2nd Generation Charging Station

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Team 13

Concept Generation
Document

Submitted towards partial fulfillment of the requirements for
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1.0 Introduction

Our project is about completing the design and fabrication of the 2nd Generation Recharging Bicycle Station started by a capstone team the previous year. Our main objectives for this year's capstone project is designing and building the electric control system, the interactive display screen, and the enclosure that will house the entire electric control system including the storage system. In this report we will be analyzing different design concepts for the three main objectives listed above. We will define the criteria for each category and develop resulting decision matrices that will be used to highlight the best designs in each group. After this, we will combine the best concept designs of each category into four different complete designs. These designs will then have their own criteria's chosen and defined. A decision matrix will then be created for the completed bike designs then which a final design will be chosen for the entire project.

2.0 Concept Generation

The team has been asked to complete and improve the charging station since the current design has not yet been completed. Every engineering design should have ideas and steps, and this is called concept generation.

The concept generation is when a product development team comes up with conceptual ideas and designs, and is the most critical step in the engineering design process. The team has divided the concept generation into three categories which are Electric Control System, Interactive Display Screen, and Enclosure.

The electric control system must convert mechanical energy from the user into usable electricity and it must store unused electricity for later use as well as power the interactive display screen. The team has also developed some designs that will convert DC electricity to AC electricity for AC required devices and this feature may be utilized to charge devices such as laptops.

The second concept generation category is the Interactive Display Screen. It has to be capable of displaying generated power, calories lost, total distance traveled, as well as time duration. The interactive display screen needs to be easy to use so that it is user-friendly for all types of audiences. It must also be educational so that it can be used as a tool for teaching younger generations. This can be done by showing certain data outputs on a colorful graph over time. This will show the fluctuations in power and velocity as the rider slows and speeds up their peddling.

The third concept generation category is Enclosure which must house and protect the electric control system from any possible damage. For aesthetic purposes, the enclosure must also hide any loose wires they may not look appealing to the eye. It should also be built of a thin material or lightweight material to keep the gross weight of the bike to a minimum. One of the most important properties of the enclosure is to keep any water or outside moisture from seeping into the housing which could cause components of the electric control system to malfunction or even break down entirely.

2.1 Electric Control System

One component to the overall system is an electric control system. This electric control system will transfer power to the electronic devices and will also provide power to the interactive display.

2.1.1 Criteria

The criteria for the control system includes cost, efficiency, ease of buld, compatibility, and capacity. Cost will be quantified by the amount of dollars spent to build the control system. Efficiency will be the minimal amount of energy wasted on the component. Ease of build includes the amount of ime to build the component. Compatibility is the number of objects the bike is capable of charging. Lastly, capacity is the colume of space that the design will occupy.

2.2 Interactive Dispay

Another important component to the system is the interactive display. The interactive display will show the user useful insight such as amount of power generated, calories lost, and distance traveled.

2.2.1 Criteria

The criteria for the interactive display includes ease of use, educational, aethetics, accuracy, and programming. Ease of use describes the simlicity of operation and navigation of the interactive display. Educational represents how capable the display is for teaching the user how it works and providing useful information. Aethetics is how pleasing the dispay looks to the user. Accuracy is how precise the outputs are to their actual values. Programming is the simplicity and capability of the programming language.

2.3 Encloure

The final component is the enclosure on the bike. The enclosure will be the casing and protection of the wiring and electronic components. The enclosure should house the components in a way that will provide excellent protection so that the electronic parts last long.

2.3.1 Criteria

The criteria for the enclosure includes aesthetics, space, durability, cost, and ease of build. Aesthetics describes how pleasing the enclousure is to users. Space represents the amount of volume inside the enclosure. Durability is the ability to resist stressed throughout excessive usage. Cost is measured by the amount of dollars spent of the enclosure. Finally, ease of build measures the time spent designing and building the elnclosure.

3.0 Combined Bike Design

The combined bike design takes the top two components that received the higher score in the decision matrices and makes combinations out of the three categories. The team decided to examine four different combinations based on specific criteria.

3.1 Criteria

The criteria for the combine boke design includes aethetics, effectiveness, durabilty, cost, ease of build and usability. Aethetics for the combined bike will identify how pleasing the entire system is to the user. Effectiveness is how quickly the system can charge an electronic device. Durability measures the ability to overcome stresses on the entire bike. Cost is the amount of dollars spent on the entire system. Ease of build is how difficult it is to design and build the system. Lastly, usibility measure the simplicity of operating and managing the bike.

4.0 Final Bike Design

The final bike design for the charging station will have a generator attached to the gears in the back. From the generator a line will lead to the regulator that will be in the component box. The component box will be in the middle part of the bike frame. It will hold most of the necessary components such as the regulator, batteries, converters, wires, etc. The box will be made of wood. It will be painted over with a varnish or sealant to protect from general use and the weather. Because it is in an enclosed space and the parts generate heat, there will be holes cut into the wood. This will allow for ventilation of the area and prevent the components from overheating. There will be a fan placed inside that runs from the generator power. It will serve as a cooling system when the bike is being used in the stationary mode. When moving the outside airflow will cool it.

From the component box, a single wire will run to a second box on the handlebars. This smaller box will serve to hold the charging wires and the touchscreen display. As before, it will also be made of wood and all cooling/ventilation will be the same. The chargers come out from the box. To the side of the touchscreen will be a slot that is cut out. The purpose of this is to hold any phones or devices that the user chooses to charge.

The bike is both mobile and stationary. The bike has a basket on the back that rotates around the tire and sets down as a stand. This will allow the user to choose whether the bike should be mobile or sit in place.

5.0 Conclusion:

In conclusion, since this project is a continuation of a previous capstone project, the concept generation was broken up into three main categories. These main categories were Electric Control System, Interactive Display Screen, and the Enclosure which houses the electric control system. From these categories four complete bike designs were conceptualized. A decision matrix was created for these designs and a final design concepts was chosen. Our final design will consist of an electric control system that utilizes a voltage regulator to stabilize the oscillating power output coming from the generator attached to the rear wheel. Lithium ion batteries were chosen as the storage system for the design due to their high energy density which is beneficial for the bike when it is being ridden around. An inverter was decided to be added to the design to further the charging stations capabilities. After talks with the client though, this may not be a good design choice and a further analysis will be done to see if the benefits of the inverter outweigh the costs and drawbacks that it may create. The C++ programming code was chosen for the coding to be done on the interactive display screen. Again, after talks with the client, additional research will be done in this category and we will see if going with a tablet as an interactive display will decrease the burden the programming would have on us.

Appendix A: Team Sketches

Figure 1 - by Ryan Murphy

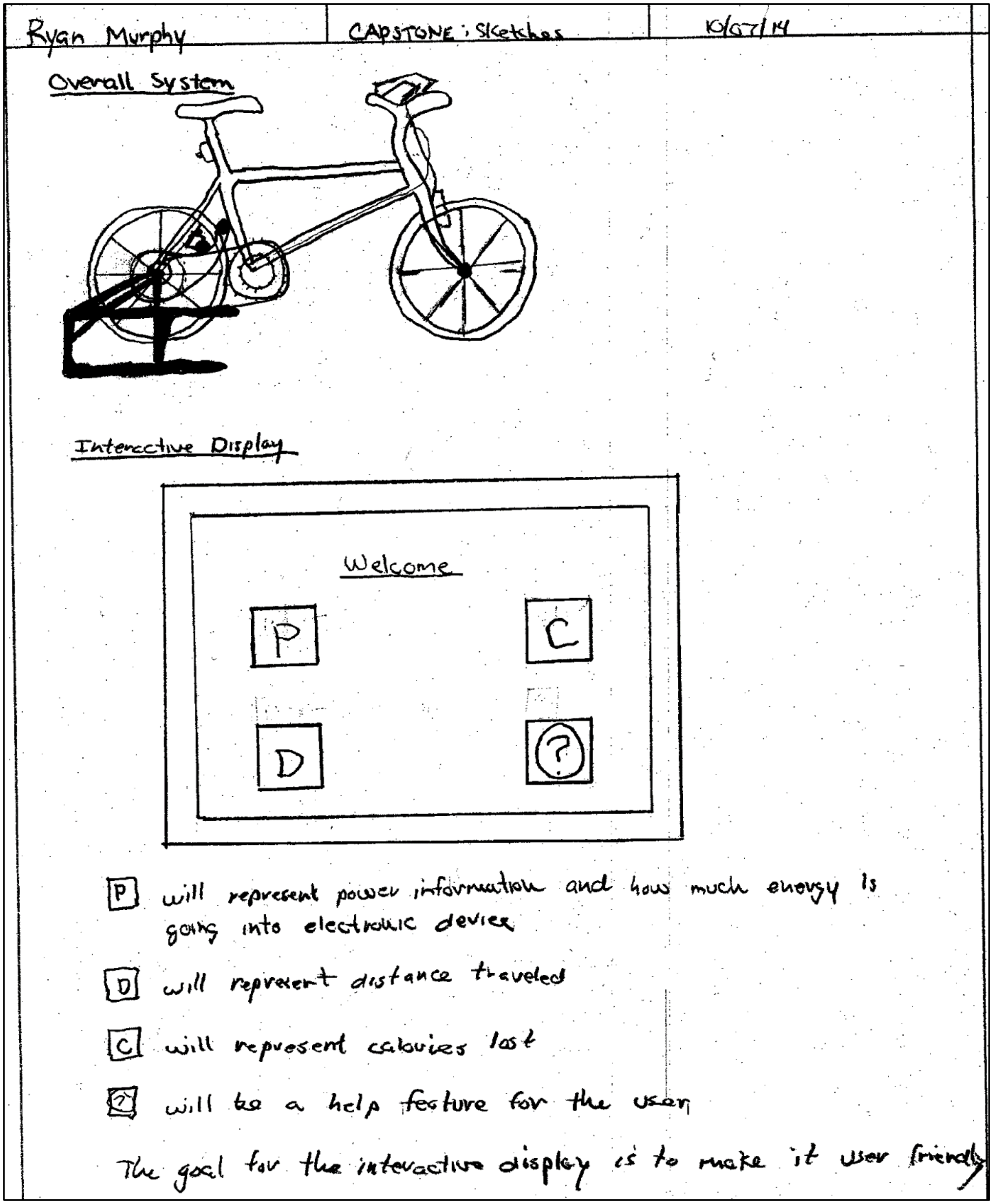


Figure 2 – by Jasem Alhabashy

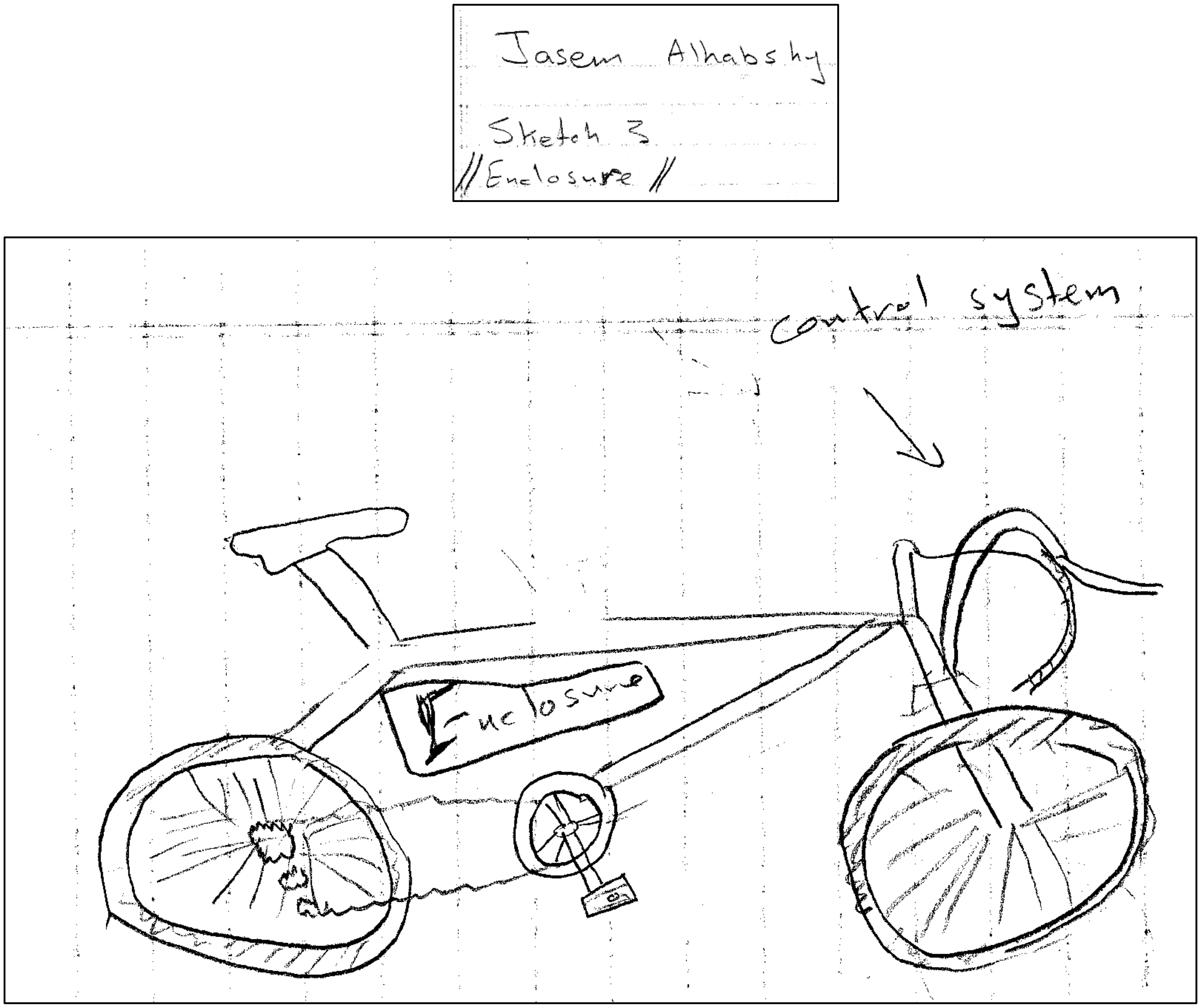


Figure 3 – by Jasem Alhabashy

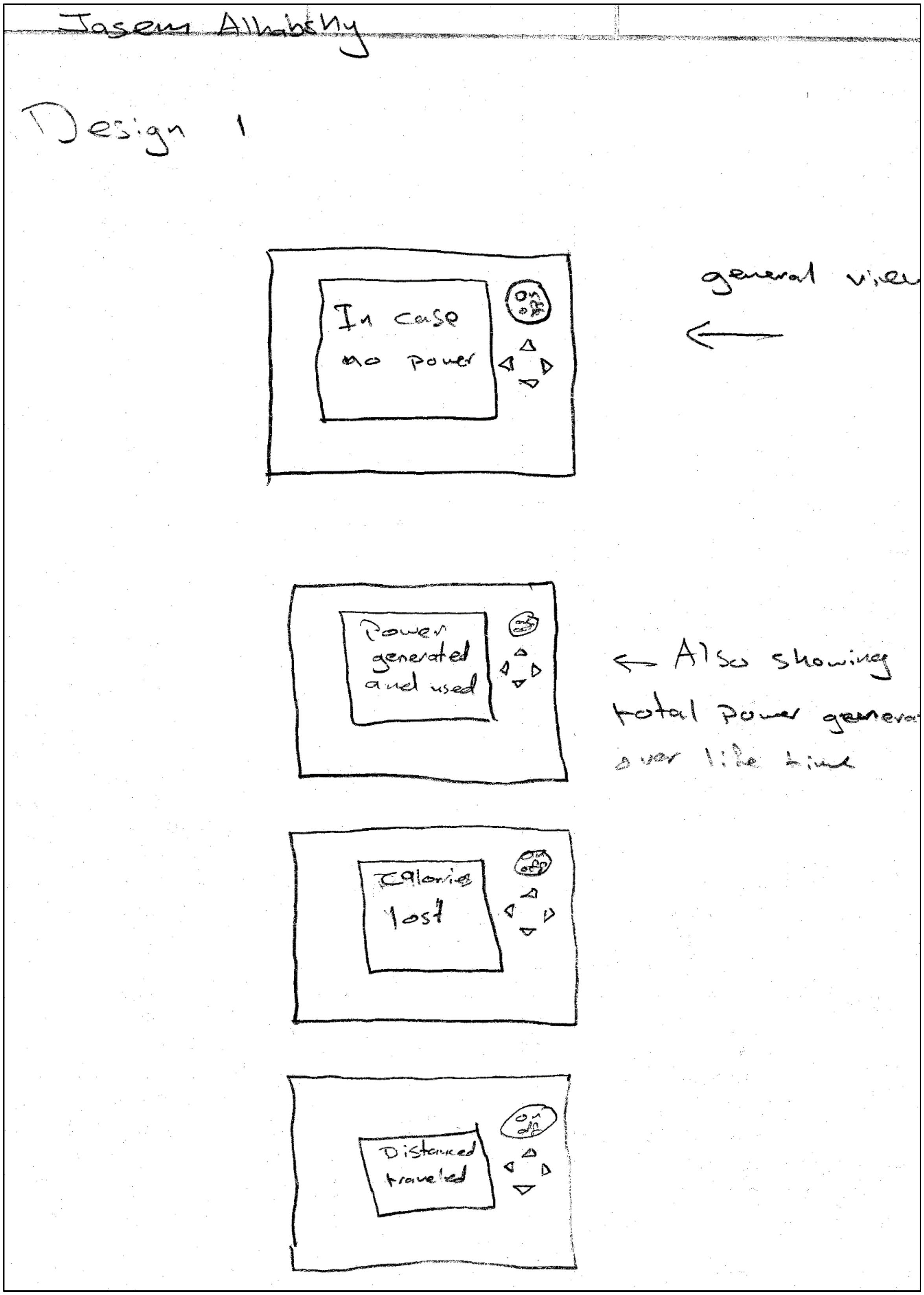


Figure 4 – by Jasem Alhabashy

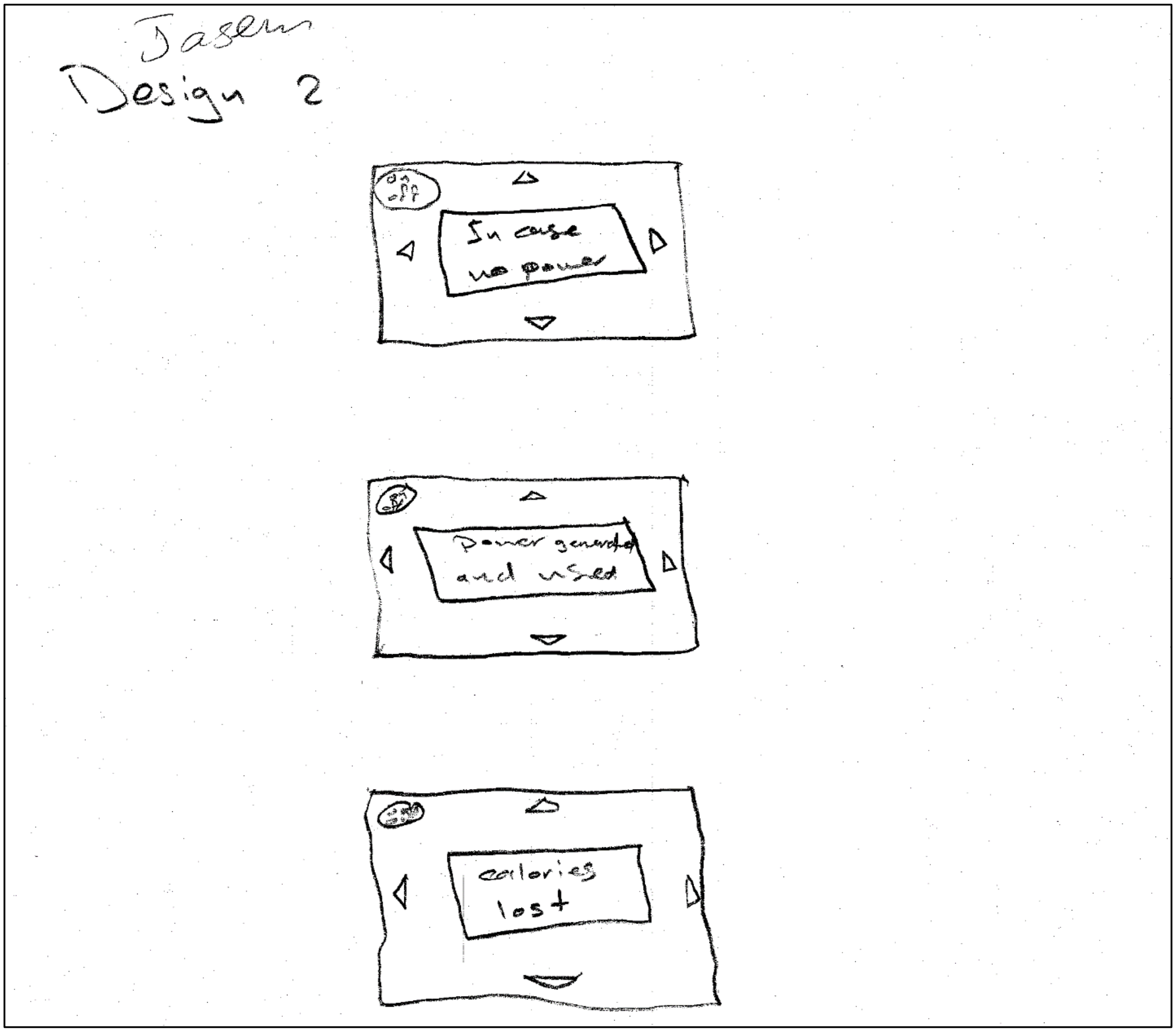
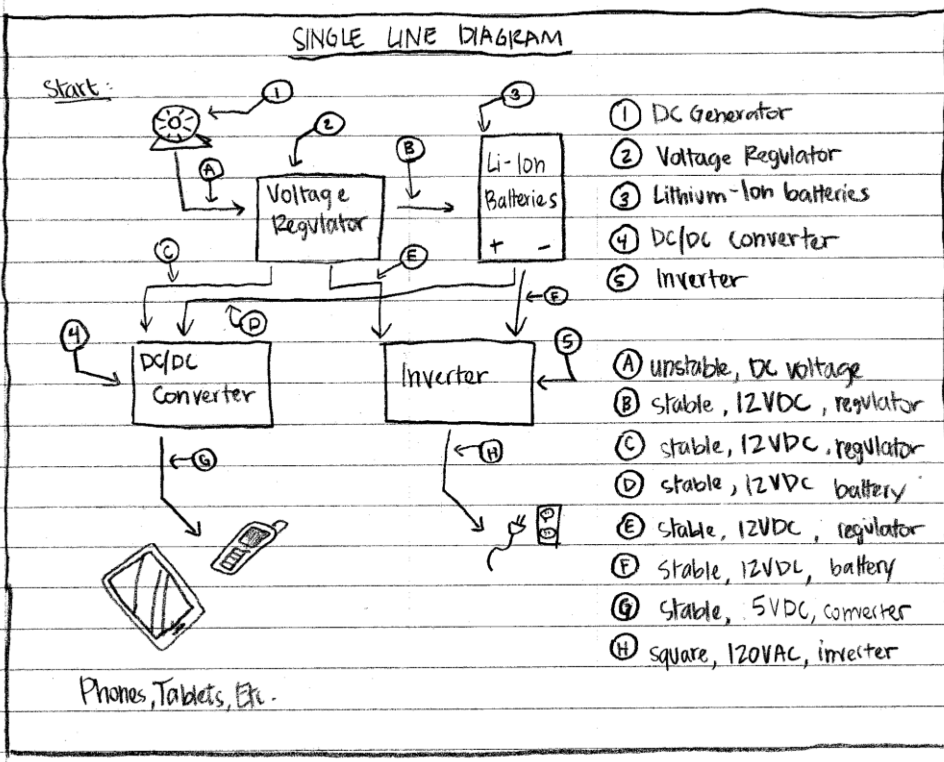


Figure 5 – by Brandon Gabrelcik

ELECTRIC CONTROL SYSTEM (DESIGN #3)

Lithium-Ion Batteries w/ Inverter

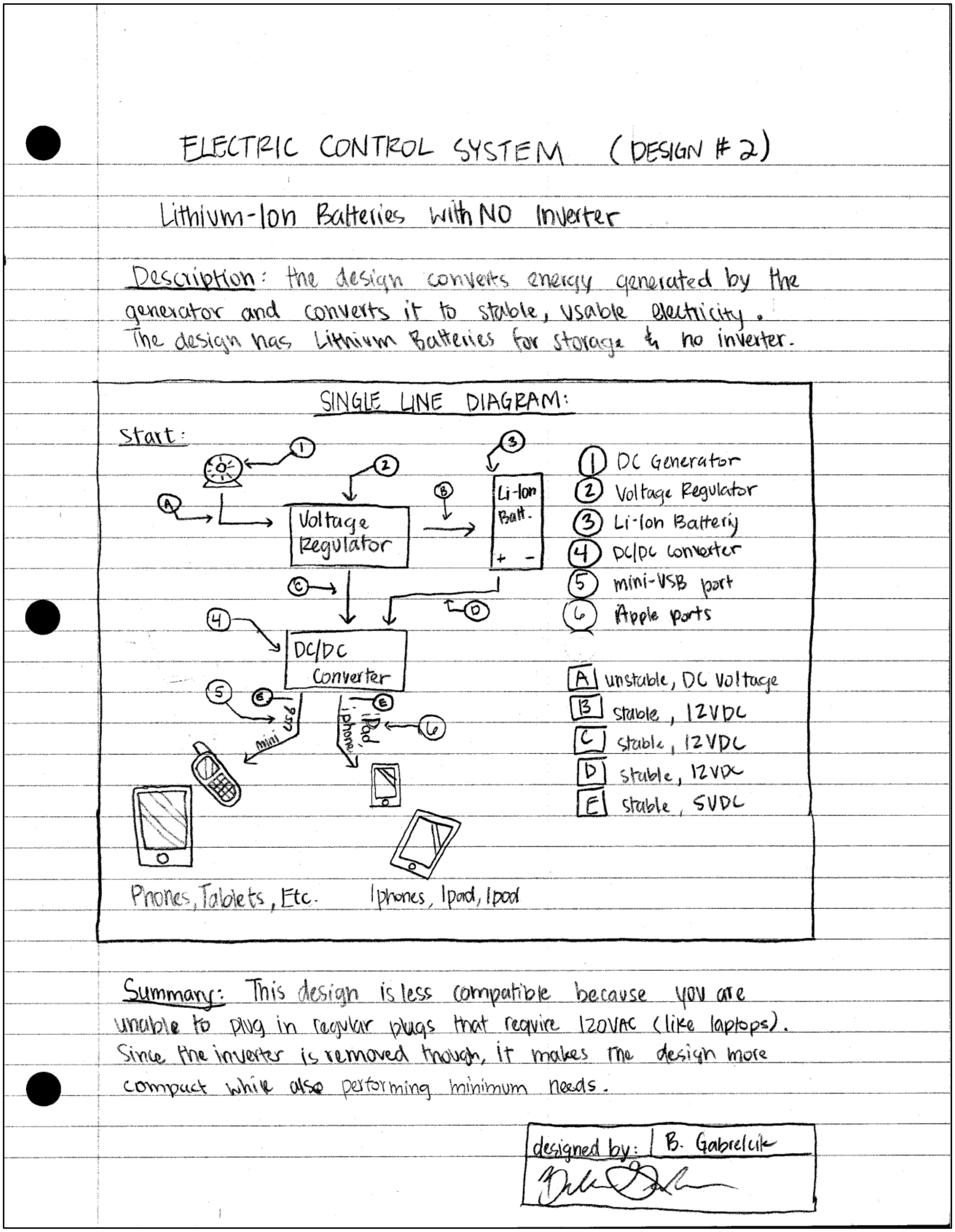
Description: This design converts energy generated by the DC generator and converts it to stable, usable electricity. The does uses Lithium-Ion batteries for storage and does have an inverter to produce AC power.



Summary: This design utilizes lithium-ion batteries instead of super capacitors to increase reliability and ease of build of the entire design. An inverter is included in the design to increase the amount of devices it is capable of powering.

designed by: B. Gabrelcik

Figure 6 – by Brandon Gabrelcik



ELECTRIC CONTROL SYSTEM (DESIGN # 2)

Lithium-Ion Batteries with NO Inverter

Description: the design converts energy generated by the generator and converts it to stable, usable electricity. The design has Lithium Batteries for storage & no inverter.

Summary: This design is less compatible because you are unable to plug in regular plugs that require 120VAC (like laptops). Since the inverter is removed though, it makes the design more compact while also performing minimum needs.

designed by: B. Gabrelcik

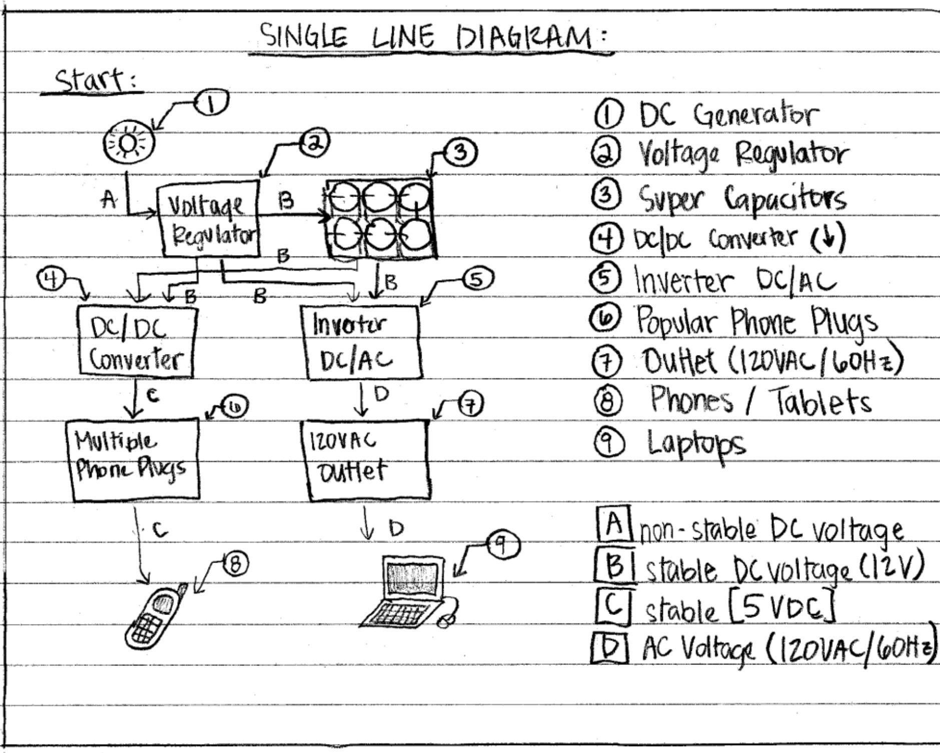
Figure 7 – by Brandon Gabrelcik

BICYCLE CHARGING STATION (2^{nd} Gen)

NAME: ELECTRICAL CONTROL SYSTEM (DESIGN #1)

SUMMARY: This design is of the electrical control system for the Bicycle Charging Station 2G. It will control the power input from the generator all the way to the outlets where the electronic devices will be plugged in for charging.

SINGLE LINE DIAGRAM:



OPTIONS: Multiple options with this diagram can be done to reduce the amount of components. For example, a voltage regulator with multiple adjustable outputs would eliminate the need for a DC/DC converter.

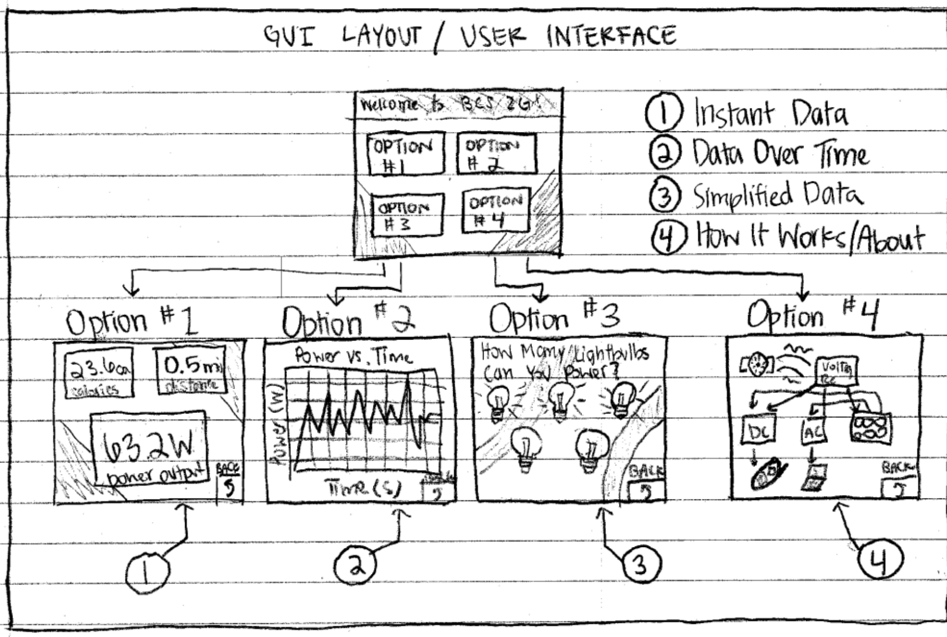
Designed By:	B. Gabrelcik
(signature)	

Figure 8 – by Brandon Gabrelcik

BICYCLE CHARGING STATION (2nd Gen)

NAME: DISPLAY SCREEN GUI LAYOUT / USER INTERFACE

SUMMARY: This design is out the display screen and user interface of the Bicycle Charging Station 2G. The interface will have a main screen displaying three (3) options to see the data output; Instant Data, Data over Time; & Simplified Data Output. It will aslo have a "How it Works Button"



NAMES: The titles of each option and the names displayed will NOT be the ones used for the actual display screen. Names will be chosen that best summarizes the data contained on the page. It will also account for people who have no knowledge of electricity and/or engineering.

Designed By: B. Gabrelcik

Figure 9 – by Riyadh Alzahrani

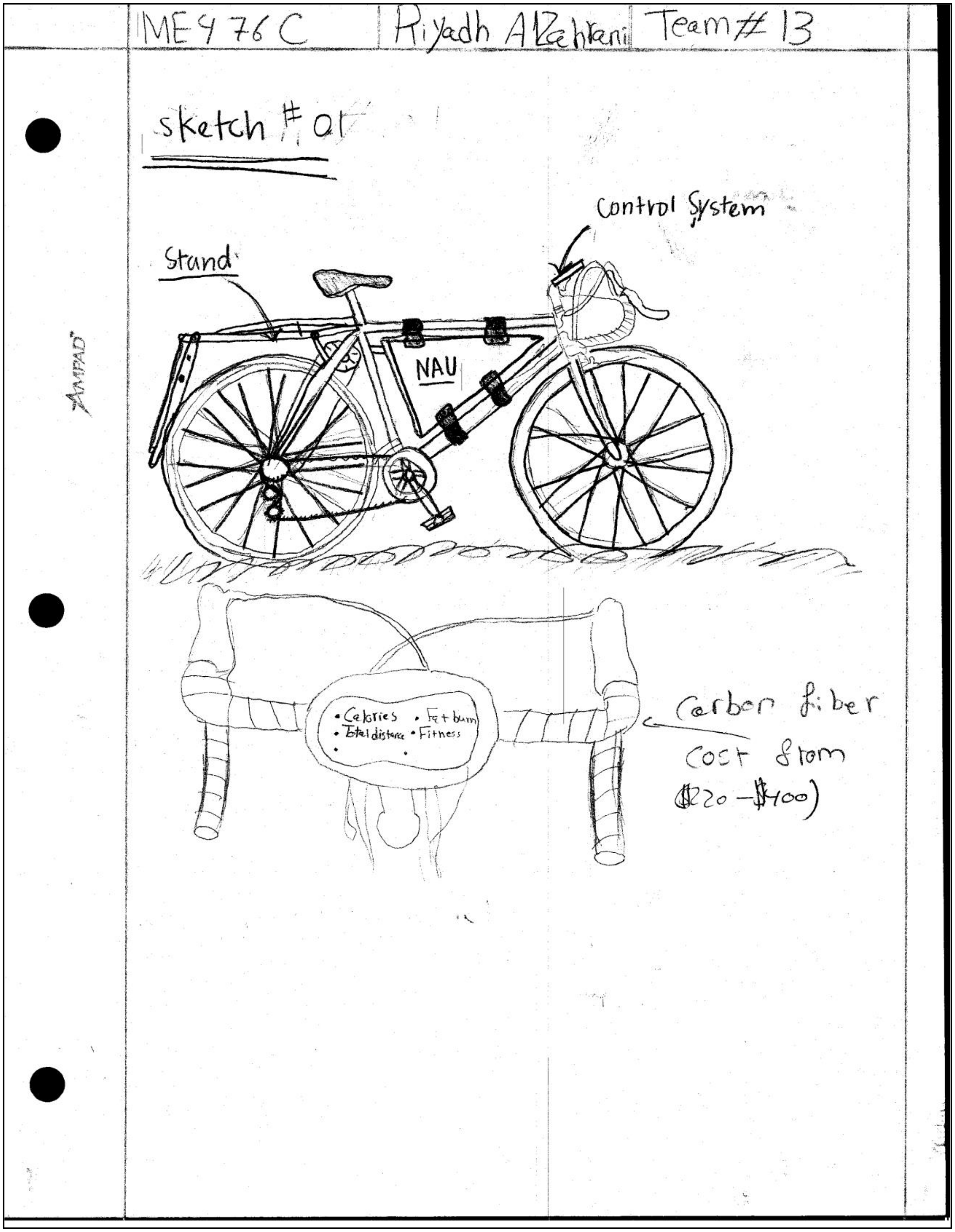
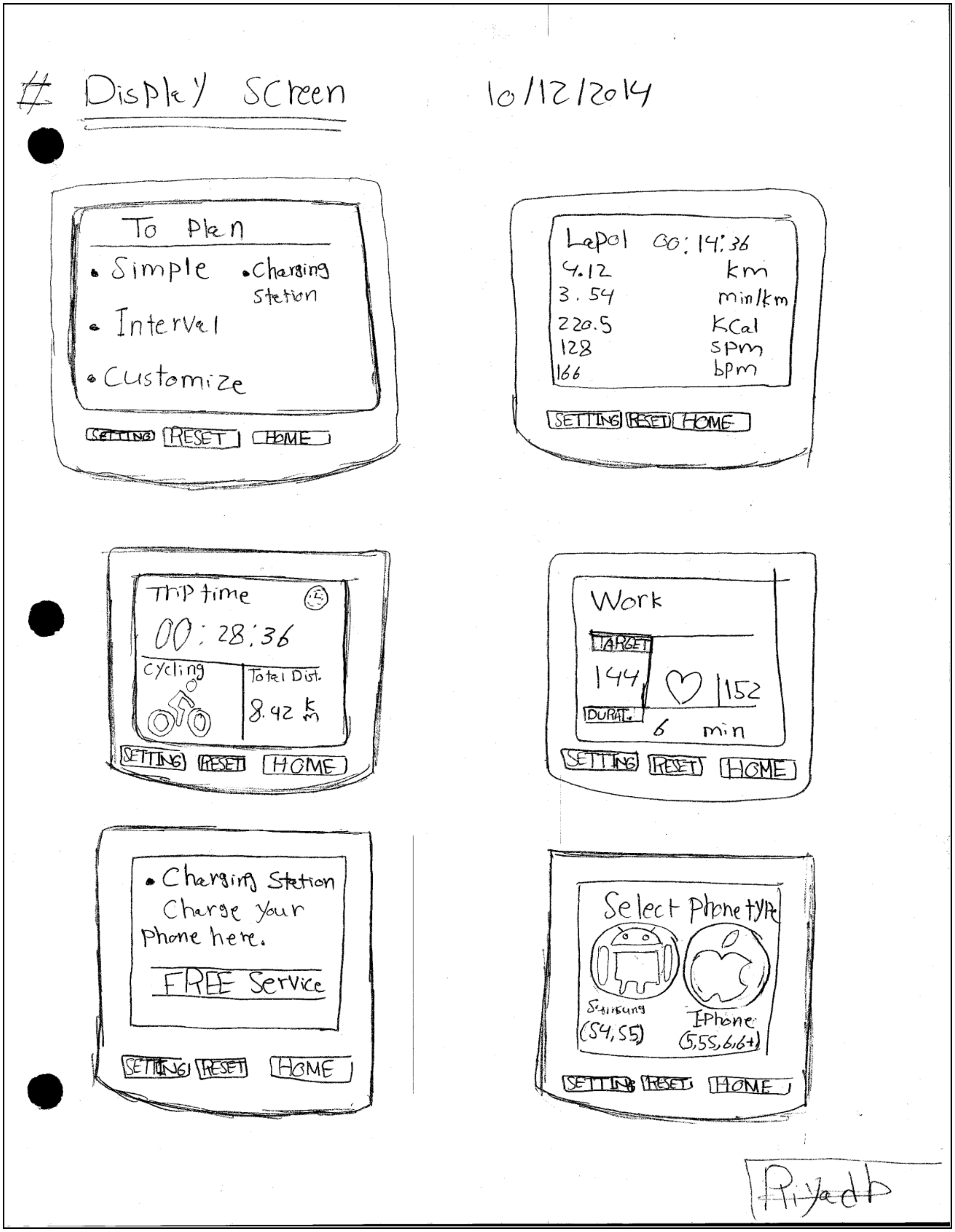


Figure 10 – by Riyadh Alzahrani



Appendix B: Individual Decision Matrices

Table 1, 2 & 3: Decision Matrices by Brandon Gabrelcik

Category #1:

Enclosure Design

by Brandon G.

Designs:	Aesthetics	Space/Room	Durability	Cost/Expenses	Ease of Build	Total Score:
Weighted Score:	2	1	2	3	2.0	10
Design #1:	7	7	7	8	6	71
Design #2:	5	4	8	5	7	59
Design #3:	9	8	8	8	8	82
Design #4:	6	8	6	7	9	71

Category #2:

Interactive Display

by Brandon G.

Designs:	Ease of Use:	Educational:	Aesthetics:	Accuracy:	Programming:	Total Score:
Weighted Score:	3	1	2	1	3	10
Design #1:	8	9	8	5	8	78
Design #2:	8	6	6	5	5	72
Design #3:	8	7	7	5	8	74
Design #4:	8	7	7	5	6	75

Category #3:

Control System

by Brandon G.

Criteria:

Designs:	Cost/Expenses:	Efficiency:	Ease of Build:	Compatibility:	Capacity:	Total Score:
Weighted Score:	3	2	2	2	1	10
Design #1:	9	6	7	8	6	75
Design #2:	5	7	8	8	8	69
Design #3:	7	8	7	8	6	73

Table 3, 4 & 5: Decision Matrices by Jasem Alhabashy

Category #1:

Enclosure Design

by Jasem Alhabshy

Criteria:

Designs:	Aesthetics	Space/Room	Durability	Cost/Expenses	Ease of Build	Total Score:
Weighted Score:	1	2	1	3	3	10
Design #1:	7	10	10	10	9	94
Design #2:	6	9	8	8	9	83
Design #3:	8	8	7	8	8	79
Design #4:	7	8	6	8	7	74

Category #2:

Interactive Display

by Jasem Alhabshy

Criteria:

Designs:	Ease of Use:	Educational:	Aesthetics:	Accuracy:	Programming:	Total Score:
Weighted Score:	1	3	1	2	3	10
Design #1:	8	9	8	10	9	90
Design #2:	7	8	8	9	6	75
Design #3:	8	8	7	9	8	81
Design #4:	6	7	6	9	9	78

Category #3:

Control System

by Jasem Alhabshy

Criteria:

Designs:	Cost/Expenses:	Efficiency:	Ease of Build:	Compatibility:	Capacity:	Total Score:
Weighted Score:	1	3	2	2	2	10
Design #1:	7	8	9	6	5	71
Design #2:	9	8	6	7	7	73
Design #3:	9	7	7	8	8	76

Table 5, 6 & 7: Decision Matrices by Ryan Murphy

Category #1: Enclosure Design

by Ryan Murphy

Designs:	Aesthetics	Space/Room	Durability	Cost/Expenses	Ease of Build	Total Score:
Weighted Score:	2	3	3	1	1	10
Design #1:	8	7	7	10	9	77
Design #2:	9	8	10	2	5	79
Design #3:	6	6	8	9	8	71
Design #4:	8	8	8	10	9	83

Category #2: Interactive Display

by Ryan Murphy

Designs:	Ease of Use:	Educational:	Aesthetics:	Accuracy:	Programming:	Total Score:
Weighted Score:	3	1	1	2	3	10
Design #1:	9	8	8	9	8	85
Design #2:	8	8	8	9	7	79
Design #3:	7	8	7	8	8	73
Design #4:	7	8	7	8	7	73

Category #3:

Control System

by Ryan Murphy

Designs:	Cost/Expenses:	Efficiency:	Ease of Build:	Compatibility:	Capacity:	Total Score:
Weighted Score:	1	3	1	3	2	10
Design #1:	8	9	6	8	8	81
Design #2:	7	7	7	7	9	74
Design #3:	9	7	9	7	9	78

Criteria:

Table 8, 9 & 10: Decision Matrices by Ruben Villezcas

Category #1:

Enclosure Design

by Ruben V.

Designs:	Aesthetics	Space/Room	Durability	Cost/Expenses	Ease of Build	Total Score:
Weighted Score:	1.5	1	3	3	1.5	10
Design #1:	7	7	8	5	7	67
Design #2:	8	7	8	3	5	66
Design #3:	8	7	7	8	7	75
Design #4:	8	8	8	7	7	76

Criteria:

Category #2:

Interactive Display

by Ruben V.

Criteria:

Designs:	Ease of Use:	Educational:	Aesthetics:	Accuracy:	Programming:	Total Score:
Weighted Score:	3	2	1.5	1.5	2	10
Design #1:	9	7	8	7	7	78
Design #2:	8	7	7	7	6	71
Design #3:	6	7	6	7	7	66
Design #4:	6	7	6	7	6	64

Category #3:

Control System

by Ruben V.

Criteria:

Designs:	Cost/Expenses:	Efficiency:	Ease of Build:	Compatibility:	Capacity:	Total Score:
Weighted Score:	3	3	1.5	2	0.5	10
Design #1:	6	6	5	6	6	59
Design #2:	8	5	7	6	7	65
Design #3:	6	6	6	6	6	60

Appendix C: Team Decision Matrices

Category #1: Enclosure Design

Designs:	Aesthetics	Space/Room	Durability	Cost/Expenses	Ease of Build	Total Score:
Weighted Score:	1.6	1.7	2	2.6	2.1	10
Plastic Side Clip	6.6	7.2	7.2	6.8	7.2	70
Carbon Fiber	7.4	6.6	8.2	5.4	6.8	68
Treated Wood	6.8	7	7.5	7.6	7.2	73
Plexiglass	7	7.2	6.6	7.6	7.6	72

Category #2: Interactive Display

Designs:	Ease of Use:	Educational:	Aesthetics:	Accuracy:	Programming:	Total Score:
Weighted Score:	2.5	1.6	1.7	1.8	2.4	10
B.G. Design 1 - C++	8.2	8	8.2	7.6	8	71
J.A. Design 2 - Python	8.2	7.2	7.8	7.4	6.2	65
R.A. Design 3 - C++	7.8	8	7.4	7.4	7.8	69
R.M. Design 4 - Python	6.2	6.8	6.2	6.8	6	64

Category #1:

Control System

Designs:	Criterias: Cost/Expenses:	Efficiency:	Ease of Build:	Compatibility:	Capacity:	Total Score:
Weighted Score:	2	2.8	1.7	2	1.5	10
Super Capacitors	7	7.2	7	6.6	5.6	68
Lithium Ion / No Inverter	6.4	6.8	7.4	6.2	6.6	67
Lithium Ion / Inverter	7.4	7.2	7.6	7	6.8	72

Appendix D: Combined Bike Decision Matrix

Final Category:

Combined Bike Designs

Criteria:

Designs:	Aesthetics	Effectiveness	Durability	Cost/Expenses	Ease of Build	Usability	Total Score:
Weighted Score:	1	3	2	2	1	1	10
Plexiglass w/Lithium Ion	8	8	8	8	7	6	68
Plexiglass w/Super Capacitor	6	7	8	7	7	9	68
Wood w/Lithium Ion	9	8	8	8	7	7	70
Wood w/Super Capacitor	7	7	8	7	7	8	66