Divide and Conquer 2

Senior Design 1

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Group 21

Keegan Van Wyk – EE

Daniel Birath – EE

Benjamin Tamayo – EE

Sandhya Singh – CpE

Bike System

Project Narrative:

The bicycle is a vital form of transportation for millions of people around the world today. Many security systems already exist to secure bicycles to bicycle racks or fixed objects, but they are not always sufficient. Additionally, bicycle owners who do not own or choose not to wear a smartwatch such as an Apple Watch or Fitbit, have no way to track metrics such as calories burned, distance traveled, or the speed at which they are traveling when they are cycling. The solution to this need is the Bike System.

The Bike System will be designed to maximize portability, such that it will fit most, if not all, popular bicycle designs. The Bike System also aims to maximize on convenience for its users. By maximizing convenience, the user will save time every time they want to lock or unlock their bicycle. In order to achieve this design goal, an RFID scanner will be available so that the user can swipe an RFID card across an RFID reader to have the locking mechanism lock or unlock in seconds – much faster than traditional bicycle locking systems already on the market. In the odd event that the Bike System is out of power, the user is provided a key to manually unlock and lock their bicycle. Metrics such as calories burned, distance traveled, and speed for the current trip will be displayed continuously on the LCD display once the bicycle is unlocked and in motion. The user will also be able to choose which metric is displayed on the LCD display by using one of three buttons on the electronics housing. By allowing the user to cycle through which metric is being currently displayed on the LCD display, the information is displayed larger, thus taking the user less time to interpret the displayed information and as a result, not become distracted while riding. This is one of the many features on the Bike System that prioritizes safety.

This Bike System also includes the addition of lights as another safety measure that will be mounted on the bike frame itself. If the user chooses to ride his/her bicycle at night, he/she would need to be visible to both pedestrian and motor traffic. With lights mounted to the bike frame itself, the bicycle will be visible from hundreds of feet away. To make the Bike System circuitry as reliable as possible, rubber washers will be installed between the bike frame and the electronics in order to minimize vibrations that will eventually cause wear and tear on the system. The system will also be battery powered and will emphasize long lasting battery life by making the circuitry as energy efficient as possible.

Should time permit, there are many other features that can be implemented to the Bike System to offer the user more convenience and reliability. For example, making the electronics housing waterproof and thermal resistant is currently listed as advanced features under our engineering specifications. Having an electronics housing that is both waterproof and thermal resistant will add to the overall reliability of the Bike System since water can cause short circuit conditions and high temperatures can cause solder joints to melt. If both of these sources of error were to be eliminated, or minimized, by a secure electronics housing, the Bike System would become more reliable and would need very minimal maintenance. Another advanced feature to be implemented is the ability to unlock and lock the system with the user's fingerprint. This feature is a failsafe in the rare case that the user does not have the RFID tag or the key to manually unlock or lock the system. This serves a perfect failsafe since the user would always have their fingerprint.

A stretch feature that would offer the most convenience to the user would be the implementation of an alternate power source that would allow for the on-board battery to be charged while the user is cycling. The alternate power source would be a generator that will generate power from the mechanical energy transferred from the user. If the battery is fully charged, the power from the generator could be used to take over the most power draining features such as the lights mounted on the bicycle frame or the LCD display. This alternate power source will allow the user to go for longer periods of time without having to remove and charge the battery. Ideally, the battery, in conjunction with the alternate power source, should last for weeks at a time without needing to be removed from the electronics housing to be charged.

Basic Goals	Advanced Goals	Stretch Goals
RFID module as the main locking/unlocking method	Fingerprint locking/unlocking method as a failsafe	GPS tracking module added to system to locate the bike
Alternate mechanical method of unlocking/locking the bicycle in the event of power failure	Thermometer added to Bike System to measure the ambient temperature as an additional metric	Creation of mobile app to save the metrics being measured during each trip via a Bluetooth module
Added lights to frame for safety precautions	Waterproofing/Insulation of the box housing the electrical components	Generate power/charge from the bicycle itself, instead of having replaceable batteries
Rubber mounting washers for shock resistance	-	-
Mounted LCD on handlebars to display metrics	-	-
Sensors attached to the bicycle's wheels to measure distance travelled and calculate average speed	-	-

Table 1: Tiers of specifications/goals for the Bike System

In Table 1 above, the Bike System specifications have been broken down into tiers based on importance/vitality of the Bike System. The basic goals such as the RFID module and manual key module are fundamental to the Bike System's claim of convenience to the user. The manual key module also serves as a secondary security measure that most people are familiar with. This ensures that power failure does not leave the user and his/her bicycle vulnerable and un-rideable. Although the added lights to the bicycle frame are a small feature, the lights would give the user added visibility that traditional bicycle reflectors do not provide. In an effort to extend the life of the Bike System and minimize wear and tear, rubber mounted washers will be utilized. Sensors attached to the wheels to measure distance and speed which would be displayed on the mounted LCD display are the barebones of the Bike System design.

The fingerprint module will be added as an advanced feature since two different modes for unlocking/locking the bicycle have been discussed. This is the ultimate failsafe (power permitting) since the user always has their fingerprints with them (unlike a key or RFID tag). The ambient temperate is an advanced feature since it is not a vital part of the Bike System design, but it may be useful to the user to know this information due to Florida's daily fluctuating temperatures.

Waterproofing and insulating the electrical system is directly tied into the types of weather experienced in Florida. The unexpected rains will not be a concern to the user if all the electricals are waterproofed. Similarly, the outside high temperatures may affect the Bike System's equipment and damage certain sensors if not considered.

Bike System Specifications

- Inclusive bike locking system that can be attached to a pre-existing bike frame:
  - The locking mechanism will be housed in a box which can be attached and secured to the bike frame via a clamping lock.
  - The Steel cord will extend from the housing at one end and will be secured in the opposite end.
  - The housing will contain all circuitry.
- Main marketed method of locking/unlocking via RFID module:
  - RFID tag will be housed/attached to a keychain to make this "key" more user-friendly.
- Failsafe method of locking/unlocking via fingerprint:
  - A fingerprint module will be easily accessible on the housing. Once the fingerprint is processed, the locking mechanism will release allowing the user to stow the tethered cable.
- Alternate unlocking mechanism in the case of low power:
  - A key will be supplied to unlock the system in the event of low battery.
- LCD Display:
  - Display speed, ambient temperature, and distance traveled on LCD will be mounted on the handlebars of the bicycle for easy viewing.
  - The current battery level of the internal battery pack will be displayed.
- Measure revolutions of wheel and tire assembly:
  - Sensor mounted to the frame to measure the revolutions of the wheel and tire assembly to calculate speed and distance traveled.
- Additional lights mounted on bicycle frame as a safety measure.
- Rubber mounting washers will be used for shock resistance.
- Waterproofing and insulation of the entire electrical box system to make the system weatherproof and extend the lifespan of the entire Bike System.
- GPS module added to Bike System to help locate bike in event of theft.
- Creation of a mobile app to save the metrics (health data, ambient temperature, distance, and average speed) from each trip.
  - Metrics can be sent/saved to the app by a Bluetooth module.
  - Possible Google Maps integration to give more insight on the location of the user's trips.
- Generator:
  - A DC power generator with drive pulley will be fixed to the frame of the bike to charge the battery.
    - Drive pulley will connect to the existing drive chain on the bicycle.
  - In the event there is not enough power to operate the system, riding the bike will supply enough power to bring the system back online.

Bike System Block Diagram(s):

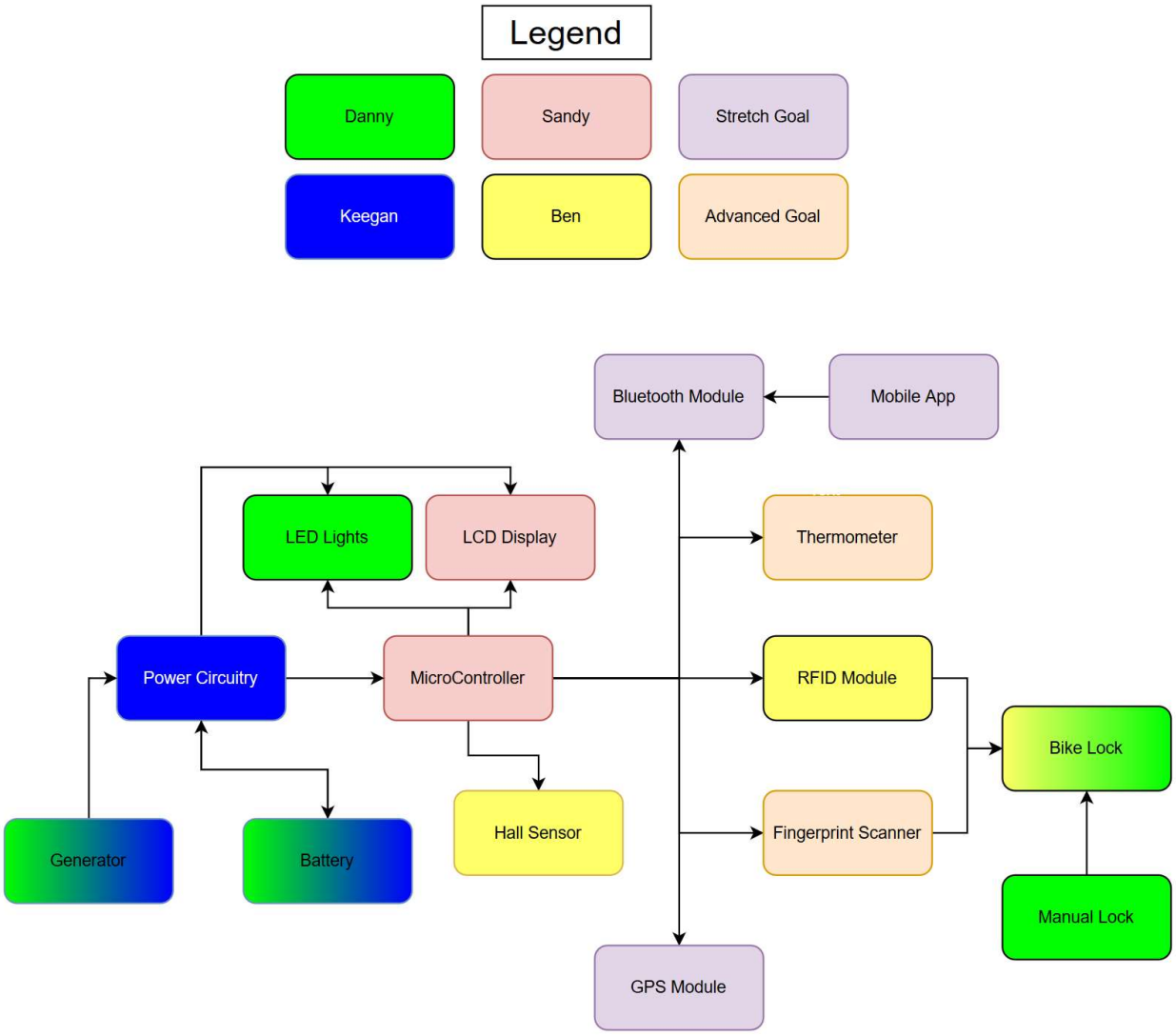

Figure 1: Block Diagram for Prototype

Bike System's House of Quality

The house of quality we designed will describe in a systematic way, all the critical engineering requirements as well as the critical marketing requirements. To bring this product to market, several key areas must be met to make it desirable. Looking deeply into the customers interests, we found five areas we would like to meet. Engineering requirements are the main focus relating to how we will reach the marketing requirements. There are seven key areas within the engineering requirements we need to address to entice consumer interest.

We want the product to be attractive to the consumer and have employed methods to attain this goal. First, we want to focus on user convenience. If the product is easy for the user to understand and use, it will be more attractive to them. We can achieve this by incorporating an easy to use LCD to display the information that utilizes three buttons at most. Making the product more convenient also includes installation and setup. We want to include a primary system, secondary system, and emergency system to lock or unlock the system. Including a seamless method for securing the box to the bike will also be a key task for development.

Next, we want to mold the box to the bike to provide a streamline, aerodynamic casing that will not impede on the riders' natural motion. Designing an aerodynamic case will reduce drag and frustration by the rider. Included in the marketing requirements, we want the user to experience minimal upkeep for the product. By reducing the maintenance of the lock system, we increase the attractiveness of it. Lastly, we want to ensure that the battery life is long lasting and reliable. We want to utilize a low-power mode to save energy while the bike is not in use.

The engineering requirements is where all the magic happens. First, a power generation system will allow the user to continuously charge the batter and power the system in the same way an alternator does in a vehicle. Overall, we expect a minimal draw of power to be expended within the lock system providing opportunity for a long battery life. Next, we want to ensure that we save power where applicable and design an energy efficient system. This means reducing the loss of power when the user is on the bike and not moving. Lastly, the box dimensions and install time are crucial the success of this product. By providing the user a way to easily mount and unmount the bike system is as important as giving the user the illusion that the system is not even there.

We believe that the mix of marketing requirements will make this product attractive enough to warrant attention and the engineering requirements will pave the path for future bike systems. Incorporating this system into an existing bike will provide a convenient and reliable way for the user to upgrade their status in an ever-changing world.

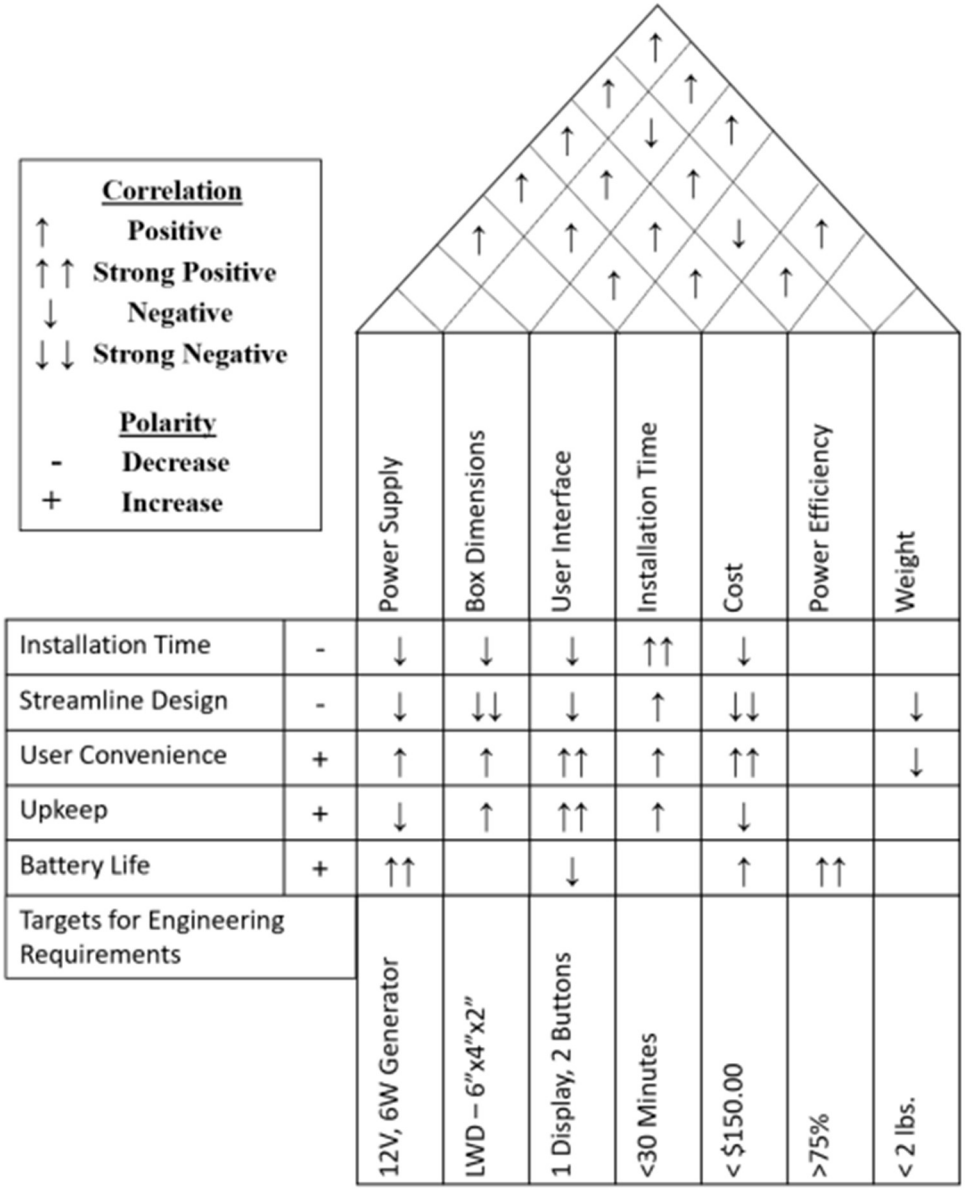

Figure 2: House of Quality

Bike System Initial Budget:

Item	Quantity	Price Estimate
Bicycle	1	Already acquired
Hall Sensor	6	$5.99
Bicycle Generator	1	$18.99
1602 LCD	1	$9.99
30 awg Copper Wire (60’ spool)	6	$13.99
Locking Mechanism	1	TBD
Temperature Sensor	5	$9.97
Lithium Ion Battery	1	TBD
Stainless Steel Cable	33’ x 1/8”	$19.88
Fingerprint Module	1	$20.99
Housing Lock	1	$25.66
Housing Fabrication	1	TBD
PCB w/ Integrated Circuit	1	TBD
RFID Module	1	$7
Total		**~ $300**

Table 2: Estimated cost of parts for Bike System

Bike System Project Milestones:

Senior Design 1 Tentative Schedule:

Week	Deadline	Milestone
6	October 2	Continued research
7	October 9	Beginning of writing final document
12	November 13	Halfway mark of final document
14	November 27	Individual group members parts to be completed
15	December 1	Compilation and formatting of final paper
16	December 8	Submit final document to Webcourses

Table 3: Projected Schedule for Senior Design 1

Senior Design 2 Tentative Schedule:

Week	Deadline	Milestone
1	January 15	Order all parts
3	January 25	Testing of components
6	February 15	Project build
7	February 22	Test project build
8	March 1	Fix any problems/bugs
13	April 5	Preparation of final presentation
15	April 19	Final presentation

Table 4: Projected Schedule for Senior Design 2