GNG2101

Deliverable B - Needs, Problem Statement, Metrics, Benchmarking and Target Specifications

Submitted by

Team 1.1

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Abstract

Our team held its first meeting with our first client, Madeleine Kyne, and asked questions to receive further context for the project and extract statements that can be used to determine her needs. The client requested a system for an indoor garden that generates enough power through human movement to power a set of grow lights for a suitable duration of time. The meeting provided enough statements from the client that we were able to deduce client needs from them. The client needs helped to synthesize a problem statement to summarize the project. Following this, six metrics were made based on the client needs. These metrics were used to compare and contract several existing human-powered solutions including Makeup Mirror Pedal Generator, Garosa Hand Crank generator TEC1-12730 Thermoelectric Cooler, K-Tor power Box and DIY Bike system, through the process of benchmarking. Finally, the metrics were given target specifications based on the benchmarking as a guideline when designing our own solution.

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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

1 Introduction

The goal of this project is to create a human powered system able to generate enough energy to power lights for an indoor garden. To better understand this a client meeting was had to empathize with the client and understand the project use. From the statements and observations made during the client meeting a set of client needs was derived. A problem statement is created to clearly orient the project in the right direction. The metrics and benchmarking can be created next to determine measurable values and compare related products available on the market currently. A list of target specifications can then summarize the output goals for the project. Reflection on the client meeting and its impact of the report show that the desired problem should be solved as determined in the client meeting. The design process used so far has been design thinking but at any point during the project the process can be reiterated, and the processes completed in the following sections can be modified.

2 Client Meeting Findings

The client meeting provides an opportunity to create more in-depth criteria based on the client Madeleine's specific individual needs.

2.1 Client Statements

Upon formally introducing ourselves, we asked the client several questions that were scheduled to be asked, including follow-up questions based on her response.

The client is a recent graduate of the University of Ottawa studying Electrical Engineering. She had previously worked in the Richard L'Abbé MakerSpace and was a former Project Manager.

The client has hypermobile joints, resulting in chronic pain in most of her joints. Although she can engage in physical activity since she is an active biker, repetitive motion for anything longer than half an hour can trigger the pain. In addition, any sudden movements will also result in discomfort, so she is currently avoiding rushing too hard in physical activity. Finally, staying immobile (e.g., sitting, standing, lying down) for too long will cause the joints to hurt. The client stated that her right wrist and arm had been causing her grief for years. She has described her pain as an “active life pendulum”, alternating between physical and dormant activity to avoid joint pain.

The client would like to grow vegetables for the winter. To do this, she would need grow lights, and would like to try out innovative methods of renewable energy such as human generation. The garden will not be too large, and the client would like to allocate a 3-by-4-foot area for the project. She has also stated that while she hasn’t done research on grow lights, she would like to have them on for 6-8 hours in the day.

The client also mentioned the past attempt made by a previous team last semester, citing the idea of a bicycle to generate electricity was a good concept and make sense. However, the lack of documentation resulted in skepticism for it to work. In addition, the amount of biking needed to sustain the grow lights was not feasible for her, since she had to work.

There are other details that are not relevant in revealing customer needs but provide greater context to the client’s reason to instigate this project. She does not eat meat. She has been motivated to contribute to the earth’s wellbeing since she was in Grade 1. She is interested in turning her garden into a hydroponics basin, but that would change the scope of this project. She prefers not to use solar panels for generation as they produce waste during creation and are difficult to recycle.

2.2 Client Observation

Communication is much more extensive than just the words exchanged, it also includes body language, facial expressions, tone of voice and much more. During the client meeting non-verbal communication was observed and recorded to help further tailor the needs of the specific client. The client showed physical excitement about working with makerspace and the possibilities of human powered lights. When talking about aspect of the project such as environmental impact and potential creative solutions the client was very engaged in the conversation, she was talking with her hands, sitting up straight and spoke clearly. Secondly, it was observed that the client is interested in the group contribution. The client Madeline asked the group several questions to determine the group's interest. It was also noted that she seemed not overly impressed by the last attempt and the project. When speaking about this attempt she stumbled in her wording and expressed some concerns with the attempt. Finally, Madeline did not seem uncomfortable talking about her joint limitations, and openly provided a lot of information without needing to be prompt.

2.3 Customer Needs

From section 2.1 (Client Statements), the problems and needs of the client can be defined. Any missing information will be outlined in this section and will be gathered in the next client meeting. The following table outlines client statements and the translated need statements. The needs statements are listed in order of priority (highest priority first).

Table 1: Client Statements and Need Statements

Client Statements	Need Statements
• Hypermobile joints, chronic pain in most joints. • Can do biking, lifting, other physical activity. After a while, joints don't like it (repetitive motion). • Can bike approximately 30 minutes every day. If it is stable and comfortable 1-1.5 hours.	System can be comfortably and safely operated up to 1.5 hours.
• Actions that are too quick can hurt.	System operates at a controlled speed.
• Would like to grow vegetables for the winter. • Some plants (succulents, basil, tomatoes, potatoes)	System can be compatible with a variety of plants and vegetables.
• Plan to have on for 6-8 hours.	System provides energy to lights for 6-8 hours.
• The less time the better. • From the previous group, amount of biking needed was a lot/not feasible for someone with a job. • Would like to do a lot at once, then won't have to do it for a while.	System can store sufficient energy within a brief period of usage.
• Needs grow lights, does not have any currently.	System is compatible with standard grow lights.
• Has lots of space. • Garden will be approximately 3-4 feet long.	System can fit in a space that is 4 feet long.

The prioritizations of the needs statements is as follows. Since the client struggles with hypermobility, safety is the number one priority. Furthermore, the client would like to grow a variety of plants. Therefore, compatibility with a variety of plants is the second highest priority as insufficient lighting would be fatal to the garden. In addition, different plants may require different hours of lighting. Finally, since there are no grow lights currently being used and there is no space concern, those are the lowest priority needs.

The client mentioned that she planned to have the lights running for 6-8 hours, the client also mentioned that she is not sure and will need to research the time required. A more accurate time will be gathered in the next client meeting. Furthermore, the client stated her garden will be approximately 3-4 feet long. The width however is not known, and more detailed dimensions will be gathered in the next client meeting. Additionally, the client currently does not know what type of lights she will be using. The type of lights will be inquired about at the next meeting. It should be noted that the client stated throughout the meeting that she is open to various ideas and would be open to experimentation.

3 Criteria

3.1 Problem Statement

Design a human powered energy capture system capable of providing enough energy to power grow lights to grow a variety of indoor plants and vegetables. Overly repetitive motions should be avoided in order to accommodate people with hypermobile joints.

3.2 Metrics

A list of metrics can be created based on the established client needs. Each of these metrics satisfies one on the client needs as functional requirement, non-functional requirement, or a constraint. Table 2 list all the metrics along with their predicted unit.

Table 2: Metric Units

Metric Descriptor	Unit	Need Satisfying	Functional/Non-Functional/ Constraint
System footprint	Feet (ft)	System can fit in a space that is 4 feet long.	Constraint
Lights have enough power to be compatible with either standard hydroponic vegetables or succulents	Lumens (lm)	System can be compatible with a variety of plants and vegetables.	Functional
Speed of the system	Revolutions per minute (RPM)	System operates at a controlled speed.	Functional
Time required for lights to stay on	Hours (hr)	System provides energy to lights for 6-8 hours.	Functional
Time needed to generate sufficient power	Minutes (min)	System can be comfortably and safely operated up to 1.5 hours.	Functional
Cost	Canadian Dollar ($)	Project Budget was provided as $100.	Constraint

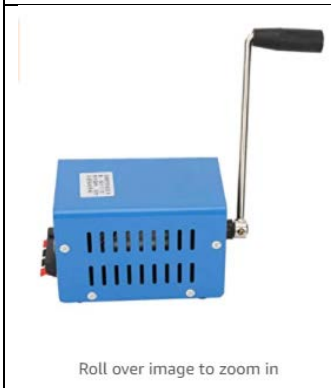
3.3 Benchmarking

Products with a method of gathering power from human movement have been benchmarked in table 3. These products will each satisfy some of user needs. This will allow us to be able to directly compare current solutions on the market to new concepts. Each of the products that has

been benchmarked is given a team rating out of 5. A score of 5 points is the best score possible. The scores are based on how well the system meets the clients needs.

Table 3: Benchmarking of Similar Products

Product Name Comments	Team Rating	Final Specs	Comments

 **Figure 1: Makeup Mirror Pedal Generator**	3.5/5	Wattage: 100 Watts LxWxH: 10x9.8x 8.5 in. Weight: 3.13 kg Voltage:100V Dual USB output interface Direct DC output: 35 Volts	Safety features: Pedals require very little effort to generate power, diodes placed at each line prevent power from going back into the machine. LED lights light up to reflect when it is receiving too much or little power. No seat comes with it, allowing for space flexibility. Product is within the 4ft maximum space. Loud Generator, non-adjustable pedal positions. [1]
 **Figure 22: Garosa Hand Crank generator**	2/5	Max Wattage: 20 Watts LxWxH: 13 x 8 x 9 in. Weight: 0.76 kg USB charging generator RPM: 2000 Voltage: 3V Current: 6.6A Material: Metal	Crank to generate power Crank speed flexibility, faster the crank, more power generated Crank must be adjusted to 5V in the USB port before using external electrical appliances. It would require much more effort to power because arm muscles are smaller than leg muscles. [2]

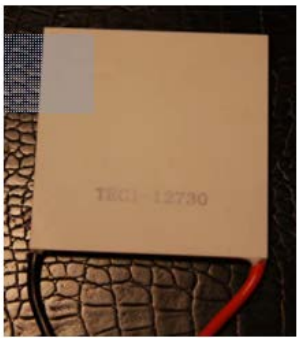
 **Figure 33: TEC1-12730 Thermoelectric Cooler**	1/5	Max Voltage: 12V Current: 30A LxWxH: 62x62x4.8 mm Weight: 0.023 kg	Thermoelectric Cooler. Uses thermoelectric technology to power pad using heat the body naturally produces. Produces very little power, would be difficult to generate enough power to power a whole system, would be very difficult, but, if possible, thermoelectric solutions would require the client to put little to not effort in turning human power into electricity for plant lights. Small, space efficient. [3, p. 1]
 **Figure 44: K-Tor power Box**	4.5/5	Wattage: 20 W Weight: 4 lbs Voltage: 120V Frequency: 60 Hz Horsepower: 0.03hp Amps: 167 mA LxWxH: 12x6.5x4 in.	Can easily charge cell phones, electrical appliances power household electrical devices. No seating for the “bike”, only pedals, allows for more flexibility space wise. Can be placed under a workplace desk. Minimum pedal speed is easy and manageable based on user comments. Slightly larger than the Makeup Mirror pedal generator. Outputs more Voltage than all other bicycle style solutions. [4]

 **Figure 55: DIY Bike system**	4/5	Watt: 200 Voltage:24 V WxL: 2x4 ft	Ideal for LED lights, system is easy to use, easy to power. Users must be careful to set the multimeters to the correct measurements to monitor how hard the user should pedal. The system is very spacious. It has seating and handlebars, making it easier, comfortable, and allowing for a natural bike ride. [5]

3.4 Target Specifications

Table 4: Target Specifications

Metric ID number	Metric Description	Unit	Marginal Values	Ideal Values	Reference (when applicable)
1	Footprint	Feet (ft^2)	<20	16	
2	Light	Lumens (lm)	500-1600 lumen	1000 lumen	[6]
3	Speed	Revolutions per minute (RPM)	<159	61	[7]
4	Time (lights)	Hours (Hr)	>6	8-14 (mimic natural daylight)	[8]
5	Time (power generation)	Minutes (min)	<90	45	
6	Cost	Canadian Dollar ($)	<100	80	
7	Weight	Kilograms (kg)	<50 kg	<30 kg	

4 Reflection on Impact of Client Meeting

The client meeting was important in leading our design criteria. It allowed us as a group to empathize with the client and understand how this project would impact and be incorporated into her daily life as well as what the personal limitations were in terms of joint movement and pain. The client needs which were translated from the client statements gathered during the client meeting were used when creating metrics, benchmarking, and target specifications. So far after this client meeting, we have been using the design thinking process, where the first step was empathizing with the client during the meeting and then after the meeting a list of needs was derived. An important takeaway from the client meeting was that the client was open to unique solutions and wanted to provide us as much freedom as possible in designing. Based on the problem statement compared to the target specifications it appears that we are on track to keep with the goal of the project established during the client meeting.

Based on the client meeting it was established that the previous attempt made had concerning power numbers. It remains unknown which movements will be able to provide the required to power the LED lights for the time needed. As well if there is any way to generate this power while limiting repetitive motions.

5 Conclusions and Recommendations for Future Work

The first meeting with our client was critical in understanding the needs for her project. Through various methods such as empathizing with the client, asking important follow-up questions, and making observations on her nonverbal forms of communication, we were able to extract several key statements and refine them into need statements. These client needs were then used to determine specific metrics to be aware of, which were then used when benchmarking products in the market that generate power from human movement. Through this, we were able to come up with target specifications for our prototype to meet. This will help us narrow our scope once we begin the ideation process for our product.

6 Bibliography

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