E-Bike Charging Station

Milestone #1

Team Members:	Bilal Rafiq
	Jacob Knoblauch
	Bryan Castro
	Justin Johnson
	Seve Kim
Advisors:	ECE - Dr. Frank
	ME - Dr. Hellstrom
Efficient Systems LLC:	Fabio Vargas
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1. Overview of the Design Team

Seve Kim
ECE Team Leader

The ECE team leader serves as a co-project manager with the ME team leader. The ECE team leader is the main point of contact for the ECE team members, to delegate tasks and manage the work that is given to the ECE portion of the design team. Ensures that the scheduling of meetings and presentations corresponds with all members' availability.

Technical Area: Microcontroller programming

Bilal Rafiq
ME Team Leader

The ME team leader serves as the other co-project manager for the ME portion of the design team. Manages delegation of work and assisting in communication of group members. Helps group members accomplish tasks and guides team to follow requirements and meet deadlines.

Technical Area: Mechanical systems specialist

Bryan Castro
Financial Advisor

The Financial Advisor is responsible for contacting the external sponsor and allocating funds to the needs and specifications of the design project. Financial Advisor also plans the budget and logs the itemized list of costs. The FA is accountable for utilizing the budget in the most cost-efficient manner possible.

Technical Area: Power & electronic systems specialist

Jacob Knoblauch
Team Coordinator

The Team Coordinator is responsible for contacting all faculty and external advisors as well as the board of reviewers for meetings and updates. TC is also responsible for keeping meeting minutes and managing all documentation for the design team.

Technical Area: Coding specialist

Justin Johnson
General Assistant
Technical Area: Virtual Model

2. Needs Analysis

2.1 Problem Statement

Efficient Systems, LLC has proposed a project for developing a dually purposed station for charging and docking their electric bicycles (E-bikes). Overall, the company wants the team to design a product that makes it easy for the user to dock and charge their E-bikes with minimal user interaction to activate, charges at a fast rate, and also features a locking mechanism. They

want the E-bike users to be able to have easy access to rapidly charged E-bikes and for the station to lock them to prevent them from being stolen or damaged.

2.1.1 Background

Efficient Systems, LLC is a Tallahassee start-up that intends to develop E-bike sharing solutions for companies, cities, and communities. The company has partners located in South American, El TomaCorriente who currently has three operational E-bike Sharing programs with 90 E-bikes in service. Their intent is to bring E-bike sharing solutions to Tallahassee businesses and communities as a viable alternative to conventional transportation. Efficient systems is proposing a project to develop a new way to charge their electric bikes that will be simple, cost-efficient, and easy to use.

2.1.2 Statement of Needs

Efficient Systems, LLC gave the statement of needs in a few features that they need the charging and docking station to have. The station needs to have a method of rapidly charging the E-bike by resonance or induction. In the past, the bikes have been hooked up to wires that charged the E-bikes. The battery that the team would be working with has a three-pin connection where a detachable plate would be connected to the bike. The other plate that resonates or induces charging would come from the port. The detachable plate is not a need for the project, as the client company said they could provide that portion, although the plate that is attached to the dock would be needed in the project development.

2.1.3 Supporting Information

2.1.3.1 Marketing Requirements

Required Capabilities (Highest to lowest priority)

CAP-0001: The station must charge the electric bicycle by resonance or induction and be protected by weathering conditions.
CAP-0002: The station should dock the electric bicycle in place.
CAP-0003: The station must have locking capability.
CAP-0004: The station should be easy for the user dock and undock the bicycle with minimal use.
CAP-0005: The station should have a modular and attractable design and be cost efficient.

3. Requirements Specifications

3.1 Functional Requirements

REQF-0001: The docking station must provide an automatic locking mechanism, most likely to lock onto the frame of the bike.

REQF-0002: The station must be able to charge the battery fully within 3 to 4 hours. If at all possible, induction through plates will be used to charge the bike without needing a wire connection. These plates must also be removable to let the user charge through a standard charger. The batteries used are rated at 36V and either 8A or 14A.

REQF-0003: The station must have some user interface. This may include LEDs, an LCD/OLED display, or even integration with a mobile device such as a smartphone or tablet.

REQF-0004: The docking station should have a modular design such that the number of docks can be changed to meet the customer's needs.

3.2 Non-Functional Requirements

REQN-0001: The design must be as cost-efficient as possible.

REQN-0002: The station should be customizable to allow for possible future changes in the bike design.

REQN-0003: The product should be eye-catching in order to encourage customers to use it.

REQN-0004: The design must be compact in order to fit as many docks as possible within the allotted area, such as a parking spot.

REQN-0005: All parts of the final design must resistant to weather conditions including rain and extreme heat/cold.

3.3 Constraints

CONS-0001: The cost of the bike station cannot be significantly higher than options that are already in place.

CONS-0002: The station cannot be overly complicated as the product will be used by a variety of users.

3.4 Interface Requirements

The end-product must interface both between the user as well as the local or remote database that keeps track of the status of each bike:

INTR-0001: The user portion may be as simple as a set of LED indicators to give users the status of the bike.

INTR-0002: If a mobile device interface is to be set up, a remote database will likely be needed, which will require the bike station to have network capabilities.

3.5 Operating Environment

Because the bike charging station will generally be outdoors, the product will need to withstand any environmental extremes:

ENVR-0001: The station must be capable of operating in temperatures approximately as high as 110 degrees Fahrenheit (43 degrees Celcius) and as low as 20 degrees Fahrenheit (-7 degrees Celcius).

ENVR-0002: The station must be able to operate in humidity as high as 100%, as well as heavy rain and winds.

ENVR-0003: Vibration will likely not be an issue, but measures may need to be taken to ensure long-term performance, especially in parking lots and other high-activity areas.

4. Preliminary Test Plan

The following test plan encompasses the proposed design tests for all capabilities, requirements, and constraints. Each of them should be tested at least once for full functionality, in order to meet the demands of Efficient Systems, LLC for the charging and docking station of the electric bicycle (E-Bike).

4.1 Capabilities Test Plan

TESTC-0001: Resonance/Induction Charging Test
The E-Bike will be placed in the charging station and begin to charge the Lithium- Ion battery through either resonance or induction as soon as it is correctly positioned. No metal to metal contact shall take place in order for the battery to charge. User will not connect any type of cable to the battery. The battery will be fully charged in four hours or less. Also the battery enclosure and the overall docking station should be protected from weathering in different conditions such as rain, wind, snow, and temperature spikes in both directions.
(CAP-0001)

TESTC-0002: E-Bike Docking Test
The E-Bike will be positioned in the station by simply placing the rear tire into the tire mount. The bicycle will be able to stand alone without the user having to utilize the kickstand. Move the bicycle forward, backwards, and to the left and right to ensure minimal movement. Observe whether the E-Bike is upright and has no tilt. The user will interact with the station's interface to allow for the bike to be removed and will then be able to move the bicycle forward without further interaction with the station.
(CAP-0002, CAP-0004)

TESTC-0003: Locking Test
The E-Bike will be placed in the station by placing the rear tire into the tire mount and shall become locked once it is correctly positioned. The bicycle will be attempted to be removed using a full body pushing force. Observe whether the E-Bike manifests any type of major movement. The user will interact with the station's interface to unlock the position at the station and will proceed to removing the rear tire from the mount without any further interaction. The locking mechanism will remain unlocked at the position until a tire is placed in the mount once again.
(CAP-0003, CAP-0004)

TESTC-0004: Attractable and Cost Efficient
The E-Bike docking station prototype should be designed such that the prototype can be multiplied and tied into a series to charge and dock multiple bikes. The design should also be under budget and cost analysis will be reviewed before any purchase. Also the overall design will be analyzed for sleek and attractable look to fit modern day designs.
(CAP-0005)

4.2 Requirements Test Plan

TESTFF-0001: Automatic Locking
The E-bike will be tested for automatic locking mechanism that will be actuated by an electric signal from computer. A force meter will assure that the lock is tightly fitted so that it cannot be removed.
(**REQF-0001:** Locking Test (CAP-0003, CAP-00004))

TESTFF-0002: Charging Test
The time to fully charge will be timed to ensure it is under 4 hours and the charging station should charge using induction/resonance plate without plugging in by user. Also the plate will be tested for easy removability or user to charge using a traditional plug. Batteries must meet rating of 36V and either 8A or 14A using a special electric testing device.
(**REQF-0002:** Charging Demands (CAP-0001, CAP-0004))

TESTFF-0003: User Interface Test
The charging station will be tested for user interface that is the most user friendly. Must also be cost efficient when choosing between LED, LCD/OLED, or personal user devices.
(**REQF-0003:** User Interface (CAP-0004))

TESTFF-0004: Modular Design Test
The prototype should be able to be modulated to connect multiple ones in series to allow for multiple bikes to be charged at the same time.
(**REQF-0004:** Modular Design (CAP-0005))

TESTFN-0001: Cost Efficiency
The cost analysis will be constantly calculated to track spending to ensure that the budget is not exceeded.
(**REQN-0001:** Budget (CAP-0005))

TESTFN-0002: Customizable
The design will be tested to be able to mold and change it to fit different bikes and/or different fitting constraints. Also the docking station should be able to change in series to fit in areas of small spaces.
(**REQN-0002:** Modular Design (CAP-0005))

TESTFN-0003: Attractable
The overall design will be tested to ensure that it is attractable and costumers are drawn to it just by its looks.
(**REQN-0003:** (CAP-0005))

TESTFN-0004: Compactness
The design will be tested to fit close spaces and be able to mold to fit with different arranged areas.
(**REQN-0004:** Compactness (CAP-0005))

TESTFN-0005: Protection from Weathering
The overall docking station and charging connection should not interact or be effected by weathering conditions. The types of weathering conditions that will be tested is rain and temperature extremities.
(**REQN-0005:** Protection (CAP-0001))

4.3 Constraints Test Plan

TESTCS-0001: Cost Efficiency
Cost analysis will constantly be evaluated to ensure that the cost of the overall design does not exceed current designs and manufactured docking and charging stations.
(**CONS-0001:** Cost efficiency)

TESTCS-0002: Simplicity of Interface
The user interface module should not be over complicated and a user that is not computer proficient should be able to interact and use the system.
(**CONS-0002:** Simplicity of Interface)

TESTCS-0001: Cost Efficiency
Cost analysis will constantly be evaluated to ensure that the cost of the overall design does not exceed current designs and manufactured docking and charging stations.

(**CONS-0001:** Cost efficiency)

4.4 Interface Requirements Test

TESTIR-0001: Communication to User
LED lights should be simple and colored to ensure the user identifies when the lock is removed and when the charge is complete.
(**INTR-0001:** Communication)

TESTIR-0002: Networking
Mobile device interface should be simple and have a strong and steady connection to the docking station to allow for the fastest access possible from the moment of purchase to unlocking the E-bike.
(**INTR-0002:** Networking)

4.5 Operating Environment Test

TESTENV-0001: Temperature Range
The operating temperature will be tested between the 110 to 20 degrees Fahrenheit to ensure the device is still fully operational while during these different weather extremities.
(**ENVR-0001:** Temperature Range)

TESTENV-0002: Weathering
The station will be tested in conditions of heavy rain and winds and as well as %100 humidity to ensure all electronics are safe from weathering effects. These conditions will be tested in a sauna room.
(**ENVR-0002:** Weathering)

TESTENV-0003: Other Factors
Factors in the ambient area will be tested such as vibration, high traffic, flooding, long term effects, and other random factors that might arise during design process. This will be tested in many different ways so the station sustains operation.
(**ENVR-0003:** Other Factors)

5. Conclusion

The device being designed will be a docking and charging station for and electric bike for Efficient Systems LLC. The design requirements and specifications were explicitly cited and will be our main guide for designing the first prototype. The group's main goal is to achieve these requirements in an efficient and timely manner. Because there is no pre-existing prototype for the design, the sponsor has given the group flexibility in implementing a creative solution. The main needs and requirements for the project are to build a docking and charging station that has locking capabilities and will charge the battery through resonance or induction in the fastest manner possible. The design should be cost-efficient and modular, as well as aesthetically pleasing. All of these requirements will lead to a bike station that is user-friendly and that fulfills all of the needs of the consumer.

6. References

[1] Fall 2014 Senior Design Group 7, "About Milestone #1 – Needs Analysis and Requirements Spec," Unpublished

[2] Fall 2014 Senior Design Group 7, "E-Bike Proposal," Unpublished

[3] "Featured Products." *Efficient Systems*. Web. 15 Sept 2014. <http://www.efficientsystems.us/store/c1/Featured_Products.html>