Senior Design 1
Stationary Bicycle Cardio Game

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Initial Project Document - Divide and Conquer

Group 20

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Project Narrative

Many gyms are now offering group exercise classes to entice members to become more motivated to get and stay in shape. Examples of these classes are yoga, Pilates, Zumba, kickboxing and cycling. Classes are typically available twice a day at differing times throughout the week, making it difficult to have a set workout schedule. The classes are mostly based on aerobic exercise, meaning they raise the participant's heart rate for an extended period of time. Interestingly, most attendees are millennials, and females outnumber males 5 to 1 (Slide Share). In addition, a Nielson study found that 85 percent of active members visit the gym at least twice a week solely to participate in these group classes (club industry), leaving a disproportionate number of middle-aged males in the dust. With the typical member being 40 years old (Credit Donkey), what can fitness clubs do to entice their male constituents to participate in necessary cardiovascular activities? The answer is simple: Make cardio more enjoyable by turning it into a game rather than a group activity.

The stationary bicycle cardio game is a novel approach to motivate those who feel out of place in group exercise classes or simply cannot fit one into their hectic schedule. The setup includes two stationary bicycles that are interconnected to race against each other, which is ideal for the 44 percent of gym-goers who work out with a partner (Credit Donkey). The bikes will have a user interface to indicate speed and distance, the gear the bike is in, as well as the status of the other person biking with you.

The typical commercial exercise bike that would be found in the gym retails between $1,200 and $4000. The stationary bicycle cardio game is meant to be a replacement for these bikes at a comparable cost, should it go into production, depending on what bike frame the controls are integrated into.

The stationary bikes will have identical setups. A power management circuit will be used to regulate power to the rest of the systems. A motor will be used for the user to control which gear the bike is in. The bikes will be connected via cables to the interface to display the current status of both riders in real time. There will also be transmitters and receivers on both bikes to send a signal to the motor from the accompanying bicycle.

At certain milestones, such as a sustained speed for a period of time, the rider will then have the opportunity to sabotage his or her co-rider. There will be an indicator that you have received an object and the ability to accept or deny that object. If accepted, the rider's bicycle sends a signal to its counterpart, causing the opponent's bike to shift to the lowest gear. This effectively has the opponent spinning his or her wheels, covering less distance. In addition, if one player is behind by a certain distance, the before mentioned ability will be made available.

This causes both partners to push each other to perform better while keeping both engaged. Research has found working out with a partner perceived as better can cause workout length and intensity to skyrocket by 200 percent (Newswise).

Currently, there are two different options for cycling in a fitness club. The first is group exercise classes. As mentioned before, these classes occur at certain times depending on the availability of the instructor and are a specified length. The second option is to go to the cardio section of the gym and find a stationary bike, for which you can change settings for different intensity rides.

At home, there are three stationary bicycle options. The first allows the gym group exercise experience brought to you. The Peloton Indoor Exercise Bike includes a 22 inch HD display with which the user can access unlimited cycle classes for monthly membership of $39. The cost of the equipment itself is $2,245 (Peloton), making it inaccessible to many. The second is a stationary bike much like that in the cardio section of the gym which can be situated in whatever manner the owner would like, be it facing a window, television, etc. The third option allows the user to connect to his or her television to play a racing game.

While options for cycling at the gym and at home each have their own benefits and drawbacks, none motivates the users with healthy competition. This sets the stationary bicycle cardio game apart from its cohorts in the market. The stationary bicycle cardio game allows its riders to maximize the health benefits of aerobic exercise that the average 40-year-old gym-goer needs, such as improving heart, lung and mental health, all while still having fun with his or her partner.

Project Requirements and Specifications

For the stationary bike cardio game, we will be using the mechanical energy created by the user to ultimately drive the entire system. In order to do so, we will have a 12-volt battery as a power source to initialize the system to allow the user to start the game. The user at this point can select how far they want to ride for their workout. Then, when the user begins pedaling the bike, the mechanical energy that is created will be passed to a power converter in order to recharge the battery power supply. This battery will be used to power all the electrical parts of our system, including a charging station for a mobile device. We will need a DC-AC inverter to convert the battery, 12-volt DC, to an AC source to power all the electronics.

On average, a typical biker can generate 100 Watts of power in one hour of riding (michaelbluejay). During short bursts, it is possible to generate upwards of 400 Watts when pedaling as fast as the user can. So to not waste the energy that the user is putting into the system, we would want a DC converter with a max power output of at least 400 Watts. The specifications that we are putting in place are to keep our losses at a minimum and allow our system to be as efficient as possible.

Specification	Value
Power Input	12V DC, up to 400W
Power Output	120V 60Hz
Speed	35MPH max

Table 1: *Project Specifications*

The above table reflects all of our known project specifications to date. Along with the power input and output, we have also specified the speed of the bikes since we will have to both measure and limit the speed of the bikes.

Possible Project Constraints

There are a few possible constraints that our project could run into when designing it. One possible constraint would be the motor being used to apply tension to the bicycle. We have to choose a motor that has enough power to apply tension to the bicycle, but also not be too loud to disturb the gym goers. Also, depending on how the motor is implemented, we would have to worry about its durability. Durability may not only mean the motor burning out based off how we decide to implement it. For example, if it is used as a rubber stopper like the brakes on a normal bike, we need a material that will be able to hold up for a long time. Another constraint could be the cost of the materials needed in the project. As a group, we do not have a lot of money to throw into this project, and we do not have any sponsorships to help pay for parts, so we may be limited on what we are able to buy. As we research more and begin building the project, there will likely be more constraints added to this list.

House of Quality Diagram

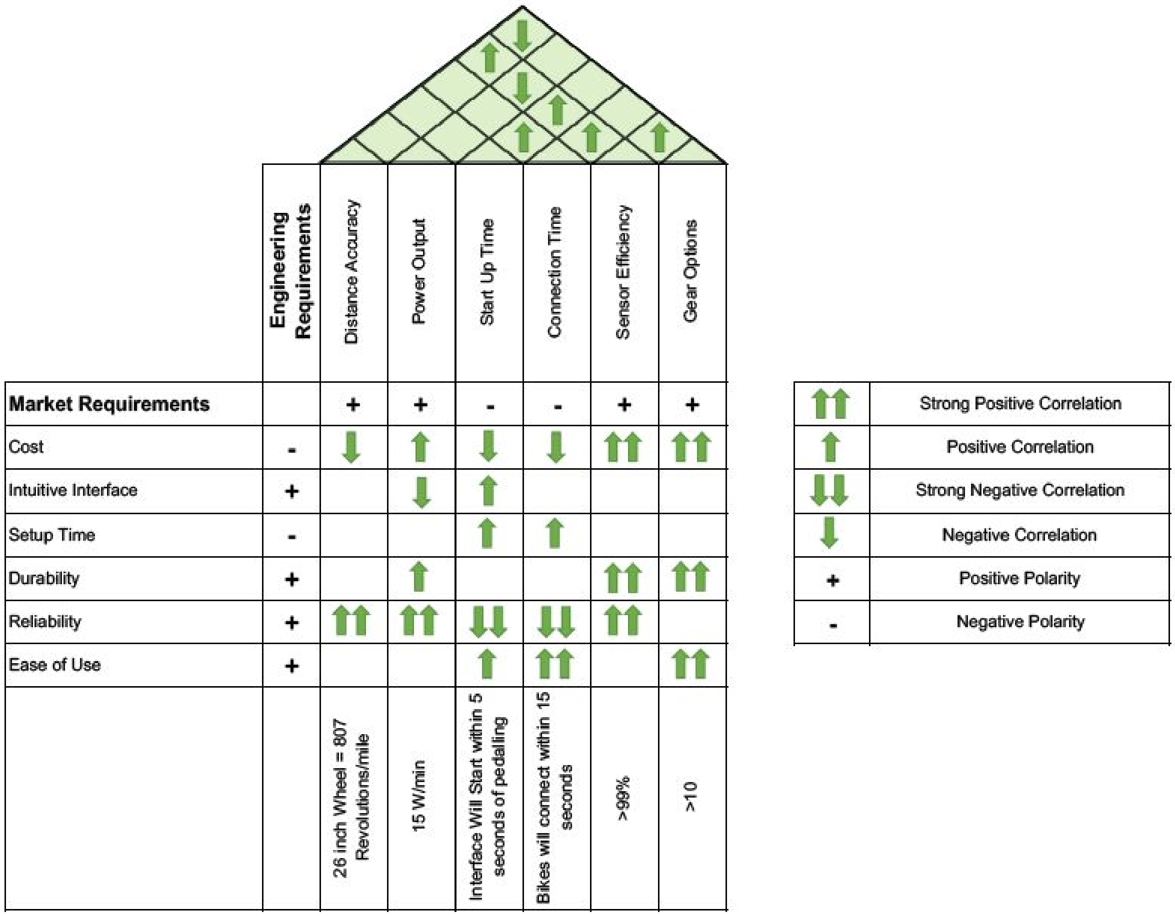
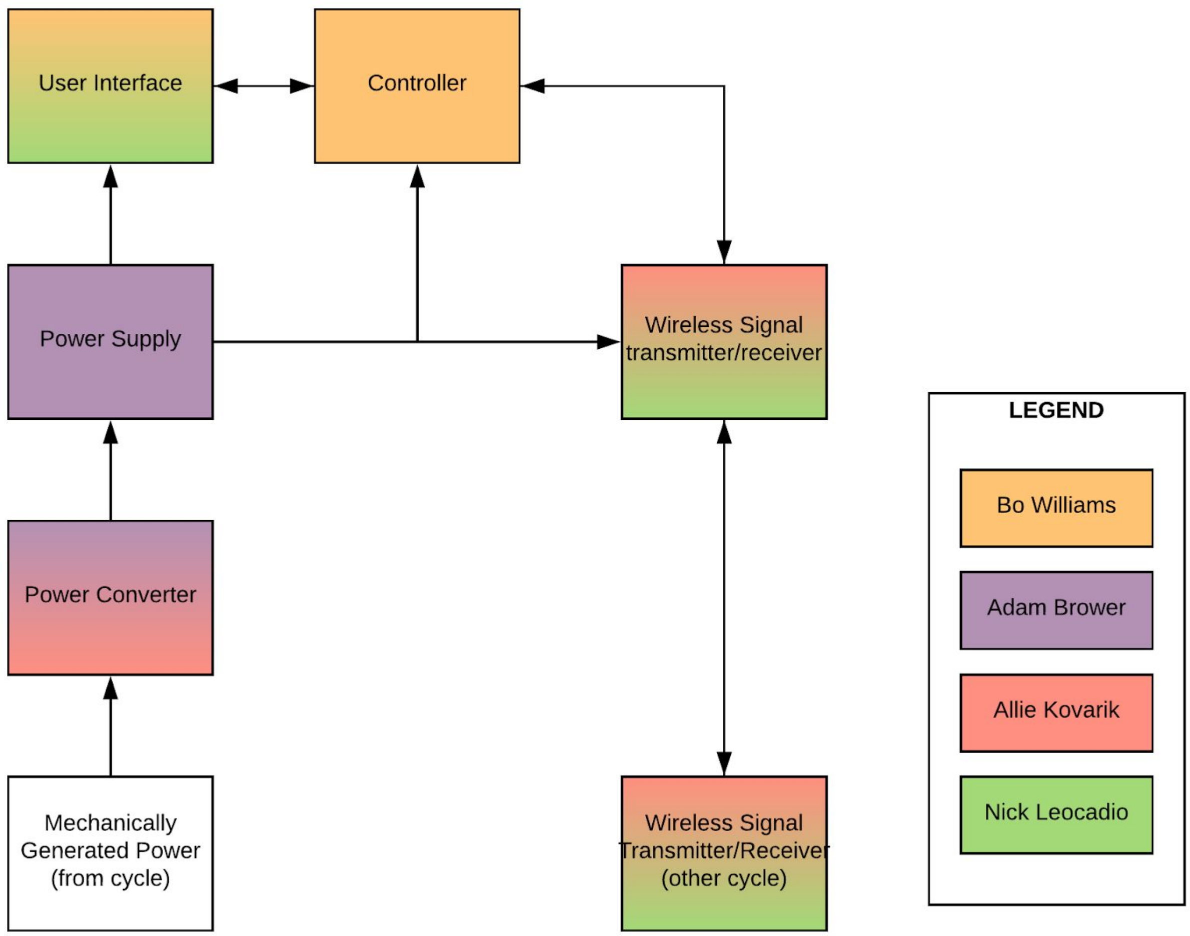
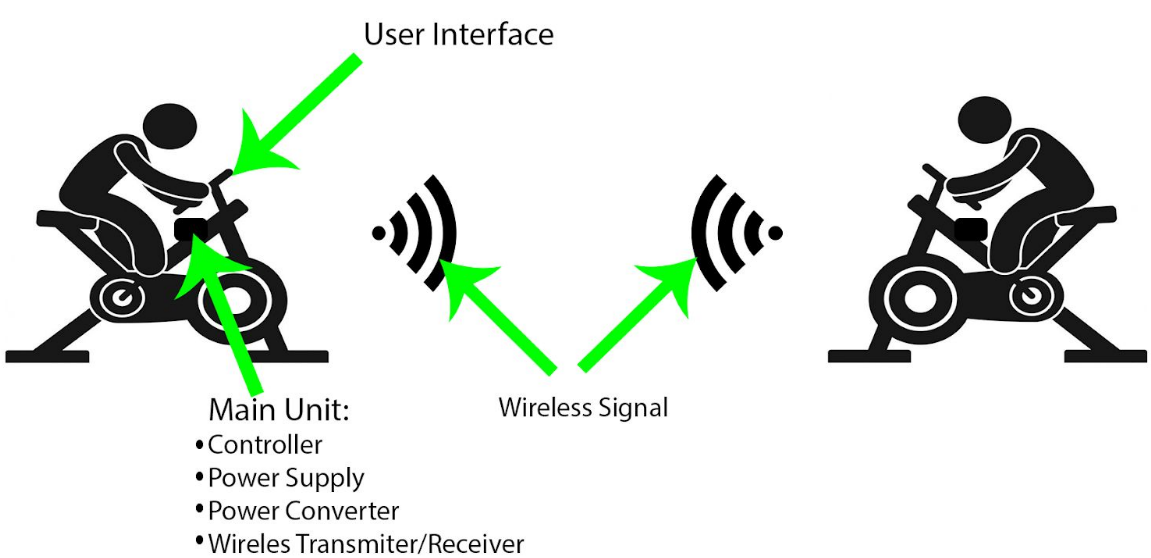


Figure 1: *House of Quality diagram for the stationary bicycle cardio game.*

Project Block Diagram and Illustrations





Project Budget

After reviewing the desired requirements and specifications, our team decided that this project will be self-funded with each member contributing an equal one-quarter of the final amount necessary to complete it. With this in mind, we have created a table of the materials that we predict we will need for this project.

Item	Price	Function
Stationary Bike x2	300	Main Component
Motors x4	200	Change resistance of bikes Generate electricity from bikes
PCB x2	40	Wireless communications, project logic control
Microcontroller Board x2	60	Runs touchscreens
7”Touchscreen Display x2	120	Interface with user
SD card x2	20	Holds code for raspberry pi
Battery Charger	90	DC-DC Converter
DC-AC Inverter	90	AC power
Battery	15	Provide steady power for electronics
Mounting plates, casings	75	Clean looks
Total	1000	

We expect that there will be many unforeseen items that we will need to include in our project during further designing and prototyping. However, we believe that we have identified all necessary major components for the project and expect that the majority of the overall cost will come from the two stationary bicycles and the power components that we have to purchase. We may also be able to find cheaper versions of current items that will further reduce the overall required budget. Keeping all of this in mind, we have come up with an initial budget of $1000.

Project Schedule

We have separated our schedule into two straight-forward parts. The first part is in the table below and is for the Fall of 2018. The items in this first half of our schedule are mostly fixed and will only need to be revised with additional subtasks, which will allow us to stay on track for our final project through Senior Design 1.

Milestone	Task	Start Date	End Date	Owner
1	Brainstorm	8/29/18	9/7/18	ALL
2	Pick Top Ideas	9/7/18	9/7/18	ALL
3	Role Assignments	9/8/18	9/9/18	ALL
4	Initial Project Document – Divide and Conquer	9/9/18	9/14/18	ALL
5	Group Discussion to Finalize Project	9/18/18	9/18/18	ALL
6	Research and Documentation	9/18/18	10/8/18	ALL
7	Select Components	10/2/18	10/8/18	ALL
8	Design PCB(s)	10/9/18	10/23/18	Brower Kovarik Leocadio
9	Order Components	10/24/18	10/26/18	ALL
10	60 Page Draft	9/18/18	11/2/18	ALL
11	60 Page Feedback Meeting	11/6/18	11/6/18	ALL
12	100 Page Submission	11/6/18	11/16/18	ALL
13	Test Components	11/16/18	11/20/18	ALL
14	120 Page Final Document	11/16/18	12/3/18	ALL

Table 3: *Project Schedule for Fall 2018 (Senior Design 1)*

The second part of our schedule is in the next table. This schedule is very tentative as it is dependent on many aspects that will be determined during the first half of our project schedule. The testing, troubleshooting, and redesigning phases will take the bulk of our time during the Spring of 2019.

Milestone	Task	Start Date	End Date	Owner
15	Populate PCB(s)	1/7/19	1/14/19	ALL
16	Test & Troubleshoot Individually	1/15/19	2/3/19	ALL
17	Redesign	2/4/19	2/15/19	Brower Kovarik Leocadio
18	Retest & Troubleshoot Individually	2/16/19	2/20/19	ALL
19	Integrate System	2/21/19	3/15/19	ALL
20	Finalize Prototype	3/6/19	4/8/19	ALL
21	Peer Presentation	TBD	TBD	ALL
22	Final Report	TBD	TBD	ALL
23	Final Presentation	TBD	TBD	ALL

Table 4: *Project Schedule for Spring 2019 (Senior Design 2)*

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