Second Generation Bicycle Charging Station

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Problem Formulation and Project Plan

Document

Submitted towards partial fulfillment of the requirements for
Mechanical Engineering Design I – Fall 2013

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Project Summary

In 2012, Marilla Lamb and a team of engineers designed and built a bicycle generator that was meant to power small electronics and educate the public about electrical power generation. The purpose of this project is to design a second generation of the Bicycle Generator in the Engineering Building at Northern Arizona University. The current design, located on the second floor of the building, is limited in both its power output and ability to address user needs. The 2nd Generation Bicycle Charging Station project team aims to redesign the charging station in a way that improves the portability, efficiency, usability, and versatility of the assembly.

Project Formulation

Recognizing the Need

The client for the 2nd Generation Bike Charging Station is Marilla Lamb, a member of the 1st Generation Bike Charging Station team. She received her Bachelors of Science of Environmental Engineering, and is currently a graduate student in the Mechanical Engineering program at NAU. In 2011, a grant was proposed to the NAU Green Fund to build a bicycle generator that students could use to charge small electronics, while simultaneously demonstrating how much physical effort is required to generate small amounts of electricity. In 2012, the Green Fund approved the grant request. The 1st generation bicycle generator was designed and built shortly after. The purpose of the bicycle charging station is to provide students with an avenue to understand and compare the amount of energy required to power and charge electronic electronic devices with the amount of energy produced by pedaling a bicycle.

Problem Definition

Goals

The goal of this project is to design an improved bicycle powered charging station which will produce power to charge small electronics while teaching about power generation. The improved station will be easier to use and transport, while also integrating a more informative display. The second generation design will be more versatile, and efficient than the first generation model.

Objectives

The bicycle will be simple to use and understand for all age and size ranges. The bicycle will be designed to be comfortable for a variety of users by installing adjustable settings on the station. Transparent housing will allow visibility of electrical components so that students can better understand the process. In addition, increased visibility of components add to the educational aspect of the assembly.

The charging station will be more versatile than the previous version by offering a wider and more current variety of chargers including an iPhone 5 Lightning connector and an AC plug for charging laptops and other small devices, as well as the chargers available on the First Generation station. By including a wider range of charging adaptors, the station will appeal to a broader audience.

The new station will be much more easily transportable. The transportable design will involve a station that is easier to assemble/disassemble as well as a customized carrying case or container. The new station will be able to achieve greater efficiencies by adding a set of gears to maintain higher RPMs. Gearing the bike will also improve user comfort by allowing more resistance while pedaling at higher speeds.

Constraints

The majority of project constraints pertain to the station's display. Information about power generation will be displayed both numerically and graphically. It must display power generated and power used per session, in addition to total power generated over the lifetime of the station. The total number of users must be displayed as well.
The charging station must be able to produce enough power to charge a standard laptop on alternating current. It must be built within the budget of $1,600 provided by Green Fund.

Quality Function Deployment (QFD)

The QFD matrix, shown below, displays the relationship between the project objectives and engineering specifications (Figure 1).

			Specifications				
		Weighted Importance	Weight	Power Output	Cost	Required Mantainence	Accuracy
Objectives	Adjustable	7	1		1	1	1
	Interactive display	10		3	3		3
	Sufficient AC Power	10	1	3	2		2
	Collapsible	4			2	2	
	Geared	8	2		2	3	
	Geomerty	3	3		3		
	Multiple Chargers	8		2	1		
	AC plug for Laptop Charging	10		3	1		
	Shows Power Generated	10		1			2
	Shows Power Used	10		1			2
	Shows Total Power Generated	9		1			2
	Shows Total Number of Users	9		1			2
	Carbon Offset	8		9			2
		Score	42	216	108	39	149
		Relative Weight	0.19	1.00	0.50	0.18	0.69
		Unit of Measure	lbs	Watt	$	Hours	*
	* = relative error						

Figure 1- QFD Matrix

As seen in Figure 1, the most important specification for the project is power output.

Project Planning

Throughout NAU's 2013 fall semester, certain deliverables are required leading up to the final project proposal. A Gantt chart, as seen below, shows when these deliverables will be worked on and turned in (Figure 2).

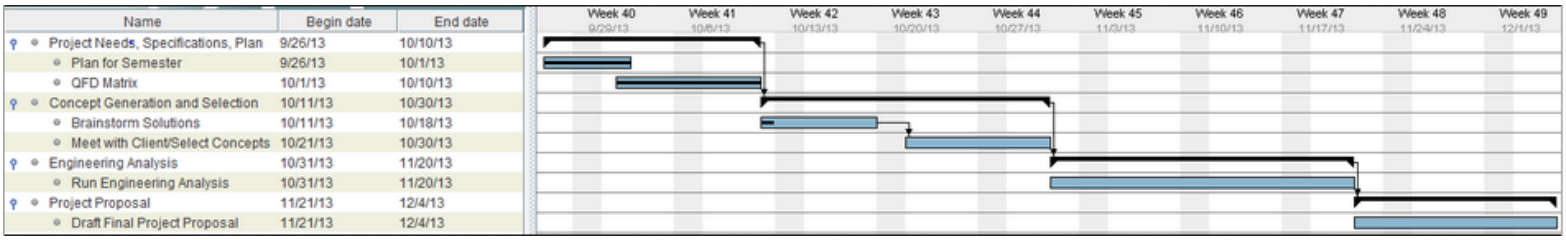

Figure 2- Gantt Chart Fall 2013

These deliverables are structured and timed to guide the engineering decision process in the completion of the problem at hand. This report is in fulfilment of the project needs, specifications, and planning. The remainder of the project includes:

- Concept Generation and Selection: During this process, our team will brainstorm a variety of ideas to meet the constraints and objectives. While consulting the Quality Function Deployment matrix, ideas will be ranked based on ability to meet or optimize specifications. Selection of a design will then take place and a plan to implement will be formulated.

- Engineering Analysis: Having chosen a design, a comprehensive engineering analysis of the system will be completed showing proper configurations to maximize objectives while allowing for a product that is safe, reliable, and durable.

- Project Proposal: The project proposal will be the final deliverable this semester and will outline the build plan for the Spring 2014 semester. All materials, needs, costs, outlines and designs will be included for the successful building and implementation of the project, as well as the expected outcomes.

Conclusions

The need of the client was identified as to provide students with an avenue to understand and compare the amount of energy required to power and charge electronic devices with the amount of energy produced by pedaling a bicycle.
This led to outlining the problem by defining the goal, objectives, and constraints. The goal of the project is to design an improved bicycle powered charging station which will produce power to charge small electronics while teaching about power generation. Objectives include improving the station's efficiency, making it easier to use and transport, and more versatile.
There are constraints on the display as well as the budget and compatible devices. The display must show power generated, power used, total power generated at station and total number of users. The budget is $1600 and the station must generate enough power to charge a laptop.
The Quality Function Deployment (QFD) matrix relates the various objectives and constraints to the specifications that will quantify the success of the project. The QFD matrix demonstrates that the most important specification in this project is the power output.
In order to successfully complete this project, the Mechanical Engineering team and Electrical Engineering team must work together to satisfy the client's request and provide a product that is both functional and informative.

References

Lamb, M., First Generation Bicycle Generator Design & Build Team. Personal Communication. 2013

Lamb, M., The NAU Green Fund Addendum Application for Second Generation Charging Station. Feb. 2013.