Senior Design I

Automatic Score Detection Cornhole

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Initial Project Document and Group Identification
Divide and Conquer

Group 10

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Introduction

The fame of the game, Cornhole, rose in Cincinnati throughout the late nineteen nineties, spreading across the United States rapidly. The game is friendly to players of all ages and skill levels, and has the versatility to played in almost any place; parks, backyards, beaches, schools, and parties, for example. Game technology has improved throughout the past few years, however, the scoring guidelines of the game have not changed much. As of now, the game remains in a state akin to its original. This brings up the idea of a more advanced Cornhole, technology wise. Integrating a system which will detect score changes and keep track whilst updating and displaying the score as the game progresses. One of the main problems while playing the game, is that since no one takes time to write down or keep track of the scores, dishonest players may try to cheat by lying and boosting their scores to gain an unfair advantage. So, while players are having a great time playing, a malicious player may try to artificially increase their score. This can lead to arguments happening between the teams, causing the game to end prematurely, and even break longstanding friendships between the players.

The rules of the game are simple to grasp, there are two teams made up of two players each. The game utilizes two boards which have the following dimensions: two feet by four feet with a six-inch diameter hole in the upper center region, nine inches from the back of the board and 1 foot from either side; going from one-foot-tall on the back to zero in the front. The boards are separated by a distance of 27 feet, from the front of each board. There are a total of eight beanbags, with four bags per team, which each side takes turns to throw. Landing a bag on the surface of the board scores one point to the designated team, and making the bag in the hole scores three points to the designated team. A bag failing to land in the hole, or on the board at all, scores zero.

The way our team wants to improve the game, is by adding an automated bag detector and score keeper. Using a microcontroller to detect inputs from sensors placed on the board, which will detect any bag that would land on the board, scoring one point. The microcontroller will then process this input, and update the scoreboard. The scoreboard will remain fixed after the turn is over and the bags are removed from the board, and then proceed to the next turn. Furthermore, in another scenario where the bag is made into the hole, the microcontroller will detect the bag going into the hole, updating the scoreboard by adding three points. A display will be implemented into the design, which will display the score to both teams. The scoreboard will be synchronized wirelessly, to keep both scoreboards displaying the correct score, and at the same time, update the score when more points are scored.

Another one of the big problems when playing Cornhole, is that the player who is next to throw, doesn’t have a safe place to put their drink during their turn, this can cause the player to perform poorly, since the player has to worry about not spilling his drink when performing a throw. A solution will be implemented by adding a hinged rod, strong enough to hold two drink holders. At the top of the rod, it will have two cup holders on each side. The rod will have to be placed such that that it won’t interfere with

the game. As an example of an unacceptable situation, a player throws the bag, which hits the rod and the bag bounces back into the board. Additionally, the rod has to be able to fold down, flush with the board, for storage capabilities and improved mobility. The rod should be an appropriate size, to allow the players to place the drinks more comfortably, while at the same time, reachable by small children.

The idea of this project is mainly to provide an automatic score detection/keeper system, but at the same time, provide some missing features to the game, which are universally desired by players of the game. Cornhole can become rather boring while the player is waiting for their turn, therefore, we propose the addition of wireless speakers to the cornhole board. Players will be able to listen to their favorite music and even dance while they're playing the game. The idea is to implement speakers in each cornhole board, allowing the players to connect their smart phones and play their favorite music while playing cornhole. Each board will have their own speaker, which can be connected to an individual smartphone. The speakers will not be in sync with each other meaning each pair of players by each board will be listening to different music according to what they like. The speakers must be chosen carefully, keeping two main concerns in mind: power efficiency and sound loudness. Concerning power efficiency, the battery should be able to power both the speaker and the microcontroller unit for a few hours to allow the users to play many rounds of the game. On the other hand, the speaker needs to provide a decent amount of loudness, since in most cases, users play the game in places with loud background noise. This will allow the speaker to be heard clearly by both of the players around the cornhole board in all of the various settings and scenarios.

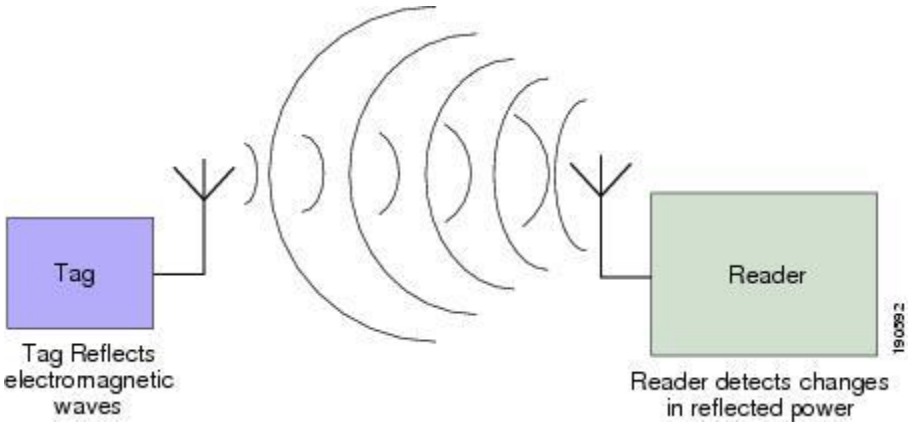
The fact that Cornhole is an outdoor game, brings up the use of a battery to power all the components that make up this advanced version of the game. The biggest issue is that there isn't a normal AC wall plug available at most places where the game is played. Even if there was a wall plug, there would be a need of an extension cord to reach both of the Cornhole boards. A battery for each cornhole board solves this issue with a portable power source. The battery will allow users to play in any place, as well as being versatile in more environments, and offer greater mobility. Each of the batteries should be able to last for a decent amount time while playing Cornhole and listening to music through the wireless speakers. Furthermore, the battery should be able to detach from the board itself, to provide the ability to charge the battery without having to move the whole board near a power supply. It should also allow the players to charge the battery during a game of cornhole to provide a longer usage.

There will be a simple on/off switch to turn on power to the board after the battery is plugged in. We would like to take it a step further on show, and light up the board with LED lights to improve the overall attractiveness. There will be soft-reset switch on side of board to restart/reset the display for new players to start the game. Foot pedal switch will be used to switch teams after 4 bags are thrown. The challenging part about this project is how we will accurately detect score. After much discussion and research on our idea we came up with the ideal method for detecting score. We went through multiple ideas to detect scores such as weight sensors, cameras, or RFID sensor

systems. Each approach has its advantages and disadvantages. In order to win the game, a team must score exactly twenty-one points, no more, no less. If the team goes over twenty-one it resets the score back to the last known score of the team. For example, if the red team is at twenty points, and the red team player shoots in the hole instead of landing on the board, this will make his total score twenty-three, which is over twenty-one and the score will automatically reset to twenty for the red team.

We live in an age where we are surrounded by a lot of advanced technological devices which have made our lives easier and easier. When thinking about such devices, the word sensor often pops up in our mind. A sensor is a device that converts real-world data into digital data that a computer can understand. Sensors are used everywhere and have revolutionized technology in many industries. With the help of sensors, we now have autonomous cars and planes. We would like to use the same technology to detect our beanbags. Detecting a three-point throw would be simple, we will use a sensor in the hole which will be activated once bag has landed in the hole. Upon landing in the hole, it will add three points to the display score board. Detecting score of bags on the board has proved to be quite challenging. When a player, let's say a red team player, lands a bag on a board its one point, and on a next turn when a player from blue team lends a bag on the board is also a one point, so both scores will cancel out each other. We are leaning towards RFID as the best way to implement our system. RFID stands for Radio-Frequency Identification. The acronym usually refers to small electronic devices that consist of a small chip and an antenna. Each of the eight bags would have their own separate RFID tags which will be placed in each of the bag. These tags will be detected by RFID reader system, and the points will be totaled by the microcontroller and displayed on the display depending on the where the bag lands. Once total score has reached to twenty-one the winning team will be declared victor.

Sensor in the hole to detect score



RFID sensor under the board to detect score of landed bags

Specifications

- Score Detection
  - RFID reader antenna under the board to detect bags that land on the board.
  - Hole sensor to provide and accurate reading of a three-point throw.
  - Microcontroller unit will receive inputs and send output to/from different components.
- Scoreboard
  - The scoreboard shall be big enough to be seen while standing above the board.
  - Shall announce a win after reaching to twenty-one points.
  - Shall be reset after each game.
- Power Supply
  - The batteries should be able to last a decent amount of time.
  - The batteries should be rechargeable.
  - Batteries should be able to detach from board.
- Speakers
  - Speakers should have wireless Bluetooth connection capability.
  - Be loud enough to be heard by both nearby players.
- Board Dimensions
  - Two feet in width by four feet in length.
  - One foot in height from the rear to 4 inches in the front.

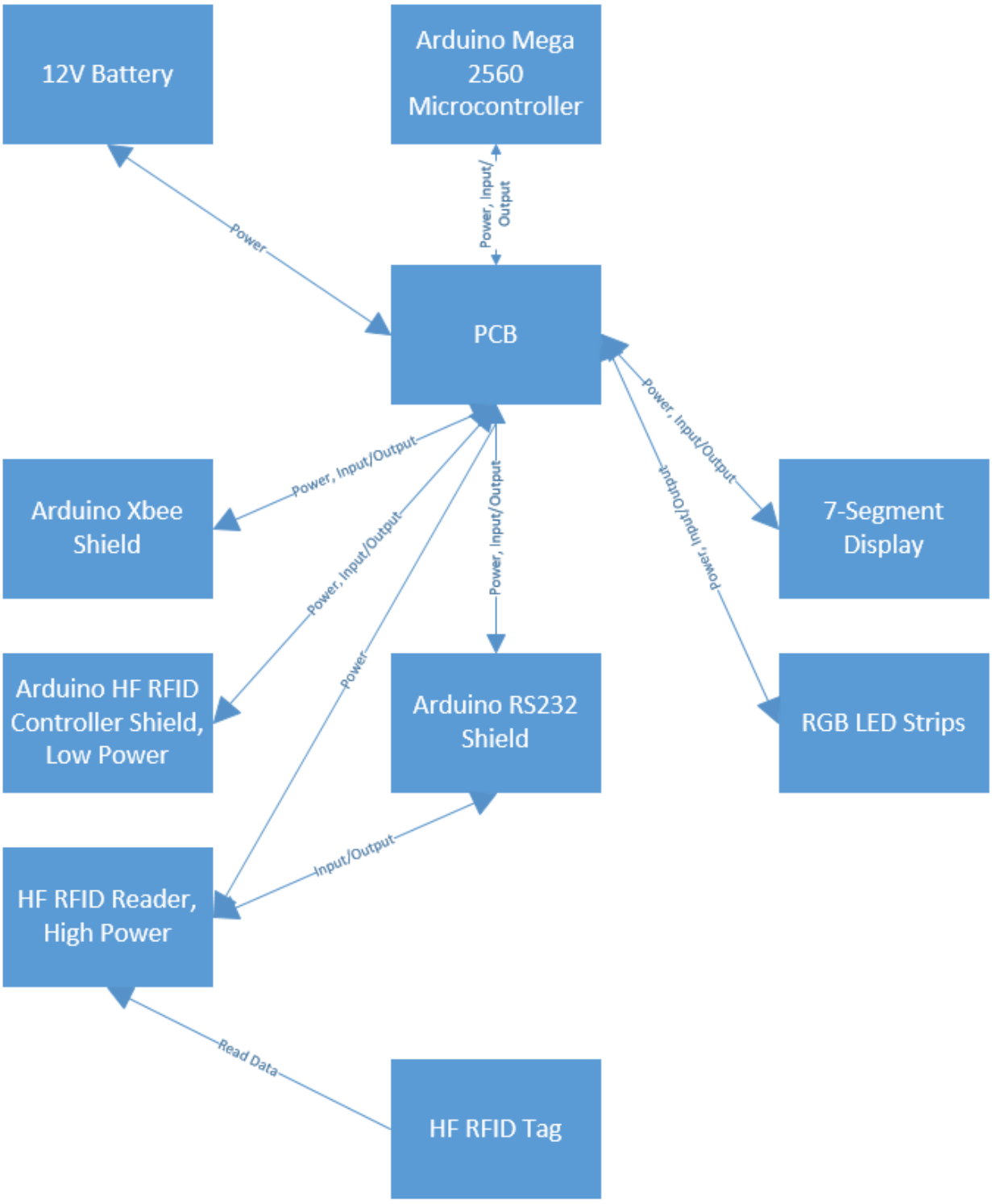
The Engineering-Marketing Tradeoff Matrix

			Engineering Requirements					
			1) Quality	2) Power	3) Weight	4) Dimensions	5) Deadline	6) Cost
			+	+	-	+	+	-
Customer Requirements	1) Portability	+			↑↑	↓		
	2) Official dimensions	+	↑				↓	
	3) Ease of use	+		↓		↑		
	4) Lifetime	+	↑↑	↑				
	5) Cost	-	↑↑	↑				
Targets for Engineering requirements			Up to Standard	TBA	<35 lbs	24 X 48 inches	2 Months	<$1000

Project Schedule

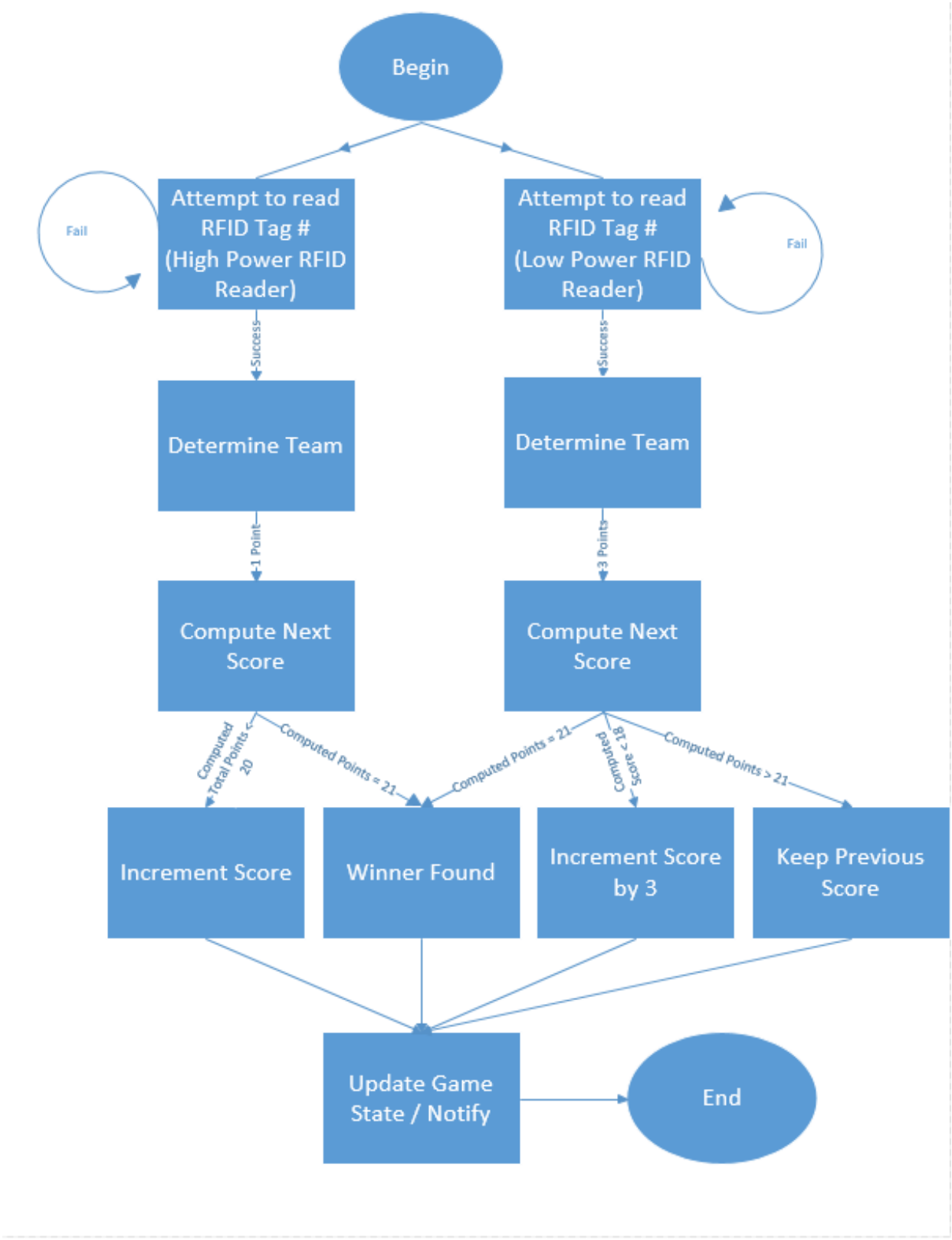
Objective	Dates Start – End		Status
Senior Design I			
Group selection (first meeting)	1/19/17	1/19/17	Completed
Project Ideas	1/19/17	1/26/17	Completed
Idea selection	1/26/17	1/27/17	Completed
Initial Documentation	1/27/16	2/3/17	Completed
Table of contents	2/3/17	3/24/17	In progress
First Draft	2/3/17	3/31/17	In progress
Goal for Documentation: 3 pages/week to meet 30page deadline each			
Final Document	2/3/17	4/27/17	In progress
Research and Design			
Research design implementation	2/2/17	N/A	In Progress
Cost of design	2/2/17	N/A	In Progress
Power supply	2/2/17	N/A	In Progress
PN532 RFID controller shield	2/2/17	N/A	In Progress
High Frequency RFID reader	2/2/17	N/A	In Progress
PCB layout	2/2/17	N/A	In Progress
Senior Design II			
Build Prototype	4/27/17	5/16/17	To be completed
Testing	TBA	TBA	To be completed
Peer Presentation	TBA	TBA	To be completed
Final Report	TBA	TBA	To be completed
Final Presentation	TBA	TBA	To be completed

Hardware Block Diagram



Block Status: All blocks shown above is currently “To be acquired”, with the exception of the PCB block which is currently “Design”.

Software Logic



Budget

Item	Quantity	Cost(Estimated,Each)	Total Cost
Plywood Sheets	3	$10.00	$30.00
Beanbags	8	$1.70	$13.57
Arduino Mega 2560	2	$27.29	$54.58
LCD 7-Segment Display	4	$7.48	$29.90
RGB LED Strips (10 meter rolls)	2	$7.49	$14.98
Wooden Rods	2	$5.00	$10.00
Metal Hinge	2	$2.50	$5.00
Push Button Switch	2	$1.95	$3.90
Toggle Switch	2	$1.50	$3.00
Arduino Xbee Shield	2	$14.95	$29.90
Black&Decker 12v Battery	2	$27.48	$54.96
Black&Decker 12v Battery Charger	1	$17.00	$17.00
HF RFID Reader + Antenna	2	$300.00	$600.00
HF RFID Tags	8	$2.50	$20.00
Arduino RS232 Shield	2	$5.98	$11.95
Foot Pedal Switches	4	$5.95	$23.80
HF RFID Controller Shield	2	$39.95	$79.90
Custom PCB	2	$30.00	$60.00
Wiring and Resistors	Varies	Varies	$20.00
		Grand Total	**$1,082.44**

We will be sourcing most of the materials from online shops such as SparkFun.com. The Plywood sheets are the base material for each game board, this will be purchased locally. The beanbags are necessary to play the game, and can be purchased readily in most department stores. The Arduino Mega 2560 microcontroller is a versatile choice with enough General Purpose Input/output pins to fit our needs. 7-Segment displays are required to display scores. The RGB LED Strips are flexible and will be cut to fit our needs. Wooden rods and metal hinges are for the cup holder mechanism. Toggles switches are needed to reset the game on demand. The Arduino Xbee shield is used to implement a wireless standard called ZigBee which is for short range communication between microcontrollers. The battery we chose, is of modular design and can be charged with a commercially available charger. The High Frequency RFID Reader is the biggest component of our build and operates at 13.56 MHz for medium range detection. The High Frequency RFID tags also operate at 13.56 MHz which is a compatibility match for our reader. The Arduino RS232 shield is used to expand the capabilities of the Arduino to be able to read from a serial connection, which is what the RFID reader requires. Foot pedal switches are used as convenient methods of switching turns between teams. The High Frequency Arduino shield is a lower powered RFID solution for more accurate detection. The custom PCB will be designed

and fabricated by BayAreaCircuits.com which offers a student discount. The wiring and resistors will vary in cost because they are usually offered in bulk.