more solid understanding of the programming language C or C++ would need to be gained in order to effectively debug the code written into the Arduino IDE. The tasks that would need to be changed for this involve spending more time on the arduino IDE and potentially going to the makerspace on our own time to get help from staff.
The arduino input systems that we order are not compatible with the computing system we are using, or the input system that we require is different to the one we order.	A preventative measure that will be taken in order to circumvent this risk would be to ensure that all products are well researched. However, in the instance that this project risk is carried through, the contingency plan is to ask the project managers or staff at the maker space to help us make a more well educated decision on what new materials to buy, and then purchase them accordingly. This will set

	the project back slightly, so the task update would involve moving other deliverable working periods back slightly in order to make room for more time to work on the arduino inputs.
The speed of the conveyors move too quickly or slowly to be tracked by the arduino sensor.	In order to mitigate this risk, the extensive and thorough research will be conducted regarding what sensors are appropriate for recording large-scale moving objects. Additionally, a dialogue will be opened with the client to ask for specifics regarding the exact dimensions and speed of the conveyors. However, if this risk is carried out, then the contingency plan that will be executed will involve utilizing a different method of input (i.e. investing in a different sensor), and asking the product managers for more assistance if needed.

Prototyping Test Plan

Objective	Stopping Criteria	Unit of Measurement & Acceptable Fidelity/Simplifying Assumptions
To test if the temperature input system is effective gathering accurate data in real-time.	When the temperature sensor is connected to the Arduino Uno board, and when this is then connected to the Arduino IDE, a series of tests will be conducted to ensure that the program is collecting and displaying accurate real-time data. The stopping criteria for this would be conducting a simulation of the conditions that would be similar to the ones found in the floor of the brewery. If the Arduino IDE is accurately outputting data at a rate of a temperature value for every second, then the stopping criteria will be fulfilled and it can be concluded that this input system has fulfilled the requirements to be considered as a successful system in the prototype.	**Measurement**: values/second, ^{o}C/second **Acceptable Fidelity:** ● The temperatures that the temperature sensor would be reading would not be as high as the ones expected to be seen in the actual floor of the brewery. Therefore, it is assumed that a successful run will produce temperatures that are on average, lower than the ones that will be seen in the actual trials of the product.
To test if the speed sensor of the input system is effective in gathering accurate data in real-time.	When the speed sensor is connected to the Arduino Uno board and when this is connected to the Arduino IDE, the speed sensor will be put through a series of rigorous testing to ensure that the prototype is consistent with the standard required for the final product. The way in which the actual speed sensor will work is by tracking the speed of cans as they move by on the conveyor belt. As the cans move past, the sensor will track the speed at which they pass and relay this information to the arduino IDE. Once this information is being relayed back to the IDE at a rate of 1 value per second, then the test will have been successful.	**Measurement**: cans/second, m/s^2 **Acceptable Fidelity**: ● As much as the group will try to recreate the same environment for the prototype testing to take place, it will be very difficult to recreate the exact conditions. As a result, the closest simulation may be inaccurate. For instance, to simulate the motion of a conveyor belt, an escalator or treadmill may be used.

To test is the energy sensor of the input system is effective in gathering accurate data in real-time.	When the energy sensor is connected to the Arduino Uno board and when this is connected to the Arduino IDE, then the energy sensor will be put through a series of tests to gauge the efficiency of the input system. In order to attempt to recreate the conditions that would be observed on the floor of the brewery, a device will send a controlled amount of voltage to the energy sensor. The current from this device will then be recorded and displayed on the Arduino IDE. If the Arduino IDE outputs information at a rate of 1 value per second, then it will have been considered successful.	**Measurement**: Hz/second **Acceptable Fidelity**: ● It is expected that the amount of voltage being produced in a controlled environment is unable to recreate the exact conditions that will be seen in the real-world application of this device. Accordingly, an acceptable voltage will be much lower than that being used to power the machines on the floor of the brewery. If changes need to be made in order to gain a more accurate measurement for the client, then a more powerful sensor will be used.
To test if the system interface is user-friendly and easily accessible by people of different backgrounds.	In order to effectively test if the software being created is user-friendly, a series of user tests will be conducted. In these tests, a series of randomly selected participants will be asked to navigate through an initial prototype of the software. With their permission, they will be recorded and asked to talk about their thinking process while navigating the software. Should a participant not say their thinking process out loud, they will be prompted to by the person running the test.	**Measurement**: The amount of time that it takes for a user to navigate to certain areas of the app. **Acceptable Fidelity**: ● The people who will be asked to navigate the app are simply giving us a gauge of how user friendly the app is and may not be very well versed in the technical specifications of the product. It can therefore be assumed that they will take a longer time to navigate through the app in comparison to the employees who will have access to a comprehensive video tutorial.

Wrike Snapshot

https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=Ao8IorhLtraR7qlYzGA01Olkkg PgjW8E%7CIE2DSNZVHA2DELSTGIYA

Conclusion

To succeed in today's business world, it's crucial to have a well-planned prototype to develop a successful product. Accurately estimating the cost of each prototype is also essential for staying within budget and ensuring profitability. That's why we developed a comprehensive plan to achieve these goals. The first step in the plan was to test the first prototype to identify any flaws or areas for improvement. This testing phase allowed us to determine if the product was

functioning correctly and meeting the design requirements. By performing thorough testing, we could make any necessary changes to the prototype before moving on to the next phase.

Once the first prototype was tested and approved, we calculated an overall bill of materials for the prototype. This calculation allowed us to determine the total cost of all components and materials required to manufacture the product. By understanding the cost of each component, we could optimize the design to reduce the overall cost of the product.

An analysis of the critical components and systems was also conducted to ensure that the product was functioning optimally. This analysis allowed us to identify any potential issues that could arise during the manufacturing process. By identifying and addressing these issues early on, we could mitigate any potential delays or additional costs.

Finally, potential risks were identified, and appropriate contingency plans were created to mitigate these risks. By having contingency plans in place, we could respond to unexpected challenges quickly and efficiently, minimizing any potential impact on the project timeline or budget.

In conclusion, the prototype plan developed allowed us to achieve the objective of creating an effective prototype plan to provide an accurate estimation of cost for each prototype. By following this plan, we could optimize the product design, mitigate potential risks, and ensure that the project was profitable. With this successful prototype plan in place, future iterations of the product can be executed with confidence, efficiency, and cost-effectiveness.