March 1st, 2016

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440W Design Specification for the SmartPitcher

Dear Dr. Rawicz:

Attached is the post mortem document for the SmartPitcher with details which outline the full design procedure of the SmartPitcher. We are designing and implementing a smart pitching machine that can automatically fire the ball to the athlete's exact location. The project's purpose is to increase the practice output of an athlete and to introduce a reduction of manpower, and to providing more convenient practicing environment to an athlete.

The following document provides all the outcomes related to the SmartPitcher. It provides an overview of costs, features that can be appealing in the market, and challenges that took place until the completion of the SmartPitcher prototype. The technologies described in this document are intended for development of a proof-of-concept prototype. In order to market our product, additional design work will be required to meet the market standards of a competent and cost effective design.

If the reader has any questions or comments, please feel free to contact us via email at youjungk@sfu.ca.

Sincerely,

Youjung Kim

Enclosure: Design Specification for SmartPitcher

SmartPitcher

Post Mortem

Project team: Youjung Kim
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Submitted to: Dr. Andrew Rawicz
Steve Whitmore
School of Engineering Science
Simon Fraser University

Issue Date: April 19th, 2016

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1. Introduction

The idea that initiated this whole project was to innovate a low-cost ball launcher with a unique control system that reflects current trend of technology. Almost all of the existing systems available in the market are very expensive, lack critical functionalities and while they can make a pitcher's life easier, they do not eliminate the need for a human ball pitcher. The systems that tried to introduce more functionality other than just two spinning wheels with a manual ball loader usually have controllers with complicated design where the player himself is not able to control the machine during the training session. We strived for a simpler system that is cost effective and responds to the player. After all, the player is the only one who knows when he is ready and when is the best time for him to hit the ball. We started developing a smart system with the vision to align an athlete's practice experience with available technologies and help them train easier and more efficient. We chose to call our innovation SmartPitcher because it is a smart, automated ball launcher that is very efficient and can successfully replace the old fashioned training methods. The launcher system is integrated with a microcontroller, also known as Arduino. This machine is controlled by the use of Android smart phones to enhance the manageability. A 3D virtual prototype is developed using SolidWorks software before the testing stage. This prototype can detect the player movement and shoot the ball towards the player when he sends the "shoot" signal. The firmly affixed mobile device on a user's armband will interface with Bluetooth transmitter which will release a ball to the accelerated wheel, delivering the ball to where the user is standing. More specifically, the machine consists of a ball loader, which is triggered by a Bluetooth signal, Roborealm that is a software that is used to track motion and color, and wheel speed control, which is controlled by a microcontroller with a motor shield. With adjustable wheels on a rotating platform, the player is able to practice almost all types of strokes while focusing on his best posture and position. We focused on the following engineering criteria to obtain a safe and sustainable design:

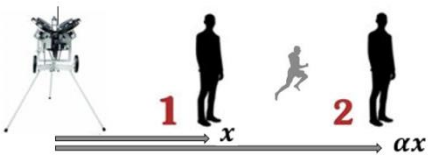
- The ability of the machine to aim the ball over a wide range of angles
- The ability to pitch the ball with the required maximum speed
- Stability of the whole machine specially when it is not mounted to a wall or ground

We first used kinematics to calculate to determine the angles that we wanted and then we determined the torque requirements to launch a ball at the desired speed. Our approach for designing this system is to note the basic requirements, add components one by one, and define every force interaction during our calculations. We performed force analysis to calculate the reaction forces that will happen within the machine and assessed its stability. The machine is tested and analyzed in terms of ball speed, ball shooting coverage, feeding rate and shooting distance. The results showed reliable records to confirm that this system could improve a player's ability to return the ball with proper strokes as well as increase the player's reaction. Furthermore, this system is significantly cheaper for its function compared to the other advertised products.

2. High Level System Overview

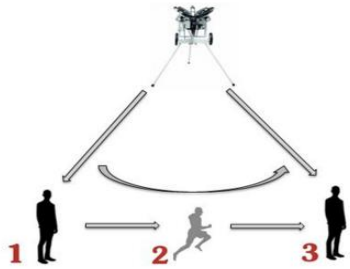
A high level diagram of the components of the SmartPitcher is shown below.

Motor Speed control



Sensors → Microcontroller with motor driver

Motion tracking system



Camera → Motion tracking software with servo motor

Loading mechanism

Bluetooth trigger → Linear gear with servo motor

Figure 1: High-level diagram of the SmartPitcher system

The SmartPitcher is designed to increase athlete's practice output. Figure 1 shows that the system is divided into three main parts which are: motor speed control, motion tracking system, and loading mechanism.

The main function of the motor speed control is to set how fast the wheel should be spinning according to the measurements from the distance sensor. The control uses ultrasonic range finder, Arduino Uno microcontroller, and motor driver. More specifically, the distance between the pitcher and an athlete will be measured by the range finger which will restrict the rotational speed of two wheels to ensure that the ball does not travel too far. The two wheels will be controlled simultaneously using Arduino microcontroller with dual Polulu motor driver.

The automatic motion tracking system consist of three main parts namely the camera capturing movement of an athlete real-time, the motion tracking software called Roborealm, as well as the servo motor with a mount which acts as a rotational platform of the pitcher, interfacing through Arduino to command the horizontal rotation in the range of 0 to 180 degrees. Software development of Roborealm will revolve around camera that captures a specific color which will trigger color code identification feature.

The loading mechanism of the ball requires a user to wirelessly trigger the servo motor through Arduino Bluetooth control which will determine the number of rotations in the linear gear. As a result the rotations in the linear gear will push the ball into the spinning two wheels. More specifically from a software perspective, the number of rotations can be determined by the set of APIs which are already pre-set in the mobile device application called Arduino Controls. In addition, all the important readings from sensors, microcontroller, and software will be displayed in a user-friendly fashion through Arduino LCD.

3. Group Dynamics

Our team consists of two electronic students, two systems students and one computer-engineering student and we all have had previous experience both in circuit design and in software development projects. The first few team meetings were mainly focused on the overall design and the features that we could include in our final prototype considering our time and budget constraints. After initial agreement on the final design of SmartPitcher, we concluded that the system consists three main functional parts:

- Ball loader mechanism to get the signal from the player and automatically load the ball into the launching wheels
- The Roborealm part to continuously monitor the user movement through color identification feature
- Ball launcher system consisting of the Arduino and motor driver to control the speed of the two wheels

We agreed that it is easier to divide our team into 3 sub-groups so each of us could focus on one part of the design. After careful considerations of everyone's interests, we arrived at the final task division table:

Tasks	Youjung	Jeff	Joel	Sana	Sion
1. Automatic loader					
Arduino Coding			**xx**		
Hardware Development				**xx**	
Firmware Development			**xx**	**x**	
2. Motion Tracking System					
Arduino Coding					**xx**
Hardware Development					**xx**
Firmware Integration					**xx**
3. Ball Launcher System					
Arduino Coding	**xx**	**x**			
Hardware Development (including soldering)	**xx**	**xx**			
Firmware Integration	**xx**	**xx**			
4. Documentation	**x**	**xx**	**x**	**xx**	**x**
5. Final Integration + Design	**xx**	**x**	**xx**	**x**	**xx**
6. Team Management	**xx**	**xx**	**xx**	**xx**	**xx**
7. Team Meeting	**xx**	**xx**	**xx**	**xx**	**xx**

Table 1: Group Responsibilities

After dividing the tasks, we knew exactly what we were responsible for and worked on the design specifications and details more precisely. We still had regular team meetings to make sure that our individual tasks are aligned with the overall design of the project, to inform each other of any changes and to discuss how our individual parts would integrate together at the end.

For each of the documents that were submitted around the project including the functional specification, design specification and progress report, every member of the group wrote about the part that they were working on and at the end and Fereshteh and Jeff were responsible for revising the drafts and making sure the document has the right flow.

4. Cost

When we first started the project we had estimated the cost of various components in our design and by the end of the project. The table below shows a summary of our expenditure throughout completing this project. Even though the funding from ESSEF was provided for our group, it was not still sufficient compare to the entire budget which was estimated during the proposal and actually spent for the final development. As mentioned in the

Equipment List	Estimated Cost	Used Components	Expenditure
Microprocessor	$150	OSEPP™ 201 Arduino Basic Starter Kit	$100.00
Motor x2	$160	Arduino UNO R3 MEGA 2560	$15.00
Motion Sensor	$15	USB 2.0 A-B M/M 6 ft cable	$9.86
Touch Switch Sensor	$20	Gear Motor 12V 500 RPM x2	$31.50
Infrared Sensor x2	$30	Alligator Test Leads 30 mm	$7.97
Ranger Sensor	$90	RS-775 Motor 7000rpm 12V 76.13oz-in x2	$39.98
Motion Tracker	$70	Universal Mounting Hub - 5mm Aluminum (M3 screws x 2) + (4-40 screws)	$28.80
Motor Controller x2	$80	Pololu Motor Driver Shield VNH5019	$60.00
Wheel	$10	Battery, Rechargeable SLA, Lead Acid, 12V, 4Ah	$16.95
Others	$100	ATLAS MTD 6" PLASTIC WHEEL (AT-0062) x3	$26.85
		Roborealm Software	$70.54
		Webcam	$20.00
		Digital Servo Motor	$31.00
		Bluetooth Shield v2 (for Arduino)	$42.24
		LEGO Red Housing 2 x 15 x 3m F/gear Rack	$3.02
		LEGO Dark Stone Gray Gear with 24 Teeth	$0.45
		LEGO Dark Stone Gray Rack 14 x 2m with groove	$12.29
		Power Functions XL-Motor	$11.49
		Power Functions Battery Box	$8.49
		DRV8833 Dual Motor Driver Carrier	$26.23
		Platform Developments (including Nuts & Bolts + Wooden Boards + Plastic Boards + Super Glue + Tennis Ball)	$61.96
		Others (products = refunded + shipping cost = not refunded)	$187.22
Total Cost	$725	Total Cost	$811.84 (-$86.84)
		ESSEF Funding	$415.00

Table 2: Comparison of estimated cost and actual expenditure for the SmartPitcher development

As mentioned in the table above, the actual budget utilized for the development exceeded the expected cost by approximately $87.00 dollars. The major reason was due to the online shipping products which were purchased as backup but refunded at the end. The major reason for the high shipping cost was because our group ordered the products with top priority shipping service due to time constraints and unavailable local stores to purchase the certain components. If shipping cost was actually refunded, the actual cost would definitely be less than the estimated cost provided above.

5. Market

Pitching machines can be divided into different categories depending on their functionality, durability, speed and warranty. Our observation indicates that the price tag alters greatly depending on the strength and quality of the motor but not many features are included in the system itself. Many of these machines boil down to some motor spinning two wheels and throwing the ball in the direction that the machine is placed. In our extensive market research we did not find any industrial company that delivers the motion tracking features. The optimized aspect of the current pitching machine provides a pre-set of horizontal orientation, selecting of positions where the player wants the ball to be passed and a delay in between each pass within 180 degree of rotation. SmartPitcher will be a new and strong competitor in the pitching machine market because currently there is no such device that uses sensors to measure athlete's position. SmartPitcher uses advanced technology bringing together features like automatic ball feeder, horizontal platform rotation and motion tracking mechanism in one compact, easy to use system.

Brand	zooka	JUGS	Shoot-A-Way	Heater	Auto Sports
Image					
Cost (US $)	$750	$2200	$6000	$600	$1300
Warranty (Years)	1 yr	5 yrs	5 yrs	1 yrs	TBD
Speed or Distance	10 - 70 MPH	20 - 104 MPH	15 - 35 Feet	15 - 60 MPH	TBD
Curves	✓	✓	✗	✗	✓
Auto-feed	✗	✗	✓	✓	✓
Horizontal Rotation	✗	✗	✓	✗	✓
Motion Tracking	✗	✗	✗	✗	✓

Table 3: Existing solutions compared to Smart Pitcher [1, 2, 3, 4]

6. Challenges

We were facing some challenges during our design process and many of them related to our limited time and budget, some could simply be avoided with more initial research.

One of the challenges was that since we are using a third party software, we were limited to only use functions/interfaces that this app offers. Usage of Android device, in our case, a phone, is a limit. In future, we are hoping to develop our own app with a lot more flexibility to overcome this challenge.

We could have used a Bluetooth button or a smartwatch or health related wrist band such as FitBit but considering our time and budget, it was too complicated to integrate Bluetooth. Bluetooth button seems to be simple, just a touch. It would be easy for even first time users to correctly operate. On the other hand, if we will be able to develop suitable interface within smartwatch or FitBit, it would give way more advanced functionality but it may also be difficult for first time user to operate. Our goal is to find great balance point between features and functionality of the device and the user friendliness.

Another challenges we faced during the development phase of motor control system are choosing a correct DC motor, and stabilizing the wheels when attached to the motors. Firstly, we couldn't choose a suitable motor for our design in the first attempt because of our inexperience in motors. However, as we had more hand-on experiences on multiple motors with variety of specifications, we were eventually able to find a DC motor that delivered enough power and torque to the wheel. Lastly, when we finally attached the wheel to the shaft of the motor, the wheels were not spinning in a perfect circle. In addition, this problem also caused great instability to the whole mounting platform by vibrating the whole piece as one. As a result we stabilized the wheel to the shaft by adding in fillers to the mounting hub which made the wheels to spin in a more circular pattern, and minimized the vibration.

7. Conclusion

As mentioned within the content of this document, there exist three important mechanisms within the SmartPitcher: Motion speed control, motion tracking mechanism, and Bluetooth automated ball loading system. We performed detailed design analysis and various types of testing in each mechanism for the successful development of the SmartPitcher prototype. After software and mechanical testing was completed in each mechanism, we performed and video tape the prototype testing, where we did the last check-up on entire systems including balance/temperature stabilities and batteries.

We all had great experience working on this project and we are determined to continue working on Smart Pitcher and evolve our current design to receive at a final version that is stable enough for final the production. Furthermore, we are carefully examining the market and approaching the potential customers to ask for their input to further enhance the features in our design. Even though we had some limitations while working on this project, we learned and enjoyed in every step of the process and we learned to work as a team to bring the potentials into reality.

8. Reference

[1] Zooka. “ZS740 Pitching Machine with Tall Tripod”, zooka.com. [Online]. Available: http://www.zooka.com/Pitching-Machine-Tall-Tripod-p/10000 2016].

[2] JUGS SPORTS. “Curveball Pitching Machine”, jugssports.com. [Online]. Available: http://jugssports.com/pitching-machines/curveball-pitching 2016].

[3] Shoot-A-Way. “The Gun 8000”, shootaway.com. [Online]. Available: Way. “The Gun 8000”, shootaway.com. [Online]. Available: http://www.shootaway.com/the-gun-basketball-shooting-machine/the machine. [Accessed: Apr. 18, 2016].

[4] HITTING WORLD. “Heater Pro Curve Baseball Pitching Machine w/ Ball Feeder”, hittingworld.com. [Online]. Available: http://www.hittingworld.com/Heater_Pro_Curve_Pitching_Machine_p/tre [Accessed: Apr. 18, 2016].

Appendix A: Personal Reflection

Fereshteh Sana – Chief Communication Officer (CCO)

I was enrolled in ENCC305/440 later than the deadline and I was asked to find a group to join. By the time I was ready to join a team, the project proposal deadline was approaching and there were not many groups left who were still looking to onboard another team member. I had discussions with 4 different groups about their project ideas and when I found out about Auto Sport and the exciting product called “smart pitcher “, I was convinced that it is 100% what I wanted to work on and joined the team. It all began with an extensive research on the overall design. Finding the gap in the market was the easiest part for me because there are no systems available in the market that would offer a tracking system or even come close to the accuracy of our product. Since I had joined the group late, I made sure that I respect other group member’s decisions and be fixable in my task preferences. My bachelor is in Electronics and my Co-op experiences all relate to information security and software development so I had both hardware/circuit and software skills that I could use in this project. The team suggested that it is best if I work on the mechanics of the platform and more specifically the automatic loading mechanism with Joel. That is when I learned about different motors and compared them to each other, I also learned about Arduino microcontroller and Bluetooth and android apps. The project came together with the effort of everyone in the team but my individual gain from this process was having the freedom to think like an engineer. To experience the whole production life cycle from brainstorming and drawing the rough preliminary design on a piece of paper all the way to visualizing the design in Solid Works, ordering parts, building the prototype and testing the final product, was an amazing opportunity that tied together almost everything that I learned in my undergraduate experience.

Joel Kim – Chief Product Officer (CPO)

Throughout 4 months of this project, I had to go through many problems. I had least actual industrial experience. I had no idea how to build something with no topic given. Originally, I was grouped with three other students but another person joined later. We were having difficulty putting down ideas from four of us, then it became five. Through the researching phase, I had to learn about trends, technical features which can actually be released in the market and other hands on experience. This required numerous hours of research. I improved my research skills along with organizing and sorting skills during those valuable times. The capstone experience was valuable for me in terms of what it would be like in actual field to work from research/design to completion of the product that I did not have chance to learn.

The hardware part of this project very straightforward. There was only few hardware requirements in our project, and I was only given few tasks from those. I have never worked with Arduino board before, and it was great learning experience for me. I have worked with Bluetooth Shield along with Arduino boards, wiring and firmware designs, and the process has greatly improved my knowledge in a field which I had no experience in. One of my teammates suggested to use Bluetooth module and android device as our remote control, it opened my eyes in brand new field. It required bit of hardware design which I had to learn from many failures. This is valuable to me, as my knowledge in circuitry and hardware was minimal and my weak spot. Capstone has given me a chance to improve my weakest side.

In the software part, I was exposed to fascinating technology: Arduino and Bluetooth Shield. Programming Arduino board was most exciting experience I have had in 5 at Simon Fraser University. Also, I have learned the application of Bluetooth module along with various devices. This is the most valuable experience to me, as I would like to go into a field related to software and mobile devices. This part was closely related to my most interest, hence, I had pleasure playing with it.

Lastly, I learned the importance of group dynamics. I personally prefer working alone because of my task handling style. It was easy to meet the deadlines, manage time and assure the quality. Even when I had to work with teammates, I would prefer taking a role that follows a leader, and handle given tasks. However, in this capstone project, every one of teammates were required to be leaders in turns. We had to pull out ideas, organize conflicting ideas and also criticize them. It was hard for me to take the pressure of conflicts. However, it had taught

me how to manage those conflicts, overcome and produce the best result. It was really a valuable time for me, as it would be essential for me when I go into an actual field.

Overall, I really enjoyed being a part of AutoSports. It took me to a journey of chaos initially but had a happy ending. Learning about initial research/design process to completion of product was a needed experience in helping me grow myself as becoming professional engineer.

Jeff Yoo – Chief Financial Officer (CFO)

It is true that my experience as Chief Financial Officer (CFO) of the AutoSports over the past four months was full of unexpected challenges. However, working as one of the members at the AutoSports during spring 2016 has been a great opportunity to develop not only my technical abilities, but also professionalism. Ever since I have took part in the first meeting of the AutoSports, the discussions with other four members was full of invaluable and shocking moments.

Even though my occupation within the organization was CFO, I was also responsible for the completion of "Motor Speed Control" system part. The technical skills that I have obtained through development of the SmartPitcher are focused on firmware and documentations. Even though I worked on the software fields in all of my three co-ops, I still had a huge doubt that I will become the burden of the team when it comes to the programming. However, applying my programming codes within Arduino IDE into Arduino Uno provided more confidence, since there exists wide variety of simple references on the web, and the programming codes that is going to be utilized for the final prototype was not too difficult to understand. Since not much time was spent for the revision of the programming codes, I was able to mainly focus on the documentation tasks.

What I felt shocked throughout the four months was the creativity of other team members. While we were selecting the projects which will be doing for four months, the ideas came from other team members were truly remarkable. Rarely, I felt a sense of alienation although they explained their ideas for me with very simple terms. By listening to their ideas and opinions, I was able to apply the phase, "Simple is best" into my writing and handle the documentation tasks efficiently.

Aside from my technical abilities, I learned how to develop my professionalism after working as a CFO during the development of the SmartPitcher. During March, one of the Arduino

Microcontroller was eternally damaged due to my carelessness. After receiving strict advice from one of the team members and repurchasing the microcontroller, I realized that my current position within the AutoSports does not allow any carless mistakes. After learning from this invaluable mistake, I was able to develop an ability to analyze the features of mechanical components carefully and undertake the tasks of purchasing many components required for the prototype development. The capstone project experience provided me an opportunity to grow my professionalism which will be essential element in my future career.

In conclusion, I would like to express my gratitude towards all the other team members who provided a dedicated support to overcome the challenges that I experienced until the completion of the capstone project. Even though I lacked creativity compare to other team member, I was really glad that I was able to find the tasks which could become an assistance to my team members, such as final documentation check-up and the analysis of mechanical components which were utilized for the low level design of the "Motor Speed Control" mechanism.

YouJung Kim – Chief Executive Officer (CEO)

Over the last four months, I have had the pleasure to work with the AutoSports team in researching and developing the SmartPitcher. Even though, we had some problems with group dynamic in the beginning of the developing phase, we were able to solve the issues and work together. Furthermore, I am thankful that the team was very understanding and considerate throughout the duration of the project. The following is a reflection of experience from working on the ENSC 440 Capstone project.

I have had many valuable experiences during the project. However, the most important experiences for me were realizing what it takes to engineer a product, and how complicated the whole engineering process is. Also, ENSC 440 course was very different from most of other Engineering courses. The main difference was that we were able to create our own schedule to develop a working prototype which, involved phases such as: researching, designing, and testing. As the product gradually got more complex throughout the phases, I have learned that active communication and strict project timeline are crucial for success of the team.

Furthermore, I have gained many technical knowledge which range from hands-on experience with sensors, motors, and microcontroller to designing software architecture for the microcontroller. I was forced to work on the software and mechanical aspect of microcontroller because I was one of the members who had somewhat of a stronger background in software.

Although I have had very little hands-on experience, throughout the term I was able to get pretty proficient when handling and implementing many components with a microcontroller. This is because, as we were developing the product, not everything went as we planned, and we also encountered many unforeseen problems and requirements.

Fortunately as the new problems emerged during development, Jeff helped me in getting the required parts and testing the software. In addition, during the exam season I was really busy with studying but Jeff gladly took over my part and worked on it to meet our project timeline. I am extremely thankful that Jeff supported me throughout the whole term.

Overall, my experience in working with Auto Sports team member for Capstone project has been greatly beneficial to my development as an engineer. I have learned many important traits and requirements for maintaining a positive group dynamics. Lastly I would like to thank my team and professors for the opportunity and invaluable experience.

Sion Park – Chief Technology Officier (CTO)

Throughout the invaluable experience of Capstone, I had an unforgettable opportunity to work with team and most importantly, working on a project where I wanted to experiment on. The idea of SmartPitcher came from a conversation with group of my friend who inspired me to continue to work on through Capstone. Overall, I would like to appreciate to SFU, providing me a wonderful opportunity to expand my imaginary and creativity, which I can implement my thoughts to SmartPitcher. I loved the fact that the software and hardware skills that I have developed throughout the university life can collaborate into one masterpiece. Lastly, I would like to appreciate to my team members for their hard work although we experienced conflicts during discussion. However, because of those conflicts and consideration brought us to this point where we are proud to introduce our SmartPitcher to the world.

I have gained many hardware designing skills and knowledge which contain critical thinking and deep brainstorming. The main issue that we have encountered was hardware design, assembling the three main features of SmartPitcher: Motor speed control, Automatic ball load, and Motion tracking system. I had to spend several days and hours to finalize the exterior design of the product to reduce the vibration from the DC motors and minimize the total weight of platform in order for servo to rotate without any hindrance. Since I mostly took in charge of the motion tracking system, I got to learn Arduino Software IDE to code based on our desired features.

Furthermore, I have gained knowledge on the third party software application and technical components including sensors, motors and motor shield, integrating with Arduino interface to

have required characteristics of our design. The knowledge that I have learned can be implemented not just in Capstone but in any further project in the future where I want to build an automated video filming by using RoboRealm, the vision application, to have motion following system as well.

Other than hardware skills, I have learned how the company starts and how to manage our plans with financial situation according to our design. I did not know a company can start like what we did. However, now I noticed that every masterpiece starts by digging into unopened ideas. The main difference between studying for a course and Capstone is time management, creating our own timeline schedule to follow along our phases such as: Researching, Designing, Integrating, Developing, and Testing. Time management was critical to our schedule, using time wisely and effectively where I have learned to perform professionally on time.

Overall, my experience in Auto Sports is unforgettably valuable for me to become who I am as a professional engineer today with diligent working habit. I earned my colleagues' trust by demonstrating my professional mindset during Capstone projects, researching into problems thoroughly, and bringing impressive results in my designated takes before deadlines.

Appendix B: Meeting Agenda

1. **January 13th - 8:00 to 9:30 pm**
   The main purpose of this meeting was brainstorming about the various project ideas that each of the group members had.

2. **January 15th - 7:00 to 9:00 pm**
   Analyzing the cost and the components which will be utilized for the SmartPitcher in order to apply for the ESSEF funding

3. **January 17th - 7:00 to 10:00 pm (Skype Meeting)**
   Completion of ESSEF funding application form

4. **January 19th - 8:20 to 9:00 pm**
   ESSEF Presentation at 10:20 pm (Gathering for the practice of upcoming funding presentation)

5. **January 22nd - 4:40 - 5:20 pm**
   Proposal Outlines (who is going to be responsible for which part)
   - Sana was mainly in charge of entire revision.
   - Introduction + Reference (IEEE) = Jeff
   - Transmittal Letter + Executive Summary + Cost Consideration = Youjung
   - Project Overview = Joel
   - Market/Competition + Project Planning + Conclusion + Final Formatting = Sion
   - Company Profile (CEO, CFO, CTO, CPO, CCO) = Completed by everyone

6. **January 27th - 6:00 - 7:00 pm**
   Final checkup of Proposals before the submissions
   (Like January 22nd, Sana revised the document).

7. **January 29th - 4:00 - 4:30 pm**
   Project Design Discussion
   (ex: should we designed our own PCB since our group is utilizing wide variety of sensors like ultrasonic & Bluetooth transceiver)

8. **February 9th - 11:45 am to 4:45 pm (includes the time spent due to the public transportation)**
   Actual Component purchase
   - Purchased Arduino Starter Kit (including ultrasonic range finder and stepper motor), Pololu VNH5019 Motor Shield, Digital Servo Motor.
   - Moreover, we had asked the opinions of experts (employees from Lees and RP electronics) for making our final prototype product in efficient ways.

9. **February 11th - 6:00 PM to 7:00 PM**
   Functional Specification Outline Discussion
   - Transmittal Letter + Executive Summary + Introduction = Youjung
   - System Overview = Sion
   - System/Software/Hardware Requirements = Completed by everyone
   - System Test Plans + Conclusion + Reference + Final Formatting = Jeff
   - Safety and Sustainability Analysis + Revision = Sana

10. **February 15th - 6:30 pm to 7:30 pm**
    - Functional Specification Final Checkup before the submission (Sana in charge of revision)
    - Discussed about the standards which will be utilized for the design for 15-20 minutes.

11. **February 25th - 6:20 to 7:00 pm**
    - Brief outline discussion of Design Specification
    - Discussions of upcoming design review presentation. For instance, which component in exact we are going to utilize for the final prototype of the SmartPitcher.

12. **March 4th - 1:00 to 2:00 pm**

    Practice of upcoming design review presentation (at 2:30 pm)

    - Introduction + System Overview = Youjung

    - 3 Mechanisms of the SmartPitcher

    a) Jeff + Youjung = Motor Speed Control

    b) Motion Tracking System = Sion

    c) Loading Mechanism = Joel and Sana

    d) Timelines & Budget = Sana

    e) Questions = Answered individually

13. **March 7th - 7:00 to 9:40 pm**

    - Bluetooth + Stepper Motor integration part is complete (waiting for gear to be shipped) - by Joel

    - Design Specification Workload discussion

    a) Transmittal Letter + Executive Summary + Introducation = Youjung

    b) System Specification + Test Plan + Conclusion + Reference + Final Formatting = Jeff

    c) Hardware/Firmware Design = Completed Individually

    d) Software Design = Sion

    e) Revisions = Youjung + Jeff + Sana

14. **March 10th - 5:00 to 6:00 pm**

    - Final Check-up of Design Specification Submission.

15. **March 27th - 4:00 to 4:30 pm**

    - Successful completion of Joel/Sana & Sion's part

    - Progress Report Workload discussion

    a) Introduction = Youjung

    b) Schedule = Joel

    c) Financial = Jeff

    d) Progress (based on Hardware + 3 Significant Mechanisms + Software) + Remediation = Sion

    e) Conclusion = Jeff + Sion

16. **March 28th - 5:00 to 9:30 pm**
    - Final Check-up of Progress Report
    - Outline + Final Check-up of Test Plan
    a) Testing Overview = Sion
    b) Basic Integration Testing + Functional Testing + Failure Testing = Jeff + Sion + Joel

17. **April 4th - 4:00 to 7:00 pm**
    - Beginning of Integration phase: Tested the integration between Motor Speed Control + Ball loading mechanism part just using Hardware Components and Arduino Code (Platform is not designed yet)
    - Successful Bluetooth connection (Phone scanning Bluetooth device)
    - Changes within Arudino Code necessary to repair minor delays (to do list until the next meeting) -> Revised code sent on April 6th.

18. **April 8th - 3:30 pm to 6:00 pm**
    - Discussed about the entire platform for the SmartPitcher
    - Platform (for servo motor) to perform stable motion tracking is completed by Sion.
    - Current Problems: Unstable wheels + Unsure whether servo motor can handle the mass of the entire platform
    - Solutions = Making the wheels as soon as possible and see whether the wheel is rotating smoothly or oscillating like sine/cosine wave

19. **April 14th - 4:00 pm to 11:00 pm**
    - Entire Platform Design
    - Used Laser Cutter and Solidworks to make the holes for motors within thin plastic
    - Used Drills to make the holes for motors in wood scrap platform

20. **April 16th - 6:30 pm to 2:30 am**
    - Made Wheels stable
    - Successful integration between Motor Speed Control + Ball Loading Mechanism Part