GNG2101

Deliverable D – Detailed Design, Prototype 1, BOM, Peer Feedback and Team Dynamics

Submitted by

Team 1.1

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ABSTRACT

A client meeting was conducted where a series of statements were obtained, the most notable statement being that the client would like the design to be modified so that the tire can stay on the back wheel as the client finds it difficult to pump up her tires. A proof-of-concept prototype was developed using a power source and a diode, the prototype was successful, the LED light turned on. The new design has detailed sketches relating it to the prototype as well a list of materials was compiled into a BOM to determine the cost of the final prototype. The final prototype was within budget totaling $86.92 including tax and shipping. Details of the modified design including the bike trainer will be presented to the client at the next client meeting.

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LIST OF ACRONYMS

Acronym	Definition
ft	Feet
lm	Lumens
RPM	Revolutions per minute
hr	Hours
min	Minutes
$	Canadian Dollar
ft^2	Square feet
kg	Kilograms
BOM	Bill of Materials

1 INTRODUCTION

The design process used is an iterative design process. Based on statements and observations made during the last client meeting modifications have been made to the design to best suit the clients individual needs. This new concept was tested using a proof-of-concept prototypes, with basic electrical components to demonstrate the role of each larger component of the design. A bill of materials was compiled of each the components to be present in the final design. This is done to ensure the budget outlined is reasonable. A series of assumptions was made based on this list of materials. The prototype created in this deliverable is evaluated and related to the final design through sketches. A new list of information is compiled for the to present to the client.

1 CLIENT MEETING FINDINGS

2.1 Client Statements

This is the second meeting between the team and the client Madeleine Kyne, in this meeting, the team presented a potential solution to the problem statement of creating a human powered energy capture system capable of providing enough energy to power grow lights to grow a variety of indoor plants and vegetables. The solution presented resolved around the use of a bike pedal system to generate the power that would be stored and distributed to lights.

The client had multiple follow up questions, one of the main concerns from the client was it seemed as though if she was not biking there would be no lights that are lit up, this question was answered by the team by explaining the energy storage system that was presented in the design sketches. The second question she had was about the functionality of the bike. The client did not wish to remove the back wheel because she then would not be able to use her bike casually, such as if the weather was nice outside again. The client also stated that she was not able to pump up tires due to her hypermobile joints that would tire out, this would be an issue when removing the tires because the tires themselves would have to be decompressed until they are flat. One suggestion the client presented was to make an add-on to the bike wheel, that would allow for the V belt to still work but avoid the need to remove the tire and deflate the tires. The client also asked how much power would need to be generated by biking to power the lights, this question was answered by the team by providing benchmarks and calculations stating that the effort needed would be relatively low and is attainable for the client.

The client stated that if biking was the chosen method to generate power, she would need to reactivate her body by biking at slow intervals beforehand to build up the tolerance for longer bike rides. Ms. Kyne stated that bike rides of 30-45 mins are attainable, and that her usual gear ration ranged from 2 and 5, and 3 and 4. When asked about her usual biking intensity, the client stated that it would depend on how stable the set-up is. If the bike set up is stable enough to allow her to bike standing up, then she would be able to bike more vigorously as she would be able to generate more power with less effort. Client stated to air on the leisure bike ride intensity to allow for more flexibility.

In terms of the client's space allocations, the client confirmed that she had spare space of around 4ft x 8ft max for the entire bike and plant system in her apartment. The client also confirmed that her apartment does have downstairs neighbors, but the flooring is also made of concrete, therefore disturbance issues are not a huge concern.

Finally, the client gave the team full freedom to choose the lights as she was never stuck on a certain type or brand of light bulb. She stated that last semester the group’s lights were not the best ones, she stated that this may be because of cost constraints. Finally, when asked for her own expertise as an electrical engineer, she stated that the team should try and get converters that are already hooked onto a rechargeable battery. Getting an all-in-one set-up would be much easier in her opinion because then all that is needed is the input power, and to find a converter charger that fits with the input and related those calculations to figure out how many batteries are needed.

One of the goals for the team after this client meeting is to do tests on power generated with the back wheel removed, and power generated with a designed add on to the bike wheel, to see if the power outputs are vastly different. If there is a significant difference, and enough to support removing the back wheel, this data will be presented to the client at the next meeting.

2.2 Client Observation

The client seemed very friendly and comfortable when meeting with our team. She even asked about some of our pets and enjoyed hearing about their stories. The client responded very positively to the idea of biking and appears to enjoy the idea. The client was very comfortable and open when we asked about her gear limitations and did not appear to have issues or discomfort presenting us with her health information. When discussing the system possibilities, the client reacted the most enthusiastically to a modular system with resistance options. During the meeting, the client was consulted for her expertise as an electrical engineer, and she seemed to really enjoy providing her input.

The client expressed discomfort and seemed very closed off with the idea of modifications of her bike. She also appeared to respond negatively when given a time frame and intensity for cycling and responded much better when asked about a modular system that had options. She also appeared to react negatively when asked about the previous team's prototype attempt and seemed to dislike their attempt.

When asked about space requirements the client did not seem to have any preferences and was almost dismissive of the question. This does not appear to be an issue of importance for her. In addition, noise for her downstairs neighbor was brought up as a potential concern and she appears to have not considered this. There may be a possibility she will elaborate on this at the next meeting if she decided to consider this further.

3 DETAILED DESIGN CONCEPT

3.1 Prototyping Objectives

The objective of this prototype is to provide a qualitative, proof of concept that a DC motor can be used to generate power (human driven) in order to actuate LED lights. Furthermore, this prototype is used to verify the viability of a rectifier diode in the circuit, as it is part of the detailed design. Due to the time and resource constraints, this prototype was constructed using scrap materials found around the house. Furthermore, due to the lack of materials, it was not possible to obtain numerical results to compare to target specifications at this time. However, future prototypes will obtain numerical results for comparison.

The description of this prototype is as follows. A 6 V DC motor is used to power a LED diode. A rectifier diode and a 110 Ω resistor were placed in series between the DC motor. The purpose of the rectifier diode was to allow 1-way current flow. The resistor's purpose was to protect the led from full voltage. The prototype was constructed on a breadboard. The circuit diagram of the prototype can be seen in Figure 1.

3.2 Physical Prototypes

The following figure shows the circuit diagram of the prototype described in the previous section.

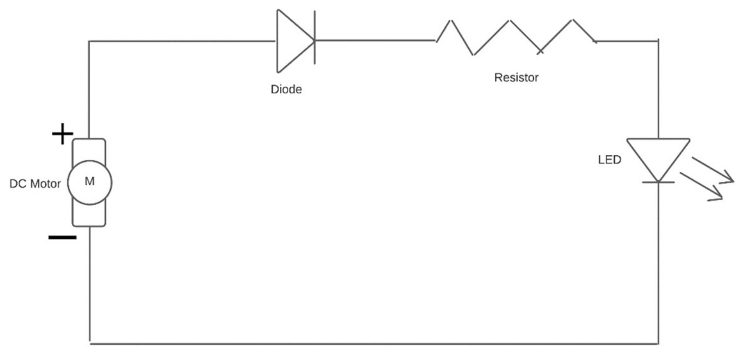

Figure 1:Circuit Diagram of Prototype

The next 2 figures show the constructed prototype on a breadboard. Figure 2 shows the prototype with the DC motor not spinning and the LED not actuated. Figure 3 shows the DC motor being spun and the LED being actuated. The DC motor was spun using fingers (human powered).

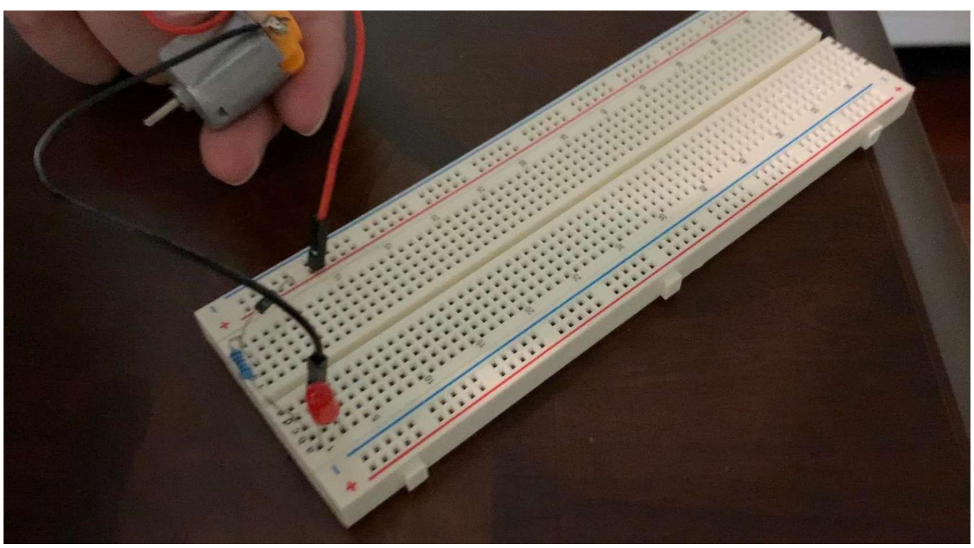

Figure 2: Constructed Prototype (not in use)

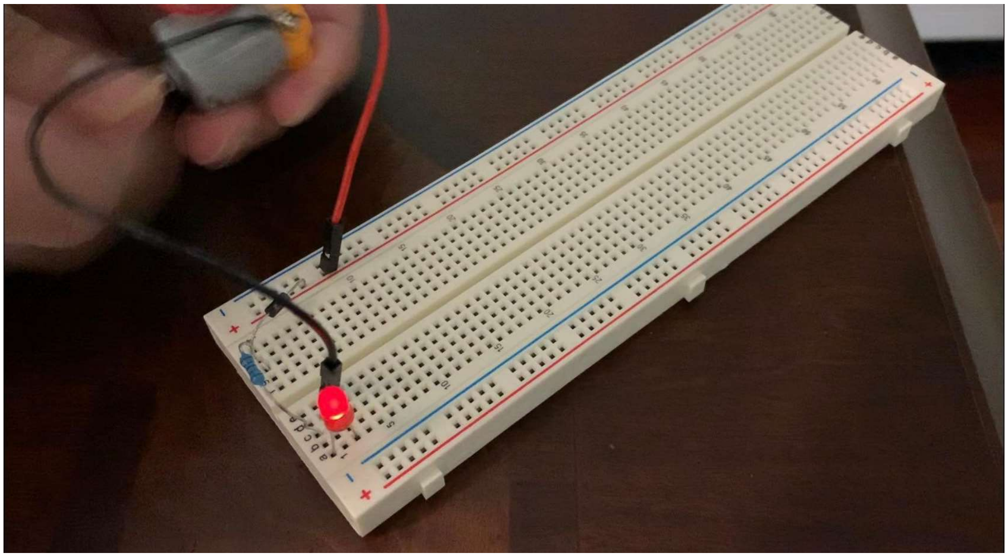

Figure 3: Constructed Prototype (in use)

Upon observing Figures 2 and 3, it can be seen that this initial prototype is successful. This provides a qualitative, proof of concept that a DC motor can be used as a method for human power generation to actuate LED lights. Furthermore, the rectifier diode did not interfere with the LED lights turning on, verifying the viability of the diode in the overall system. Future prototypes will be more complex and will produce numerical data that will be used to compare to target specifications.

4 BILL OF MATERIALS (BOM)

Table 1: Bill of Materials

Item No.	Description	Unit of measurement	Quantity	Unit cost	Extended Cost	Link
1	Bicycle	ea	1	0	0	[1]
2	Bike Trainer	ea	1	0	0	[2]
3	Wood	kg	1	0	0	
4	DC Motor	ea	1	0	0	[3]

5	Shaft	ea	1	0	0	
6	Diode	ea	1	6.99	6.99	[4]
7	Buck Converter	ea	1	11.99	11.99	[5]
8	Power Bank	ea	1	29.99	29.99	[6]
9	Grow Light	ea	1	27.95	27.95	[7]
10	Wiring	ea	1	0	0	
Total product cost (without taxes or shipping)				$CAD		76.92
Total product cost (including taxes and shipping)				$CAD		86.92

5 CRITICAL ASSUMPTIONS

Based on the materials selected there is a set of assumptions made regarding performance and properties. These fall into the categories of meeting the specified values, being readily available and the overall functionality.

5.1 Spec Values

The first specification value the materials need to accommodate is to be compatible with 10 W lights. The project will be based off the specifications for the Otryad 10W LED Grow Light. The battery pack was picked to be able to provide enough energy to the lights for over 2 hours. Another assumed spec value is that the client is able to bike at above a leisurely pace for 45 min a day, the designed parameters which the materials were selected off of are based on the assumption the client will be providing it with a specified input energy.

5.2 Material Availability

To avoid setback from product delays or faulty products assumptions have been made. The first assumption made is that the material being provided by group members has been tested for viability and is assumed to be reliable. The second assumption regarding material available is selecting very commonly used materials to allow for a backup plan of being to order an alternative product if it arrives faulty or the shipment is delayed. Finally, it is assumed all products will arrive in February as materials very selected with quick delivery times, even if it meant selecting a slightly more expensive option.

5.3 Critical Functionality

An assumption made regarding the functionality is that the bike trainer is stable enough that the client will feel safe and secure using it. If the client feels sturdy in riding, she will be able to go for longer and harder. This is a fair assumption to make as a group member has used the exact bike trainer several times before. Another critical functional aspect is assuming that the battery charging set up light works properly. This is important as it will alert the client when enough energy has been generated and she can stop biking.

6 PROTOTYPE TESTING

6.1 First Prototype

Due to time and resource constraints, our group's first prototype was a simplified physical proof of concept test. In previous deliverables, our group had generated a concept idea of using manual pedal power of a bicycle to generate electricity needed to power LED lights. Our concept idea centered around the assumption that it was possible to generate electricity to light LED lights using pedal power of a bicycle. Using a DC motor, circuit board, resistor and a small LED light, a test on if a spinning DC motor by hand with very little effort (which acted as a smaller version of pedals turning a shaft) was able to power the LED light on the circuit board. This test allowed the group to validate the assumption that it was possible to power LED lights with the use of a motor and rotational power. Although it was a smaller scale test of what our chosen concept will potentially do, this test was proof-of-concept validation, allowing the team to progress forward knowing that our assumptions have been validated. Given more time and resources, our team would have liked to test to see if the stored power in a power bank was able to light up LED lights.

6.2 Description of Prototype Using Sketches

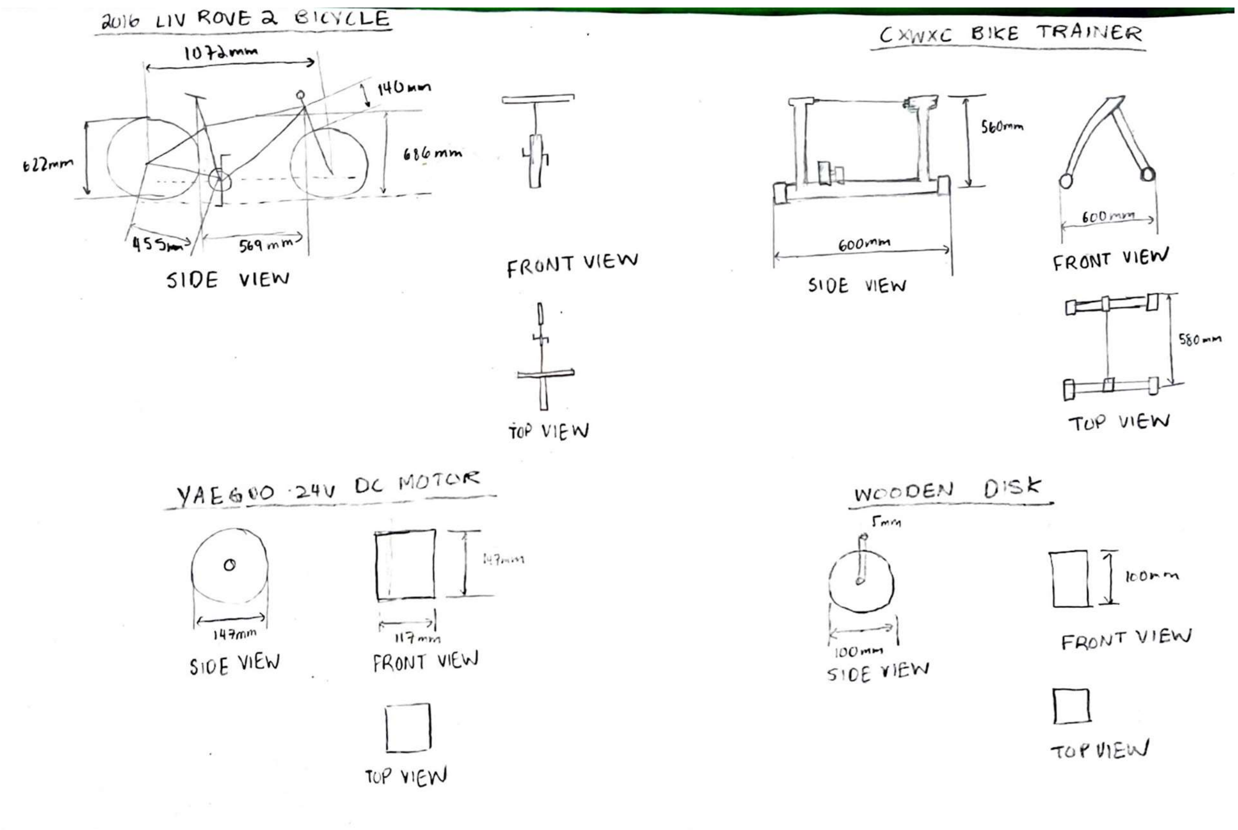

Figure 4: Sketch of Materials Needed for the Design Idea with Dimensions

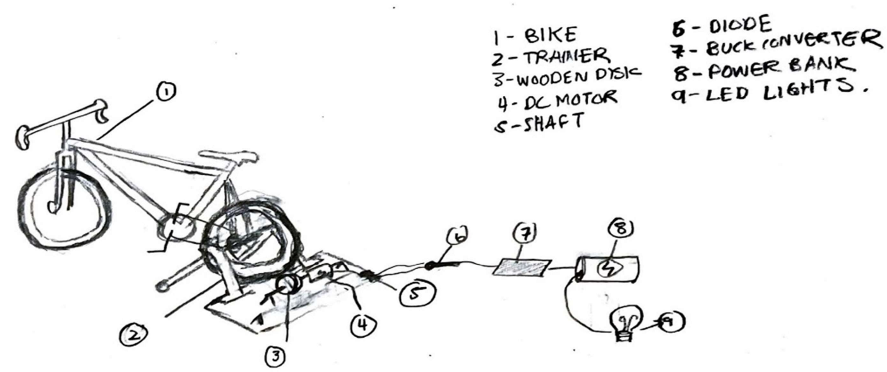

Figure 5: Sketch of Design Set Up with Mechanical and Electrical Components

In Figure 5, with the full set up sketch of the design idea, the sketch explains how power will be generated and converted into electrical power to light up LED lights. The client will pedal the bike and the back wheel of the bike, which is held stationary and secures it in place with a CXWXC bike trainer will turn a shaft on the rear wheel of the bike. There will be an add-on wooden disk that is in contact to the back wheel bicycle. So if the back wheel turns, the wooden disk will also rotate, the DC motor is then also placed on the same shaft as the wooden disk. Every revolution the client makes while pedaling will turn the wheels, the wooden disk and turn the DC motor. The rotational energy applied to the DC motor will then be transferred to a one-way diode and buck converter to then be stored in a rechargeable portable battery pack. The Rechargeable battery will then be removed light up LED lights. It should be noted that the design idea was altered to include the client’s feedback of wanting to have an add on to the back wheel, rather than the presented plan to remove the back wheel and deflate the tires. This change of an add-on was made because the client stated she had difficulty pumping and deflating tires, and the client would rather not take apart her bike for functionality purposes.

The purpose of the first prototype was to generate proof of concept by testing if a DC motor was able to light up a LED, and if adding a diode to the circuit board would result in viable one-way flow in the circuit. This prototype test was important because it validates our assumptions that it is possible to power LED lights with human rotational power at a smaller scale. Having proven that LED lights light up at a smaller scale, our group is now able to take this set up and apply it to a larger scale with the bicycle, trainer, wooden shaft, and battery power bank in the scenario. This addition was not possible due to the time resource constraints but will be tested in the second prototype.

6.3 Prototype Testing, Analysis and Performance

The purpose and function of the first prototype is to show a proof of concept, although very little to no quantitative data can be documented for the tests, the initial goal of the prototype was to prove that our concept design idea's electrical and mechanical aspects could work together properly to light up lights. The data collected with our first prototype was that diodes were able to provide viable one-way current flow, rotations from a motor can light LED light, and prove DC motors could provide adequate power output to light up LED lights. Prototype two's purpose would be to conduct heavy data analysis to allow comparisons to Deliverable B and C's target specification values.

Table 2: Prototyping Results

Prototype goal	Expected Results	Actual results
LED lights lit up	Yes	Yes
Effort level needed to turn on lights	Medium	Low

1-way current diode flow	Yes	Yes

7 MATERIAL TO PRESNT TO CLIENT

The client meeting will begin by presenting the client with a PowerPoint presentation containing the following information: a video of the proof of concept, sketch of the entire system and the estimated dimensions of the system. A question-and-answer session regarding the fundamentals of the system and anything that is unclear from the last meeting will occur.

Following this we will then present the bike trainer that is currently being considered to the client. The client will be instructed on how the bike trainer works and will then be asked if this is an acceptable way of mounting. The client expressed discomfort at our previous idea of removing her back tire, thus the goal is the new trainer mounting system would better suit her preferences. During this section of the meeting, it is important to remind the client that this will not require her to deflate and pump up her back tire or remove any components as she is unable to perform either of those actions. Details regarding acquiring the client's bike for a fitting will be discussed as well.

Lastly, compatible plant options with the system will be discussed. The system is most compatible with small succulent plants. The client has mentioned in previous meetings that this is most like the plants she currently owns. The client will be asked to show her current plants if she is comfortable with doing so and additional possible plants will be presented to her via PowerPoint. A final question, answer and reflection period will occur to let the client get and final points in and discuss the mounting and plant options.

7 CONCLUSION

This deliverable presented the first prototype of a human powered light for growing plants. Feedback from the previous client meeting was integrated into our previous design. Subsequently a functional prototype displaying the potential electronics as well as a sketch of the end goal of the system were included. Using this a bill of materials was generated and will be used in procurement. The prototype as well as sketches of the next iterations of the prototype will be presented to the client at the next client meeting. Using the information gathered at the next client meeting the prototype design will be iterated and improved.